PROCEEDINGS AND PAPERS

OF THE

TWENTY-SECOND ANNUAL CONFERENCE

OF THE

California Mosquito Control Association

AT

UNIVERSITY OF CALIFORNIA, BERKELEY

AND HOTEL CLAREMONT, OAKLAND

DECEMBER 2, 3, AND 4, 1953

Edited by

HAROLD FARNSWORTH GRAY

PUBLICATIONS COMMITTEE

HAROLD F. GRAY JOHN R. WALKER G. EDWIN WASHBURN

CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC.

P. O. BOX 629

TURLOCK, CALIFORNIA

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PROCEEDINGS AND PAPERS OF THE TWENTY SECOND ANNUAL CONFERENCE

OF THE

California Mosquito Control Association

FIRST SESSION, WEDNESDAY, DECEMBER 2, 1953, 9:00 A. M.

AGRICULTURE HALL, UNIVERSITY OF CALIFORNIA, BERKELEY

The meeting was called to order at 9:00 a. m., by President Robert H. Peters, Manager of the Northern San Joaquin Mosquito Abatement District.

President Peters: I hereby call the 22nd Annual Conference of the California Mosquito Control Association to order. Before we proceed with our program this morning I would like to make one announcement. We are going to ask each and every one of you to perform a very valuable service by participating in a special activity which is found in the room just adjoining here. A test to determine the relative presence or absence of encephalitis is being given to all who are willing to participate. This is a wonderful opportunity for us to lend ourselves to science without any adverse affects. It is a simple matter of giving a few ounces of blood and having a test injected into the skin. I don't know if it is enjoyable, but I haven't heard any screams come out of that particular room. Are there any other announcements before we begin with the program?

One announcement that our Secretary very definitely wants made is that all those who have not done so will please turn in their papers today at the time their talk begins.

This morning, to start our program, we have a welcoming address by Dr. Gorton Linsley, Chairman of the Department of Entomology and Parasitology of the University of California at Berkeley.

Dr. Linsley: Mr. Chairman, and members of the California Mosquito Control Association, it gives me a great deal of pleasure on behalf of the University of California, and more specifically the Department of Entomology and Parasitology, to welcome you to the campus for the meeting today. For many of you this means coming home, for others of you it means a return to a congenial environment, perhaps for a few it may be your first visit. Whatever the case, we hope that you will enjoy your stay here and that you will have a most refreshful time at this conference. The facilities of the Department of Entomology and Parasitology are at your disposal, and perhaps during some of the breaks in your program you may care to visit our insect collections just across the way. For the benefit of those who may not be familiar with this particular activity, about five years ago the department decided to depart from a policy of maintaining a limited teaching collection, and to embark on an intensive survey of the insect fauna of California. This means that the collections which we are now assembling are designed to include a long series of specimens of each species, with the hope of getting a definite ascertainment of the geographical distribution of insects, and among other things ecological information in connection with the specimens that we need to be concerned with. As far as our mosquito collection is concerned, it has a somewhat longer history, as many of you know. We can go back to the early days of Freeborn's collection, and the intensive work that was done here by Dr. Reeves, Dr. Brookman, Dr. Baker, and others. Five years ago when we changed our policy we formalized this activity under the title of the California Insect Survey, and in 1951 we expanded further by initiating a publication which we call the Bulletin of the California Insect Survey. Most of you are familiar with this because the second number of this series, published in 1951, was "The Mosquitoes of California" by Freeborn and Bohart. If there are any members of the group here that do not have a copy of this publication, who would like it, it can be obtained at the Departmental Office in Room 112, right next door to this meeting room. The objectives of this bulletin are to put on record the details of the mosquito species within the State, insofar as they are known, to summarize the critical ecological and biological information about these species, and to provide rapid means of identification. We have published six or eight of these bulletins already, and we have another twenty-five or thirty in various stages of production at the present time. The bulletin is printed by offset, which means that we have an inexpensive process where it actually costs us less to produce illustrations than text, so that there is no limit to illustrations. By printing limited editions of some 3,000 or 2,500 copies, we can then reprint as necessary or revise, so that there is a good deal of flexibility within the program. We hope that it will eventually be of considerable value. I will call attention to the fact the department of parasitology is on the third floor. Perhaps you would have a few moments that you would care to visit those laboratories and activities.

If you have time to spare at noon-time or some time this afternoon you might care to visit our new insectary, which is at the southwest corner of the Oxford Tract. This will provide the Department for the first time with facilities for large scale rearing of insects and large scale work under controlled and far more satisfactory conditions than in the past. I am sure many of you who have visited our laboratories have seen rather large cages where temperature and humidity have not been controlled. In the new location we have seven laboratories with clean-out facilities, and we expect to have another ten laboratories down there in the near future. These added facilities will assist our work very greatly. Most of the activities are planned immediately for the moving in of insects, but we

expect to have complete facilities for parasitology before long.

For those of you who have not been on the campus for some time, I might point out that the new building that is just inside Sather Gate, on the opposite side of the Campus, is Dwinelle Hall. That is the second largest building on the campus now. It is second only to the Life-Sciences building just across the way from this building. As soon as it was erected it was immediately occupied and is already bulging at the seams. We find it very difficult to keep up with our space needs on the campus. To the west of us between Hilgard Hall and the Forestry Building is the new Home Economics building, the most recent addition to our Agriculture group. On top of this building is a pent-house bungalow, in which some six or eight girls will be living all the time. Although this building is not completed at the present time, you may wish to wander through it and look at the modern equipment and facilities available. Generally you are welcome to go where you wish, see what you wish, and do what you wish in any spare time that you may have, with the added proviso that this includes everything except the keys to the pent-house on top of the Home Economics building.

We are very pleased to have you hold your meetings on the campus here because we are very much interested in what you are doing. Your program today looks very interesting and I am looking forward to it. While I am on the floor I would like to invite all of you to attend the national meeting of the Entomological Society of America, which will be held at the Biltmore Hotel in Los Angeles next Monday to Thursday. This is the first time that the Society has met in California or on the Pacific Coast since just after Pearl Harbor in 1941. If any of you are interested in seeing a program, if you are not a member and have not received one, we will place one in the office in room 112 and you may look it over. There are a number of features on the program which would be of particular interest to this group. In addition to the formal program there are a number of social activities, including a banquet and dancing in the Biltmore Bowl, which is being taken over by the Society on Tuesday evening with all of the entertainment. A fine program has been planned for the ladies also. This is, I believe, an unusual opportunity to meet with the Society in our own backyard, and I hope that you will be on hand. I want to express again my pleasure in having you with us and wish you the best in your meetings.

President Peters: Thank you, Dr. Linsley. An unexpected pleasure today is the unusual number of out of state guests, and although all of them are not known to me I am going to introduce at least some of them and ask them to say a few words. Undoubtedly the first one that we should call upon is the President of the American Mosquito Control Association, Dr. Fred C. Bishopp.

Dr. Bishopp: President Peters, members of the Association, and friends. I assure you it is a great pleasure for me to be here personally and to extend the greetings of the American Association to you people who have for so long served more or less as the backbone of the parent association. I always enjoy coming together with the folks out here because of their enthusiasm, their active interest in all phases of mosquito control, from research down to the actual handling of the equipment in the field, and it is a great pleasure to participate, as a listener, in your program. I will not take time to discuss the work of the American Association, because I think most of you are familiar with what is going on, but I do want to say that the Association is in the best position both from the standpoint of finances and membership and activities that it has ever been in. We now have about a thousand members scattered over the whole world and a tremendous interest centering upon the broad objectives of the Association. You people here, of course, are participating in it in a vigorous way through your secretary of the Association. Ted Raley has been, I think, our outstanding officer, and is doing wonderful work for the Association.

I think you may be interested in recent changes in the Bureau of Entomology and Plant Quarantine. Probably a good many of you have heard that I retired at the end of the last fiscal year, to accept the position as Coordinator of Pink Boll Worm research for the Oscar Johnson Cotton Foundation at Brownsville, Texas. Some have felt that might mean I have become completely dissociated from the field of medical entomology, and that I might lose my interest in the mosquito and its control. I want to assure you that that is not the case. After a man has worked in the field for as many years as I have, with medical entomology being the dominant interest, it isn't easy to drop out and quit the job. I hope in my new position with its headquarters at Brownsville, Texas, down in the extreme end of the state, not only to continue my interest in mosquito work, but to do a little more active work on my old hobby, the ticks. If any of you people who are out in the field doing mosquito work run into ticks, I would be delighted to receive specimens, both from the standpoint of records of hosts, and for geographical distribution, and perhaps there might even turn up some undescribed species. I feel certain there are a few, even in this country. I didn't plan to make any talk at all this morning but I assure you that I am mighty pleased to be with you and I shall enjoy immensely listening to this fine program your committee has laid out.

President Peters: Thank you, Dr. Bishopp. I am going to introduce a second out-of-state guest today, Dr. Don Rees, who is past president of the American Mosquito Control Association, and also is from the great state of Utah. Don, would you be so kind as to step up and say a few but not too few, words?

THE UTAH MOSQUITO ABATEMENT ASSOCIATION 1953

By Don M. Rees, PhD.
University of Utah

It is a real pleasure for me to be able to attend the 22nd annual conference of the California Mosquito Control Association. I have been attending these meetings since almost the beginning of this Association and although I am not a native son I have been admitted as a member of your association and have actually paid membership dues when I have been unable to avoid it.

The members and friends of the Utah Mosquito Abatement Association have asked me to express their best wishes to all mosquito control workers here assembled and the regrets of those who are unable to attend the meetings this year.

The Utah Association was organized in 1948 and has been holding annual meetings each year since its organization. These meetings are patterned after those held by the California Association but of necessity on a smaller scale.

There are now six organized mosquito abatement districts in Utah. Three of them are in Salt Lake County and the other three on a county-wide basis are in Box Elder, Weber and Davis Counties. An attempt is now being made to consolidate the three districts in Salt Lake County or reorganize the three into a single district.

Organized mosquito abatement districts now provide this service for 60% of the people living in the state. In addition there are a number of small communities in different parts of the state that conduct some mosquito abatement work as a community project. There are two other counties at present considering the feasibility of organizing districts.

The Salt Lake Mosquito Abatement District was organized in 1924 and has successfully operated every year since its organization. The second district was not organized until 1945, 21 years after the first. The other four districts were organized one each in 1946, 1947, 1951 and 1953.

The Utah Mosquito Abatement Association has made it a policy to hold its annual meetings in rotation at the headquarters of the various districts comprising the Association. The last meeting was held at Brigham City in the Box Elder County District. The next meeting will be held at Magna, about twenty miles west of Salt Lake City on March 19th and 20th, 1954. We extend to all of you an invitation to attend these meetings and participate in the program and in so doing assist us in solving our mosquito abatement problems.

President Peters: I am not altogether certain as to who may be in the audience, that we might hear at this time, so I am going to initiate a new procedure. I call on Tommy Mulhern, who I am sure will introduce one guest, and perhaps the rest of you can take the cue on that.

Mr. Mulhern: Thirty-three years ago, a young man fresh out of school accepted the responsibility, not as a manager of a mosquito *abatement* district, but he went the whole way and became manager of a mosquito *extermination commission*. That man has seen the tides and fortunes of mosquito abatement rise and fall and then rise again. He has seen what happens to mosquito abatement work, through great economic depressions, through wars, and through prosperous times. He has seen the techniques of mosquito control go from very crude equipment and very crude methods to the high degree of perfection that has been arrived at today. He has come clear across the country to attend our conference. Gentlemen, I present Lester Smith, Superintendent of the Middlesex County, New Jersey, Mosquito Extermination Commission, and past President of the American Mosquito Control Association.

Mr. Smith: Mr. President, members of the Association, it is a pleasure that I have been able to attend this meeting and some of your meetings in previous years. I extend to you the greetings of the New Jersey Association and also extend to you an invitation to attend the joint meeting of the American Mosquito Control Association and the New Jersey Association at the playground of the world. That's Atlantic City. I am sure that Dorer, who is assisting Dr. Bishopp in arranging the program along with Dr. Pepper, will have a very fine program, and arrangements have been made to entertain the ladies. We hope that some of you will be able to attend. We are planning to attend your meeting next year, if it is a joint meeting. We plan to come out in a caravan. As far as this thirty-three years is concerned, that makes an old man out of me, but I can remember when Tommy first came in as an inspector, and then went to the Experiment Station and worked on what we call "the White Elephant." The machine weighed twenty or twenty-two tons, and I can remember having that thing down almost out of sight on the salt marsh. We had to go and get a big derrick from Atlantic City to help Tommy out. However, it has been a pleasure to be in the work so long. I have been pretty much over the country, and out of the country a little bit, and I enjoyed every year of it and it won't be too long—as soon as my last child is out of college—that I may move to California or Florida, I don't know which.

President Peters: Thank you very much. I had felt that we should have a representative from the Chamber of Commerce on our program, but Les Smith has beat us to it. Are there any other introductions?

Dr. Bishopp: Mr. Chairman, I think it might be appropriate to add a further word to what Lester Smith has just said about the American Association and the New Jersey Association meeting jointly in Atlantic City. We want not only a few of you, but we want you to come in numbers. I think we will have an interesting program and it does not seem right not to have a good number from your Association present at that meeting. The facilities are going to be excellent for the meeting, and as usual there is the hand of welcome extended, not only by the people of New Jersey, but by the adjacent states where much work on mosquitoes is going forward.

President Peters: Thank you, Dr. Bishopp. Are there any other introductions at this time? If not, I would like to make an announcement to those who did not hear me originally. We are carrying on a very important activity in the adjoining room, and I believe that some of the people who are coming in now are perfect examples that nothing adverse can happen to you. I urge everyone to participate in this scientific endeavor through which we hope to be able to determine the presence or absence of encephalitis within us. It certainly offers us a cross-sectional opportunity that could seldom be reached under any other set of conditions. We will now recess until exactly ten thirty.

RECESS

President Peters: Those of you who have had the opportunity to note that, Chamber of Commerce or no Chamber of Commerce, we have opened this meeting in one of the best days that the town of Berkeley has had all year. The weather is perfect.

We have one other introduction of a guest, and I would like to call on Dick Peters to introduce him.

Richard F. Peters: We have a distinguished guest of this state at the present time, who is spending a great deal of time with the Department of Public Health and is going to the entomological meetings in Los Angeles next week as well. I present Dr. Antonio Ejercito, who is Chief Malariologist of the Philippine Islands. Dr. Ejercito, would you like to stand and make yourself known to the group from California? I have found Dr. Ejercito, who is a medical doctor, to be a profound scholar of engineering and entomology. In the Philippine Islands one does not lead a simple existence as a medical man, but he must be a complete individual in the field of malariology.

Dr. Ejercito: Mr. President, members of the Association, and guests, I received the kind invitation to attend just this morning, and I wasn't expecting to be called. I wanted to attend this meeting incognito. First of all I extend to you the greetings of my people, our people in the Philippines. On several occasions when I have been asked to speak I do not forget to express the cordial relationships between the Philippine people and the American

people. My work is malariology, and in the fields of engineering, entomology, epidemiology, tropical medicine, and other matters. In this tour of observation studies I am doing in the states, I have covered big areas already, but I am very happy to be in California and attending your meeting, and I am very hopeful that I will pick up many things that I can carry back with me to the Philippines and introduce into our country.

President Peters: It is with extreme pleasure that we call on Dr. Lindquist, who is known to most of you for his work in the past. His title will be "Biological Research on Mosquitoes As a Basis for Their Control."

Dr. Lindquist: Mr. Chairman, members, and friends of the CMCA. I think it is needless for me to say that I'm very happy to be here today; it is something like coming back home. I lived in California for four years, and lived on the Pacific Coast for about 12 or 13 years. The weather man certainly pulled the right lever today. This is the way I remember California. I have very many happy memories of working cooperatively with many of you. Several of our staff members of the Bureau of Entomology and Quarantine are actively working with you during the summertime on mosquito control. As you know, I have a new job in Washington and it is entirely different from what I have been doing. It's kind of tough, but I think we can make some progress.

BIOLOGICAL RESEARCH ON MOSQUITOES AS A BASIS FOR THEIR CONTROL

By Arthur W. Lindquist
In Charge,
Division of Insects Affecting Man and Animals
Bureau of Entomology and Plant Quarantine
Agricultural Research Service
U.S. Department of Agriculture
Washington 25, D.C.

Those of us engaged in mosquito control are up against a barrier in our efforts to progress steadily. It is time we stopped to take a good look at what we are doing and how to break through. For the last 10 years we have been so busy developing and evaluating new insecticides that some of us have forgotten fundamentals.

Before DDT came into the picture in 1942, we had a very few chemicals that would control mosquitoes well. I can count them on the fingers of one hand. Since that time we have had dozens of new mosquito killers. Large groups of scientists have been evaluating potential insecticides by the thousands. So much effort has been poured into insecticide evaluation that there has been little time or manpower available during recent years for studying the mosquitoes themselves. We have been forced into a pattern of research—a pattern in which the mosquitoes themselves have been forgotten.

Mosquito control with chemicals today would be far less successful if we did not have considerable biological knowledge of the pests. It took us 60 years to accumulate that knowledge, but we still do not know enough to solve the problems of unexpected developments such as have been brought about by resistance and toxicology.

Now it is understandable how we got involved in this insecticide predicament. During the last war we in the Bureau were asked for a more effective mosquito-control program, and we were asked to produce it immediately. I ask you, how could we meet this demand except with insecticides? Insecticides were without question the best answer to mosquito-control problems under conditions of war, when troops and civilians were shifting into new and sometimes remote areas. Insecticides were developed which appeared to be the answers—chemicals that promised far more than we had hoped.

Where do we stand today? Several species of mosquitoes already have developed a marked resistance to DDT and other insecticides. There is little reason to believe that the resistance problem will become less. Rather, it will plague us for a long time. Although substitute chemicals will be developed, one naturally inquires how long it will be before the insect develops a tolerance to them.

I am strongly in favor of continuing research designed to develop new, better, and safer insecticides, but we must awaken to the urgent need of learning more about the biology of mosquitoes. I am using the word "biology" in its broad sense to include behavior, habits and physiology. The objective of this biological research is to make chemical and other types of control more effective and less costly. A full knowledge of the habits of the pests may show weak links that can be taken advantage of.

This sounds like a reasonable and practical proposition. Why, then, is it difficult for the layman and persons engaged in mosquito control to appreciate biology? Why do they not demand more biological research? The foremost reason, I believe, is that sound biological research is difficult and is slow. Significant developments usually do not come overnight, but only after years of intensive study under changing climates and environments. The laymen and even some directors of research become impatient with the slow accumulation of results.

I think we should look on biological work as part of a construction job. Each piece of good research serves as a foundation upon which others build. Results that will be usable in mosquito control may not be forthcoming for several years, or even in our lifetime, but we will be bequeathing something worthwhile for posterity. Future generations are entitled to inherit basic contributions. We as scientists or laymen have an obligation to look forward 25, 50, or 100 years and consider leaving a record of such research.

What are some of the problems on which research should be conducted? I will point out only a few.

The need for a simple, rapid means of sampling adult mosquito populations has been recognized by many entomologists. A screen device baited with a substance attractive to mosquitoes would be a great aid in various types of studies. The problem is to find and develop such an attractant. One would expect some of the tens of thousands of organic compounds available to be attractive to mosquitoes. A fine example of chemical attractants for insects is methyl eugenol, which is a powerful lure for males of the oriental fruit moth. For some species a chemical lure may not be necessary but rather an attractive artificial resting place. There is the further possibility that economical control could be achieved under some conditions by destroying the mosquitoes brought to the attractive substance or equipment.

Although information on the overwintering of adults is available on some species, a great deal more is needed by control workers. Probably *Culex tarsalis* overwinters only in the adult stage, but can we be sure that eggs do not overwinter under some conditions? Let us assume that the adults overwinter. Are all types of hiding places known, and can estimates be made of the number of

mosquitoes per acre or square mile? Perhaps the best time to fight this species is during the winter.

We should know more about the resting habits of adults of various species. This information is exceedingly difficult to obtain when mosquitoes are physiologically ready for a blood meal, because the moment an observer comes near the insect it is ready to bite. Before these studies can be made, it will be necessary to eliminate man odors or movements.

Studies on swarming, flight habits, oviposition, hatching, and food requirements of both larvae and adults all need careful attention. What are the habits of different species before they are ready to bite? What foods do males and females seek after emergence? We can ask dozens of questions on the behavior of mosquitoes under different ecological situations.

Insect physiologists have not used mosquitoes a great deal in their studies on general physiology. They have worked more on larger insects and perhaps those more easily reared. We should encourage physiological research on mosquitoes.

How do the various insecticides kill mosquito larvae and adults, and why is it more difficult to kill pupae than larvae with DDT and related insecticides? How are resistant mosquitoes able to tolerate large dosages of DDT? Are the breakdown products of absorbed DDT the same as in other resistant insects, such as the house fly?

Attention should be given to the relation of the different species of mosquitoes to their environment. In natural mosquito-breeding areas, such as marshes, minor changes in environment could possibly reduce mosquito numbers, if we knew more about the habits of the pests and their relation to the environment.

Our information on insect pathogens is far from complete. Diseases of mosquitoes and the possibility of using them in control should be investigated.

What is the most effective way of conducting such research? A group of competent entomologists and others working together in one place under an able and imaginative leader could go far in solving these problems. I should like to emphasize teamwork in a group like this. Teamwork in any group is a tremendously valuable asset in getting things done. There must also be a good degree of permanence in the setup, and programs should be projected for 3 to 5 years. The research unit should keep a balance between the two types of biological research—that is, the collection of information that may be of immediate use in mosquito control and the collection of information for its own sake, or the so-called basic work. The latter, academic approach should not be discouraged, but directed into channels where it will bring fruitful results.

Who is to pay for this type of research? In my opinion it is the responsibility of States or the Federal Government. Seldom have smaller units of government taken upon themselves the direct support of this type of research. This is because most of these problems are not limited to cities or counties. The pests concerned are regional or nationwide in distribution. States and the Federal Government also have the background of organization and experience for this type of research.

Many of us are concerned that States and the Federal Government have given so little attention to research on mosquito biology and control. Mosquitoes affect millions of our people. They bite domestic animals as well as man. The farmer has a special interest because mosquitoes affect his livestock with a consequent reduction in weight as well as in milk production. The monetary loss has not been measured, but must reach high figures. Furthermore, much of the trouble originates on the farmers' land where mosquitoes breed in his irrigated pastures. It is difficult to measure the injury to man himself, but the irritation and consequent loss of his efficiency must be considerable. It seems we have justification for more support, and we should keep legislative bodies informed of these problems.

All the funds provided by the Department of Agriculture for mosquito research are used at the Corvallis, Oregon, laboratory. Only a small amount is available for this purpose. This small unit has produced some worthwhile results. Of necessity, the efforts have been directed towards the use of insecticides during the past 6 or 7 years. The Department of Defense allocates a considerable amount of money to our Orlando, Florida, laboratory for research on insects of medical importance, particularly to the Armed Services, but most of the results obtained are not readily applicable to civilian needs. Here again all efforts are along insecticidal lines.

In closing I should like to emphasize that all lines of research on mosquitoes are important. I have not mentioned water management and source reduction, but we all know how important they are. The research on development of insecticides is of great value, and their use in a practical way rests firmly on our present knowledge of mosquito habits. We have used all the biological information available. Urgently needed is new information on the habits, behavior, and physiology of mosquitoes. It behooves us to encourage new and greater efforts along these lines.

President Peters: A number of us have had occasion during the past year to appear before legislative committees in relation to encephalitis, and met a man who is much interested in this problem. We may have the occasion to become more familiar with him in the future. I introduce Assemblyman Ernest Geddes, who is a member of the Assembly Public Health Committee, and who was Chairman of the sub-committee on Encephalitis during the 1953 session of the legislature.

THE LEGISLATURE AND MOSQUITO CONTROL

HON. ERNEST R. GEDDES
Assemblyman, 49th District

Mr. President, distinguished guests, and members of the Association: Many of you I see again after having had you before the Committee on Public Health, listened to you there and talked personally with you in the hall after the formal meetings were over, and had you explain some particular problem and some particular point that the Committee may have missed. I have chosen for my topic today "The Legislature and Mosquito Control." I want to speak to you today, not as this particular Legislator, but as a representative of the Legislature having, I believe, a pretty working knowledge of thought processes, if any, of the "genus legislatorum."

I know that we are faced with a continuing problem and so I can hardly justify my time or yours, and the long journey here, to speak to you unless we got down to facts and fundamentals. A person can't get very deep into subjects such as we are interested in without some of it rubbing off onto him. I think one of the things that rubbed

off on me was that I was terribly, terribly afraid of mosquitoes for some reason or other. About ten days ago we had a hard rain down in Claremont, just outside of Pomona, and right after that, one night I heard a buzzing behind my ear, and I think an air-raid alarm couldn't have made me any more awake. I didn't like that sound at all. So, I wonder how people in uncontrolled areas feel when they not only get the sound of the mosquitoes' whine, but must also feel the jabs of their business instrument. So I think that is something which we would more or less take for granted. I have two little grandchildren that I took up to Oregon with me last summer. Their mother worked in one of the committee offices helping put the report of the committee together, since we were working against time, and some of what she read must have rubbed off on the kids, since every time they passed a mud puddle or a tin can full of water, the children would say, "Look, Grandpa, *Culex tarsalis.*" Well, that is education. Those kids up in Oregon, although we had no mosquitoes up there, would never allow, after a rainfall, any tin pan or can or anything else that collected water, to remain with water in it. They turned it over and drained it. If we had people in our cities and infested areas doing more of that, I am sure that we would all appreciate it, would we not?

But I would like to get down now to the subject that we are discussing and say that in my opinion the study of encephalitis merely focused the whole State interest in the general subject of mosquito control. It was something which is easily dramatized; people were dying from the effects of it, people were going to the hospitals, we have positive tests that were made of all the suspected cases, and it was rather easy, I say *rather* easy, to get the appropriation to make the study. After the study was made it was a little harder to get some of the committee recommendations followed out. But we did obtain an amount of money in addition to the four hundred thousand dollars, that was already in the budget—we got three hundred thousand dollars which was to amplify the program and to be used as was stated in the successful bill, for increased subventions on an emergency basis. I think probably every one of us has felt the impact of the increased subvention, or have wondered what we could do with a little more money, and wondering how that would relate itself to our own particular problem of home financing of our programs. So what we are interested in—I'll make no bones about it—is whether or not the amount which will continue to be appropriated will be four hundred thousand, two hundred thousand, five hundred thousand, seven hundred thousand, or ten hundred thousand.

So let's raise some of the questions that my colleagues are going to ask when we go before the Ways and Means Committee for any amount of money. First, what did you do with the money you got? Was it wisely spent, and what results were obtained? We are pleased to hear from the report on the year to date, that we have had a pretty good year. I think probably because we have been out killing mosquitoes we have been doing something to prevent the spread of them, and we were aided in the early part of the year by nature, which is something to be thankful for, but we haven't had nature or anyone else wipe out our whole basic problem. A question that is going to be asked is "How much for how much?" I can hear some member asking that now. What are we going to get, what will the people get for this money? Then there is the question that has been raised a number of times in the Committee when we were making our study, and that is "What equity exists in the subvention program?" I do not mean that perhaps every member of this Association as a whole might not be well satisfied with the formula that is used in making the subventions, or perhaps that none of you are satisfied with it, but the Legislature has developed a philosophy on subvention programs; we probe a little deeper into the final effects and the method of distribution. I think that there are some things in connection with that which we will discuss later. Another question is "Is this going to be a continuing program?" In 1946 the State took over from the Federal Government the operation of Child Care Centers in California on an emergency basis. It has been an emergency ever since. I have had it in the budget only twice, which meant that the State Department of Education then came in with the amount that was deemed to be necessary if the present formula of collecting from the parents and from the local school district and from the State is to be maintained as is. Any variation in that formula is going to cause a variation in the amount of money that is budgeted. The Legislative Auditor makes his recommendations that certain amounts may be cut down, as far as the State expenditure is concerned, by increasing the contributions from the parents, and by increasing the participation by the local school districts. Now, I cite that because that is a five million dollar program and we might expect that five million dollars is going to be looked at a little more closely than seven hundred thousand, but, basically, the Ways and Means Committee of the Assembly, and the Finance Committee of the Senate look at it in exactly the same way. How was the money spent and what results were obtained? Is it right? Is it fair? And how would you modify it?

Then there is a question that must be resolved, and one which we cannot escape. I see that you have something about it on your panel for the last day of this Conference, that is, "How are we going to treat the marginal cases of the poorer districts," I mean the financially poor, and the indifferent cases, which are complicated by factors which we must take into consideration. Then we are interested in the answer to whether this seven hundred thousand dollars will be continued for another year. It all depends on what is put into the budget, because the Constitution of the State of California says that in the even numbered years the Legislature, which shall convene on the first Monday in March, shall confine its activities to the consideration of the budget and necessary revenues to support it. Now it is entirely possible for the Governor to issue a call for a special session, to run contemporaneously with the budget session, where items other than budget items may be considered. It is also possible to make an interlinear amendment to the budget, either raising the amount already included in it, or deleting it in its entirety, or changing it to some other status. That, of course, is more or less an additive process unless it is proposed to make a subsequent change in existing law, through a budget amendment which is legal, so I think we should dismiss that from our thinking and plan any approach to the Legislative powers through getting facts and figures together to show that the amount that was appropriated last year was justified, and also to show that the continuation of some figure can be justified. Then, of course, we will have the answer to this basic question of ours. It depends on the understanding and presentation of the program. You people have no paid lobbyists. You have

really only the Department of Public Health to appear before the Budget Committee and to work for you. You have a certain number of friends who are members of the Legislature, but we must operate without being members of any particular committee set up to make an investigation of the need. And, of course, it will depend upon the battle for every dollar that is in the budget—the demand and the necessity and the politics of cutting the budget to the lowest possible figure.

You know that we've got some folks that they call the pruners that operate in Sacramento, and they take a good deal of pleasure in this. There are the pen-knife pruners and the pickers, they just go through and they pick off a couple of dead leaves here, and a blossom there (it is ready to fall anyhow)—it does the garden a little good. Then we have the pruners that have a good sharp pair of shears. They come along and lop off a twig and they straighten up a tree and make it grow a little straighter, so that it will appear better to the eye. And then there are the boys that carry a hatchet, and really do a job. And so we have to have someone that knows how to get along with these people and who will anticipate the questions that will be asked.

I am astonished, and I use the word advisedly, at the sketchy laws we operate under. I'll tell you why. We have down in Los Angeles County an air pollution control act. All that the people in the surrounding counties have to say about it is that Los Angeles is spending a lot of money and we are getting their smog. It blows over with the same wind that helps to create it and makes the inversion. Yet we have a detailed procedure by which the County Counsel can go into court and bring an injunction against the Air Pollution Control Board that allows someone a variance. We have the methods under which variances will be granted. We have the provision that before a man can buy a factory, building it on his own land with his own money, put in his machinery and everything and enjoy the rights of his property, he must get a clearance from the Air Pollution Control Board as to what he can make or produce in that factory if there is any chance that he might contaminate the air. Yet we have nothing at all as to the marginal area operator, the agriculturist, that corresponds to our mosquito abatement law. We do have the problem which is always going to be thrown at you: what are you going to do with these island areas that lie between two areas that are spending themselves up to the hilt on mosquito control and are getting a State subvention, while these people are either too poor, or too indifferent, to do anything about it themselves? The proposal is of course made that we should bait them with some money, which is of course hardly fair to the people who have been working as hard and as long to solve a problem as those who are represented in this room. That is something which will ultimately have to be answered, but cannot be worked out at the budget session.

I want to help you all I can and try to anticipate some of these things and tell you that the next item, I believe, is going to be the very apparent lack of evidence of uniformity of effort. I am not throwing any blocks at anyone at all on this, but I was just trying to study the reports on the expenditure of money by the different Districts and compare that, in the time that I have remaining, with the basic question of equalization of State aid. But before I go on with that, I think we should give consideration to solving the problem of the marginal and indifferent area on the basis of having an over-all authority that wouldn't interfere unduly, any more than is done now, with the local operation, but would certainly declare in an endemic area particularly, a quarantine to exist, or a state of emergency to exist, and would walk in and take hold. I think that would be better, perhaps, than merely trying to use bait. But I was studying in the material that was submitted to the committee, a comparison of some thirteen mosquito abatement districts in the Central Valley. The average amount available through the valley was $182.00 per problem, or controlled, square mile. Of the thirteen agencies that were reported, six were below the average of $182.00, one was very nearly at the average, at $180.00, and six were above the average. Two were at $200.00 per square mile, one at $208.00, one at $215.00, one at $293.00 and one at $300.00. That was the total money available per problem square mile. Now that is a wide variation, and somewhere on the basis of an engineering survey, that is cost engineering, we should determine why there is that wide spread in the money spent, which is again the money that is available per square mile. We will look at the local effort that is made to raise money for their own needs, and try to make a determination as to why some people go way beyond a reasonable limit but receive less in State aid than might be reasonably anticipated when we make comparisons with others.

You know this average business is always rather interesting. It reminds me of the story about the man that was taking the Pullman train for the first time in his life and he didn't want to show that he was ignorant. So he asked the porter when he got on: "Now I don't want to be bothered with tipping all the time, so what is the average tip that you receive on the run from here to New York? The porter said: "Well, the average is five dollars." "Thank you," said the man, "I'm very glad to know it." "Here is your five dollars so you won't be worrying." The porter took it and said: "You know, you're the first man that ever come up to the average." Nevertheless, I made some averages of these thirteen reported districts. The seven lows averaged $138.00 per square mile, of their own funds plus State funds. The six high averaged $236.00 per square problem mile. That is a difference of $98.00, which is almost the total fund raised in some of the districts per square mile. In the low group there were two with the same assessed valuation, and had the same tax rate, yet their average per problem square mile was not the same. In one there was an assessed valuation of their problem square mile of $82,963, and in the other $68,716. Your difference there amounts to $21.37 in taxes that is raised on a fifteen cent tax rate. We don't allow that to go on in support of public schools in California. In case some of you don't know how we support public schools under an equalization program, I'll try to sketch it for you.

First of all, and that is why I have quoted these figures for you, we determine what should be the minimum educational opportunity for a child, in each of the several areas, in schools in California. Then having made that determination, we pick a certain amount of money from the State taxes that we must appropriate to the schools, and take that certain amount of money and spread that across the board to every school, rich or poor, in the State of California, on the basis of so much per child in average daily attendance. And then we take what is called a computation tax, it isn't a real tax, it is a certain percentage of the maximum tax that a school district can levy without a vote of the people, and we say "suppose we raise the tax at this rate, how much money per child in average

daily attendance would be realized?" So we add that and the base together, and if that doesn't come to what is determined to be the minimum, then from the rest of the school support fund, we allocate on a per capita basis, until it comes at least to that. The fortunate districts, Beverly Hills and some other places, can by putting in a very small tax in addition to the minimum tax necessary, provide a gold-plated opportunity for children. That is their good luck; no one is trying to take it away from them. But the point that I am trying to make is that if we find we have a basis for equity, for example, that even San Francisco, which city contributes a great deal of money, and even Los Angeles and Los Angeles County, that collect an enormous part of the total sales tax, will support through their elected representatives, even before the people of California approved it several times by their action on the ballot, then the whole State buys the principal of equalization of educational opportunity.

I don't think that we are stretching it too far, then, to say that in our particular problem of financing mosquito control that we should make an appraisal of the basis on which we subvent to the local agencies. I think we need to make a declaration, as is made in a number of instances, as to why the State is interested in this particular problem. We'll go on the usual basis, I think, and buy that. As Lincoln said, "When a group of people cannot provide a necessity for themselves, it is the duty of the State to provide it for them." We have followed that principle in providing for flood control. We use it to justify the expenditure of State money in aid to the local governments on a number of different occasions. It would be well to come in with a program that is justified, that represents the best thinking of everyone here in this room, and which would be intelligible to the members of the Legislature.

Now these of course are things that I have read in the report. I have talked to various ones of you in the Department of Public Health about it. I have talked to other people in the State government, and I think that I am safe in saying that the kind of approach I have suggested would be much better than one which is just making a great deal of noise. Yet we are faced with the very serious problem of what we will do in 1954. Budget hearings are going on, and there is no legislative committee of your organization with which we can work. So I would give this to you as my earnest recommendation, that when you have your business meeting, you establish a Legislative Committee; that your Legislative Committee start working on some of these problems so that you can do two things. First, that you have a little brochure that may be placed in the hands of the Legislature, and in the hands of the interested committees. Then if it prevails there, that you place it in the hands of every member that is going to vote when it finally comes upstairs and has to be acted upon.

It is a pleasure for me to have been here. I especially enjoyed some of the remarks that the previous speaker has made. I think that that was pointed up in our committee meeting, that is the good that may be derived from the use of chemicals. I was approached no sooner than the committee had been appointed by a manufacturer of chemicals that wanted the committee to test it. That wasn't our function. Someone who didn't want a profit himself—he just wanted to do something for the State, but we certainly assured him that we had plenty of people that were interested in the problem, folks that would make tests, that would make final determinations on their own. I asked Mr. Peters for some figures yesterday that I think you would be justified in using, that were obtained of course by records that had been taken for the entire current year, that is compared of course with the 700 and better total cases reported for the year previously to substantiate the bid for emergency funds. We had 267 virus cases. Of these 149 were clinical, and those which were traceable to chicken pox, mumps, or measles were 116, leaving only 21 confirmed. Thus we find that you can answer the question "Was any good done by the expenditure of the money?" In taking this before the Legislature, well, we won't take all the credit, because I don't think we are that kind of people, but certainly we can say that those figures didn't come about just by themselves. Then we won't forget what Dr. Lindquist has told us this morning, that there is a very important relationship between the mosquito abatement activities in the field and the biological studies that should continue to be made. I think it is inescapable that the mosquito abatement districts and the Department of Public Health will continue to work together with such a fine relationship and mutual advantage.

President Peters: Thank you very much, Mr. Geddes. I am sure everyone enjoyed having you here. We have about five minutes. I do not whether it would be out of order to ask if there are any questions. Would anyone like to ask questions of Mr. Geddes?

Mr. Gray: I would like to ask Mr. Geddes whether the members of the Legislature were well convinced that this problem, which in itself lies in the Central Valley, is really a matter of State concern.

Mr. Geddes: Yes, I think they were pretty well convinced, although we had some debate when the Committee was set up for this special study. Some of the members were afraid that we were going to put on long white coats and be doctors after a short course. We convinced them that it was not so. In supporting the resolution, I stated just what a terrible thing encephalitis could be. My daughter had encephalitis the year before, but they called it mumps, however; and even if you can't distinguish the disease as to where you get it, certainly no one is going to wish it on anyone else. So the Legislature will generally go along when there is a problem of public health that can be really pointed out. In the Committee on Ways and Means, we had a little more argument, but the members on the Assembly side had a good representation from the Central Valley and other counties. Even having a certain amount of the disease in Los Angeles County and Orange County and Riverside County helped us there, in spite of the recommendation of Mr. Shaw that no further Legislative study was necessary. The rest of the Committee on Public Health, with the exception of the chairman, who was away, went along with the final recommendation of the intent.

Let me say this, that I think everyone of you and your Boards should be familiar with your District Representative, and certainly that is the place to get in some first hand licks, by going to him directly and giving him some inside information as to your own particular local problem. On the other hand, you are going to have a tough session. It is a budget session, it is harder to make any changes, and the hatchet men are going to demand some pretty straight positive answers.

President Peters: Are there any other questions? The next participant on our program is the Vice-President of the California Mosquito Control Association, and Manager of the San Mateo County Mosquito Abatement District, Don Grant.

A PERSPECTIVE ON OUR INVESTIGATIONS WORK IN CALIFORNIA MOSQUITO CONTROL

C. DONALD GRANT, MANAGER-ENTOMOLOGIST
San Mateo County Mosquito Abatement District

In reviewing the considerable discussion concerning our field research projects during the past few years, there has been noted an atmosphere of impatience, certain doubts as to procedure, and frequent conjecture as to what tangible benefits have been, or will be, provided to those in actual mosquito abatement work. Criticism of any such projects has its place and may be commendable, but the failure to recognize the importance of such field studies has already hampered our progress in some respects; to continue without due regard for the urgent problems facing us and the resultant needs for reliable ecological data, our past successes may well be placed in jeopardy.

It has already been pointed out most effectively by Dr. Lindquist how biolological studies have directly aided mosquito abatement work throughout the world, and how these results are incorporated into our own procedures here in California. However, often their introduction is so subtle or gradual that the significance and reason behind such adopted practices are lost in transition or accepted as popular knowledge never subject to question. The establishment of time elements in life cycles, a species' predilection for certain types of habitats, the failure or success of trial methods . . . all bear their influence on each District in modifying its efforts as to spraying and inspection schedules, where to expect the need for greatest emphasis under pressure, what channels of approach may be deemed impractical in certain districts, and what operations are substantiated as feasible on a broader basis than that afforded by numerous variabilities within a local area.

At the present time the outlook on our own operational investigations projects is especially gratifying as we note that within the large bulk of accumulated basic data we are resolving hypothetical points of attack and investigation which will bear most directly on the control of mosquitoes. One of these consists of the work being done on the aquatic algal form found in rice fields which apparently directly interferes with the development of mosquito larvae. Although the possible effects of this plant were noted many years ago, it has been dependent upon the background of ecological facts established in the rice field studies to make possible the final determination of its practicality in control measures. There is also the indication that the greatest potential merit of this algae will depend on further analysis, in the laboratory, of the physiological and chemical means whereby its deleterious action is effected.

Another point of specific study and direct concern to control practices lies in determining the effects of soil condition in irrigated pastures on mosquito development therein. Only a large body of data based on the correlation of soil samples and mosquito development can resolve this problem, and the acquisition of this knowledge as such is already well underway. The effects of soil condition on aquatic environment must also be analyzed, and again much of this information has been previously garnered through earlier studies of this project. The eventual control step will very possibly lie with educational measures and advice to agricultural interests, whose cooperation is basic to any successful abatement effort in irrigated areas.

Objectively, our operational investigations undertakings are woefully inadequate to seize upon, or even glimpse into, many promising studies which lend promise of fruitful results. This has been a necessity born of financial limitations rather than desire, but the design of our undertakings has been from their inception that of building a factual basis from which the most promising hypothetical points of attack on our rice-field and irrigated-pasture mosquitoes may be formulated and followed through. A primary objection to this has been that such substudies on direct control procedure have not been formulated or explored at an earlier date, so as to bring us significant achievements in our methods of abatement and thus relieve our headaches and heavy expenditures. Such impatience is not well-founded for obvious reasons: thorough ecological studies evaluating seasonal changes and effects demand the results of many seasons for the reliable interpretation; the development of secondary aspects brought forth by initial findings may also demand several seasons to develop; the hypothetical points of attack in determining control measures are basically dependent upon the background of previous results; and adequate funds and manpower have not been available to investigate the manifold possibilities which have been suggested on the basis of previous results.

In the interests of abatement agencies desirous of tangible benefits, it should be acknowledged that ecology involves the study of changing relationships over a period of time, and thus no ecological study of a population can ever be deemed finished, so that at some point the gathering of mass data reaches an impractical status. In viewing the past year's trends of study on these projects, it has been heartening to note a channeling of efforts into more restricted phases with preconceived objectives somewhat in mind. It is a personal opinion that the time has been ripe for a more intensive pursuit of leading specific problems which should be carefully considered, chosen, and planned towards definite ends. Such pursuit cannot come without enlarged budgets or facilities, and therein lies the obligation of interested agencies and members of this association, an obligation not to the interests of the studies, but to ourselves, to the public, and to efficient mosquito abatement.

And thus we come to the consideration of why research studies are so important to our future efforts. In general it has been taken for granted that such investigations are a good thing but too often it is found difficult to logically justify the time and cost. The importance of such data and new information is of course dependent upon the need for it and so we might review the needs.

It is acknowledged that we know a lot of the answers in regard to killing mosquitoes within a relative sense, relative to the economic pressures and standards of mosquito prevalence encountered in the past. Unfortunately for our methods, such factors have not remained static and our problems have outgrown efficient means of coping with them. Some of these factors are as follows:

a. There has been a significant increase in the total area under mosquito abatement districts.
b. There is an increasing amount of mosquito source area due to increased irrigation in agricultural areas.
c. As more efficient abatement is attained, the people correspondingly increase their demands in regard to freedom from mosquitoes.
d. A continuing influx of population and its normal increase lead to settlement of areas which normally act

as harboring points for adult mosquitoes which results in further service demands.

e. Wider recognition of the association of mosquitoes with disease prevalence puts special demands on abatement procedures.

f. Although refinement of previous methods is yielding greater efficiency, the rising cost index, and adaptability of the mosquitoes to our procedures, has prevented any decrease in relative costs.

g. The available funds are in many respects limited by law, and even where drastic need might justify new legislation, such means are usually slow and inadequate to meet the demands of the problem.

To be dependent upon constantly increased funds to meet our ever greater problems without significantly improved methods of abatement is hardly a bright outlook for the taxpayer or ourselves. Therein lies a great need to look elsewhere for our answers.

Often pertinent developments are brought forth in parallel fields: the Department of Agriculture in studies of other insects; chemical companies in the development of insecticides; universities and other research institutes through providing indirect but pertinent data; and scientific papers from divers sources; but despite these excellent contributions, the direct application to practical mosquito abatement must be provided in a great measure elsewhere. Here in California, that this Association has been foresighted enough to work with the State Public Health Department in direct studies towards such ends is a most significant step, and has given considerable prestige to California mosquito abatement work. Yet is has been repeatedly pointed out that such total expenditures in the past have amounted to only a minute portion of our overall needs.

There is one need which has not too often been pointed out but which should be considered one of our most important aspects for the future. This is the need for reliable, scientifically demonstrated facts as a basis for our theories and methods in mosquito abatement. Not because we can't still kill mosquitoes without it, but because incontestable concrete data in black and white shall become ever more essential in gaining outside support for our work.

If funds are to be sought in support of our activities in the future, such requests are going to be viewed with an increasingly critical eye. Although exceptions have occurred, and probably will again, it may be rightfully expected that the reasons presented for the need of additional funds will be met with the demand for concrete statistics which may only be obtained by reliable studies or investigations. In conjunction with such requests there may be expected critical examinations of our work, our use of public funds, and our efficiency. Our work is always subject to public scrutiny and we must not ignore the fact that there are many qualified people capable of evaluating our work and the factual information whereon it is based.

Such evaluations and demands for facts shall be made when we seek the aid and cooperation of other agencies in such projects as water control, improved agricultural practices, or specific drainage undertakings. Only if we maintain our operations at the highest possible standards and in accord with a sound background of information, can we meet with such agencies or bodies on at least equal footing and expect their cooperation in justifiable proposals.

The successes thus far achieved in such relationships have in a great measure been due to the fact that significant studies are being conducted in this field and that reliable data can be presented to support our proposed courses of action, rather than that we have suffered heavy mosquito populations and feel that the action of other agencies can lighten our load.

In the formulation of recommended procedures it is most impractical to call upon a body of general, and often contradictory, observations on mosquito behavior, knowing that any wrong guesses or inaccuracies can readily sabottage these efforts in the future. To this end, facts are our tools. Let us ascertain them and use them.

The above needs are in themselves unquestionable; it is the means wherewith to bring about the necessary accomplishments that remains the problem and the obligation to which we fall heir. When we consider that the basic function and purpose of this Association lies directly with the furtherance of mosquito abatement work, established and maintained as a body to aid in providing for the needs of its constituents, individually and collectively, then certainly the long list of needs dependent upon scientific investigations, and specifically upon our most pertinent projects of study here in California, must merit the uncompromised support of this organization. Our success in meeting the challenge of the increased problems in mosquito abatement work is dependent upon the ability of every individual and organization here represented to recognize these needs and to cooperatively seek the means of answering them.

President Peters: Thank you very much. This concludes the portion that has been scheduled for the morning session. We will adjourn until 1:30 p.m.

SECOND SESSION, WEDNESDAY, DECEMBER 2, 1953, 1:30 P.M., AGRICULTURE HALL, UNIVERSITY OF CALIFORNIA, BERKELEY

*Dr. L. W. Hackett:** As President Peters is evidently delayed, we will begin without him.

The first business for the afternoon session is a Panel Discussion on the "Implications of the Lake Vera Malaria Outbreak in California." The members of the panel are Dr. Rosemary Brunetti of the Epidemiology Section of the Bureau of Acute Communicable Diseases, California State Department of Public Health; Harold F. Gray, Engineer-Manager of the Alameda County Mosquito Abatement District; and Russell E. Fontaine, Associate Vector Control Specialist, Bureau of Vector Control, California State Department of Public Health.

There was a curious outbreak of malaria at Lake Vera in Nevada County, California, beginning in 1952, but with cases cropping out for almost a year after the July when the mosquitoes were apparently infected. This outbreak gives us an unusual opportunity to study malaria as a cloistered experiment in nature which we find very rarely occurring. We know the source, and how it spread in a group of non-immunes and in a non-malarious area, and we can therefore eliminate many of the confusing factors in epidemiology which sometimes present prob-

*The Moderator of this panel was Lewis W. Hackett, M.D., Editor of the American Journal of Tropical Medicine and Hygiene, Visiting Professor of Public Health at the University of California, and a Trustee of the Alameda County Mosquito Abatement District.

lems. This outbreak throws light, first, on the competence of our epidemiological agencies. As you will see in the panel, the elucidation of the problem was a piece of detective work that gives a good deal of credit to our agencies. Secondly, it throws light on Korean malaria, because the originating infection evidently was obtained in Korea. It's lucky for us that we had a Korean strain of *vivax* and not some of those heavily relapsing South Pacific strains, which might easily get into our mosquitoes and cause us a great deal of trouble for years to come. This is a warning, I think, to our Armed Forces' medical services. They are now supposed to treat every returning Korean veteran, on the way home, with one of the new drugs which enables us to clean out all of the malaria parasites in these returning service men before they land in this country. Thirdly, it throws light on the conditions favorable to the spread of malaria in California, one thing that we are apt to forget as we had so little of it in recent years. This one outbreak gave us more cases of malaria than we have had in all of California for many years past, and provided almost all of the indigenous malaria cases that occurred in the United States in 1953.

This occurred in a mountain or foothill vacation area, and not in the Central Valley; this is another interesting point.

There are more mosquitoes and more carriers in the valley than there are in the foothill areas. Why has there been only this one outbreak? We have had a great many veterans returning with malaria. We've had six thousand veterans returning in one year to California with possibilities of malarial infection. We have immigrant agricultural labor coming into the valley every year, yet the only outbreak with a significant number of cases has occurred in a non-malarious area in the foothills. Our margin of safety in California is always, we thought, quite sufficient to protect us from such outbreaks, but it is evidently much thinner in the foothills where the old miners' fever was our principal malaria in the early days. In the foothills there are two possible vectors, in the valley apparently only one. I hope that the speakers on this panel will clear up that which is perhaps the only remaining mystery about this outbreak, that is, what mosquito caused it? The first speaker is Dr. Rosemary Brunetti, who did the epidemiological work on the Lake Vera outbreak.

OUTBREAK OF MALARIA, LAKE VERA, CALIFORNIA

ROSEMARY BRUNETTI, M.D.
Bureau of Acute Communicable Disease, California State Department of Public Health

There is nothing more challenging in the field of epidemiology than the appearance of the unusual or unexpected. The occurance of three cases of malaria presented such a challenge in California in August, 1952. These cases were puzzling. They were all young girls who lived in three separate localities. They all became ill about the same time early in August and they all were reported to have *P. vivax* malaria. This was indeed unusual and unexpected. California had not recorded a case of locally contracted malaria since 1945.

More information on these strikingly similar cases was clearly indicated. The investigation started routinely enough but rapidly developed into one of the most fascinating epidemiologic studies of malaria to occur in this country.

From August 1952 through August 1953 thirty-five cases of malaria were recognized in seven Central California counties and Reno, Nevada. Did this geographical concentration mean anything? What about onset? Eight cases had onsets in August 1952, one in September 1952, one in March 1953, ten in April 1953, eight in May 1953, five in June, and one each in July and August. This was peculiar—it looked like two outbreaks. Was there a sex difference? Thirty-two of the cases were females, 27 of whom were between 9 and 20 years of age.

This concentration of cases in young girls was the most promising and fascinating clue. What one factor did these girls have in common? We soon found out that most of them were Camp Fire Girls who had attended a summer camp at Lake Vera, Nevada County. We now were given a clue to the possible place of exposure. What did Lake Vera have to do with these cases?

The four central California Camp Fire Councils who conducted camps at Lake Vera coincided with the place of residence of the cases. Evidence that this was the only place of exposure rapidly accumulated. No other unexplained cases of malaria appeared in these seven counties. All of them were either associated with the Camp Fire Girls organization or resided near Lake Vera. None of the cases gave a history of previous exposure or attacks of malaria. A survey of the Lake in August reveal innumerable *Anopheles* mosquitoes, both larvae and adults, and substantiated the statements made by the victims that the mosquitoes were terrible.

The Camp Fire officials magnificently cooperated in providing details of the camp organization and lists of persons who attended the various sessions of 1952. These data provided invaluable records for follow-up of the population at risk and offered a clue as to the probable date of exposure. The camps opened late in June and closed the first week in August. Approximately 1800 persons had been in the area during this time. The majority of the campers attended for one or two weeks but some stayed for the duration. The fact that 20 of the cases were at Lake Vera after July 10th and that there were no cases in the groups that had been there previous to that time led to the speculation that the mosquitoes were infected sometime early in July.

Efforts were then concentrated on finding the original source or sources of these infections among the persons known to have been at Lake Vera early in July. The speculation was made that the most probable source was a Korean veteran although all other possibilities were also investigated. Through a fortuitous circumstance such a veteran was found. He had returned from Korea in November 1951, and had experienced his first proven attack on *P. vivax* malaria in April 1952. He spent the Fourth of July weekend at Lake Vera and while there suffered a relapse of his malarial infection. He slept out-of-doors, and volunteered the information that every mosquito at the lake bit him, and we are inclined to believe him. No other possible source could be found among visitors to Lake Vera or in this sparsely settled area in a county that had not reported a case of locally contracted malaria for over 20 years.

This pinpointing of the place of contraction with known dates of exposure of the source and the population at risk was recognized in the fall of 1952. The outbreak at that time consisted of nine cases and was itself noteworthy. However, the 26 cases with onsets in the spring and summer of 1953 made this outbreak an epic in the study of

malaria. It offered the opportunity to follow the natural history of *P. vivax* malaria in a non-immune population living in a non-endemic area.

All but two of the cases were confirmed by the laboratory to be *P. vivax*. The exceptions are included on clinical and epidemiologic grounds. None of the 26 latent cases had any symptoms of malaria prior to their onsets 226 to 307 days after exposure at Lake Vera, nor had they been given any suppressive therapy. None of them had any other known exposure—either previous or subsequent to their visit at the Lake.

A detailed account of the investigation, the findings and the control measures instigated are being published in the American Journal of Tropical Medicine and Hygiene. Because of the time limitation only the highlights of our findings will be presented today.

This outbreak fortifies Kortwieg's hypothesis that two-thirds of the *P. vivax* infections contracted in autumn remain clinically latent for eight to nine months. Being able to document the date of exposure and the date of onset was perhaps the most significant contribution of this investigation. As far as these infections are concerned suppressive therapy did not contribute to the long latent incubation period of this strain of *P. vivax*. Another interesting observation was the fact that seven of the original nine cases which had clinical malaria in 1952, later relapsed.

The illness in twenty-nine of the cases pursued the classical course of chills, fever, and sweating every forty-eight hours. Fifteen of them experienced premonitory symptoms, such as lassitude, headache, arthralgia, nausea, vomiting, chilliness, and fever from 1 to 7 days before their first rigor.

Two (SH and MT) of the six possible atypical cases developed daily paroxysms after three typical tertian reactions. Two others (ID and PC) had a prodromal stage of intermittent attacks of pharynigitis 41 to 48 days before their first paroxysm. In one girl (CP) the predominating symptoms and subjective findings pointed to pyelitis. These symptoms were also present at the time of her relapse in April. A two-day episode of fever, chills, arthralgia, nausea, vomiting, and headache occurred in one patient (SR) two weeks before the first classical attack.

Whether or not these cases represent the total remains to be seen. However, we do not believe that additional cases which come to our attention will change the incubation time. So far we have been able to verify that this latent period can be from seven to ten months. The two cases with onsets in July and August tend to substantiate this. One of the males (FP) moved to the vicinity of Lake Vera in September 1952. He became ill July 3, 1953, and assuming he became infected on arrival his incubation period would be nine and one-half months. The other person maintains a summer home at the Lake. She (RP) was subject to exposure from the time the mosquitoes were infected until October when spraying activities were conducted. Another case (PP) surreptitiously visited one of the camps for three days in mid-July. She became ill nine months later. Another (BC), the mother of one of the campers, came to the Lake the last two weekends in July 1952. She became ill in April 1953 or about eight months later. Twenty-one of the cases were definitely established as having onsets from eight to ten months after exposure (seven each eight, nine and ten months).

This observation has tremendous epidemiologic implications. Perhaps the cursory question of where were you three weeks ago will have to be revised. When dealing with temperate zone *P. vivax* infections in California, where were you three weeks ago *and* eight to ten months ago apparently will be more elucidating.

Obviously this outbreak demonstrates that this country is vulnerable to the introduction of malaria from abroad. As long as the vector is prevalent among our susceptible population transmission can occur. Our control endeavors to reduce this hazard should not overlook the possibility of secondary cases arising from those cases which have had their onsets months after original exposure.

NOTE: Acknowledgement is made to Roy Fritz, Senior Scientist, U.S. Public Health Service, Communicable Disease Center, Atlanta, Georgia, who is co-author of the report to be published.

Dr. Hackett: I'm glad that the mother was punished because you ought not to visit your daughters at these camps, but I'm sorry about that surreptitious girl.

I had a paper presented to the American Journal of Tropical Medicine from Fort Bennington by two doctors there, who said that they had a couple of soldiers who had come down with primary attacks of malaria eight or nine months after leaving Korea, but I rejected the paper because they told me that the soldiers had assured them that they had not taken any suppressive drugs while in Korea; I rejected it because you can't believe a soldier about suppressive drugs. But it is true that you can get the northern European and Asiatic malaria and suffer no symptoms whatever for eight to ten months before the attack. This outbreak has aroused a great deal of discussion among malariologists as to why it hasn't occurred more often.

What historical evidence have we that would bear on a determination of the vector of this outbreak. I hope Mr. Gray will throw light on some of these points.

INTERESTING ASPECTS OF THE MALARIA OUTBREAK AT LAKE VERA, CALIFORNIA

HAROLD F. GRAY, GR.P.H.
Engineer-Manager,
Alameda County Mosquito Abatement District

At the outset, the epidemic of malaria among the Camp Fire Girls at Lake Vera, California, in 1952, must be characterized as an abnormality. The conditions were almost completely different from any usual setting for a malaria outbreak. In the first place, there was no housing in the usual sense, and the girls were freely accessible to the mosquitoes. In the second place, the girls were all non-immunes, coming from areas where malaria had never been endemic, or from areas where endemic malaria had been absent for many years. Third, the area in which the infections occurred had not had reported cases of malaria for many years. Fourth, the area in which the infections occurred had never, so far as I am informed, had any organized mosquito control work, nor an effective local health department. Fifth, efficient *Anopheles* vectors had always been numerous in the area—to my personal knowledge for over forty years.

These vectors are *Anopheles freeborni,* generally considered to be *the* malaria vector in the western part of the United States, and *Anopheles punctipennis,* generally considered to be an ineffective malaria vector except in special conditions, as it seldom enters houses.

Anopheles punctipennis tends to be relatively more numerous than *A. freeborni,* at least in the foothill areas,

in May, June and July, with *A. freeborni* generally becoming predominant in August, September and October. Since the infections in this outbreak were received in July, and since even in August at Lake Vera *A. punctipennis* adults were by observation more numerous than *A. freeborni,* as Mr. Fontaine will tell you, it appears that numerically *A. punctipennis* could be involved. And as it bites humans freely outdoors in the evening and also in the shade during the day, there was ample opportunity for this species both to obtain malaria parasites and to transmit them. On the basis of my own observations in similar situations in past years, and of the conditions occurring in this outbreak, it is my personal opinion that in the Lake Vera situation *A. punctipennis* could have been as efficient a malaria vector as *A. freeborni.*

Under these unusual conditions, all that was needed was the introduction, for a few nights, of a gametocyte carrier accessible to the *Anopheles* mosquitoes. The inevitable chain of results followed promptly.

BUT—and here is a big *BUT*—if the gametocyte carrier had slept in a screened house, possibly only a few *Anopheles* could have been infected; or if the girls had slept in screened houses, possibly only a few girls could have been infected. Or if the girls had come from areas where malaria was endemic, new infections would probably not have been suspected or noted as such—relapses would probably have been diagnosed, and the local origin of infection not discovered.

But, even if all these buts did not occur, the epidemic *could* have slipped by unsuspected as to source if Dr. Brunetti had not sensed a possible common origin in the nine initial cases of widely scattered home residence. It takes more than a routine shuffling of case history cards to ferret out the source of this type of an epidemic, and Dr. Brunetti deserves an accolade for having her feminine intuition in good working order.

One factor that we had to consider in this epidemic was an imponderable. What were the chances that it could occur again in 1953 if no mosquito control measures were attempted? On the basis of past experience it would appear that such an outbreak was unlikely to occur more than once in forty or fifty years. It is possible that no new cases of malaria would have occurred at Lake Vera in 1953, even without mosquito control. It is also possible that a girl who was infected there in 1952 might return in 1953, and in spite of medication she might still have gametocytes of malaria in her peripheral circulation. In that event another series of cases probably would have occurred, with consequent damage to Lake Vera's reputation and future use as a summer camp. In view of the Camp Fire Girls' investment in the camp, aside from any considerations of health, the chance was too great to risk. The decision to do mosquito control work for the 1953 season was therefore wise.

An interesting corollary to this outbreak would be far from some epidemiologist to work out the malaria picture in Nevada County in reverse—why and how did malaria die out in this region, after having been epidemic one hundred years ago, and endemic up to about thirty or forty years ago. Actually, the essential conditions that permitted this small outbreak to occur were very similar to those under which extensive and intense malaria occurred in the Sierra Nevada foothills a century ago—unhoused people freely exposed to a probably large Anopheline population, with gametocyte carriers present who brought their infections from the southern states or acquired them en route at Panama.

In this case, the control methods were simple, obvious and easy to apply. Fortunately, we had reasonably frightened Camp Fire Girls' executives to deal with, and not a lot of amateur health experts with pig-headed notions about DDT. We were able to persuade them to fill in the marginal shallows of the lake, from which came most of the *Anopheles.* Here, as almost always, the bulldozer was mightier than the spray can. After the event, I feel confident that the bulldozer work would have been sufficient to have prevented a recurrence of the outbreak, if applied to all the possible *Anopheles* sources. But some DDT spraying was necessary to mop up small residual sources. This was done with nearly 100% effectiveness. An encomium or two should go to Russ Fontaine for supervising the control job successfully.

It is probable that if a little additional bulldozer work is done to fill the marginal shallows along the lower end of Brush Creek, no *Anopheles* control work will be necessary in this area in the 1954 season, as a malaria preventive measure. And if a reasonably good job of *Aedes varipalpus* control is done in the spring of 1954 (which involves climbing all the deciduous trees in the camp area) further mosquito control work for the comfort of the campers may be unnecessary.

One sidelight on this outbreak especially intrigues me —but after many years of experience does not astonish me. It is the apparent utter indifference of the county officials, the health officer, the chambers of commerce, and the general public, to the implications of this outbreak. It seems to me that if I were a local chamber of commerce executive I would have been screaming to the board of supervisors and the health officer that such an outbreak was disadvantageous publicity for the area, and would be bad for business, and something must be done about it. And if I were a PTA member, or a hotel or a motorcourt proprietor, or any one in local business, I think my reactions would be the same. Possibly the real significance of this outbreak has been concealed from the local community mind by the far more spectacular and concurrent epidemic of encephalitis that summer. But this type of malaria epidemic can happen again, perhaps not at Lake Vera, but at any one of numerous localities in the Mother Lode area. It seems to me that this not only is a phase of recreational sanitation which has not yet been adequately considered by the State Department of Public Health, but it is also an area of local sanitation in which the State has not adequately stimulated the local health officials involved. Here is a field of action more useful and basic and valuable than some of the "modern" excrescences on the present corpus of public health practice.

Dr. Hackett: I would like to ask Mr. Gray whether Mexican agricultural labor goes up into Nevada County to pick fruit?

Mr. Gray: Probably only a few in that county, and probably none in the general vicinity of Lake Vera. There are a number imported in adjacent Placer County around Colfax, Auburn, Newcastle and Penryn.

Dr. Hackett: Any other questions on either of these first two papers? The surprise of this was, of course, that this hasn't happened before, and not that it should have happened at this time. When we consider the number of carriers which get into the Central Valley with 300,000 acres of rice growing *Anopheles freeborni,* you wonder

what it is that protects our people from malaria in the valley.

Mr. Russell Fontaine was sent up to Lake Vera so expeditiously that he got there before the end of August, and he made a survey, and also had charge of the preventive work there.

CONTROL MEASURES FOR THE MALARIA OUTBREAK AT LAKE VERA, CALIFORNIA

RUSSELL E. FONTAINE
Associate Vector Control Specialist,
Bureau of Vector Control,
California State Department of Public Health

One of the intriguing aspects of the Lake Vera malaria outbreak to the Culicidologist was, which one of the two prevalent *Anopheles* present in the area was the vector, *A. freeborni* or *A. punctipennis*? Of course both species may have been involved, but *Anopheles freeborni* is presumed to be. Perhaps the facts of the mosquito situation at Lake Vera as we found them when we first visited the area on August 30 ,1952 shortly after it was suggested that the Camp Fire Girls' camps were the source of the malaria will shed light on this question. Our search for *Anopheles* species in permanent buildings in the camps, particularly in washrooms and toilets, revealed both *A. freeborni* and *A. punctipennis* in abundance. However, *A. punctipennis* according to our crude counting methods outnumbered *A. freeborni* nearly two to one. Outdoors under the shade of the forest canopy both species were collected attempting to bite in the afternoon between 3:30 and 7:00 p.m. Other species noted included *Aedes varipalpus, Culiseta incidens* and *Culex tarsalis*. Although the *Anopheles* were found in considerable numbers at the four camps, the Piedmont camp which is located furthest from the lake on a hill had the lightest infestation. This finding was interesting because this was the only camp where malaria cases did not occur. A total of 8 *A. punctipennis* and 8 *A. freeborni* were dissected and examined for oocysts but all proved negative.

The major source of mosquitoes for the area was traced to the lake, which incidentally might be better classified as a pond because its area is only 15 acres. *Anopheles* larvae averaging about 10 per dip were taken in all the shallow areas less than two feet deep where emergent aquatic vegetation and floating mats of algae were present. These favorable mosquito source conditions comprised about 20% of the total lake area. Other sources were found at the outlets of Rock and Brush Creeks which flow into the upper part of the lake. A small sample of larvae and pupa were reared and identified as *Anopheles punctipennis* and *A. freeborni.*

Our findings in late August do not necessarily represent conditions existing during the July 4th weekend when the Korean veteran visited the lake. The only information available offering a clue to the mosquito situation in early summer is contained in a Bureau of Vector Vontrol report by Harvey I. Magy who made a survey at Lake Vera in early June of 1950 in response to a request of the Camp Fire Council directors who were interested in a control program at that time. Mosquitoes observed in the adult stage according to the report included *Anopheles punctipennis, Culex tarsalis, Culiseta incidens, Aedes varipalpus,* and *Aedes increpitus*. Both *Anopheles punctipennis* and *A. freeborni* were taken in the larval stage in the lake. Of particular interest is the fact that this report to the Camp Fire officials included pertinent recommendations for conducting a control program. Unfortunately the directors failed to forestall the consequences of their 1952 experience by not adopting these recommendations. If they had I'm certain this panel would not be seated here today.

There is of course nothing unusual about finding a preponderance of *A. punctipennis* in this Mother Lode county at 2500 feet elevation. Prof. W. B. Herms in his report on a state-wide mosquito survey carried out in 1916 also observed a considerably larger proportion of *A. punctipennis* in the Anopheline population of the Mother Lode counties and suggested that malaria among the miners in the early days may have been transmitted by this species.

The demands of the *Culex tarsalis* emergency control program incident to the encephalitis epidemic of 1952 forced us to limit our survey at that time to a single day's observations. However, the time spent appeared adequate to size up the major problem conditions and to draw general conclusions for a mosquito control program in preparation for the 1953 camping season. For example, it was evident that a project involving resloping and realignment of the shoreline and deepening or filling in shallow areas of the lake to eliminate the extensive, dense growths of emergent vegtation was a basic need. Fortunately there was no problem to accomplishing the job by bulldozing because of the routine practice of draining the lake in the fall by removing the flashboards at the dam, and refilling in the spring before opening of the camp season, allowed at least a six-month period when earthmoving equipment could be used.

The need for some larviciding work to supplement permanent control was clearly evident not only in the lake but for controlling the scattered, minor sources in Brush and Rock Creeks and in the area surrounding the camps. A residual DDT spraying of the permanent buildings also appeared desirable in order to effect an immediate reduction of the large population of *Anopheles.*

The Camp Fire officials were advised on control methods and procedures by the Bureau of Vector Control staff and eventually succeeded with considerable aid from the Alameda County Mosquito Abatement District in carrying them out to the letter, not only at the lake but for a one-mile radius surrounding the four camps.

Some of the highlights of the control activities and the results achieved in terms of mosquito reduction may be of interest.

The first operation performed was residual spraying of the permanent buildings in October 1952 resulting in complete disappearance of adults from all of the buildings shortly thereafter. The following spring on April 20 only two *A. freeborni* females were found after a prolonged search in nearly all of the buildings in the area. Undoubtedly they were overwintering survivors of the 1952 population. The first evidence of aquatic stages was observed on the same day. A moderate infestation of *Anopheles* 1st instar larvae and *Culiseta* 4th instar larvae, averaging about 4 per dip, were recovered in shallow seepage pools in the drained lake bottom. We are certain that this represented the first generation in the area. These pools were sprayed with DDT by the Camp Fire officials and no further larvae were noted until after the lake was refilled on June 18. Refilling of the lake was

delayed purposely until the latest possible date before opening the camping season in order to delay the growth of aquatic vegetation and algae, and the mosquito cycle. Early in June before the lake was refilled a bulldozer was put to work eliminating most of the shallow areas in the lake bottom and resloping and clearing the shoreline of brush and tules. On June 22, a few days before opening the camp a worker was employed part time for inspection and larviciding over an area of about 1 square mile. This work was concluded on August 15, the closing date for the camping season.

The effectiveness of the operation in terms of mosquito reduction exceeded expectations. During the camping period adult mosquitoes, excepting *Aedes varipalpus,* were almost entirely absent from the area. Only one *Anopheles freeborni* adult female was captured within the one square mile of the control area while active operations were under way. The only larvae observed were scattered, isolated broods of *Culex* and *Culiseta* which were promptly controlled by spot spraying. The lake remained free of emergent vegetation and algae until about August 1. Thereafter conspicuous growths appeared in shallow areas missed in the bulldozing operation.

We had expected that after spray work had ended on August 15 the area would become reinfested within a few weeks. However, this situation failed to materialize. Our final inspections made on September 14 revealed a few *Anopheles* larvae, either *freeborni* or *punctipennis,* in a weed-grown shallow area at the lake, and a few *Culiseta incidens* resting in some of the washrooms. We have concluded that the area remained free of mosquitoes primarily because of the few adults available to propagate the species so late in the season.

The consumption of spray material for larviciding was surprisingly low. Only 5 gallons of 25% DDT emulsion was thus used. Residual spraying consumed about 15 gallons of 25% emulsion. The grading and leveling work costs were $300.000, involving use of a bulldozer for 4 days. The man-hour costs for inspection and spray work are difficult to assess because of the diverse duties of the man hired for this work; however, an estimate of $100.00 appears to be close to the actual expenditure. Total expenditures including bulldozing are estimated at $440.00.

Costs of control for the 1954 season should not exceed $250.00 including *Aedes varipalpus* control since the bulk of the expensive permanent control work has been completed. Can anyone bicker over this amount when weighed against the benefits of comfort and protection of health which it will bring to 1500 young girls?

The question as to the vector species posed at the start of this discussion still remains to be answered. It probably will never be but can we reasonably discount *A. punctipennis* as a possibility?

Nevertheless we are sure of one fact and that is whether it was one or both *Anopheles* involved in malaria transmission at Lake Vera, their efficiency as vectors were irrefutably established.

Another question often raised is why malaria epidemics have failed to materialize in the Central Valley? There certainly have been ample opportunities for serious outbreaks to occur since the early twenties when malaria passed out of existence as an important public health problem in the State long before the advent of DDT, and before the effective therapeutic agents came into being. For example, during the middle thirties tens of thousands of "dust bowl" migrants moved into the Central Valley from malaria endemic states. Although small scattered, outbreaks did occur, epidemiological investigation revealed that by and large the majority of the cases had a previous history of malaria in their home state. Then in later years during and following World War II thousands of soldiers who had contracted malaria overseas returned to California. And more recently a large population of Mexican farm laborers have moved into the Central Valley, not to mention the Korean returnees, but malaria has generally failed to reach the native permanent population.

Perhaps a clue to this enigma might be had by asking another question. Would the Lake Vera epidemic have occurred in the Valley under similar circumstances, that is, if the same set of conditions were transferred to the Valley—the time, the population, the pond, and the one acute malaria case—to an area similar to Colusa County where mosquito abatement is still to be realized?

Some of the outstanding differences between the two areas are first of all, climate—a lower relative humidity and higher temperature shortening the life span of the mosquito; secondly, the composition of the vector population in the valley—there are fewer *A. punctipennis* in comparison to *A. freeborni* during June and July; thirdly, the biting characteristics of *A. freeborni.* June and July are two months of the year when *A. freeborni* is most depressed from the standpoint of adult prevalence and biting activity, as the studies of Dr. S. B. Freeborn, the MCWA and the Rice Field Mosquito Project have consistently shown over many years of observation.

It appears that the conditions stated particularly with respect to the depressed activity of the vector mosquito and the shorter life span in the Valley in July would preclude the possibility of an outbreak occurring as was experienced at Lake Vera.

Dr. Hackett: Thank you, members of the panel. I think we have had a very interesting discussion. I would like to add one more factor to Mr. Fontaine's summing up. It seems to me that we might take into account also the number of domestic animals present in the Central Valley as compared with those in the foothills. That may have been why the miners were a pushover for *punctipennis,* if that was the vector mosquito. The protection of our valley population by domestic animals must be now very solid, whereas I think we can conclude from this discussion that there must be other vacation areas in a precarious situation provided an effective human carrier should come at the proper time.

President Peters: Thank you, Dr. Hackett and panel. I regret that I was unable to open the meetings this afternoon, but I was delayed in offering myself to science. I believe I was the last one to submit to the test.

There a few announcements that should be made in regard to future events. One: we would like to expedite the sale of dinner dance tickets, in order that we can get an idea on attendance. During the recess, which we will have around three o'clock, those tickets can be purchased. We would appreciate it very much if all of you would assume this as part of your obligation in making this a tremendous success in the conference. I am sure you won't regret it. In addition I have been asked to announce that any proposed resolutions should be submitted to the Resolutions Committee. These can be submitted either to the Secretary, Ed Washburn, preferably before five p.m. today, or to any of the members of the Resolutions Committee, of which Harold Gray is Chairman. Lloyd Myers is another member and Roy Holmes is a third

member. In addition, Bill Reeves has asked that those of you who have questions to ask on encephalitis will please get them to our Secretary or to Bill directly, and we have set, as a tentative deadline for the submission of such questions, not later than the recess of tomorrow afternoon, because it will be necessary for Bill to formulate his presentation on these questions from you. Are there any other announcements at the present time? If not, I introduce our next speaker, Dr. James R. Douglas, who is Associate Professor of Parasitology at the University of California at Davis. Dr. Douglas will talk on "Some Vector Problems of Veterinary Interest."

SOME VECTOR PROBLEMS OF VETERINARY INTEREST

JAMES R. DOUGLAS, PH.D.
Associate Professor of Parasitology
School of Veterinary Medicine, University of California
Davis, California

Although the California Mosquito Control Association would appear to be a somewhat specialized organization, dealing largely with the control of mosquitoes which directly affect the health and well-being of man, I would like to think of it as an organization concerned with the control of all arthropod vectors, not only those which affect man, but also those which affect the health of our domesticated animals. Many of our vector problems in veterinary medicine are regional or state-wide and require the application of regional or state-wide control measures. The control of horse flies may be cited as an example. What could be more logical than to have these problems handled by this state-wide collection of organizations which has had so much experience in the complex field of vector control?

To illustrate and establish the fact that we do have problems in the control of vectors of diseases of domesticated animals, I should like to discuss a few of these diseases with you. The list is by no means exhaustive, there are obvious omissions, such as equine encephalomyelitis. The diseases were chosen because each one presents a challenge, an unsolved problem. They have little in common except that an arthropod vector is known to be or thought to be an important factor in the maintenance or spread of the disease. The hosts include cattle, sheep, horses and dogs. The infective agents cover as wide a spectrum as do the hosts, including viruses, bacteria, protozoa and helminths.

ANAPLASMOSIS

Anaplasma marginale, the protozoan which causes anaplasmosis, appears to be specific for cattle although it has been found in deer. In natural infections, after an incubation period of 20 to 40 days, the disease begins with a high temperature. After a day or two the temperature drops and the animal becomes anemic and jaundiced, the feces are hard, often bloodstained and covered with mucus. In acute cases the animal may die within 2 or 3 days after the appearance of symptoms. In chronic cases the animals become weak, progressively emaciated and have a severe anemia. The mortality is quite variable, ranging from 5 to 50 percent. Many of the animals which survive become immune carriers.

The transmission of anaplasmosis is accomplished by ticks *(Dermacentor sp.)* and by horse flies *(Tabanidae).* Mosquitoes have also been incriminated. Some species of ticks are true biological carriers while other species as well as the horse flies and mosquitoes are mechanical vectors. Every summer many cases of anaplasmosis occur in the Central Valley where there are no *Dermacentor* ticks. These infections result from the intermittent feeding habits of horse flies, feeding on carrier animals and then on healthy susceptible animals. Probably any blood-sucking anthropod would be capable of transmitting anaplasmosis mechanically, even the stable fly and horn fly. However, these insects, like the mosquito, generally fill with blood from one host and do not feed again for some time. The horse fly on the other hand, frequently feeds on several animals in the course of obtaining a meal.

ANTHRAX

Cattle, sheep, and horses are all very susceptible to *Bacillus anthracis.* In the per acute and acute forms of the disease the animal usually dies in a matter of hours with a high fever and bleeding at the body openings. The causative organism forms spores and is capable of persisting in areas for long periods, giving rise to subsequent infections. In normal circumstances an animal will acquire the infection by ingestion of feed contaminated with the spores. However, during the summertime, when most outbreaks of anthrax occur in California, the spread from animal to animal is dependent on biting flies, largely horse flies. As a result of this mechanical transmission anthrax spreads with amazing rapidity over large areas, limited primarily by the distribution of horse flies.

In passing it should also be emphasized that the horse fly, in addition to its disease transmitting potential, constitutes a major pest of livestock every summer, particularly in the northern end of the central valley.

The control of horse flies has not been accomplished in California. Since the immature stages are found in mud, often along canals, sloughs and similar situations, it is difficult to reach them with insecticides. The control of adult horse flies is likewise difficult, the application of insecticides to animals has thus far failed to give satisfactory results. The problem requires a great deal more study before effective control measures can be instituted.

BLUE TONGUE

In the summer of 1952 a disease, previously unreported in North America, appeared and rapidly became epizootic in California sheep. It was soon determined to be blue tongue, a virus disease known originally from South Africa. The outbreak stopped suddenly following the first frost in the fall. In the late summer of 1953 blue tongue reappeared and by November had been reported from Modoc County to Riverside County. Thousands of animals were affected and although the average mortality was probably less than 10 percent the loss to the sheepmen was high due to the failure of infected animals to gain weight as they normally would.

In Africa investigation has indicated that gnats of the genus *Culicoides* are capable of transmitting the virus of blue tongue. There is also evidence to indicate that at least one species of *Aedes* was able to transmit the disease.

Relatively little is known concerning the biology of California *Culicoides.* However, there is good circumstantial evidence which leads us to believe that some species do feed on sheep. On the other hand, *Culicoides* are sometimes extremely difficult to find in localities where blue tongue is rampant. Purely on epizootiological grounds it would appear that some other bloodsucking anthropod might be involved. *Aedes nigromaculis,* for example, is found in abundance wherever blue tongue is found. Some transmission experiments with this species as well as *A.*

dorsalis and *Culicoides variipennis* have been undertaken but conclusive results are not yet available.

Should *Culicoides* species be determined to be an important vector of blue tongue in California a great deal of investigative work must be done before rational control measures can be started. Previous work has shown that there are some sixty-odd species of the genus in California and has given us some information on their distribution, but with few exceptions their feeding and breeding habits are unknown.

Pink Eye

Infectious keratitis of cattle, usually referred to as pink eye, is apparently caused by a complex of microorganisms. It is very common in the range country in the summer, and often thousands of animals are infected. Beginning with a simple conjunctivitis, affected eyes develop opacities of the cornea, the inflammatory process becomes purulent, and may invade the orbit, producing permanent blindness.

The transmission of pink eye may be by simple contact between an infected and non-infected animal; however, it is thought that flying insects are an important factor. Here again, it appears to be a purely mechanical type of transmission, potentially any insect which is attracted to the discharges of an infected eye would be capable of carrying the organisms to the eye of a healthy animal. Practically nothing is known concerning the insects which may be important in the spread of this disease, possibly the house fly is an important vector, or flies of the genus *Hippelates* which are attracted to eye discharges.

Arterial Worms

During the past year we have found that we have a new sheep disease in California, Filarial Dermatosis, apparently caused by the larvae of the roundworm *Elaeophora schneideri,* the adult of which inhabits the larger arteries and even the left ventricle of the heart. The disease has been previously reported from New Mexico, Arizona, Colorado and Utah. In New Mexico up to about one percent of the animals in certain ewe flocks are affected. The infection in sheep is manifested by an inflammatory lesion of the skin of the top of the head. This lesion may progress down the cheek and chin and in a small percentage of cases is transferred by contact to a hind leg and thence again by contact to the abdomen. Although the infestation is not a serious one it does cause considerable irritation and disfigures the animal.

E. schneideri is also found in deer but seems to be well adapted to that host and produces no cutaneous lesions. Since other filarids require an intermediate host it must be assumed that *E. schneideri* requires one also. Although this is thought by some to be a blood sucking arthropod there is no information to indicate what it might be.

Heart Worm

Dirofilaria immitis, the heart worm of dogs, is found not only in the right ventricle of the heart but frequently in the pulmonary arteries. The infestation is quite common in California dogs and in severe infections may result in the death of the animal. As in many filarid infestations, the microfilariae of *D. immitis* circulate in the blood stream. They are picked up by a suitable intermediate host, such as a flea or probably certain species of mosquitoes and after a period of development the larvae are inoculated into a dog. The role of fleas and mosquitoes in transmitting this organism is not clearly understood. It is believed by some that the mosquito, although capable of developing infective larvae, is of no consequence in the natural spread of the disease. However, from what is known of the epizootology of heart worm infections, it would seem likely that a vector somewhat more ubiquitous than the flea is involved. The mosquito would appear to be ideally suited to this role.

Eye Worm

Thelazia californiensis, the eye worm, so far as is known is limited to the brushy hill areas of California. Although it is frequently referred to as the eye worm of dogs, it has also been found in a number of other hosts, including cats, wild rabbits, sheep, deer, bear and man. There is some reason to believe that the dog is only an incidental host.

The adult worms inhabit the conjunctival sac and may be seen moving over the surface of the eye. If they are numerous, there may be as many as twenty or thirty in one eye. Their presence produces a severe conjunctivitis and their movement on the surface of the eyeball produces corneal opacities which may in extreme cases lead to blindness.

By analogy with related worms it can be assumed that *T. californiensis* requires an arthropod vector; however, there is no evidence to indicate what this might be. Whether or not the infective larvae are deposited on the eye is unknown. The immature forms may even pass down the nasolacrimal ducts to be ultimately swallowed and subsequently emerge with the feces where they could be taken in by a suitable intermediate host.

In conclusion it can be said that the vector problems of veterinary interest are diverse, only a few of them have been presented here. They offer a challenge to anyone attmpting control measures. Furthermore, there are great gaps in our information where we are reduced to pure speculation on the identity of suspected vectors.

That some of these problems are of considerable economic importance in our agricultural production is obvious to anyone with even a slight knowledge of the field.

In spite of available drugs and vaccines sound economic control of most of these vector-borne diseases of domestic animals must ultimately depend on adequate control of the vector.

President Peters: Thank you, Dr. Douglas. Also from the University of California at Davis we have returning to us Dr. Bohart.

Dr. Bohart: I think it is a good idea, at least once a year, for mosquito abatement people to take time off from their work and to do a little philosophizing about mosquitoes. During the year they are so busy trying to control the pests that they hardly have time to wonder why the mosquitoes are acting as they are. Some of their actions may be taken entirely too much for granted. There are undoubtedly some interesting cases, as I hope to indicate, of peculiarities in the distribution of mosquitoes in California. You might ask "Why don't we have all the species of mosquitoes which we know in the State, around 41, found pretty much throughout the State?" There are probably very good reasons for this uneven distribution, and I want to point out just a few of these.

SOME PECULIARITIES IN THE DISTRIBUTION OF MOSQUITOES IN CALIFORNIA

RICHARD M. BOHART, PH.D.
Associate Professor of Entomology,
University of California, Davis

It is not surprising that California with its great diversity of terrain and climate should have interesting problems in the distribution of mosquitoes. Upon analysis the fauna of this state appears to be the result of a fusion of elements of varied origin. These have been rather arbitrarily placed in the six categories listed below:

1. Endemic species (ones which may well have originated here).—*Anopheles occidentalis, Aedes bicristatus, A. squamiger, A. ventrovittis, Culex boharti, Culiseta maccrackenae,* and *Orthopodomyia californica.*

2. High altitude species ranging into California from lower elevations in Canada.—*Aedes communis, A. fitchii, A. cataphylla, A. hexodontus, A. cinereus,* and *A. pullatus.*

3. Widespread species rather firmly established in California.—*Anopheles punctipennis, Aedes dorsalis, A. nigromaculis, A. taeniorhynchus, A. sticticus, A. vexans, Culex tarsalis, C. quinquefasciatus, C. pipiens, C. stigmatosoma, C. thriambus, C. territans, Culiseta incidens,* and *C. inornata.*

4. Typicall Western U.S. forms.—*Anopheles p. franciscanus, A. freeborni, Aedes increpitus, A. varipalpus, Culex erythrothorax* and *C. apicalis.*

5. Eastern or northern imports still with very restricted distribution in this state.—*Mansonia perturbans, Psorophora confinnis, Aedes flavescens, Culex restuans* and *Culiseta impatiens.*

6. Lower Californian species which seem to have strayed into this state.—*Uranotaenia anhydor, Culex anips,* and *C. reevesi.*

These listings are primarily geographical. Another type of breakdown of distribution could be made on the basis of habitats such as salt marsh *(Aedes squamiger, A. taeniorhynchus),* melting snow pools *(Aedes communist, A. hexodontus, etc.) and treeholes (Aedes varipalpus, Orthopodomyia californica).* Similarly, groupings could be made of species which tolerate certain conditions, but which are commonly found under other conditions. For example, salt-tolerant species are *Culex tarsalis, Culiseta inornata,* and *Aedes dorsalis*; high altitude-tolerant species are *Culiseta incidens, Culex tarsalis* and *Aedes varipalpus.*

It should be obvious from the above examples that distribution in California is closely tied up with ecology and those species with the least specialized requirements can be expected to have the widest distribution. It is more than a coincidence that such species as *Culex tarsalis, Culiseta incidens,* and *Aedes dorsalis* can be found in practically every county in the state.

On the other hand it is interesting to examine the converse situation and try to find an explanation for the extremely limited distribution of some of our species. Arbitrary groupings can again be made as follows: (1) those rather recently introduced species which may be in the process of extending their distribution; (2) those forms limited by intolerance to extreme temperatures at some stage in their life history; and (3) those forms which require a very special ecological habitat. Undoubtedly many other categories and combinations of categories exist.

Possible examples of group 1 above are *Psorophora confinnis,* occurring since 1937 in a few of our southern counties, and *Aedes pullatus,* recorded from Mono and Tuolumne Counties as early as 1947. Both of these species are dominant forms elsewhere and there seems to be no obvious reason why they should not become widespread in California much as did *Aedes nigromaculis* in the years following 1938.

Group 2, which is intolerant of temperature extremes, might include *Culex anips, C. reevesi,* and *Uranotaenia anhydor.* Evidence for this is circumstantial and based largely on the occurance of the species in Lower California as well as on a few scattered records in mild climate areas of California over a long period of years. Although by no means rare, *Culex quinquefasciatus* also appears to be restricted by low temperature and has not extended its range north of San Joaquin County.

A good example of the restricted ecological habitat group 3 is *Orthopodomyia californica* which is found only in treeholes and particularly in those of cottonwood.

A factor not previously mentioned but one which is probably the most limiting of all is competition. Biologists generally recognize that where two species attempt to fill the same ecological niche the one with the higher biotic potential will prevail and eventually will eliminate its competitor. An example of this all-important principle in acton is the partial displacement of *Aedes dorsalis* in irrigated pastures by *A. nigromaculis.* Given high temperatures the latter develops more rapidly than the former and this single factor may be enough to tip the scales. On the other hand, *A. nigromaculis* has shown no disposition to invade salt marshes where *A. dorsalis* is dominant.

This brings up another circumstance worthy of comment. The salt marshes of central and southern California harbor both *Aedes squamiger* and *A. dorsalis.* Thus we have two species in what appears to be the same ecological niche. *A. dorsalis* seems to have the greater biotic potential, yet *A. squamiger* persists very well except with man's interference. An analysis of this situation reveals that competition does not exist in the full sense of the word. *Aedes dorsalis* develops its several generations during the summer and tapers off in the fall. *A. squamiger* completes its single generation during the colder parts of the fall, winter and spring. *Aedes bicristatus* pursues a similar course in fresh-water grassy areas flooded by winter rains and disappears before having to meet the competition of *A. dorsalis* in warm weather.

This same problem of competition may be the factor which is slowing down the spread of *Aedes pullatus* in mountain snow pools and of *Psorophora confinnis* in waste irrigation water north of its present range. Competition may also be the influence which makes *Orthopodomyia californica* a rare and local species. In most types of treeholes it is discouraged or crowded out by the more vigorous *Aedes varipalpus.* It is only in certain types of "soupy" cottonwood treeholes that *O. californica* holds its own year after year. As these special holes are not common, the species is correspondingly restricted.

One final point deals with the effect of "larval preference" on distribution. It is natural to assume that given time and lack of competition a species will eventually extend its range into all situations which its larvae will tolerate. However, adult oviposition habits have a far greater bearing on distribution and type of larval habitat than do larval preferences. It is well known that many species of salt water larvae will mature in fresh water and

vice versa. Treehole larvae will mature in ground pools under certain circumstances, and ground pool types will often appear to thrive in treeholes. The reflex-governed egg-laying habit of the female mosquito is just another factor affecting the pecularities in distribution.

President Peters: Thank you, Dr. Bohart. We have one more paper before recess, so I will call on Mr. R. E. Darby, University of California at Berkeley, who will make a progress report on the Clear Lake gnat investigations.

A PROGRESS REPORT ON THE CLEAR LAKE GNAT INVESTIGATION

By R. E. Darby
Graduate Student in Entomology
University of California, Berkeley, California

Most entomologists are aware of the treatment of Clear Lake on September 15 and 16, 1949, in which Rhothane (DDD or TDE) was used with remarkable success in the elimination of the larvae of the Clear Lake Gnat, *Chaoborus astictopus* D. and S.; however, the reappearance of the gnat larvae in this lake is not so well known. Although no written records were made at the time, Mr. Arnott H. Camp of Nice, who has been associated with the gnat control problem since 1942, reported that a fairly heavy emergence of adult gnats occurred about the fifteenth of September, 1952. The source of reinfestation is not known, since in contrast to the pre-treatment investigation, no thorough post-treatment studies were made. Now the larvae are abundant in the sloughs and other shallow parts of the lake throughout the year; whereas in earlier studies [Herms (1937:4) and Lindquist and Deonier (1943:144)], except for a short migration period, they were reported only from the deeper water well off shore.

In May of this year the Lake County Mosquito Abatement District instituted a study program in preparation for a second treatment of the lake, if and when the number of adult gnats increases to serious proportions. Results of light trap studies showed that early in the relatively cool summer of this year, 1953, the percentage of adult gnats was not proportionately greater than that of other insects, especially members of the Family Tendipedidae (Chironomidae). However, following a sharp rise of water temperature to 78°F. on July 22, the bottom water temperature of the lake levelled off at 73°F. in early August, during which time there was a steady increase in the number of gnats trapped, with the peak emergence on August 9. Even at this time, their numbers did not approach those of the summers before the 1949 treatment. Yet the gnats were plentiful enough to be responsible for mass meetings by the citizens and demands for an immediate treatment of the lake.

One of the principal problems considered this summer, and one which is still largely unsolved, is the ability of the larvae, which inhabit the smaller ponds and the sloughs around Clear Lake, to survive fairly high concentrations of Rhothane. Since these larvae apparently thrive under extremely varied environmental conditions, the possibility of two or more species was investigated. Adults collected from a wide variety of habitats were sent to Dr. Edwin F. Cook of the University of Minnesota for identification. He reported that only one species was involved, but that there was the possibility of several cryptic species or physiological races.

In order to learn whether the survival of the larvae was due to something inherent in the insects themselves or to their environmental conditions, it was necessary to have a knowledge of the physical and chemical factors of the various lakes and ponds of the area. In addition to Clear Lake, twenty other bodies of water were checked for water temperatures, pH, hardness, and dissolved oxygen content. Then field tests were conducted on four lakes selected as representative of different habitat types. After the application of Rhothane, water samples were taken for biological tests. To determine the ultimate fate of the insecticide, post-treatment checks were made and mud samples were collected at regular intervals extending over a period of twenty-four days. Since the analysis of these samples has not been completed, no statement of the results can be made at this time. The water samples taken twenty-four hours after the treatment were tested for the presence of insecticide by using mosquito larvae under controlled laboratory conditions. These tests indicated that there is a correlation between water hardness and either the absence of insecticide or a decrease in its toxicity, since there was a much higher survival of larvae in the lake water of greatest hardness than in the samples from the other lakes treated.

Numerous experiments, designed to test the effect of different concentrations of the insecticide (Rhothane or TDE) on gnat larvae, were attempted throughout the summer. All toxicity tests in which pint jars were used as containers failed due to the inability to keep the control samples alive. By using larger earthenware containers a successful test was finally conducted from August 29 to September 3 with larvae from a shallow slough. A comparison of the two concentrations used showed that 1 part of insecticide to 70 million parts of water gave less than a 94 percent kill over the five-day period, but that the 1 to 50 million concentration resulted in a 100 percent mortality.

Although still in the preliminary stages, this work has produced some evidence which is worthy of future consideration. At present most bodies of water in and around Lake County contain larvae of the Clear Lake gnat. Successful treatment of many of these ponds has never been achieved even with very high concentrations of insecticide, and there is the possibility that a subsequent treatment of Clear Lake may require a concentration of 1 to 50 million parts of water in order to be as successful as that of 1949. Because of the increasing number of lakes and ponds being constructed, and this wide range of tolerance exhibited by the larvae, Clear Lake gnats may be destined to assume a position of major importance in other parts of northern California. It is hoped that the findings of this study, when completed, may be of value in future gnat control projects.

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President Peters: Thank you, Mr. Darby. Our Secretary requests that those who have not turned in their papers please do so as soon as possible, at the intermission

if they are available. We will now recess for no more than ten minutes.

RECESS

President Peters: Ladies and gentlemen, we are about twenty minutes behind schedule, so I ask those people who are on the remainder of the program to make every effort to keep their presentations as brief as is practical. The first participant in the last portion of the program will speak on "Additional Uses of Granular Insecticides in Mosquito Control" by Dr. Don M. Rees, head of the Department of Entomology, University of Utah, George F. Edmunds, Jr., and Lewis T. Nielsen of the University of Utah. I take great pleasure in introducing Dr. Don Rees.

ADDITIONAL USES OF GRANULAR LARVICIDES IN MOSQUITO ABATEMENT

BY

DON M. REES, PH.D., GEORGE F. EDMUNDS, JR., PH.D., AND LEWIS T. NIELSEN
University of Utah

Previous reports on the use of granular insecticides in mosquito abatement programs have been confined largely to extensive operations, involving mechanical applications of the granules. This report is concerned with satisfactory results obtained in the Salt Lake City district and vicinity by hand application of granular insecticides to small, scattered areas in which mosquito larvae were present.

It was found during this investigation that there are various types of mosquito producing situations in Utah which are small and separated from each other, where granular insecticides can apparently be used more efficiently than other types of larvicides and can be applied by hand more effectively than by mechanical means. In the Salt Lake City district these small areas, prior to 1953, were treated with larvicides applied by hand dusters, portable spray pumps or with "tossits." The method used was dependent upon the type of situation and the nature of the larvicide.

The granular larvicides used in these field tests were formulations of 2½% or 5% of heptachlor in 30-60 screenings of bentonite or 5% dieldrin in irregular sized particles of diatomaceous earth. For carrying the granular larvicide in the field a canvas army-surplus general utility bag with both belt and shoulder straps proved to be excellent. One to three rubberized waterproof bags containing pellets were carried inside each utility bag. The insecticide was thus protected from accidental contact with water. Each of the rubberized bags held approximately four pounds of larvicide and thus was adequate for treating two acres. In general, it was noted that personnel tended to overtreat pools rather than to use inadequate amounts.

It was not feasible to use gloves to provide protection to personnel for they were soon discarded when it was found that they interfered with the man's ability to uniformly broadcast the granules. Personnel were instructed to keep the hands below the waist while dispensing the larvicide, thus minimizing the danger of inhaling the insecticide, and to wash the hands thoroughly after spreading the granules.

Most granular formulations are made so as to require from one to two pounds of granules per acre. While the one-pound per acre formulations have the advantage of requiring less bulk material per acre treated, in hand broadcast the two-pound per acre formulations result in greater uniformity of dispersal of larvicides because of the greater number of pellets applied per acre. It was determined by field experience that pellets can be hand broadcast with excellent penetration of even the heaviest vegetation and still provide uniform coverage at the rate of two pounds per acre.

Each field inspector and insecticide crew member of the Salt Lake City Mosquito Abatement District was supplied with carrying bags and granular larvicides. Field inspectors carried granular material at all times while making inspections for mosquito larvae. The pellets were used on all small pools requiring treatment at the time of inspection, and on some larger areas that were distant from access roads. Although an inspector is considerably hampered by carrying even a small spray can, he is able to carry with considerable ease and comfort a sufficient supply of granular pellets to adequately treat several acres by hand broadcast. A considerable number of man-hours were saved each week by this procedure as inspectors are reluctant to carry a spray can during inspections, thus making it necessary, when larvae were located, to return to the vehicle for spraying equipment or to call on an insecticide crew to treat the pool. During 1953 all inspectors treated more pools themselves and called on the insecticiding crews less often than was the case before granular materials were provided. The speed and ease of hand broadcasting is equal, or superior to, spraying with a knap-sack sprayer.

The granular material also proved to be very useful in any area where it was necessary for the crews to carry the insecticides long distances. This was especially true of shallow marshes where no suitable water was available for mixing the insecticides for spraying purposes.

Mountainous areas, where difficult terrain often combines with long distances to make larviciding difficult, were found to be very suitable to the use of granular formulations. A great number of the pools where mountain mosquitoes are located within dense growths of willows. It is considerably easier to cover such areas with hand-broadcast granules than it is to traverse this heavy growth encumbered by a hand sprayer. In such dense willow growths it is often difficult for spray crews to keep moving in one direction and frequently a member of the insecticiding crew will wander from the designated course or will double back onto ground that he or another member has just treated. This unquestionably results in waste of insecticides and manpower and a reduced kill is obtained as a result of the failure to treat some areas. When using heptachlor in 30-60 mesh bentonite granules, we had the unexpected advantage of being able to readily see the swollen, nebulous, colloidal-gel-like particles in the water. Because of this it was readily possible to prevent duplications and omissions of the areas treated. During subsequent checking of the effectiveness of the kill it was possible to see the distribution of granules in relation to the percentage kill. It was also noted that a 5% formulation of dieldrin in diatomaceous earth was not as easy to locate visually as were the heptachlor formulations in bentonite.

When treating mountainous areas, patches of unmelted snow which covered known breeding areas were encountered. Granular heptachlor (2½%) scattered on the snow was apparently effective for no larvae were seen in any of the resultant pools during subsequent inspec-

tions, and the distribution of the granules in the water could be seen clearly.

Previous to the use of granular materials in treating the small and not readily accessible pools within the jurisdiction of the Salt Lake City Mosquito Abatement District, larvicides were applied in the situations described above by hand dusters, portable spray pumps, or as "tossits." In a number of these situations "tossits" (12½% DDT and 4¼% BHC) had been used previously, but granular materials have the distinct advantage of a more uniform spread when the mosquito-producing waters are in the form of small, scattered potholes or pools, when the pools are attenuate, or densely vegetated. In such situations it was often necessary to use excessive numbers of "tossits" or to break the "tossit" and scatter its contents over several small areas. "Tossits" are, however, very effective against pupae. Neither 5% dieldrin nor 2½% or 5%heptachlor granules gave significant pupal kills on mountain species of *Aedes,* even when applied at high dosages.

On one of the gun clubs heavy concentrations of granular heptachlor were used to treat the margins of a number of islands which were inaccessible to regular inspection and spraying. Approximately 5 pounds of granular 2½% heptachlor per acre applied in mid-summer served to prevent mosquito production from these islands during the remainder of the year. A number of non-granular forms of DDT were also used successfully in this program. The islands serve as nesting and shelter sites for many birds but no ill effects were noticed on the birds or fish at any time. Granular formulations of dieldrin were not used in these areas because of the possible toxic effects of such heavy dosages upon the birds and fish.

SUMMARY

During the 1953 season, the Salt Lake City Mosquito Abatement District effectively used granular formulations of 2½% and 5% heptachlor and 5% dieldrin hand broadcast on mosquito-producing waters that were small, scattered, or of difficult access. The granules can be evenly distributed at rates of 2 pounds per acre. The application of granular larvicides on smaller pools by field inspectors resulted in great savings in man-hours. The fact that bentonite formulations are readily visible in the water is advantageous in determining areas treated in relation to effective kill. These granules are superior to "tossits" in many situations, but were comparatively ineffective against pupae. A residual larvicidal application of granular heptachlor also proved effective in the one area where it was tested.

President Peters: Thank you, Dr. Rees. The second paper by Dr. Rees this afternoon is going to be presented by Mr. Graham, "A Season of Mosquito Control With Heptachlor," by Jay E. Graham, Don M. Rees, and George F. Edmunds, Jr., University of Utah.

A SEASON OF MOSQUITO CONTROL WITH HEPTACHLOR

JAY E. GRAHAM, DON M. REES, PH.D., AND GEORGE F. EDMUNDS, JR., PH.D.
University of Utah, Salt Lake City, Utah

Heptachlor was selected as the principal insecticide to be used by the South Salt Lake County Mosquito Abatement District for the year 1953 because it seemed to be well adapted to the particular needs of the district.

Heptachlor is an economical larvicide as the amount required to treat an acre costs approximately 12 cents. Although precautions are necessary, it is a relatively safe insecticide for personnel to handle and, at the dosages used, is not harmful to livestock. Lehman (1951) reports the LD 50 for heptachlor as 90 mg./Kg. weight, with symptoms of poisoning similar to aldrin, dieldrin and chlordan. However, the most important reason for the selection of heptachlor was its effectiveness at low dosages. This was important because most of the mosquito production in the district occurred in areas that were too small to be treated by airplane and could not be reached by vehicles except with great difficulty and then only by circuitous routes. The most practical way of treating such areas was by means of a larviciding crew carrying with them granules or knap-sack sprayers and a quantity of emulsifiable concentrate. A crew using this method could treat 40 acres of water surface with a gallon of 25% heptachlor emulsion. The same area would require 4 gallons of 25% DDT emulsion.

Although heptachlor has not been used previously as the principal insecticide by a mosquito abatement district, as far as could be determined, considerable experimental work has been done. Laboratory tests by Soroker (1951) have shown Velsicol heptachlor to be 8.6 times as effective as DDT against larvae of *Culiseta inornata.* Stage (1951) reports almost perfect control of *Aedes sollicitans* and *Aedes taeniorhynchus* larvae at 0.05 to 0.1 lbs. per acre. This is in accordance with results from California where 85% control of *Aedes nigromaculis* larvae was obtained with 0.04 lbs. per acre (Anon, 1951). McDuffie (1949) reports a 73% kill of *Aedes* larvae at Churchill, Manitoba with a concentration of 0.2 lbs. per acre. Rees and Graham (1953) found heptachlor to be effective in Salt Lake County against larvae of *Aedes dorsalis, Culex tarsalis,* and *Culiseta inornata* at 0.04 lbs. per acre.

The spraying equipment used for the control program consisted of Champion knapsack hand spray pumps with a 4-gallon capacity, and a Farm Master orchard sprayer with a 50-gallon tank mounted on a truck.

Heptachlor was applied at the rate of 0.05 lbs. per acre for larval control and at the rate of 0.1 lbs. per acre for adult control. Number 2 fuel oil containing heptachlor was routinely used for the control of pupae, but in the event that a larviciding crew found a small isolated pool containing pupae, heptachlor was used at the rate of 0.5 lbs. per acre rather than return for fuel oil spray. The great majority of the mosquito larvae and adults treated belonged to the following species: *Aedes dorsalis, A. nigromaculis, A. vexans, Culex tarsalis, C. pipiens* (group), *Culiseta inornata* and *Anopheles freeborni.* Although heptachlor has been found effective against *Anopheles quadrimaculatis* (Keller, 1951) at 0.025 p.p.m., it has not been reported as being used in the control of *Anopheles freeborni.* For this reason, several quantitative experiments were conducted with larvae of *Anopheles freeborni.* It was found that 0.04 lbs. per acre and all higher dosages gave practically 100% control. This is identical to results obtained with other species of mosquitoes found in Salt Lake County.

Heptachlor was used as a residual adulticide on vegetation at the rate of 0.1 to 0.2 lbs. per acre in an effort to prevent the late summer migrations of *Aedes dorsalis* from reaching the populated areas in the district. The insecticide was applied both by hand pumps and a Farm Master orchard sprayer to vegetation along possible migration routes, including streams and marshes. This method

proved to be highly succesful as shown by the following observations. During the week from August 12 to August 18, a migration of *Aedes dorsalis* moved through part of the district before any attempt was made to establish an insecticidal barrier. This migration, although minor, caused considerable annoyance, and many complaints were made by the residents in some areas. Personnel in the field were able to observe adult mosquitoes in considerable numbers along streams and damp areas throughout the district. On September 14, the first mosquitoes of a major migration appeared in the district and heptachlor was immediately used in treating all moist areas and possible migration routes that led to populated sections. Although the later migration was greater than the first, there were no complaints except from sparsely populated areas where no attempt had been made to control the migrating mosquitoes. Personnel in the field were unable to observe adult mosquitoes in areas where treatment of the vegetation had been made with 0.1 to 0.2 lbs. of heptachlor per acre.

Similar results were obtained by the Salt Lake City Mosquito Abatement District in a somewhat different situation. In the marshes bordering Great Salt Lake there are small isolated broods of *Culex, Culiseta* and *Aedes* produced continuously. During August, as the populations of *Culex* and *Culiseta* began to increase on the marshes, light trap catches at the Salt Lake City Mosquito Abatement field headquarters were markedly higher than previously. This light trap is located within a few yards of a drain connecting the city with the mosquito-producing marshes, and since there was no noticeable increase in the mosquito population in the surrounding area, it was apparent that the drain was functioning as a route for mosquitoes moving into the city. The banks of this drain were treated, although not in the vicinity of the light trap, with heptachlor emulsifiable concentrate diluted in water. The heptachlor was applied at the rate of 0.1 to 0.2 lbs. per acre and achieved promising results. Light trap catches for six nights during the three weeks prior to treatment averaged 21.5 while the average catch for a similar period following treatment was 4.7. A third three-week period following the second showed a light trap average of 11.1 mosquitoes per night. The other five traps operated in the district showed little or no change during this time.

A TIFA fogger was used for the control of adult mosquitoes of *Aedes dorsalis* and *Aedes nigromaculis* with 2 gallons of 25% heptachlor emulsifiable concentrate in 50 gallons of No. 2 fuel oil. The results were highly satisfactory.

Heptachlor in granular bentonite of 30-60 mesh was used in areas where the vegetation was thick and satisfactory results were obtained. Granular bentonite containing 2½% heptachlor was applied at the rate of 2 to 3 lbs. per acre and achieved practically 100% control of larvae. Granular bentonite containing 5% heptachlor was applied at the same rate because of the difficulty of spreading the material evenly at lesser concentrations.

Summary

During the year 1953, the South Salt Lake County Mosquito Abatement District used heptachlor emulsifiable concentrate as the principal insecticide for both larviciding and adulticiding. It was found to be effective against all species of mosquito larvae in the county when used at the rate of 0.05 lbs. per acre and against all species of adults when used at the rate of 0.1 to 0.2 lbs. per acre. Heptachlor applied as the residual adulticide on vegetation at the rate of 0.1 to 0.2 lbs. per acre was found to be an effective barrier to migrating or dispersing *Aedes dorsalis* and various species of *Culex* and *Culiseta*. Heptachlor was used for the first time in the control of larvae of *Anopheles freeborni* at the rate of 0.04 lbs. per acre and found to be effective. Granular bentonite containing 2½% heptachlor was used as a larvicide in areas of thick vegetation and found to be effective when applied at the rate of 2 to 3 lbs. of granules per acre. One per cent heptachlor in No. 2 fuel oil was found to be an effective formulation for the control of adults when used in the TIFA fogger.

As a result of these experiments, it is concluded that heptachlor is an effective and economical insecticide for all species of mosquitoes in Salt Lake County when used according to above specifications.

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President Peters: Thank you, Mr. Graham. The final portion of our program will be a panel discussion, titled "New Information on Insecticides." I call on the Moderator, Dr. William M. Upholt, Chief, Toxicology Laboratory, Communicable Disease Center Activities, U. S. Public Health Service, Wenatchee, Washington, to come forward and take charge of the meeting.

Dr. Upholt: Mr. President, members and friends of the California Mosquito Control Association, I assure you that it is with a great deal of pleasure that I stand on this particular platform today. It was several years ago, more than I like to tell, that I was sitting up there in that particular chair, the one in the second with one of your men in it. I was sitting there very attentively with my eyes half closed, when the professor walked in the door here and said "Before I start my lecture this morning, I would like to say something." I feel that I am in somewhat the opposite situation this afternoon. I assure you that after I get through talking the gentlemen on the panel are going to say something.

The question of insecticides, at the time I was sitting up there in the second row, seemed to be a bit divorced from medical entomology as I knew it at that time. In fact I wasn't much interested in medical entomology. I was interested in insecticides. However, I am sure that

all of you are aware that one of the earliest professional recommendations for an insecticide for insect control, was the recommendation for kerosene as a mosquito larvicide. It wasn't very long after that it was discovered that Paris green was a very effective mosquito larvicide and it became widely used in many parts of the world. A few years later, pyrethrum sprays were developed as an adulticide, specifically against those mosquitoes that get into houses and therefore transmit malaria. More recently, DDT has been used as an insecticide against mosquitoes, especially against malaria mosquitoes as an adulticide and residual spray. This more or less revolutionized our concept of insecticides, and it was also used as a larvicide in very small volumes with spectacular results. This added a great deal of hope and impetus to the whole subject of mosquito control. Of course the subsequent developments have been not quite so pleasant, though perhaps more interesting. You folks in California are particularly aware that certain mosquitoes followed the lead of the housefly and developed resistance to some of our new insecticides. Since then a large group of new insecticides has been developed, and we are still trying to find the perfect insecticide that we thought DDT was, and which proved otherwise.

When I have talked about DDT and the development of resistance in houseflies, I have felt like thanking the flies for developing resistance. Actually, we have become pretty neglectful of the fundamental importance of sanitation when we thought that DDT was the whole answer to fly control. I don't think that apology is necessary in mosquito control. I don't think that there are very many people in this room that have forgotten the very important lesson that was learned during the Second World War in the regard to malaria specifically, that malaria control, and mosquito control in general, is a team work proposition. Insecticides have only one small part in the whole picture. I certainly would be the last one to argue with Art Lindquist on the importance of biological information. I certainly wouldn't want anyone to go away from this panel this afternoon with the idea that any member of the panel thought insecticides would take the place of proper engineering. When it comes to malaria control, certainly there are none of us that think that even mosquito control can completely supplant the medical aspects of a disease control effort of that sort. Therefore, in listening to these discussions this afternoon, remember that while insecticides are not the only answer, or golden approach, to mosquito control, we are going to have to depend upon insecticides in many situations for many, many years to come, and our efforts should be to keep up to date, to keep ahead of the mosquitoes, from the insecticide standpoint, as part of a balanced program.

The developments in the last few years have been largely along two lines. One has been improvements in formulations and methods of employing insecticides, in order to make them more effective, and the other has been exploring into the more dangerous insecticides, particularly the organic phosphates. A few years ago we would have thought this group of insecticides too dangerous to even consider their use in a program such as mosquito abatement. I think we have some pretty good experts on both of these lines of development on our program this afternoon. I don't known how I am going to urge the members of the panel to make their remarks a little more brief than I am making mine. Whether they can best do it by throwing away their manuscripts and condensing their remarks, or by following their manuscripts very closely, I don't know. I'll leave that up to the individual speakers. First, I call on Mr. Gjullin to tell us something of the results of his comparative studies of insecticides during the past year.

ABSTRACT OF THE TOXICITY OF AEROSOLS AND RESIDUES TO RESISTANT MOSQUITOES IN CALIFORNIA*

By C. M. GJULLIN
U.S.D.A., Agr. Res. Adm., Bureau of Entomology and Plant Quarantine

Eleven chlorinated hydrocarbon and seven organic phosphorus insecticides were tested as aerosols and residues against resistant *Culex tarsalis* and *Aedes nigromaculis* female mosquitoes collected near Fresno, California. Allethrin and pyrethrin were also tested. Exposures to the aerosols were made in a large building and residue tests were made on glass.

EPN and malathion were the most effective of the insecticides tested as aerosols and several others of the phosphorous group were almost as effective. Females of both species were highly resistant to the chlorinated hydrocarbon insecticides. Lindane was the most effective but 30 times as much lindane as malathion was required to give equal kills of *A. nigromaculis* and 40 to 100 times as much to give equal kills of *C. tarsalis*.

Malathion may be safe to use as an aerosol since guinea pigs and rats have been reported to suffer no ill effects from a 2-week exposure to dosages 100 to 300 times greater than required to kill *C. tarsalis*.

The residue tests also indicated that *C. tarsalis* females were highly resistant to all of the chlorinated hydrocarbon insecticides except lindane and that none would be of any value as a residue under field conditions.

The majority of the organic phosphorous insecticides were effective at low dosages as residues but 21/199 and B-21/200 were much less effective as residues than as aerosols. The relative toxicity of the phosphorous compounds in residual tests followed the same pattern as in the aerosol tests, with the exception of these two materials.

Dr. Upholt: I am sure that there are a number of questions. I have thought of some. If the other speakers do not answer them, I would like very much to have the opportunity to discuss them later if Bob Peters will let us stay overtime a little while. As we learned from Mr. Gjullin's talk, an important part of the new insecticides are the organic phosphates, and Gordon Smith is going to talk to us on the field applications and results with organic phosphates. I think you all know who these speakers are and I'm not going to take time to identify them.

THE ROUTINE USE OF EPN AS A MOSQUITO LARVICIDE

LEWIS W. ISAAC, ENTOMOLOGIST, AND
GORDON F. SMITH, MANAGER
Kern Mosquito Abatement District

Routine use of EPN as a rural larvicide was begun in the Kern MAD early in July of 1952. Circumstances surrounding this major change from the comparatively safe chlorinates to the more hazardous phosphates are already generally known.

* A cooperative project between the Bureau of Entomology and Plant Quarantine and the Bureau of Vector Control of the California Department of Public Health. Grafton Campbell and James W. Huntsman of the Bureau of Vector Control assisted with the work on this project.

In considering a program for the establishment of the use of phosphates in our spraying program, background on three particular subjects were asked for by the regulatory officials before EPN was used extensively in the field. This background involved hazard to field operators, both acutely and chronically; toxicity to livestock feeding in an immediate area being sprayed, and chronic toxicity to livestock through a possible residue build-up on pasture feed.

For information on the possible hazard to field operators spraying this material, routine laboratory checks on blood cholinesterase were necessary. For this study, the pilot and three spray operators were given EPN to use routinely. Blood cholinesterase tests were given these men every two weeks covering a period of four months. The entomologist who did the repackaging of the concentrate for field usage was also given routine tests. During this trial period, several minor accidents occurred, but none with any deleterious effects. First, the pilot was accidently exposed to a fine spray of 0.8% EPN as it blew back from a leaking pressure line, some of the spray entering his eyes. He immediately landed, rinsed his eyes, washed the exposed parts, then went to a doctor for clinical evaluation. Serial blood tests revealed that both the plasma and erythrocyte activity remained within normal variation and no clinical symptoms of poisoning were apparent. On other occasions, one man accidently spilled some of the 45% material on his hands and another spilled some on his clothes. In all cases, the operators were diligent in proceeding with the prescribed precautionary measures. There were no apparent physiological changes and blood activity remained within the normal range, subsequent to contamination.

In addition to this information, another study was conducted to evaluate the potential effects of atmospheric exposures during the application of EPN. This work was performed at the request of the Bureau of Vector Control and was conducted by Paul Caplan, Industrial Hygiene Engineer, and Harold Brown, Industrial Hygiene Chemist, both from the Department of Public Health, Bureau of Adult Health. Atmospheric samples were collected in ethyl alcohol with a midget impinger and analyzed for EPN by the Averill method for the paranitrophenyl group in EPN. The impinger was placed in the cockpit of the plane for testing atmospheric contamination to the pilot and in several of the jeeps while the operators were spraying. I quote from a report which was submitted by these men in August of 1952

> "Since all of our analyses showed atmospheric conditions which are regarded as an acceptable operating level, and since your operators spray approximately 10% of their working time, it does appear that their exposure will be excessive."

With the background on cholinesterase studies and atmospheric contamination completed with favorable results, we felt relatively confident that there was little chance for over exposure to the operators from the dilute tank spray.

While the cholinesterase and atmospheric contamination studies were in progress, pasture studies were also being conducted under the technical advice of Dr. F. A. Gunther, Toxicologist at the Citrus Experiment Station at Riverside. These experiments were undertaken on a typical irrigated pasture covering an area of some 40 acres. Thirty acres were sprayed with EPN while 10 were left as a check area. All spraying was done by air, one gallon liquid at .075 lbs./acre. Immediately before and 24 hours after spraying, grass samples were cut and sent to Dr. Gunther. This was done after each irrigation over a period of three summer months. Six irrigations occurred in this interim. To our knowledge, no phosphate was recovered from any of the grass samples sent. Several samples of treated and untreated grass were sent to the duPont Experimental Station at Wilmington, Delaware, but their toxicologists were also unsuccessful in recovering any residue. There was no indication of EPN build-up in the field. Several times cattle were in the field at the time it was sprayed, and to our knowledge, none of the cattle gave any indications of poisoning. With the accumulation of this data pretty well completed, our reports were submitted to the State Bureau of Chemistry. Permission was granted for us to use EPN not to exceed 0.1 lb./acre.

It appeared then that our principal concern would lie in the handling of the concentrated material before it was diluted to the 0.1% emulsion in the tank. Therefore, before any EPN was used for spraying routinely in the field, each spray operator was issued a written set of instructions informing him of the hazardous nature of the material and just how he was expected to conduct all procedures involved in its use. He was also given a pair of rubber gloves, soap and a partitioned wooden box which was tailor-made to hold six bottles of concentrate. A short demonstrative meeting of instruction was also held so that there would be little chance for any misunderstanding.

The 45% emulsifiable EPN is measured out in single tank charges; each man carries six bottles in his partitioned box. Tanks are completely emptied before refilling, and a full tank is always prepared. Before preparing a full tank, the man is expected to use the following precautionary steps:

1. Put on rubber gloves.
2. Open spray tank.
3. Remove bottle of concentrate from box and empty it in the tank, taking care not to spill concentrate on outside of tank or to contaminate outside of bottle.
4. Replace cap on bottle while it is still over the tank opening and replace bottle in box.
5. Wash the gloves while still on hands, with soap and water.
6. Remove gloves, put them away, and again wash hands.

Although resistance in the *Aedes* wasn't as advanced as in the *Culex* at the beginning of the 1952 season, and we may have been able to use Aldrin or Toxaphene for a little longer on these species, it was felt that attempting to use two different insecticides in the field would be confusing and would hamper control measures by too much lost motion in continually changing insecticides. Also, the operators in the field were compelled more and more to increase the percentage of the spray mixture in the tanks to insure a consistent control of *Aedes*. It appeared only a matter of time before they, too, would be able to withstand extreme amounts of larvicides. It might also be added that by increasing toxaphene to perhaps ½ to 1 pound per acre, it is likely that more danger to livestock would be involved than in spraying EPN at .075 lbs./acre, since chlorinates such as toxaphene and DDT have a longer residual in the field that EPN. That is, there is a much greater chance to build up a toxic residue on pasture grass with the chlorinates. This fact was illustrated by the pasture residue studies and in observing that first stage *Culex* larvae will develop within several days after the water has been sprayed with EPN. Our present application rates are .075 lbs./acre by jeep spray tanks and

.1 lb./acre by airplane. It is our experience that airplane applications pound for pound are slightly less effective than the spraying done with ground equipment.

Rapid hydrolization of EPN does have certain disadvantages in that permanent water holes must be sprayed more often than they were with chlorinates, however, the rapid disappearance of the toxic agent should lessen the chance of resistance developing as quickly as it did with the chlorinates. One of the questions most frequently asked is the possibility of resistance of larvae to EPN. The answer to that is something only time will tell; however, in our opinion, it is very probable that resistance will occur just as it did with the chlorinates. Although little is known of the physiological and genetic backgrounds of this phenomena, observations and studies have indicated that resistant populations are born from a numerically small but highly tolerant natural population. And by natural selection, over a period of generations, this population will increase and prosper. We have had several failures with EPN in one area, but the actual reason, whether resistance or mechcanical, was not positively determined.

In looking back on a full season and a half of using EPN, we have been very satisfied with the material. It has given us excellent overall control. It might appear, then, that our control program for the immediate future, at least, should be very bright. However, one ironic aspect has occurred. Will EPN be available to us for next season's operations? Last season, we were forced to adapt our spray equipment to utilize wettable powder because only enough of the emulsifiable was available for airplane use. It seems possible that no emulsifiable will be manufactured for next year's use. To adjust our airplane for wettable dust at the proper concentration would not only greatly hamper our operations but might very well be impossible without complete rebuilding. Also, a full season's operations of spraying wettable dust in our equipment has indicated that this material is very abrasive and much harder on pump parts than was the emulsifiable. Even though we did use the dust successfully this past season in our jeep spray tanks, we much prefer the emulsifiable. I understand that we will be informed shortly as to whether the emulsion will be available for next season's operations. If it is not, then our control program will hinge on either spraying parathion or again developing one of the new phosphate compounds, several of which have proved to be good and are favorable because of low mammalian toxicity; however, availability for most of these compounds is not yet known.

Dr. Upholt: It is quite apparent from what Gordon has said that we are getting into some problems that involve more than just mosquito control. We get into regulatory problems and we get into agricultural problems and it is appropriate that we should have Mr. Rollins, Assistant Chief of the Bureau of Chemistry of the State Department of Agriculture, talk to us about the relationships of these problems to the Department of Agriculture.

REGULATION OF PESTICIDES

By Robert Z. Rollins
Assistant Chief, Bureau of Chemistry
California State Department of Agriculture, Sacramento

The Bureau of Chemistry of the California State Department of Agriculture administers laws pertaining to the registration, labeling, sale, and use of pesticides; the operations of agricultural pest control operators and their aircraft pilots; and administers laws governing deleterious spray residues on fruits and vegetables, hay and fodder.

Registration of Pesticides. Every chemical product intended for control of any pest must be labeled in accordance with certain requirements of law and registered before being offered for sale in California. Registration may be refused if the product is of little or no value for the purpose intended or if its proposed use presents too great a hazard. More than 11,000 pesticides are registered at the present time and new ones are being registered at the rate of one every 45 minutes. Throughout the State the Bureau samples products found in the channels of trade and analyzes them to determine if each material conforms to the statement of ingredients guaranteed for it by the registrant. Approximately 2,000 products are sampled each year, and an annual summary of the analytical findings is available to any interested person. It is a violation of law for anyone to sell a material for control of mosquitoes unless the product has been registered. Sale of a pesticide in any other than the registrant's sealed or closed container is prohibited, and each container must be labeled with certain minimum information concerning composition and intended use. These requirements of law pertaining to registration and labeling do not apply to material that is given free-of-charge to the user for experimental work. However, in handling and using such experimental material, the user may incure greater responsibility for any damage or injury than would be the case in handling a registered product for which more information and experience has been developed.

Operator Licence. Anyone who engages for hire in the business of pest control must secure an agricultural pest control license covering the type of pest control in which he proposes to engage. This license does not include structural pest control (which is regulated under the Business and Professions Code), preservative treatment of fabrics or structural materials, or household or industrial sanitation services. Such licensing is not required of a mosquito abatement district itself or of its bona fide employees, but it provides a degree of protection or assurance to a mosquito abatement district that may engage the services of an agricultural pest control operator. Licensed agricultural pest control operators are required to register with the Agricultural Commissioner of each county in which they operate and to submit to each commissioner monthly reports on work done in his county. Unless authorized in writing by the Agricultural Commissioner at the written request of the grower or owner, no operator can apply any material not registered in California as an economic poison or apply any registered product for a purpose other than one for which it is registered.

Pilot Certificate. A pilot who operates aircraft in the business of pest control must be examined by the Department of Agriculture and secure a certificate of qualification. Special provision is made for an apprentice to permit restricted operations as a preliminary requirement for a certificate of qualification. This is a personal license renewable each calendar year.

Injurious Materials. Certain pesticides are classified by Department of Agriculture regulations as injurious materials, and a permit must be secured from the county Agricultural Commissioner before they are used. These specific materials are:

(1) Pest control materials containing calcium arsenate, standard lead arsenate or copper acetoarsenite (Paris

green), when applied in dust form by machine-powered equipment.

(2) Pest control materials containing tetraethyl pyrophosphate (TEPP) when applied in unconfined space as a thermal aerosol.

(3) Pest control materials containing parathion.

(4) Pest control materials containing ethyl-para-nitrophenyl thionobenzene-phosphonate (EPN).

(5) Pest control materials containing octamethyl-pyrophosphoramide (OMPA).

(6) Pest control materials containing O-O-diethyl O-2 (ethylmercapto)-ethyl thiophosphate.

The regulations provide detailed requirements concerning the handling and use of these materials, and the regulations apply to everyone except agencies of the United States or of the State of California, and the officers, agents or employees of either acting within the scope of their authority, while engaged in or conducting or supervising research on any such material. If these materials are used by a mosquito abatement district for control, as contrasted to research, the required permits should be first secured. Incidentally, similar permits are required for use of injurious herbicides, which are those containing 2,4-D, 2,4,5-T or MCP, and the commissioner should be consulted before these materials are applied.

HAZARDS. During recent years, an increasing interest has been evident in the potential dangers involved in handling and applying pesticides. Many of the laws, regulations and administrative problems directly concern the injury and damage that these materials may cause. There is need for an adequate assessment of the hazards that the products present to men, to livestock, to honeybees, to fish, to wildlife, and to plants or crops.

HAZARDS TO MEN. The hazards of pesticides to men are fairly well known. It is common knowledge that the organic phosphates can be exceedingly dangerous if not handled with full precautions. The hazards of excessive exposure to volatile solvents and to flammable preparations are generally understood and we have not had any recent report of mosquito abatement workers being seriously affected by the pesticides they handle, but we have had a few reports from other persons exposed to the chemicals who believed that they had been detrimentally affected.

HAZARDS TO LIVESTOCK. The hazards of pesticides to livestock are of two types, acute poisoning by direct exposure to the pesticide during application or chronic poisoning from residues on forage. Acute poisoning from mosquito abatement operations seems rare, and the available data on toxicities of the products generally demonstrate that suspicion of acute poisoning from the amounts involved lacks conviction. On the other hand, reports are sometimes received expressing the belief that mosquito abatement chemicals have caused some more obscure losses, such as reduction in expected weight gain of cattle being fattened, or reduction in milk yield from dairy cows. These are more difficult to prove or disprove. In any event due consideration should be made of all possibilities before applying any pesticide to fields where livestock or their feed would be exposed to contamination.

HAZARDS TO HONEYBEES. The hazard of pesticides to honeybees is sometimes the limiting factor in their use. Severe losses may follow application of aldrin, dieldrin, EPN, lindane, malathion and parathion to any area where honeybees are working, even though worker bees may not be present in the field at the time of application. Other pesticides such as DDT, TEPP, and toxaphene may be applied to blossoming crops if care is taken not to apply them during the warm part of the day when the bees are actually in the field and would be exposed to the spray or dust at the time of application.

HAZARDS TO FISH. Widespread losses of fish in irrigation ditches throughout the rice-growing areas in the Sacramento Valley occurred last summer when dieldrin was applied by aircraft to the rice fields to control rice leafminer. It is believed that most of the losses were caused by careless application of the spray directly to the ditches and also by permitting the contaminated water from the rice fields to drain into the ditches. There have been three separate instances this year in California where toxaphene dust being applied by aircraft drifted into commercial or private fish-raising pools and caused severe losses. Toxicity data or reports of actual experience indicate that fish may be killed by less than one part per million of aldrin, DDT, or dieldrin. The toxicity of many other pesticides to fish is not known.

HAZARDS TO WILDLIFE. The effects of pesticides on wildlife are currently being studied in a federal project conducted by the University of California at Davis. Little is known about these hazards, how important they are, and what precautions should be taken with specific materials, but everyone should be aware that such problems may exist and be alert to consider any effects that come to his attention.

HAZARDS TO PLANTS. Injury or damage to plants or to crops from mosquito abatement pesticides applied at the low dosages common for such treatment seem rare, judging from the lack of reports that have reached the Bureau. However, full consideration of this possibility should be made before any application to a food or feed crop nearing its time of harvest or use. Specific tolerances have been established for certain pesticides on food crops, and mosquito abatement applications should not be conducted in a manner that might share in the responsibility for any excessive residues found on the crop.

UNKNOWN HAZARDS. Unfortunately the hazards or degree of danger presented by many of the modern pesticides to men, to livestock, to honeybees,, to fish, to wildlife, and to plants and crops is not fully known. Consequently an application of a pesticide is frequently charged with causing an injury or damage on what seems to be false or inadequate grounds. If information concerning a pesticide is not sufficiently developed to demonstrate conclusively that it has caused damage, it is likewise difficult to exonerate it from such a charge. All this leads inescapably to the conclusion that in using pesticides for mosquito abatement, it is necessary not only to avoid evil but to avoid the appearance of evil by using only those products in those particular circumstances where their hazards have been adequately evaluated.

Dr. Upholt: This has been of a great deal of interest and I would like to go into a long discussion, but the afternoon is considerably over-crowded already. I have mentioned that one phase of the newer developments involved these newer and possibly more dangerous insecticides. The other phase was improved formulations or methods of application. We have already heard something about pellets by Dr. Don Rees, and now Dr. Bryant Rees of Fresno is going to tell us more about imregnated pellet use in mosquito control.

Dr. Bryant Rees: I too shall try to cut the time as short as possible for two reasons. The material that I am pre-

senting here concurs with what has already been given in a previous paper by my uncle Don Rees. I also have another reason. Around noon today Mr. Davis made the statement that if I could complete my paper within 10 minutes he would give me a 10% raise this coming summer. Now if you believe that you will believe anything I will say up here today.

SOME GRANULAR INSECTICIDES AND PARATHION IN MOSQUITO CONTROL

By Bryant E. Rees, Ph.D.,
Fresno State College and Fresno Mosquito Abatement District

Now, as in the past, the mosquito abatement operator in the interior valleys of California must contend with mosquito sources that form through the improper management or the excessive use of water commonly encountered in poor irrigation practices. During the crop growing season, water collects in depressed areas throughout the fields, primarily at the lower ends. Such mosquito sources are not confined to a single particular type of field, but they are to be found in all types of fields such as pastures, tomato farms, and cotton fields. The pools of water may range in extent from a few square rods to one or several acres.

Although frequently small, such sources are often numerous within a given area and are generally prolific in the production of mosquitoes. During the spring season and early summer, the individual operator may obtain satisfactory control of mosquitoes by normal abatement methods, but as the season rpogresses he is confronted with soft soil or mud and a luxurious growth of vegetation. The mud often prohibits the operation of ground power equipment used in the application of insecticides, and the vegetative growth precludes satisfactory application of liquid insectcides even when the knapsack type of spray equipment is employed. These factors add to the problems of the control operator. By the middle of the summer season, and thus into the fall, the rank growth of vegetation becomes so thick and tall in these perpetual pools, often ranging in height from two to six feet and becoming matted with the first passing wind, that very little, if any, of the insecticide applied as a spray reaches the water surface, being lost or caught on the mass of vegetation. Furthermore, these mosquito sources are often too small, too numerous, or too dangerous to reach with an aplication of insecticide by means of the airplane. The operator, and thus the abatement agency, is forced, therefore, to accept a minimum of mosquito control in these waters. Treatment may be limited to only the exposed water surfaces or to the impregnation of the water with an insecticide as it enters the field.

The fact must be faced that when the operator is confronted with such sources and problems, he may be content to treat only the water that may be easily reached, usually at the periphery of the pond. In such instances, mosquito larvae near the center of the pool are not contacted by the insecticides. Or, if the operator is conscientious, he may attempt to treat the entire area. In this attempt he may spend a great amount of time and effort on a small yet important mosquito source, returning for repeated applications of insecticides on the average of not less than once a week, and still he may not produce a satisfactory control. In numerous instances a large number of larvae may be well protected from liquid insecticides by a canopy of vegetative growth. With these problems in mind, a number of experiments were undertaken to check the effectiveness of certain insecticides, insecticidal preparations, and methods of application, when applied to areas containing waters difficult to treat by normal mosquito abatement methods.

In order to obtain data as nearly accurate as possible, a counting cell was devised and employed, the percentage error of counting larvae by the number found in a dipper of water being considered too great. Also, the dip-method of counting larvae did not show the actual number of larvae killed within a given length of time.

The counting cell was made by using an 11¼ inches by 11¼ inches pine board of three-fourths inch thickness. This served as the base of the cell. Heavy duty, wire hardware cloth, of four mesh to the square inch, was stapled to the edges of the base. The hardware cloth, when attached, varied in height from one to one and one-half feet, depending upon the depth of the water in which the cell was to be used. The standard cell, adopted in this work, was a cube, 11¼ inches by 11¼ inches by 12 inches. The sides of the cell were lined with 16 mesh household screening. The strong hardware cloth gave rigidity to the cell, and the household screening retained larvae of the third and fourth instars, and pupae, when included in the study. In this manner, a given number of specimens could be placed in the counting cell and retained there, although movement of water through the cell was not greatly encumbered. A steel rod, ¼ inch in diameter and one and one-half feet long, was attached to the center of the wooden base. Not only did the rod, when driven into the ground, hold the cell in place when submerged, but its strength was sufficient to support the cell whether or not the base of the cell rested on the bottom of the pond. By driving the rod into the ground a predetermined distance, the cell could be brought to rest at any depth desired for experimental purposes. For inspection after an application of insecticide, the cell was pulled slowly toward the surface, and the living and dead larvae counted without the necessity of removing the cell from the water. This served well in waters of sufficient turbidity to hide the bottom of the cell even though submerged only a few inches beneath the surfac. A cap of household screening over the cell, when desired after applying the insecticide, prevented the escape of any adult mosquito that may have emerged during the experiment.

In the various experiments undertaken, from three to five counting cells were distributed throughout a mosquito-producing area before an application of insecticide was made. Some of the cells were placed in open water; others in water protected by a covering of vegetative growth, or under any condition where mosquito larvae were to be found. Some cells were submerged deeply in the water; others kept near the surface. One or two cells were placed beyond the limits of the area to be treated to serve as controls for the experiment. A given number of larvae, usually 50 or 100, was placed in each cell. Dip-method counts of larvae were taken throughout the area in order to supplement the data obtained from the counting cell studies. Materials and insecticides to be tested were applied to the selected area with as much disregard as possible for the presence of the counting cells or their locations. Often the cells were so hidden from view that the person applying the insecticide did not know their positions, or, if he did, he continued his application as though the cells were not there. Whenever possible, as

the operator approached the cells that were visible, he would close his eyes, continue walking and spreading the materials until he had gone beyond the cell, or until such time that a co-worker informed him that he had passed the cell. It is believed that by following this system as nearly normal distribution of material as possible was obtained.

In conducting the various tests, protective measures were taken in the application of the materials since some of the insecticides were considered to be detrimental to the health of the operator. Protective clothing against the effects of the insecticides, however, was kept to a minimum in order to check the practicability of using certain insecticides and methods of application. In all instances, the only protective clothing consisted of a pair of heavy duty rubber gloves that reached well up on the forearm. Considered of greater importance than protective clothing in removing the operator from the dangers of the insecticides was the method of application of the granular material under question.

Starting at the downwind end of the area, the operator took five steps forward, turned to face the traversed area, and then threw a total of three handsful of material, the first handful in a sweeping arc to his right, the second in an arc directly in front of him, and the third in an arc to his left. This scattered the granules in an arc of approximately 240 degrees and cut across irrigational furrows used in watering the crop. The operator then moved five yards in the initial direction, turned, and repeated the broadcasting. By always moving away from the treated area and upwind neither the operator nor his clothing became contaminated with the insecticide that may have settled on the vegetation or the dust that may have been drifting in the air.

Although liquid insecticides were also tested during the summer of 1953, this report covers only the data obtained from test areas treated with granular preparations of various insecticides. When comparative data were desired, the experiments were conducted on mosquito sources as nearly similar as possible; otherwise the areas were selected for the difficult problems they presented in mosquito control. In some instances, where tests proved negative with one type of insecticide, another type was applied to the same area to see if favorable results could be obtained by the use of a different material or method of application. Tests were run with 5% toxophene in bentonite granules, 2% dieldrin in diatomaceous earth granules, and 1% parathion in a granular preparation of diatomaceous earth.

Two test areas were treated with 5% toxophene granules of bentonite, the first initiated on August 12, the second on August 14. In the first test a permanent mosquito source of approximately one-third of an acre was located at the lower end of a pasture. It contained vegetation typical of such waters; cat-tails, sedges, and grasses. The depth of the water varied from a few inches to approximately one and one-half feet. Continued irrigation kept the area well supplied with water. Much of the area was filled with dense growths of vegetation, but for the most part it was open water. No larvae were found to be present in the deep open water, but their count averaged around 25 per dipper near the bases of some of the plants. In the shallow temporary waters, or areas that were periodically flooded with each irrigation, the larval count often exceeded 50 larvae per dipper of water. Both *Culex* and *Aedes* larvae were present in all stages of development; adult mosquitoes were numerous.

Five counting cells were placed throughout the area, and one serving as a control was placed beyond the distribution limits of the insecticide. Into each cell were placed 50 third and fourth stage larvae and five pupae. On August 12 the field was treated with 5% toxophene in bentonite granules at the rate of 10 lbs. per acre. A check of the cells 24 hours later showed a 80 to 85% kill of the larvae, but no evidence of a decrease in the adult population of the area was noted. Pupae in all counting cells were still alive or had transformed into adults. Of the adults that had emerged 50% were found dead on the surface of the water. Larvae in the control cell were found to be normal. A repetition of this test was conducted on August 15-16 within the same general area with duplicating results.

A third test with the 5% toxophene granules proved much less successful. This was conducted over two selected acres of the Fresno City Sewer Farm. The field was densely overgrown with Bermuda grass, a foot or more in height. The water within the area averaged approximately three inches in depth at the start of the experiment. *Aedes* larvae were present in all stages of development and averaged well over 50 larvae per dipper. Pupae were numerous, but few adult mosquitoes were present. Again five counting cells were distributed throughout the area to be treated. Two additional cells, serving as controls, were placed beyond the limits of the selected area. The area was treated on August 14 by hand broadcasting with 5% toxophene bentonite granules at the rate of 10 lbs. per acre. Twenty-two hours later an examination of the counting cells showed a larval kill ranging from 80% in one cell to 15% in other cells. The overall average kill in the counting cells was 37%. A close examination of Cell #1 with the 80% kill revealed that it had received more granular material in the treatment than any two others combined. The failure of a high larval kill in this instance was attributed to the fact that sometime during the intervening 22 hours, the volume of the water in the test area had been greatly increased and now stood at a depth of two feet and over. The increase, however, did not take place until eight hours after the treatment had been applied, indicating, perhaps, that even though the water volume had not been greatly increased, the overall larval kill might not have been satisfactory. If it may be assumed that the material did not reach the water at the time of the application because of the denseness of the Burmuda grass, it would, nevertheless, come in contact with the water as the water rose on the plant growth. Several factors, then, such as the condition of the water and the slowness in which the insecticide was released from the granules, might have contributed to the failure in the effectiveness of the insecticide in this instance. Further examination of the counting cells showed the pupae to be alive or that they had changed into adult mosquitoes. Larvae in the control cells were normal, and, unlike the day of the treatment, adult mosquitoes were numerous throughout the field.

A roadside borrow pit, 275 feet by 8 feet, served as a test area for dieldrin. Waste water from a tomato farm continually collected and stood in this depression to a depth ranging from four to nine inches. On the date of the treatment, July 20, grass and other vegetative growth varied from one-half foot in height at one end of the pond, to four feet in height at the opposite end. The larval count averaged 23 larvae per dipper. The treatment of the area consisted of an application of 2% dieldrin in diatomaceous granules distributed at the rate of 5 lbs. per acre by the

adopted hand broadcasting method. On July 21, or 19 hours later, an examination of the counting cells and the water in general showed that no evident kill had been obtained.

Similar applications of 2% dieldrin granules in two additional test areas gave no better results, and in these areas the application of the material was increased to 10 lbs. per acre. The first area was approximately two acres in extent, densely overgrown with grasses and other semi-aquatic vegetation. Located at the lower end of a cotton field, it was continually supplied with water with each irrigation of the field. The height of the vegetation varied from three to six feet, and during a windy period the plants had bent over and become matted. The water depth ranged from eight inches to two feet throughout the greater portion of the area. *Culex larvae,* taken throughout the source, averaged 23 per dipper, with a few *Aedes* larvae appearing in water near the periphery of the pond. In order to insure equal distribution of the granules, the material was diluted with road dust to twice its volume. The area was treated July 27, and 24 hours later an inspection revealed no appreciable kill of the larvae. It is believed that the lack of a kill in this instance might be attributed to the fact that the insecticidal granules had been diluted with the road dust, and, thus, perhaps, the dust had absorbed some of the insecticide. If such were the case, then the insecticide was lost as it blew away with the dust or settled on the vegetation. Also, in this case, the depth of the water was not less than six inches, which might have been a contributing factor to the failure. In order to check this supposition, a second and comparable test was run on a similar area, but in this instance the material was not diluted in volume. Like in the preceding, the water was well over six inches deep throughout most of the area; no appreciable kill was noted. Concurrently and on the same date, July 28, still another test was conducted under like conditions with the exception that the water in this area had a depth of six inches or less. In this instance a 78% kill of the larvae was obtained, indicating that the depth or volume of the water treated might have an influence on the effectiveness of dieldrin. In none of the above tests were the pupae affected.

On August 3, the area formerly treated with dieldrin had been flooded so that it now covered three acres. Mosquito larvae were present and varied in number from three per dipper in peripheral waters, treated three days before with a DDT and oil mixture, to 31 larvae per dipper in the more centrally located waters. Experimental treatment was applied on this date. It consisted of an application by the hand broadcast method of 1% parathion in diatomaceous earth granules and applied at the rate of 20 lbs. per acre, or 0.2 lbs. of actual parathion per acre. Inspection of the counting cells and the general area 22 hours later showed a 100% kill in the treated areas. The larvae remained alive in untreated areas and in the counting cells used as controls. Examination on August 7 showed no living larvae in the treated areas, but they were present in the untreated areas and control cells. Some pupation had occurred. Inspection of the area on August 10 produced the same results, but in the meantime waste irrigational water had increased the water surface from three to three and one-half acres and raised the depth of the water an additional eight inches. On this date an application of parathion granules was made on the untreated area, leaving the eastern portion of the area untreated to serve as a control. The cotton field was again irrigated on August 13. An examination on August 17 showed an average of five larvae per dipper in untreated water at the eastern end of the area. At the northern fringe of the area where the water was flowing in from the cotto field, the larvae count was 0.25 per dipper. On the following day, August 18, an extremely careful inspection revealed the presence of a few first and second stage larvae, and a second general application of parathion was made. Waste irrigational waters were still flowing into the area. On August 21 two larvae were found within the treated area, while in the control area the larvae count stood at 31 per dipper. On August 26, or eight days after the second general application of parathion, another extremely careful check was made of the area at which time 9 larvae were found within the treated area, 2 first stage larvae, the rest third and fourth instars. These were found in two small isolated areas of water in the center of the treated area and semi-concealed by a dense matting of grass. During an examination of the area on September 9, after five floodings of water, 29 larvae were taken, again from small isolated patches of water within the matted grass area near the center of the pond. One was a first stage larva; the others seconds and thirds. No larvae were found in those areas where good coverage had been obtained, either within the area proper, in the treated cotton field leading into the area, or in the ditch surrounding the area. This was the date of the last inspection.

Supplementing the above, a test was run on another area of about one-fourth of a acre in extent. This mosquito source was formed from the waste irrigational water from a vineyard. Cat-tails were present, and other semi-aquatic vegetation varied in height from a few inches to three feet. After stopping normal mosquito control operations for a period of about 10 days, *Culex* larvae were found to average 38 per dipper in most of the area, while around the edges of the pond where Bermuda grass was present, *Aedes* larvae averaged 23 per dipper. The area had been treated previously at least once a week with one of several liquid insecticides without obtaining satisfactory control. On August 10 it was treated by the hand broadcast method with 1% granular parathion at the rate of 0.2 lbs. of actual parathion per acre. Inspection of the area 22 hours later showed that all larvae within the counting cells had been killed and that no living larvae could be taken anywhere within the treated waters. Repeated examinations up to August 17 revealed no mosquito production to be taking place, although the area had produced mosquitoes prolifically throughout the summer season. By this date the volume of water had decreased to one-eighth of its original amount. Five days later the pond was dry.

Keeping in mind that the only mosquito sources selected for experimental purposes were those containing luxurious growths of vegetation, areas continually being supplied with water or otherwise possessing conditions unfavorable for normal applications of insecticides, and consequently difficult to bring under proper control, the data may be summarized.

Five percent toxophene in a bentonite preparation, when applied at the rate of 10 lbs. per acre by hand broadcasting, gave a 80 to 85% control of mosquito larvae in open water, or in water in which vegetative growth was not dense. When applied to areas with dense growths of vegetation, its effectiveness was greatly reduced and resulted in a 37% larval kill.

Two percent dieldrin in a diatomaceous earth preparation gave no evident larval kill in water of more than six inches in depth when applied at the rate of 5, or even 10

lbs. per acre. When diluted with road dust, it appeared that some of the insecticide was absorbed by the dust, and thus the granules lost their effectiveness. Applications of 2% dieldrin on water with depths of six inches or less gave a larval kill of 78%.

An application of 1% parathion in a diatomaceous earth preparation, when applied at the rate of 20 lbs. per acre, or 0.2 lbs. of actual parathion per acre, gave a 100% control of larvae within a period of 24 hours, even in waters containing extremely dense growths of high vegetation. Furthermore, the lethal action of the insecticide appeared to be effective for a period of not less than two weeks, the insecticide prohibiting prolific mosquito production probably as long as three weeks. However, since larvae began to appear in two weeks after an application of the insecticide, water treated with parathion in the specified amount might not of necessity be considered exceedingly dangerous after this period of time. It has been shown that two applications of parathion produced excellent mosquito control for a period of approximately six weeks when the applications were made from two to three weeks apart.

No ill effects were experienced by the operator applying the insecticide, even with little protective clothing, since the person did not craelessly expose himself to the chemical. Protection was accomplished by taking the precautionary measures of remaining upwind from the material as it was being broadcast, and by not entering the treated area during the application.

It appears, therefore, that the use of parathion in the control of insects might be extended to the control of mosquitoes, but under certain considerations or with certain logical reservations. Its use, at the present time, can not be general, but it might be reserved for the treatment of mosquito-producing waters that are difficult to bring under control because of the failure of current mosquito control measures. The simplicity of application of the insecticide in granular form and the length of its effevtiveness, even when subjected to increases in water volume, makes its use economically and practically sound for limited control.

Dr. Upholt: I never was very good at mathematics. A ten percent raise for staying within the ten minutes! I hope the last speaker is looking for a two percent raise. Do we have time for the last speaker?

President Peters: I am afraid we do.

Dr. Upholt: There are a lot of trite statements about the last being best and so forth. This subject, to me personally at least, would be the dessert of the session. I have always been very much interested in wetting agents and detergents. Mr. Robinson of Salinas is going to talk on wetting agents or detergents for the purpose of mosquito control.

SURFACTANTS AND THEIR USE IN MOSQUITO CONTROL

By Wilbert J. Robinson, Entomologist*
Chairman, Biological Sciences
Hartnell College, Salinas

The purpose of this paper is threefold: to report the practicability of using "surfactants" or surface tension reducers in the control of mosquito larvae and pupae under routine field conditions as experienced by the average operator of the Northern Salinas Valley Mosquito Abatement District; to show the effects of the same materials in the control of *Aedes nigromaculis* in the Dos Palos area; to itemize the material cost of using "surfactants" so that a comparison can be made with a standard application of DDT. A standard application of DDT as used by the Northern Salinas Valley Mosquito Abatement District is 0.8 pounds of DDT per acre, at a cost of $0.64 with a minimum mortality of 80%.

Howard Greenfield, Manager of the Northern Salinas Valley Mosquito Abatement District, became aware of the larvicidal and pupicidal potentialities of a "surfactant" while performing some routine tests in the laboratory. Surfactants or surface tension reducers have the property of lowering the surface tension of water. Several informal laboratory and field trials followed. These trials showed sufficient promise to warrant this field investigation conducted according to approved scientific procedure.

With the exception of the Archie Swindle's permanent pasture field experiment in the Dos Palos area, all field tests were performed in the Salinas Valley. All experiments were conducted during the summer of 1953.

Material and Methods

The four commercial surfactant brands tested were RED TOP, ORONITE SLURRY, H²OK, and METTANOL.

RED TOP contains as an active ingredient polyethylene glycol and monoiso-octyl phenyl ether. This material contains a spreading agent as well as a wetting agent. A 25% solution costs $2.50 a gallon.

ORONITE SLURRY can be purchased at a cost of $14.25 per 100 pounds. The active ingredient was not revealed.

The current cost of METTANOL is 14.5 cents per pound.

A new four-and-one-half gallon Hudson Du-More Bak-Pak Sprayer capable of maintaining an 80-pound continuous pressure and containing a double-paddle type agitator operating at each stroke was used in applying the surfactants. A T-jet 8002 nozzle was finally chosen because it released one gallon of material upon each 1/16 acre test plot (17 yds. x 8.5 yds.) with one pass of wetting agent. The sprayer was rinsed thoroughly after each test.

Twenty pre-and-post larval and pupal counts were made on each 1/16 of an acre test plot. Since surfactants have a tendency to drift because of wind action, post-larval and pupal counts were restricted to the center of the plots.

The writer, assisted by John Isaac, served as a vacation-relief field operator in order to subject the four brands of surfactants tested to usual field conditions in the Salinas Valley. Useful guidance was received from C. M. Gjullin, Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, and Howard Greenfield, Manager-Entomologist of the Northern Salinas Valley Mosquito Abatement District.

Results

Field test conducted in the Dos Palos area indicated that forty-eight gallons of an 8⅓% solution of surfactant applied to an acre gave the maximum mortality. (Table I)

* Mr. Robinson was employed by the Northern Salinas Valley Mosquito Abatement District during the summer of 1953.

TABLE I—Surfactant field test. *Aedes nigromaculis* larvae, 3rd-4th instar, permanent pasture—Dos Palos

Gallons per Acre	Average per cent larvae mortality in 24 hours		
	Red Top	Oronite Slurry	H²OK
16, 25% solution	77	21	74
16, 12½% solution	0	20	0
16, 8⅓% solution	0		
48, 8⅓% solution	95	63	53

An evaluation of the four brands of surfactants tested (Red Top, Oronite Slurry, H²OK, and Mettanol) under environmental conditions prevalent in the Salinas Valley gave indications that no single brand, with the exception of Mettanol, was decidedly more toxic to larvae than others (Table II). Oronite Slurry and H²OK stand out as a dependable, inexpensive pupicide as well as a larvicide (Table III).

In competition with 0.8 pound of DDT applied to an acre at a cost of 64 cents with an 80% to 90% mortality, the figure shown in Table V expresses the futility of considering a surfactant as a larvicide with a 90% or more mortality because of the exorbitant cost of material. Oronite Slurry shows promise as a larvicide and pupicide (Tables II and III) that might be used to control Culicines at a cost of $4.64 per acre, with 98% mortality.

Table IV indicates that a 1% solution of the respective brands gave a larvae and pupae mortality of more than 80%, providing it is applied at the rate of 48 gallons of solution per acre. The cost per acre ranges from 56 cents to $4.80 (Table V).

TABLE II—Surfactant field test. 4th instar and pupae, salicornia salt marsh, brackish water confined to deep cracks in the marsh

48 Gallons of 8⅓% solution per acre	Average per cent larvae and pupae mortality in 24 hours			
	Red Top	Oronite Slurry	H²OK	Mettanol
Larvae	45	86	58	9
Pupae	72	98	13	26

TABLE III—Surfactant field test. Culicine and Culiseta larvae, 4th instar and pupae—septic tank overflow and industrial water outflow ditches, irrigation water overflow, impounded water associated with culverts. Vegetation types from algae to grasses and rushes

48 Gallons of 8⅓% solution per acre	Average per cent larvae and pupae mortality in 24 hours			
	Red Top	Oronite Slurry	H²OK	Mettanol
Larvae	98	98	92	43
Pupae	72	100	100	58

TABLE IV—Surfactant field test. Culicines—4th instar larvae and pupae—septic tank and industrial impounded water, brackish

48 Gallons of 1% solution per acre	Average per cent larvae and pupae mortality in 24 hours			
	Red Top	Oronite Slurry	H²OK	Mettanol
Larvae	81	83	83	
Pupae	100	86	90	

TABLE V—Surfactant field test. Surfactant cost per acre in comparison with an 0.8 pound of DDT per square acre at a cost of 64 cents

Concentration of Solution	Gallons per acre of Solution	Cost of Surfactant per Acre			
		Red Top	Oronite Slurry	H²OK	Mettanol
25%	16	$40.00	$4.64	$8.00	$4.64
12½%	16	20.00	2.32	4.00	2.32
8⅓%	16	13.33	1.55	2.66	1.55
8⅓%	48	40.00	4.64	8.00	4.64
1%	48	4.80	.56	.96	.56

Conclusions

Fortunately the Northern Salinas Valley Mosquito Abatement District has not been seriously confronted with a chlorinated hydrocarbon resistance problem in the control of mosquitoes. At present various solutions of wetting agents are being used to control the mosquito populations of fish-laden farm ponds, watering troughs, fire barrels and pupae-laden waters.

The results of this investigation shows sufficient promise to warrant extensive experimentation with other brands of surfactants. More field work is needed in the testing of surfactants having concentrations of less than 1%. Further information is also needed in regard to the effectiveness of a surfactant as a pupicide and larvicide in the control of *Aedes nigromaculis,* because of the incompleteness of the data obtained in the Dos Palos test plots. Finally a laboratory investigation should be made to determine whether a surfactant is a "toxicant" or merely brings about a "drowning action."

Summary

Field investigations conducted this past summer to determine practicability of using "surfactants" in the control of mosquito larvae and pupae indicate the following:

1. Of the four brands tested, Red Top, Oronite Slurry, and H²OK show definite larvicidal and pupicidal possibilities when sprayed at 8⅓% and 1% concentrations at 48 gallons per acre. Rate of application is a greater factor in control than is the depth of water treated.
2. An 8⅓% solution of Oronite Slurry is the more consistent and the least expensive to use in the control of Culicines. The mortality is usually over 90% for both larvae and pupae at a cost of $4.64 per acre.

(Editors' Note: The costs given in this paper are apparently material costs only. The relatively large volumes of solution applied (48 gallons per acre) would imply larger over-all costs of application (man-hours, and machine-hours) as compared with insecticides applied at the rate of 2 to 10 gallons per acre. In the face of a materials only cost of $4.64 per acre, with a 90-98% mortality, the statement that two of the surfactants tested "stand out as dependable, inexpensive pupicide as well as a larvicide" appears to be somewhat exaggerated.)

3. The results tabulated in Table IV are the most promising. The brands tested show an excellent pupal mortality when used in concentrations as low as 1%. The larval mortality is greater than 80%. The cost is 56 cents per acre as compared with DDT at 64 cents per acre.
4. The results gathered from the few experimental plots tested in the Dos Palos area are not conclusive, as shown in Table I, because eleven of the key plots dried up before a post-larval and post-pupal inspection could be made.
5. Surfactants do not seem to harm fish and other types of wildlife associated with ponds and other forms of impounded water.

Dr. Upholt: I have always been an optimist, and I certainly hoped that we could get in some good discussions on this panel. However, I am afraid we will have to carry on the discussions during the hospitality hour. Is that right?

President Peters: I believe so.

Dr. Upholt: Then I'll turn back the meeting to you.

President Peters: Thank you very much, Dr. Upholt and panel. One comment that I would like to make is that we all know that we have occasion to preserve our specimens in certain types of preservatives. We would like to help you preserve the ideas that you have picked up here today at our hospitality hour. Each and every one of you is invited for 6:30 to the Lido Deck of the Hotel Claremont, where I am certain that some of the ideas that we have picked up here will be consumated. We will now adjourn, remembering that the business meeting is to convene at 9:00 A.M., tomorrow at the Claremont Hotel.

THIRD SESSION

THURSDAY, DECEMBER 3, 1953, 9:00 A.M.

CLAREMONT HOTEL, OAKLAND

President Peters: This morning is our annual business session. There are several announcements that have to be made prior to entering into the business session. One has to do with the final day's program. As we announced previously, Bill Reeves has a program in which he is going to tell us what we want to know about encephalitis. The questions are your problem. We are expecting that questions will be submitted in writing to either Bill Reevees or Ed Washburn, and then Bill will make an effort to answer these questions. What are these things that we want to know about encephalitis? What are the things that you are confronted with in the field? What questions do the public ask? Think in terms of that and try to get those questions in as soon as possible.

There is one announcement regarding the dinner dance tonight. Tickets, I presume, are still available. Is that correct, Ted Aarons?

Mr. Aarons: Yes, the dinner dance tickets are available at our registration desk. We have to get word in by noon. We are hoping to get at least two hundred people there, so if you do not already have your tickets, please get them at the first opportunity. It is going to be a very nice affair, right here in the hotel main dining hall. We have a Bay Area name band lined up with entertainment, following the dinner. The price of the dinner dance is three dollars and thirty-five cents.

President Peters: What is the story, Ted, on the ladies' luncheon today?

Mr. Aarons: The Women's Committee is having their luncheon today, and I think some eighteen or so indicated yesterday that they were going to attend. The luncheon is to be held at Jack London Square at the foot of Broadway in Oakland, at the Sea Wolf Restaurant. Tickets are available, and will be available right up until noon at our registration desk, at two dollars. The wives are going to meet in the hotel lobby and go down together, so if you haven't obtained tickets for your wives, do so by then.

President Peters: I think it is an appropriate time that announcement be made that the former manager of the Kern Mosquito Abatement District, Art Geib, has been ill. Gordon Smith, can you bring us up to date on this?

Gordon Smith: I don't know too many of the details. Art had a rather serious heart attack a couple of weeks ago, of a coronary type. They are not sure whether it was thrombosis or whether it was an occlusion. He has had some warning prior when he had heart pains, and had gone to a doctor to get checked up on. The prognosis is good now. He seems to be feeling all right and he is beefing about being kept inactive. The general thing is now, that he has had his warning and will have to slack off, and give up some of his more active pursuits, but so far as I know, he is going to get over it.

President Peters: Thank you, Gordon. The Board of Directors at the business session previous to this one agreed to send a wire to Art, and also, I believe, flowers as well. In addition to that, Tommy Mulhern has been circulating a program of this conference which anyone who is interested is signing. I am sure those of you who know him well will want to put your name on the program as sort of a "get well' gesture.

Mr. Gray: President Bob, there is one very old timer here today that we are very happy to see. He hasn't been active for some time. He retired from management of the Napa District a few years ago. Old Ham Emerick, *Gambusia affinis* himself, Mr. President. The old timers know him but I would like to have him stand up and let the youngsters see him.

Mr. Emerick: It is great to see most of the boys again after an absence of about four years. You can tell this other gentleman that had this little ailment, that if he will take the advice of his doctor, he will still be around to do a little hunting and fishing and fill a position the same as I have done since I was compelled to retire. It is a great pleasure to be here with the group today and hear what new things are going to come up that I didn't hear when I was with the Napa County Mosquito Abatement District. But I have a successor here that is a very fine man to take my place.

President Peters: Thank you very much. This morning in the business session, I am hoping that we are going to be able to carry on within a reasonable time. That can only be done if we attempt to expedite all of our talks and try to use as few words as possible to express what we have to say. I wish that each and every one of you would observe that method in the presentation of your information today.

This is the opportunity for the President to sound off, here at the first part of the meeting. I am not going to take too long. I was very happy to hear what Mr. Geddes had to say yesterday, because in view of what I have to say, perhaps it is not altogether my own opinion.

PRESIDENT'S ADDRESS

ROBERT H. PETERS

Manager, San Joaquin County Mosquito Abatement District

The year of 1953 has echoed a challenge to local mosquito abatement to prove itself, against a growing mosquito problem, to a more demanding public unaware of this situation and interested only in the absence of mosquitoes in mosquito taxed areas.

I believe it can be definitely stated that the "chips are down" and it is up to mosquito abatement agencies to demonstrate even more convincingly that local direction of mosquito control in California is the most desirable and effective means of performing this phase of public service.

It must also be acknowledged that mosquitoes have a statewide significance particularly where mosquitoes and diseases are linked. To date we in mosquito abatement programs have not been able to effectively demonstrate the positive effect of our control activities on the comparative scoreboard when encephalitis cases are tabulated from controlled and uncontrolled areas in this State.

While we in mosquito abatement know full well what the mosquito potential would be in our controlled areas if our functions were not carried on, nonetheless we are not making the progress desired to curb a mounting criticism from a public which expects to fully participate in outdoor living, recreation and employment without the bothersome and hazardous presence of mosquitoes. It is becoming apparent that the public entertains the mistaken concept that we are functioning to eliminate mosquitoes; at the same time their demands for better control are increasing, and a few mosquitoes now are as objectionable as great numbers were in past years. Thus, failure on our part to maintain a low mosquito level could allow a situation to arise by which other concepts than that of our local programs might be initiated to either partially or entirely threaten the identity of our functions.

To date our Association has acted as a coordinator of mosquito control agencies, and has offered very valuable service to its members within the limit of its intent and purpose. While there has been an unquestioned gain toward the solution of many of our problems, we must not forget that the real show of strength of any organization is its unity in standing behind those decisions which have been reached through democratic process. Unfortunately, however, at times we have not always supported the majority decisions of our organization when issues of State-wide concern have been encountered. This year particularly, the ever-present disparity of agreement on subvention and operational investigations set an example of inconsistency particularly in the eyes of our State legislature. As we know, confusion reigned and in spite of active opposition from within our ranks, the legislature passed a bill increasing State Aid in the additional amount of $300,000.00. However, a bill seeking $150,000.00 for operational investigations to improve our overall "intelligence" in mosquito control and supported unanimously by our membership, was unable to be moved from Committee. This consequence can only be regarded as a step backwards, particularly when the need for continuously better mosquito control methods is becoming greater due to the growing problem. To strengthen our position it has been suggested that we consider forming a legally constituted group similar to the Conference of Local Health Officers wherein we could responsibly assume a similar influence on matters of State policy relative to the field of mosquito abatement.

Certainly it appears as though we must recognize that improving our position in the picture of state-wide mosquito control is a necessary requirement. In this regard, we cannot ignore factors of (1) disease aspects; (2) equalization; (3) standardization; and (4) uncontrolled areas, as they affect the future of our programs:

1. The disease aspects of mosquito control certainly imply a need for state-wide unity on the part of our local programs to do an effective job in curbing those species linked with disease. Otherwise we can certainly expect our efforts will be supplemented by some form of a State program, since there is a direct responsibility of the State Health Department as regards disease prevention.

2. Equalization of local programs through State monies appears to be a matter of increasing importance in many areas, and it must be recognized that this will probably be an inescapable major factor in future years to actually sustain our local direction of mosquito abatement programs. The justification for this aid to agencies of high mosquito incidence and low assessed valuation is basically the same as the equalization which is present within each local agency where the collective taxation received is used to control mosquitoes where they are produced. It should be pointed out that other local programs in the fields of health, welfare and education have accepted financial equalization as a necessity for continuation. If it must be regarded as such, then this type of State participation is certainly the lesser of the evils.

3. Standardization (with or without State subvention) of our methods, techniques, records and outlook, is a "must" in our future, if we as some fifty-odd local mosquito abatement agencies are to survive. For inter-agency coordination, we must speak a common language.

4. Uncontrolled areas definitely present a continued problem in the future state-wide control pattern. We individually think of such areas as border problems as they affect our operations, but these areas will continue to remain the weak link in the state-wide picture, particularly where the public health is a factor. The failure of local governments to assume their responsibility in mosquito abatement is in itself a threat to local direction of this service, and an open invitation to another concept of performing this function.

It is not my desire or intent to be an alarmist, but merely to point out to this Association that we have grown as separate agencies to a point where we are now collectively an important part of our way of life, affecting the health, wealth, and welfare of our State. Our future is dependent upon our ability to successfully meet our problems and to stand united in accepting our entire responsibility and obligations in a State-wide picture where each agency is a vital part.

President Peters: We are now at the time to call for reports from our standing committees. First of all we should have a report from our Secretary-Treasurer.

Mr. Washburn: This is a report of the Secretary-Treasurer of the financial status or statement of the Association as of December 1, 1953.

CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC.
REPORT OF THE SECRETARY-TREASURER

July 1, 1953—December 1, 1953

Gentlemen:

Herewith is submitted the financial report of this Association for the period July 1, 1953 to December 1, 1953 inclusive. Previously a report was circulated to the membership covering the period from February 2, 1953 to June 30, 1953 inclusive.

Balance on Hand July 1, 1953		$4018.09
Income		
Contractual Dues	$2535.00	
Associate Members Dues	90.00	
Sustaining Memberships	410.00	
Publication Sales	12.50	
Total Income		3047.50
TOTAL		$7065.59
Expenses		
Stationery (letterheads, etc.)	$ 8.80	
Postage	56.91	
State Fair Booth	434.37	
Thurman Funeral	9.11	
Cuts and Plates	28.73	
Printing 21st Annual Proceeding	1184.50	
Recorder repair	11.73	
Membership certificates	18.20	
Membership dues rebate	3.00	
Total Expenses		1755.35
Balance on Hand December 1, 1953		$5310.24

Respectfully submitted,
G. Edwin Washburn,
Secretary-Treasurer

President Peters: I believe it is probably wise to ask for a report of the Auditing Committee before we ask for a motion to accept the Treasurer's report. Mr. Preuss, are you going to give that report?

Mr. Preuss: This report is dated December 2, 1953.

CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC.
REPORT OF AUDITING COMMITTEE

December 2, 1953

Robert G. Peters, President,
California Mosquito Control Association, Inc.

Dear Mr. Peters:

We have on this date audited the books of the California Mosquito Control Association, Inc., and found that all monies received have been entered properly in the records of the association. We also found that all bills to date have been paid and proper entries have been made in the records of the association.

We found that the association's bank balance as of today is $5310.24.

We recommend to the new Board of Directors of this association that the Auditing Committee be made a permanent committee with instructions to take a physical inventory of all property owned jointly by the California Mosquito Control Association and several of the abatement districts.

We also recommend that the Auditing Committee be authorized to investigate the possibility of the California Mosquito Control Association becoming the sole owner of property now owned jointly by the California Mosquito Control Association and the several districts.

Respectfully submitted,
Edward D. Davis
W. Donald Murray
Adolph Preuss

President Peters: You have heard the Secretary-Treasurer's report and you have heard the Auditing Committee's report. Is there any question?

Mr. Gray: What is the joint property between the Association and some of the Districts?

Mr. Washburn: The joint property is the various and sundry pieces of equipment and materials that are now being used in operational investigations.

Mr. Gray: The exhibit up at the State Fair is not joint property, is it?

Mr. Washburn: No. The exhibit at the State Fair is now in the hands of the Secretary-Treasurer. That is Association property, strictly.

Mr. Gray: I move we accept the report of the Secretary-Treasurer.

President Peters: It has been moved that we accept the report of the Secretary-Treasurer. Is there a second? Moved by Gray, seconded by Holmes. Question. All those in favor say "aye." Opposed? The motion is passed.

Mr. Gray: I now move that we accept the report of the Auditing Committee with its recommendation.

President Peters: It has been moved that we accept the report of the Auditing Committee with the recommendations that it contained. Motion seconded by Holmes. In favor? Opposed? Motion carried. I call upon our Vice-President, Don Grant, to give the report of the Membership Committee.

REPORT OF THE MEMBERSHIP COMMITTEE

Any report on the status of Association memberships must be delivered with a note of disappointment. Response to this Committee's letters and form requests has met only a modicum of success. Lack of opportunity for personal contact in the first part of this fiscal year has in some measure been responsible for a relatively low number of associate members. Complete listings as of the close of this Conference will be given general distribution by mail.

Recommendations for procedure by the Membership Committee were adopted on May 14th of this year, which are included below and will be referred to the succeeding Committee Chairman for consideration.

Respectfully submitted,
C. Donald Grant, Chairman
Norman Ehmann
W. Donald Murray
George Umberger
Howard Greenfield

RECOMMENDATIONS OF THE MEMBERSHIP COMMITTEE

The Membership Committee of the California Mosquito Control Association, Inc., met at 3:30 P.M., May 14, 1953, in Berkeley, and as a result of action taken therein, the following recommendations were presented to, and adopted by, the Board of Directors of the CMCA

in their meeting which was held immediately thereafter.

1. That those Agencies contributing funds to the California Mosquito Control Association, Inc., which might not desire to be known as "Sustaining Members," shall be acknowledged only as "Contributors" This shall be no way interfere with the classifiication of "Sustaining Member," which should be reserved or maintained for such Agencies as may be more continually interested in the CMCA and mosquito abatement work and hence wish to be more directly associated with it.

2. That a letter be sent to all CMCA District Managers, together with a current list of members, requesting an additional listing of prospective members or contributors.

3. That letters be sent to all members and prospective members on such lists as may be compiled, indicating therein the benefits to be derived from the California Mosquito Control Association, Inc., and membership in it, as well as soliciting such agencies or persons for membership in the coming fiscal year. Such letters to be sent out prior to July 1st of that year.

4. That a certificate of membership, with minor alterations from the form originally drafted, shall be sent to all members.

5. That a standard of procedure be established for soliciting membership to the California Mosquito Control Association, Inc., in the future and in accord with the above recommendations.

President Peters: Have you any ideas to indicate how this group can get associate memberships?

Mr. Grant: I believe Mr. Washburn has membership blanks, I have membership blanks, and members of the Membership Committee, your regional representatives on the Board of Directors, will have membership blanks. We are still in the first half of this year and hope to have a good return yet.

President Peters: You have heard the report of the Membership Committee.

Mr. Gray: I move its acceptance.

President Peters: Seconded by Preuss. All in favor say "Aye." Opposed? Carried. I would like to have a report now of the Publications and Publicity Committee.

Mr. Aarons: The Publicity and Public Relations group met throughout the year and were happy about a number of projects.

REPORT OF PUBLICATION AND PUBLICITY COMMITTEE

Throughout the year 1953 the Publication and Publicity Committee has been active on various projects:

a. SALARY SURVEY. Continuing the survey pattern established by the Merced County Mosquito Abatement District during the previous year, a questionnaire requesting data on salaries and positions maintained by the Districts was circularized. The completed Salary Survey was distributed to all California Mosquito Districts and was received early enough to be of use in preparing fiscal year budgets.

b. HAROLD F. GRAY, again serving the Association as Editor of the Proceedings of the 21st Annual Conference, completed the enormous job of editorship and turned the 725 copies of the proceedings over to G. Edwin Washburn, Secretary-Treasurer, in November for distribution.

c. THE CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC., largely through the efforts of George Umberger, received from the State Fair Commission, a permanent exhibit booth at the California State Fair Grounds in Sacramento. An exhibit sponsored by the Association during the State Fair, September 3-13, 1953, included live mosquito material, photographs, a large map of the State showing the District areas, and pamphlets and other literature. The booth was maintained throughout the Fair session by personnel from the Sacramento-Yolo Mosquito Abatement District. Over 7,000 California Mosquito Control Association, Inc., pamphlets were distributed to individuals requesting information. The Association was awarded a bronze plaque by the Committee Judges for having an outstanding educational exhibit.

d. THE ASSOCIATION for the first time sponsored an advertisement in Mosquito News which announced our 1953 Conference and called attention to our Membership drive.

e. LAST YEAR the Culicidology Committee suggested that Districts consider using some of the data made available in the various Association Committee reports and special Bureau of Vector Control, State Department of Public Health reports for local news releases. Certain Districts have used these sources to advantage. The Publications and Publicity Committee has released general and feature story material to the press concerning our Annual Conference now in session, which has included: 1. Announcement of Conference. 2. Western Equine Encephalomyelitis Skin Test. 3 Scope and nature of Conference.

Respectfully submitted,
THEODORE AARONS, Chairman
ARTHUR C. SMITH
L. STONE
ELTON J. SIMMONDS
JOHN R. WALKER
C. PAUL JONES

President Peters: You heard the report of the Publications and Publicity Committee. Are there any questions?

Mr. Ehmann: I move the report be accepted.

President Peters: Moved by Ehmann, seconded by Gray. All those in favor? Opposed? Carried. Ed Washburn would like to make a remark.

Mr. Washburn: In regard to copies of the Twenty-First Proceedings, I think I have mailed at least two copies to every corporate member of the Association and to most of the Associate Members as of last year. I indicated in a letter to the membership, that if your Association, or your District, or you yourself desire more copies, to please contact me here. It is a big expense to mail those things out to you, and if you can pick up here at the Conference any additional copies that you might want, I do have them

here. Let me know today or tomorrow about that so you can pick up extra copies should you want them.

President Peters: Harold Gray, would you make a report on the Herms Award Committee?

Mr. Gray: The William B. Herms Award Committee makes the following report for 1953:

REPORT OF WILLIAM B. HERMS MEMORIAL AWARD COMMITTEE

The William B. Herms Memorial Award Committee makes the following report for 1953:

Two Boy Scouts from the Mt. Diablo (formerly Berkeley-Contra Costa) Area Council were sent to Camp Wolfboro for two weeks each, in the summer of 1953. They were

Michael Salli, Troop 15
Ronald Prossen, Troop 25

The Scout Executive, Mr. Victor Lindblad, requests that we extend the thanks of the Mt. Diablo Area Council to the California Mosquito Control Association for this assistance to underprivileged Boy Scouts, in memory of the Area's former President, William B. Herms.

Very truly yours,
WILLIAM B. HERMS MEMORIAL AWARD COMMITTEE
RICHARD F. PETERS
HAROLD F. GRAY, *Chairman*

President Peters: You have heard the report of the Herms Award Committee. Moved by Robinson, seconded by Ehmann, that it be approved. All those in favor? Opposed? Motion carried.

Mr. Gray: Mr. President, I move that the William B. Herms Award be continued for the year 1954, in an amount not to exceed $40.00.

President Peters: It has been moved that the Herms Award be continued during the year 1954 at not to exceed $40.00 Seconded by Raley. Is there any question? All those in favor? Opposed? Carried. Ed Smith, will you make the report of the Ways and Means Committee?

REPORT OF WAYS AND MEANS COMMITTEE

During the year 1953 the CMCA Ways and Means Committee held two general meetings of the entire committee and operated through two sub-committees. On May 7th the Ways and Means Committee met in Sacramento to delinate its own responsibilities. Included in the business for the day was a report by E. C. Robinson, Chairman of the sub-committee on Legislation. The committee approved a recommendation that the CMCA participate in the California State Fair with an educational exhibit. The most significant action of the committee was the appointment of a sub-committee to consider local-state relationships in the light of the possibility of establishing a "Conference of local mosquito abatement agencies." Gordon Smith was appointed as chairman.

The second meeting of the entire committee was held in Berkeley on October 27th. The committee went on record as favoring the formation of a "Conference of local mosquito control agencies" and passed a resolution requesting the Board of Directors to appoint a special committee next year to draw up appropriate legislation to accomplish this purpose.

The two sub-committees each had several meetings. These will be reported separately.

Respectfully submitted,
EDGAR A. SMITH, Chairman

President Peters: Any questions regarding this Committee's report? Do I hear a motion that this report be accepted? Moved by Gray. Seconded by Grant. Any questions? All those in favor? Opposed? Motion carried.

Our next report will be Lloyd Myers, who is Chairman of the Water Resources and Irrigation Practices Committee.

REPORT OF THE WATER RESORCES AND IRRIGATION PRACTICES COMMITTEE

This committee held two formal meetings during the past year, one on April 21, 1953 to determine appropriate projects for committee members, and one on November 24, 1953 to summarize the results of their endeavors. The results of committee activities are as follows:

1. Certain water-use acts passed by the California State Legislature in the 1953 session were felt to be of interest to mosquito control and abatement agencies. Summaries of these acts were reproduced and distributed to the CMCA membership. An attempt was made to obtain complete copies of these and other pertinent acts for distribution but it was learned that very few copies of such acts are printed. Mosquito control and abatement agencies in general will have to rely on Deering's Code. Summaries of current water-use legislation may be obtained by writing to the Division of Water Resources, Department of Public Works, State of California.

2. Information relative to the principal problems mosquito abatement and control agencies encounter regarding drainage of irrigated lands was forwarded to Mr. James Turnbull, Chairman of the Committee on Drainage of Irrigated Land, American Society of Agricultural Engineers. Mr. Turnbull indicated that the information will be considered in developing the future program of his Committee.

3. Preliminary steps have been taken toward publishing in the Soil Conservation magazine an article which will describe some of the mutual interests and cooperative activities of California mosquito control and abatement agencies and the various agricultural agencies. The editor of the magazine has stated that he would like to print such an article and arrangements for preparing it have been completed.

4. A survey was completed of other agencies contacted by California mosquito control and abatement agencies as of November 1952. The survey produced a surprisingly large list of other agencies cooperating with mosquito control and abatement agencies. It is encouraging to note that almost all agencies were reported as giving "good" or "very good" cooperation. The data gathered by the survey are presented below.

TABLE I

CONTACTS MADE BY CALIFORNIA MOSQUITO ABATEMENT DISTRICTS WITH OTHER AGENCIES
(from reports submitted by 20 M.A.D.'s)

	Contacts Per Year					Cooperation Rendered by Agency		
	0	1-5	6-10	11-20	Over 20	Very Good	Good	Poor
CANAL AND WATER COMPANIES	16	1	1	1	1	1	2	1
CITY AGENCIES								
Chamber of Commerce	19		1			1		
Council (or Manager)	19		1				1	
Engineer	19		1				1	
Health Department	12		2	2	4	4	3	
Planning Commission	15	1		3	1	2	2	1
Schools	19		1			1		
Street Department	Note 1				1		1	
COUNTY								
Agricultural Commissioner	17		1	1	1	2	1	
Agricultural Extension Service	7	3	3	3	4	4	7	1
Board of Supervisors	18		1		1	1	1	
Counsel (or District Attorney)	3	7	5	3	2	5	8	
Drainage Commission	Note 2				1	1		
Flood Control Commission	Note 2		1		1	2		
Health Department	1	2	4	3	10	13	6	
Planning Commission	10	7	1	1	1	2	8	
Purchasing Department	14	5		1			5	
Road Department	3	5	3	5	4	5	10	
Schools	7	6	4	3		7	5	
Sheriff's Office	Note 1			1		1		
Surveyor (or Engineer)	8	7	2	3		3	8	
Taxpayers' Association	Note 2	1				1		
DISTRICTS								
Drainage Districts	Note 2			1			1	
Irrigation Districts	7	2	2	5	4	3	8	2
Reclamation Districts	Note 2	2		1			2	
Soil Conservation Districts	Note 2	1		2	2	2	3	
Sanitary Districts	Note 2		1				1	
Water Districts	Note 2		1				1	
FARM ORGANIZATIONS								
Cattlemen's Association	17	2		1			1	1
Dairymen's Association	14	4	2				5	
Farm Bureau	8	8	2	1	1	2	10	
Grange	13	5	1		1		5	
FEDERAL AGENCIES								
U.S. Bureau of Reclamation	13	4	2	1		1	5	
U.S. Corps of Army Engineers	Note 2	1		1		1	1	
U.S. Fish and Wildlife Service	16	3		1		1	3	
U.S. Production and Marketing Administration	12	4	2	2		1	6	1
U.S. Public Health Service	11	7	2			3	3	
U.S. Soil Conservation Service	14	2	1	3		2	3	
SPORTSMEN'S ASSOCIATIONS	14	3	3			2	2	
STATE OF CALIFORNIA								
Bureau of Chemistry	19			1			1	
Bureau of Food and Drug	16	4				1	2	
Bureau of Sanitary Engineering	10	5	3	1	1	2	6	
Bureau of Vector Control		1	1	12	6	14	3	
Department of Fish and Game	9	8	1	2		3	8	
Health Department	14	2	2	2		4	1	
Highway Department	9	7	1	1	2	1	10	
Water Pollution Control Board	15	2	2	1		1	4	

NOTE 1—This agency undoubtedly contacted by M.A.D.'s which did not report such contact. A zero figure would be erroneous.
NOTE 2—This agency does not operate within all M.A.D.'s. A zero contact figure would be erroneous.

5. A survey was made to determine the relative priority given to various types of mosquito sources by California mosquito control and abatement agencies. Response to the survey was very good and thirty-eight agencies forwarded the requested information. No attempt was made to evaluate relative areas or intensities of problems involved. That can possibly be done by means of an additional survey. Regardless of areas or intensities, the summary presented below represents the relative importance of the listed sources to the agencies participating in the survey. Accordingly, these data should be of some value in planning future programs and activities which are intended the meet the needs of these agencies.

TABLE II. Order of Priority Given to Listed Sources by Agencies Reporting

	Order of Priority				
	1	2	3	4	5
Source	Number of Agencies Reporting Above Order of Priority				
Alfalfa		6	1		
Cotton	2	2	4		
Dairy Drains		2			
Industrial Wastes and Sewage Disposal	1	1	5	1	1
Irrigated Pasture	18	5	3	4	
Rice	2	3	2	1	1
Row Crops—Grapes, Orchards, Potatoes, etc.		3		2	3
Rural Miscellaneous—Canals, Sloughs, Ponds, etc.	3	5	8	6	11
Salt Marsh	5	4	2	1	2
Tree Holes	1				2
Urban	5	3	8	15	2
Wild Pasture (irrigated)	1	4	5	1	2

TABLE III. Order of Priority by Weighted Score

Source:	*Weighted Score**
Irrigated Pasture	127
Urban	93
Rural Misc.—canals, sloughs, ponds, etc.	82
Salt Marsh	51
Wild Pasture (irrigated)	41
Cotton	31
Rice	31
Alfalfa	27
Industrial Wastes and Sewage Disposal	27
Row Crops—Grapes, Orchards, Potatoes, etc.	19
Dairy Drains	8
Tree Holes	7

*The weighted score was determined by allowing points for each report of order of priority, as listed in Table 11, as follows:

Priority:	*Points:*
1st	5
2nd	4
3rd	3
4th	2
5th	1

As is usual, the Committee set its sights a little too high and some of the planned projects were not completed. These projects were:

1. To compile information relative to the identity, responsibilities, and interests of all agencies concerned with water use.

2. To develop suggested procedures for the formation of local organizations which would bring agencies concerned with water use together for the discussion of mutual problems, and to list benefits which may be derived from such organizations

3. To compile a summary of desirable and undesirable county ordinances relative to water use.

The above projects are believed to be of interest and value to the general CMCA membership and the Committee recommends that these projects be continued and completed by the Committee appointed for next year.

The Committee also recommends that continuous contact be maintained with wildlife agencies and sportsmen's associations to promote effective cooperation between these agencies and associations and the agencies concerned with mosquito abatement and control.

Respectfully submitted,
LLOYD E. MYERS, JR., *Chairman*

President Peters: Thank you very much, Mr. Myers. You have heard the report of the Water Resources and Irrigation Practices Committee. What is your pleasure?

Mr. Ehmann: Mr. Chairman, I move that the report of the Water Resources and Irrigation Practices Committee be accepted with special thanks to the Committee, and with the recommendation that the Committee Chairman for next year remain the same as the Chairman this last year.

President Peters: You have heard the motion that the report be accepted, that thanks be given to the Committee, and that the present Chairman be recommended to be retained for another year. Is there a second to that motion?

Mr. Gray: I will second it on the understanding that the last part is merely a recommendation and will not be binding upon the incoming President.

President Peters: That is right. Who seconded that motion? All those in favor? Opposed? Motion carried.

The next report will be by Ted Raley. This will be a preliminary report on the business and other aspects within the jurisdiction of Operational Investigations.

Mr. Raley: Before I make my report for the Committee, we have had the pleasure of meeting one of the old timers in this group. We had Ham Emerick, introduced by Harold Gray, and I would now like to introduce the Manager of the newest District in California. Ted Salmon, would you stand up? Ted is the Manager of the new Coalinga-Huron District in Fresno County. We have other Managers who have come into established Districts during the past year, and I understand that President Peters has in mind introducing these new Managers at a later time.

The reports that you have heard from Committees today have been taken very calmly and quietly. I hope that this report will receive the same response, although I remember that last year at Sacramento, there was a good deal of discussion after the report on Operational investigations.

OPERATIONAL INVESTIVATIONS COMMITTEE
Report

Guided by the recommendation of President Peters, the Operational Investigations Committee at its first meeting on March 27, 1953, was divided into sub-committees with each group responsible for a particular phase of the field studies. Assignments to the sub-committees were based on local and personal interest as follows :

R. PORTMAN) T. SPERBECK) R. FONTAINE)	Rice Studies
L. MEYERS) R. DE WITT) C. ROBINSON)	Pasture Studies
L. ISAAK) G. BROOKS)	Toxicology
T. AARONS) H. HERMS) J. ARNOLD) E. LOOMIS)	Culicidology

Dr. Harvey S. Scudder was asked to continue as Coordinator and a request was forwarded to the Bureau of Vector Control that C. M. Gjullin be attached to the committee as Advisor to the toxicology studies.

By June the financial commitments for fiscal year 1953-54 were well enough clarified to permit budgeting and funds available were apportioned as follows:

Rice Field Mosquito Ecology Study	$12,300.00
Irrigated Pastures Ecology Study	12,300.00
Embryology of *Aedes nigromaculis* Study	400.00

Each sub-committee was empowered to make necessary changes within the respective budgets and to allocate carry-over funds. Project directors were encouraged to use diligence in the purchase of supplies and equipment.

Full committee and sub-committee meetings were held throughout the year. The committee meeting and entomological workshop held in Fresno on March 27 brought together interested personnel from all parts of the State. Demonstrations and discussions of problems in mosquito identification were organized by Miss Bettina Rosay with the able assistance of Benjamin Keh and Ted Aarons. A discussion on mosquito measurement and recommended methods for recording data was led by Edmond C. Loomis. The fine publication on mosquito identification prepared by Ted Aarons took some of its inspiration from this meeting. The recent trend in more uniform sampling methods was stimulated by the fine work of the sub-committee on culicidology.

Field studies will be reported in greater detail by project personnel. With the active mosquito season of 1953 now history, the committee recommends that at least the same amount of funds available in 1953-54 be made available for the following year. Each project can use more financial assistance and of course there are many pertinent studies that should be made

It has been a pleasure to work with such a devoted, dedicated group.

THEODORE G. RALEY, Chairman

President Peters: Thank you very much, Ted. You have heard the report of the Operational Investigations Committee. Is there any question? Do I hear a motion then accepting this report? Moved by Holmes, seconded by Myers, that this report be accepted. All those in favor? Opposed? Passed.

The various sub-committee reports will be presented later in this session.

I believe we have successfully arrived at the point where we can call on the Chairman of the Resolutions Committee. I believe that is you, is it not, Harold?

Mr. Gray: I wish you would let me off.

President Peters: We figure when the business meeting comes around that you are probably the one who is capable enough to present the resolutions.

Mr. Gray: Mr. President, I move that as the report of the Resolutions Committee, we write the resolutions afterwards for inclusion in the Proceedings. That the Secretary-Treasurer be requested (as usual in the past) to send letters of appreciation to the Sustaining Members and everybody else who has assisted in putting on this Convention.

President Peters: Shall we take action on them as we go ahead?

Mr. Gray: Certainly, if you please.

President Peters: All those in favor of adopting this motion? Opposed? Carried.

Mr. Gray: Resolution number 1 will be a resolution of regret at the death of Eugene Bumiller, Manager of the Ballona Creek Mosquito Abatement District, and that will be drawn up in proper form and sent to the family and to the Trustees of the Ballona Creek District.

President Peters: You have heard resolution number 1. Seconded by Ehman. All in favor? Opposed? Carried.

RESOLUTION No. 1

Be is resolved, by the California Mosquito Control Association, Inc., assembled at its Twenty-Second Annual Conference at Oakland, California, on December 3, 1953, that we note with regret the death of E. J. Bumiller, who was for many years the Manager of the Ballona Creek Mosquito Abatement District, and who conducted its operations with good success.

The foregoing Resolution was introduced by the Committee on Resolutions, Harold F. Gray, Chairman, seconded by Norman Ehmann, and passed by unanimous vote.

ROBERT H. PETERS, President
ATTEST: G. EDWIN WASHBURN, Secretary-Treasurer

Mr. Gray: As we have had no other suggestions as to resolutions, Mr. President, that is the report of the Resolutions Committee.

President Peters: I believe there are one or two others.

Mr. Gray: Then why don't they give them to me? Lloyd Myers says that there should be one on subvention, but nobody has set up any policy as to what we are going to do, that I know of. We are still waiting for a report from the Vector Control Advisory Committee concerning their general policy as to subventions. I would be a little reluctant to have a resolution drawn up and passed now without knowing what the Vector Control Advisory Committee is going to report. We don't want to tell two different stories. I am always reminded of the story about the British Prime Minister Gladstone, when a cabinet meeting got a little acrimonious over a very serious difference of opinion. He finally walked over to the door and said "Gentlemen, we will go out of this Cabinet room all telling the truth or the same lie!" So, you may override me if you

wish, but I do not feel that we should attempt to pass a resolution until we know what we are resoluting about.

President Peters: I am inclined to agree with Harold in that respect. I feel that we are set up to deal with this situation when it does arise, but we have incomplete data at present to arrive at a decision.

Mr. Gray: I would be willing to make a motion in this form, with the consent of the other members of this Committee, that we authorize the Board of Directors to prepare on behalf of this Association, a resolution concerning subvention, after the policy statement of the Vector Control Advisory Committee has been promulgated. That doesn't mean that we have to follow it. At least we will see what they have to say, and then we can adjust our ideas somewhat to that, agreeing or disagreeing with them.

President Peters: That is a motion. Is there a second? Seconded by Myers. Are you ready for the question? All those in favor? Opposed? Carried.

President Peters: I believe there is one other resolution regarding Deed Thurman that needs attention.

Mr. Gray: I'll move that that resolution be adopted, and then we will write it up in good form, and send a copy to Ernestine.

President Peters: It is moved that a resolution be prepared regarding the death of Deed Thurman.

Is there a second? Seconded by Myers. All those in favor? Opposed? Carried.

RESOLUTION No. 2

Whereas, Deed C. Thurman, Jr., with his bride Ernestine, was in 1948 transferred by the United States Public Health Service to California, and they were subsequently engaged with the California State Department of Public Health, to conduct biological studies of mosquitoes in California, in the course of which work he established a field station at Turlock in which important studies in mosquito ecology were carried out, which studies helped to set the pattern in relation to the acquisition of basic knowledge concerning such important species as *Aedes nigromaculis, Culex tarsalis* and *Aedes dorsalis,* and

Whereas, his zeal and the thoroughness with which he did his work were in part responsible for the establishment of the Vector Control Field Station at Fresno, and

Whereas, the United States Public Health Service in 1951 assigned Deed C. Thurman, Jr., and Ernestine Thurman to malaria control operations in Thailand, where he did a remarkable job of improving the health of some two million people in northern Thailand with great enthusiasm and with no regard for his own health if only he could help others, and as a result of his tremendous efforts brought on his far too premature death in April, 1953, and

Whereas, Deed C. Thurman, Jr., by his idealism, his engaging personality, his scientific attainments and his industry gained the respect of and endeared himself to the people engaged in mosquito control work in California, now therefore

Be is resolved by the California Mosquito Control Association, Inc., at its Twenty-Second Annual Conference held at Oakland, California, on December 3, 1953, that we greatly regret the untimely death of Deed C. Thurman, Jr.; that this Resolution be printed in the Proceedings of this Conference, and that a copy hereof, signed by the President and Secretary-Treasurer, be sent to his widow with our profound condolences at her loss.

The foregoing Resolution was introduced by the Committee on Resolutions, Harold F. Gray, Chairman, seconded by Lloyd E. Myers, Jr., and passed by unanimous vote.

ROBERT H. PETERS, President
ATTEST: G. EDWIN WASHBURN, Secretary-Treasurer

Mr. Gray: That is the report of the Resolutions Committee.

President Peters: Thank you, Harold. At this stage we are in a position where a general motion should be made approving the acts and the statements of the Board of Directors during the period between conferences, almost a year.

Mr. Raley: I move that the actions of the Board of Directors since the Twenty-first Annual Meeting be approved by the membership.

President Peters: It has been moved by Ted Raley that the actions of the Board of Directors shall be approved. Seconded by Lloyd Myers. Is there any discussion on this subject?

Mr. Gray: There is only one question in my mind. Is there a quorum?

Mr. Washburn: Yes, there is.

President Peters: All those in favor? Opposed? Carried. Thank you.

I believe that before I call on the Nominations Committee, I will ask for any new business that should come before us.

Mr. Ehmann: I wonder if Stephen MacFarland, who is seated back here, has a point that might be considered under business. I think it should come up here at this particular business meeting. Since I have been in Berkeley I have heard from several Managers about a newspaper article written regarding the dangers of DDT that was published somewhere in the East. For some time now Mr. MacFarland, of the South East Mosquito Abatement District, has been keeping us informed down south of a similar action taken by an M.D. down there that has been hampering, and looks like it will continue to hamper, his actions in the use of things other than just plain oil. I think, Mac, you might tell us about this thing.

Mr. MacFarland: I think that you are probably all familiar with the fact that this particular M.D. is Dr. F. M. Pottenger, Jr. His father was a very competent man and a respected physician in his field of T.B. work. The son has changed over to allergy studies. Most of his allergies, according to him, apparently, at least to his patients, have been coming from the halogenated hydrocarbons. He has been given a grant, I think a year or so ago, by the U. S. Public Health Service, to make studies of the amount of DDT and other hydrocarbons, Lindane, TDE, Chlordan, and so forth, in the fatty tissues of human beings. He has analyzed I don't know how many hundreds of cadavers from the general hospital, and has come up with the conclusion that all of the ailments from a sickness standpoint in the United States, are from these particular materials. Two of his recent patients (this happened in June) lived in our District. He took a few spot samples, and they were from DDT poisoning, according to him. When he found out that we were operating in this District, he said that the Mosquito Abatement District was the one that caused the DDT poisoning of these two adults, because there is a lot of lawn drainage in this area and we had sprayed in front of these particular peoples' houses. It was just fortunate that we were spray-

ing with oil. We hadn't used DDT in that area, because there were a lot of children playing in the gutters. But he is aware now of the operations of the Mosquito Abatement Districts and he has several articles that are ready for publication about pastures that are being treated with DDT and other hydrocarbons. He is prepared, as I understand it, to blast the operations of Mosquito Abatement Districts, and of course agriculture in general. He has appeared at various professional hearings. He was the principal person that gave evidence at hearings held at Los Angeles a year or so ago, and of course he has carried on. It is no joke, because, as I say, he is working under the U.S. Public Health Service auspices. He is reported to be a cracker-jack research man in that field. He has a perfect laboratory set up. It is a thing, I think, which this Association could give a lot of attention to. In the reports yesterday, it seems that the Bureau of Chemistry is aware of it, but he not only discusses the problem of Mosquito Abatement operations, but the use of any of these insecticides; against those commercially labeled and sold in nurseries, and so forth, he is against all those. I don't know what is going to be left after he gets through, but he carries a lot of weight and he can cause us considerable difficulty.

President Peters: Thank you very much. Is there any comment?

Mr. Gray: Mr. President, I saw at least a resume of an article put out by some doctor in the East, trying to claim that all the ills that mortal flesh is heir to are caused by these chlorinated hydrocarbons which have been in use since 1945. We do not have to read it very far before we see that it is the damndest jumble of "post hoc" reasoning that you ever saw in your life. It is perfectly and completely assinine from any logical standpoint. This stuff will blow up and blow over, I think, and ultimately blow out. But you always have to expect a certain amount of crackpots, enthusiasts and congenital idiots to come out with things of this kind. It is not peculiar to mosquito abatement or agricultural insecticides; it occurs in a great many fields.

Mr. Ehmann: I move we strike that off the record.

Mr. Gray: California has 90% of the screwballs in the United States, and 90% of those are concentrated south of Tehachepi.

Mr. MacFarland: I would like to comment on Mr. Gray's statement. I had a lot of contact with this particular M. D. along other lines, particularly with his father in regard to milk, raw milk and nutrition, and a point can be made as Harold made it. But this situation is a little different. This Dr. Pottenger is considered an authority in this particular field, and, as I say, the U. S. Public Health Service saw fit to give him a grant to do the definitive work for them. It is not a crackpot deal at all. This doctor is highly intelligent, very capable, and he apparently has got a considerable amount of evidence, actual physical evidence, that substantiates his work. When he was the principal witnesss at these Congressional hearings, most of his testimony was reporting on the work that had been done throughout the United States, but now he has got his own confirmation with the backing of the U. S. Public Health Service, so it is not going to be anything that is going to blow over overnight. It will cause a lot of trouble and very soon.

President Peters: I believe this is a subject which is going to become more serious. As a matter of fact on the very day when I left to come down here, one of our Operators reported a sick cow. We have been trying to be cooperative with the farmers in any case where cattle may have been affected by our work. If we get a report that a cow may have been poisoned by DDT, we try to get a Veterinary diagnosis on the basis that if it is proven to be DDT poisoning our District pays for the diagnosis, but if it is some other disease the owner pays.

Fortunately, we had not sprayed in that area for a month and a half. But when we went to see the farmer we were greeted by the farmer waving this newspaper article in our face. It is probably something which is going to have to be ironed out when I get back, and I am afraid that it is going to be something which will be a little difficult to overcome. I personally would like to recommend to the next Chairman of the Publications and Publicity Committee that some counter publicity be considered in the way of answering this, because we are going to have to accumulate information to overcome things of this type. We can at least learn to handle the kind of people who don't use too much in the way of reason.

Mr. Umberger: I appreciate the feelings of Mr. Gray regarding this DDT subject. About five years ago when we started our Mosquito Abatement District, we had the same problem. Fortunately, it was with plants, Camellia plants. And we rode through that. However, I do believe, as the gentleman has mentioned, that this new study, this new thought, is not going to stop. It is based on evidence gained over the past four or five years and I have talked to several doctors in Sacramento. It is not a matter of taking sides, but there are things happening. Whether most of the poisoning, if we will call it that, is caused by the application to fruit, and if it is being eaten by our citizens drectly, or whether it is by contact or other means, I don't know. I say sincerely that I think we are going to have to stress source reduction more and more, and lean away from chemical control. It may sound hard, but I think that is going to be the answer. I wouldn't be surprised if within a very limited period of time, if certain evidence is presented, that we will have to discontinue aerosoling. Some agencies do not do it, but with us in the northern end of the valley, where we have our migration of *Anopheles* mosquitoes, aerosoling is an important phase of our control work in order to give the people relief. I feel that although it won't be immediate, within a very reasonable amount of time there is going to be a reappraisal of the use of these chemicals.

President Peters: Thank you, George. Gentlemen, we are pressed for time. I think that Dr. Arnold had his hand up first. Would you try to keep it within as few words as possible?

Dr. Arnold: Being entirely in agreement with the previous speakers, I would like to make one comment. Set up one bit of publicity, if possible in just three columns. One showing the percent or number of people in which DDT causes allergy, one showing the number of people or percent showing allergy to olive pollen, and one showing the number of people that are allergic to wheat. Maybe such a comparison might be valuable, and show that while we have allergies to DDT, we have allergies to two very common other products that are important in the State of California.

President Peters: The chairman of the Publicity Committee might recognize Dr. Arnold as a very good member of the Committee.

Dr. Tinkham: This last Monday, a week ago, the University of California Riverside Citrus Experiment Station

put on a panel for the Farm Bureau with Dr. Robert Metcalf, Moderator, whom most of you know as one of the most outstanding entomologists in the United States, I believe, when it comes to chemicals. This panel was staged in Indio, in Coachella Valley, and he, without pulling any punches, said that it was known definitely that DDT was deposited in the fatty tissues of the body, and that Heptachlor and Dieldrin and Aldrin, especially, were about ten times as bad as DDT. When you have a panel put on by the University of California and by a recognized authority on chemicals, you've got something to face. I am sure that we are going to have to face it, and I am sure that it is going to have to be on the basis of scientific facts. Not that I know very much about it, but having been subjected to anti-cholinesterase poisoning a few years ago, in September of 1950, when working in the field on adulticiding in the control of eye gnats in Coachella Valley, I know something of the lethal danger of the chlorinated hydrocarbons, Dieldrin and Aldrin especially. This anti-cholinesterase poisoning, or chemical myocemia, or chemical fatigue, or whatever you want to call it, is really something potent and something we are really going to have to face. I am sure that as already stated, the way to get around that is mosquito source reduction. Also we have indications in the last talk of yesterday's program, that these detergents offer us an opportunity to investigate into the pupacides. We may find that in a year or two, that we can control mosquitoes with pupacides and there is no danger of chemical deposits. By being forewarned and directing our attention to these future methods of mosquito control, we can largely ride over this storm of public interest or indignation, or whatever you are going to call it, that is going to come in the future. I can tell you that it is not going to blow over because they appear to have the scientific evidence.

President Peters: Thank you, Dr. Tinkham.

Mr. Portman: As I understand it, the United States Public Health Service is financing these investigations. I think it would be very appropriate if a committee from this organization had contact with the U.S. Public Health Service to determine what their stand on this proposition is, and if they are endorsing this information being put out. If they are not endorsing it, and if they are not taking the stand that they are out to eliminate the use of these chlorinated hydrocarbons in mosquito control and other pest control, then I think it is up to the U.S. Public Health Service and the U.S. Department of Agriculture to take a definite stand so that the people of the United States will know what is going on.

Mr. MacFarland: I just want to add one more comment. I oversimplified it when I mentioned about the allergies; that isn't the whole problem. They are working on the basis of the liver damage and all the rest of the thing. Allergy is just one of his specialties. Now he is in the process of analyzing milk samples, particularly milks coming in from the San Joaquin Valley. He is of course finding considerable quantities of DDT in that milk, quite a high rate of contamination. As far as mosquito abatement districts go, he's not pointing at them; he is pointing at all agriculture. Whether it is the farmer spraying his alfalfa with DDT, or whether it is the mosquito abatement district treating his permanent pasture, is a general thing. As far as I can see, and I have talked to a number of individuals of the U.S. Public Health Service, they are going pretty strong on it.

President Peters: There is a gentleman down here who is going to make the last comment.

A Member: The question of allergies is always present, even with lead arsenate. The question of milk is very important, and DDT is known to have been concentrated in the fatty bodies, but there is one point which has not been mentioned by most people; the fact that we also have enzymes in the body which can change DDT into TDA or TDE. That has been established by Dr. Hoskins. Some people can be subjected to the hydrocarbons and be affected by it and some will not. For example, I worked five years with a deodorant and I don't feel a bit sick or have any affects from the deodorant in a very confined room. I think we are capable, as human being as well as insects, to change DDT to TDA or TDE. Therefore this subject may have another slant entirely.

President Peters: Thank you very much. At this time I am going to call on Harold Gray as Chairman of the Nominating Committee.

Mr. Gray: As one last crack at the DDT asinity, the town of Iquique in Chile treats its water supply regularly, every two weeks, with DDT wettable powder for the control of *Aedes aegypti.* DDT is insoluble in water: nobody has died.

The Nominating Committee of the California Mosquito Control Association, Inc., having taken two ballots thereon, hereby makes the following nominations for offices in the Association for 1954:

President	DONALD M. GRANT
Vice-President	GEORGE UMBERGER
Secretary-Treasurer . . .	G. EDWIN WASHBURN
Trustee Member	ROY L. HOLMES

President Peters: Thank you, Harold. You have heard the report of the Nominating Committee. Mr. Secretary, have there been other nominations presented?

Mr. Washburn: No.

President Peters: If not, is there a good Samaritan amongst us who would make a motion to cast a white ballot?

Mr. Gray: No other nominations having been made, Mr. President, I move that the Secretary-Treasurer cast a white ballot electing the foregoing nominated persons to the offices indicated.

President Peters: Seconded by Mr. Greenfield. All those in favor say Aye. Opposed? Motion carried. Now I would like to ask those four men to come forward if they will please — the persons who have just been elected to the offices of President, Vice-President, Secretary-Treasurer and Trustee-Director.

Gentlemen, I would like to first of all extend my thanks to the members for the very fine support that I have received as President. I am very fortunate in that I have served the only short term that has been encountered in the history of the Association. But if you remember, I had to serve double duty as Vice-President, so that I feel that I have completed, to the best of my ability, my job as President. I would like to welcome you as the new Officers, and turn over my . . . I can't turn over my pipe . . . we do not have anything else to bang with, so you are going to have to furnish that yourself. All I'll give you is a handshake and say the best of wishes to you.

Mr. Gray: Mr. President, I would like to know whether the DDT allergy has anything to do with the lack of hirsute adornment on these new officers?

Mr. C. Donald Grant: Thank you, Bob Peters. As far as the incoming President saying anything, it has already been said for the future of organization in talks by Bob Peters and other talks by our speakers. I do appreciate being elected and hope that I can serve as well as my predecessors in this respect. I want to thank Bob Peters very much for a successful two terms in office and we all appreciate the great amount of work he has put in toward the success of this Association. I think we might go right ahead with our business, which would be a recess.

President Peters: May I make one suggestion before you do that, Don? I should have done it before, but it is customary that the President ask that the regional groups meet during this period so that they can select their regional Directors.

Mr. Grant: You might find locations outside of this room where the regional members can get together.

Mr. Mulhern: One other announcement. Dr. Longshore is waiting outside the door to take readings on those tests which were made yesterday. So will you please look up Dr. Longshore.

RECESS

President-elect Grant: The meeting will please come to order so that we can proceed with the program.

First we would like to have the introduction of the newly elected Regional Directors. We will start with the Bay Area and Contra Costa Region: Bill Rusconi of Napa County Mosquito Abatement District; from the San Joaquin Valley, Gordon Smith, Manager of the Kern Mosquito Abatement District; from Southern California, Norman Ehmann, Entomologist for the Los Angeles City Public Health Department; and from the Sacramento Valley, Bill Bollerud of the Durham District is going to serve temporarily.

I ask that the Regional Directors and the other officers meet for a Board of Directors meeting at the close of this afternoon's session. We have one other request. There has been considerable interest expressed in the State Fair pamphlt put out by the California Mosquito Control Association and it has been asked for a show of hands for what Districts may be interested in ordering larger numbers of those. How many Districts would wish to receive such pamphlets for distribution? Could we have a show of hands on that?

Mr. Umberger: We passed this pamphlet out at the State Fair and there were over eight thousand of them taken at the booth. I don't know if all of the Districts have seen these particular pamphlets. It is a modification of the Coachella Valley pamphlet. I know some Districts have their own particular layout, but there are a number of us who do not have them. Our agency, for instance, would like to get about ten thousand of them printed. I think they run around the price of fifteen dollars a thousand. The northern group was going to order about twenty-five thousand, but the thought was expressed that if they would hold off until this meeting, some of the Districts which do not have a specific pamphlet themselves might want to place an order at the same time. Those are very interesting; they are very good; and we have had a lot of success in schools with them, giving talks in schools and giving those to youngsters to take home.

Mr. Grant: I think it would be a good idea to get in contact with Ed Washburn at the close of this session and give your name and the approximate number that you would be interested in getting. There are a few being distributed around and they will be passed to the back so that you can see them.

I will now turn the chair over to Dr. Basil Markos, Director of the Field Station in Fresno, and he will introduce the speakers for the Operational Investigations reports.

Dr. Markos: As time is running short, we will get right along with this presentation. I present Mr. Richard C. Husbands, who is Entomologist for the California Mosquito Control Association, who will discuss the results of his investigations for the past year. It is on the Irrigated Pasture Studies.

MOSQUITO ECOLOGY STUDIES IN IRRIGATED PASTURES — PROGRESS REPORT[1]
1953

RICHARD C. HUSBANDS[2]
Vector Control Field Station, Fresno, California

The number of acres of land in California that will be devoted to irrigated pastures will have exceeded the million mark by the end of 1953. The rapid growth in pasture acreage from 235,000 acres in 1940 to 614,000 acres in 1949 and to the present million plus acres is indicative of the importance of this crop in agriculture and to the development of the beef and dairy industry within the State. Today, pastures constitute approximately one sixth of the total irrigated acreage found in California (1).

Mosquito control agencies in many parts of the State have found that irrigated pastures produce a large share of their problems in mosquito control and that these problems are becoming increasingly more difficult. Since irrigated pastures are often unfortunately considered to be permanent installations and since approximately half of the present million acres are less than five years of age, the *aging* of pastures and its influence on mosquito production is important and should receive concerted attention. Aging does not imply the increasing deterioration of pastures for in many cases proper management will gradually improve pasture crops; however, the number of pastures that are receiving proper management may be relatively low (a situation that can only be determined by a well-planned survey) and if the increasing problems in pasture mosquito control can be considered as a barometer of deterioration in pastures (as demonstrated in this report) then this situation of improper management is the rule rather than the exception.

Wherever deterioration occurs this problem can be examined as a successional phenomenon involving plant and soil changes that occur over a period of time. Furthermore, this phenomenon results in changes in the amounts and kinds of mosquitoes produced in pastures, and this change can involve increasing public health problems. The present study is an attempt to evaluate one aspect of this situation and can be used as an example of the type of problems that will develop in irrigated pastures.

1. A cooperative project conducted jointly by the California Mosquito Control Association, Inc.; the Bureau of Vector Control, State Department of Public Health; and the Fresno Mosquito Abatement District.

2. Ecologist, Project Leader, Central Valley Mosquito Ecology Study, California Mosquito Control Association.

Introduction

Investigations of mosquito production in irrigated pastures have been conducted in the Central Valley of California since 1949. From 1951 to date these studies have been carried on in a selected pasture located in Madera County near the San Joaquin River. This two-year-old pasture was selected for study because it represented a relatively new pasture with unknown potentials for mosquito production. The pasture soil is a San Joaquin Sandy Loam and is capable of excellent crop production without mosquito production, a condition that was adequately demonstrated in adjoining fields of cotton, alfalfa, and corn. It was further selected for study because it represented an example of the complexity and severity of the mosquito-irrigation problem confronting mosquito control agencies since it was felt that the demonstration of mosquito production in a nonsaline type of soil that had characteristics for good drainage before it was prepared as a pasture, would emphasize the problems and relationship between water and soil management and mosquito production.

Because of the nature of the problem and because the farmer-owner of the study pasture did not want interference with his management methods, the work was limited to an evaluation of existing farm conditions without measuring the amount of water used or interfering with daily farming practices. Mosquito control was not carried out in this area during the period of the study.

Study Area

The study pasture consisted of twelve acres of mixed grasses including Dallasgrass *(Paspalum dilatatum Poir),* Bermudagrass, alfalfa, and ladino clover. Irrigation water pumped from the San Joaquin River was applied from the east end of the field by a main lateral ditch and from a short lateral in the center of the south half of the field (Figure 1). A drain ditch at the west end of the field provided incomplete surface drainage from adjoining checks. A spoil bank from this irregular drain ditch helped to hold water at the foot of each check. The end of each check was flat or basin shaped and was well below the dam formed by the spoil bank, a condition which enhanced ponding (Figure 1). Checks ran from east to west with a slope of 0.15 to 0.20 foot per 100 feet for the first 300 to 700 feet. The last 200 feet of each check was generally flat. The field was divided into 33 strip checks approximately 15 feet wide.

Crops adjacent to the field were cotton on the north, corn on the east, and alfalfa on the south. The pasture had last priority on the water pumped from the river and was occasionally irrigated in conjunction with the irrigation of the alfalfa. Therefore, seepage from the lateral sometimes provided extended or double peaks of irrigation in the pasture while the alfalfa was receiving water.

An east-west fence confined cattle to separate halves of the pasture, with bulls and steers on the north half and cows and one bull on the south half. The number of cattle grazing on the field varied from 1 to 20 head during the season. The south section received the heaviest grazing since a few cattle were present on this half most of the time. The north section generally contained more cattle, but for shorter periods of time. Cattle were generally allowed on the field during irrigation and when the field was wet.

Procedure

In conjunction with other investigations (2), (3) limited biotic and environmental measurements were made during the years 1951, 1952, and 1953. Additional environmental measurements were conducted during 1953 which included: the study of the seasonal variations in soil moisture content by means of electrical resistance (nylon blocks) and by soil sampling at a depth of six and twelve inches, soil texture by sieving and sedimentation, water table level and fluctuations, infiltration rates in selected areas, and the measurement of sediment transportation in irrigation water.

Standard measurements conducted over the three years' period included mosquito aquatic stage sampling by means of frequent dipping (2) (3). Dipping records provided a comparative record of species composition, species density (low, medium, and high), species growth rate as influenced by temperature (2), and the number of generations produced each year as determined by temperature and the number of irrigations and duration of standing water.

Adult mosquito sampling was limited to records obtained from a single light trap, the mapping of areas in the pasture where emergence occurred, and making routine pants-leg counts at selected stations in the field.

Pasture flora was recorded in selected stations and by photographs taken of the entire pasture from an adjoining bluff.

Measurments of the physical environment during the three years' period of study included the recording of temperature and relative humidity in a standard weather station, records of irrigation water temperatures, the number and frequency of irrigations during each season, length of time water was applied to the pasture during each irrigation, the depth of standing water in ponding areas of the field, and changes in the size of the ponding areas from one irrigation to the next and from year to year.

Results

Irrigation

The comparative frequency of irrigation during 1951, 1952, and 1953 is best illustrated in Figure 2 from records showing the rise and fall of water at the foot of check seven (Station One). Water was applied fourteen times in 1953 (Table 1, eighteen times in 1952, and fifteen times in 1951. The average length of time between irrigation periods was 16 days in 1953, 11 days for 1952, and 15 days for 1951. However, due to the seasonal variations in the application of irrigations during each year, the average length of periods between irrigations for a year is less important than the frequency of irrigation during the warmer parts of the year.

Irrigation frequency during the months of July, August, and September (and possibly October) will have the greateset bearing on mosquito production in irrigated pastures. During these months the greatest numbers of *Aedes* species of mosquitoes will be produced in pastures (2), (3), (7). *Culex* species production may also increase greatly during this period if the frequency of irrigation produces standing water periods of ten days or longer (3). Figure 2 shows the relationship between irrigation frequency and the production of species of mosquitoes.

Variations in the application of water to the field were seldom related to soil moisture conditions and plant re-

TABLE 1—Study Pasture Irrigation Dates, Number of Times Water was Applied for each Irrigation, and Number of Days between Irrigation Cycles.

Irrigation (or rain)	Date Started	Number of times water was applied during this period	Number of days since last irrigation started
rain	January 15	..	..
1	April 5	1	0
2	April 18	2	13
rain	April 27	..	..
3	May 4	1	16
4	May 27	2	23
5	June 14	1	18
6	June 29-July 2	2	15
7	July 19	1	20
8	July 26	2	7
9	August 12	1	17
10	August 28	2	16
11	September 17	1	20
12	October 23	1	36
13	October 30	1	7
rain	November 14	..	..
14	November 17	1	17

quirements. Records of soil moisture changes taken during 1953 show that adequate moisture was generally present in the soil to prevent wilting. Water was not often applied to the field long before it was needed and in excess of requirements to replace depleted moisture.

Irrigation efficiency was estimated to be below typical efficiency for a medium loam soil type. Surface runoff and evaporation losses from standing water accounted for more than fifteen percent of the water applied. Deep percolation at the lower end of the field caused water table fluctuations of several feet and gave evidence that losses from this factor were also high.

Depending upon the rate of application, irrigation water required from seven to forty-eight hours to reach the end of the checks and to cover the field. Two specific types of irrigation were encountered during the periods of observation. In the first type of irrigation, water was applied slowly over a period of from twelve to forty-eight hours with the gradual accumulation of water at the foot of the field. In the second type of irrigation, less water was applied during the first forty-eight hours but this was generally followed by the release of a large volume of water which accumulated rapidly at the foot of the checks to a depth of from six to nine inches in most areas. In a few cases water was applied to the top of checks as it was spilling over the foot of the checks.

Measurements made of the advancing water front in strip check number seven, with a grade of 0.15 feet per 100 feet, showed that during a typical irrigation period water moved down the field at the rate of 90 to 100 feet per hour. Due to differential infiltration the front advanced at a decreasing rate until the water reached the ponding area of approximately the last 300 feet. At this point the front increased in speed indicating decreasing infiltration and use of water by the soil.

Infiltration

Cylinder infiltrometers were placed in pond areas, at the top of checks, and in cattle trails along fences. Tests were conducted in Stations 1, 5, 6, 15, 16, and in check 18 (Figure 1) during three irrigation periods. The soil surface was not disturbed while placing the cylinders in position, and they were sunk into the soil to a depth of one and one half inches. Measurements were made beginning forty-eight hours after water had surrounded the cylinders during irrigation. Irregularities in infiltration rates during the first forty-eight hours made such results questionable, and therefore these velocities are not reported. The average velocities are summarized in Table 2.

TABLE 2—Infiltration Velocity Determined at Various Stations in an Irrigated Study Pasture 48 Hours after Irrigation Water was First Applied.

Station		Average Velocity* cm/day	cm/hr
Foot of check	Pond No. 1	1.14	0.047
	Pond No. 5	1.27	0.053
	Pond No. 6	0.89	0.037
Top of check	Check 21	2.31	0.096
	Check 23	2.54	0.106
Cattle path	(Average 3 Stations)	5.38	0.224

* Three periods of irrigation.

Infiltration velocities are lowest in the ponding or standing water areas and highest in the cattle paths. The tops of strip checks show higher rates than the pond areas. In all cases the rate of infiltration is very low for such a soil. The significant increase in the infiltration rate in the cattle path can possibly be attributed to the fact that the soil was disturbed and worn by cattle travel, occurring before the installation of the cylinders. General observations indicated that water did not stand as long in the check along the central fence. A path worn along this fence by cattle showed that possible compaction in this region should have decreased infiltration velocities.

Soil Moisture

Soil moisture content was measured by oven-dried samples taken from depths of six and twelve inches and by electrical resistance blocks located throughout the field at six and twelve inch depths (BY 1 to 7, Figure 1).

Standing water Stations 1, 5, and 6 (Figure 1) show the highest soil moisture content in the field during and following an irrigation. Only in these areas did soil rarely approach saturation, and this condition lasted for only a very short period of time. The average field capacity was estimated to be about 15 percent. Soil moisture seldom exceeded field capacity during irrigation. From August through November the soil moisture content at Station 1 ranged from 13 to 22 percent. At BY Station 3, near the top of a check where water did not stand, soil moisture ranged from 5 to 17 percent. Other stations showed similar ranges but with some variations depending upon soil differences and the amount of water applied to the area.

Sedimentation

Sediment transported in the water during irrigations was measured both in the main lateral ditch and in the strip checks. Two methods of measurement were employed. The first method used glass plates that were placed at regular intervals on the bottom of irrigated checks. As soon as the plates were exposed by receding water they were removed and examined under the microscope. Deposits of sediments on the plates showed the presence of particles with average ranges in sizes from 0.10 to 0.0011

mm. or from fine silts to clays. Clumping of clay particles was noted.

A hydrometer pipette was used to measure sediments directly in the field. Samples were taken at various intervals during irrigations both in the ditch and check. Ditch loads ranged from 4.5 grams to 0.5 grams per liter during a single irrigation. Sediments in irrigation water in strip checks taken eight hours after water was started down the field showed that sediments could range from 0.3 grams to 2.0 grams per liter throughout the strip check when there was no cattle moving through the water, however, with cattle moving in the strip check suspended material increased in amount slightly and ranged from 0.3 grams to 2.5 grams per liter.

Soil — Mechanical Analysis

Mechanical analysis of the soil was accomplished by dry sieving and sedimentation. Samples taken from various parts of the field at the surface and at depths of six and twelve inches, were examined and no appreciable differences in silt or clay content was noted. Table 3 illustrates the results of the physical analysis of the soil taken from several stations in the pasture.

TABLE 3—Physical Analysis of Soils from Experimental Plots, Irrigated Study Pasture, Fresno, California.

Station	Depth	Mechanical Analysis		
	(Inches)	Sand	Silt	Clay
		Percent	Percent	Percent
BY 1	surface	60	37	3
	6"	71	26	3
	12"	70	27	3
BY 2	surface	76	20	4
	6"	61	35	4
	12"	60	35	5
BY 3	surface	58	38	4
	6"	56	40	4
	12"	57	38	5
BY 4	surface	58	38	4
	6"	60	36	4
	12"	62	34	4
BY 5	surface	60	36	4
	6"	61	35	4
	12"	58	35	7
BY 6	surface	60	36	4
	6"	61	35	4
	12"	58	35	7
BY 7	surface	58	36	6
	6"	54	40	6
	12"	49	44	7

The morphology of the soil under-laying the ponding areas at the lower end of the field were examined by borings, and the profile obtained shows that a clay layer exists at a depth of from eleven to thirteen feet. Below the clay layer the soil was found to be saturated with water, and the water table existed at a depth of thirteen and a half feet.

Evolution of Pond Areas

Method

Maps and photographs were made of the pasture at the beginning of the irrigation season and at regular intervals throughout the season during the years 1951, 1952, and 1953. Percentages of grasses and clovers were estimated from year to year in random areas within the pasture with emphasis on ponding regions. Standing water was measured daily for extent and depth in selected stations.

Results

Figure 1 shows the extent of standing water areas in 1953. Stations 1, 5, 6, 7, 8, 9, and 10 were selected as reliable ponding and mosquito sampling areas during 1951. Stations 1, 5, and 6 are located within the pasture strip check region while Stations 7, 8, 9, and 10 are ponds formed in the lateral drainage ditch found at the foot of the pasture. Figure 2 shows the variations in the depth of standing water at Station 1 during the three comparative years.

As the ponding areas within the pasture proper changed in extent it was noted that additional areas within the pasture were becoming reliable mosquito producing regions. By 1953 additional stations were selected for sampling, and these were numbers 11, 12, and 14. These stations represented the enlargement of mosquito producing areas that were initially very small and seldom produced adults. By 1953 the three additional stations were producing significant numbers of adults with every irrigation.

Station 1, check seven, represents an extreme example of pond evolution. Measurements made in 1951 showed that this area had extended to a length of 105 feet by the end of the season. By the end of 1952 the pond had lengthened to 345 feet. In 1953 the same pond had extended to approximately 385 feet and perhaps has reached its maximum development due to increasing field slope. (Figure 1, Profile Check Seven.) The maximum limits of pond measurement was determined by the amount of water remaining eight hours after the water was turned off at the head of the border strips. Ponds did not remain at their maximum attained length from one irrigation season to the next. At the beginning of each year the pond areas had receded from the length recorded at the end of the previous year. During the irrigation season there was an irregular increase in the length of the ponding area, and the maximum was generally attained in August or September.

Two main factors may have influenced the extention of the pond area; e.g., decreasing infiltration and the settling of soil in standing water areas. Surface structure breakdown which seals the openings ordinarily available for water flow (6), the filling of void spaces by fine sediments transported in irrigation water (4), and compaction due to cattle grazing in areas still wet from irrigation, all contribute to the ponding problem. However, it should be pointed out that it is the presence of water standing on the soil for extended periods of time which directly produces these changes or aggravates the situation. Changing bacterial action in the underlying soil should also be mentioned since it will also influence soil structure and plant growth (6). In ponding areas, decreased aeration will have an adverse effect on soil through changing bacterial action (6).

Successional changes in plant types were also noted. In all cases ponding destroyed most plant species except for Dallisgrass. In the absence of Dallisgrass a considerable portion of the ponding areas would have been without vegetation, but, the growth of Dallisgrass was good in the pond areas and rapidly replaced other grasses lost. The presence of Dallisgrass masked the increasing problem of soil deterioration. Undergrazing occurred in much of the field and was responsible for a portion of the plant suc-

cession. Much of the Dallisgrass formed seed heads and was avoided by the stock (5).

The margins of ponds were areas of fluctuating water levels. In this respect the ponds could not be defined by a specific boundary. In zones of fluctuation the gradual change in plant species ranged through the destruction of the ladino and alfalfa first, then the fescues, bromegrasses, and then occasionally to a complex of Bermudagrass and Dallisgrass which was finally replaced by a stand of Dallisgrass. Border ridges continued to support mixtures of pasture grasses dominated by Bermudagrass, unless they were submerged for extended periods of time. The submerged ridges flattened out in many of the ponding areas.

With the development of pond areas and with the lengthening of these ponds from year to year, the amount of water available for mosquito production increased. With the increase in amount of water there was also an increase in the length of time that water could remain on the pasture. Under these circumstances there was also a successional change in the species of mosquitoes found in the pasture.

Standing Water and Mosquito Production

Irrigated pastures in the Central Valley of California produce three major species of mosquitoes, *Aedes nigromaculis* (Ludlow), *Aedes dorsalis* (Meigen), and *Culex tarsalis* (Coquillett). Previous studies have shown that of all species produced in pastures *A. nigromaculis* is the most abundant mosquito (2) (7). The second most abundant mosquito is *C. tarsalis,* a proven vector of encephalitis (3). Depending upon temperature, *A. nigromaculis* takes from three to fourteen days (average, seven days) of standing water to produce adults. *Culex tarsalis* requires from seven to fifteen plus days (average, ten days) of standing water to produce adults, also depending upon temperature. Since *A. nigromaculis* eggs hatch as soon as irrigation water is placed on the field and because *C. tarsalis* eggs can possibly remain on the water for from two to three days before hatching and because both species develop at approximately the same rate, it can be seen that an increase in the duration of standing water beyond six or seven days will increase the numbers of *C. tarsalis* that can successfully emerge as adults.

In most areas in California a majority of the pasture mosquitoes are produced within the borders of the pasture proper. Tailwater, seepage, or drains from pastures are seldom major producers of *Aedes* species of mosquitoes, although there are exceptions to this rule under some conditions. *Culex* species may or may not be produced in greater numbers in drains than in the field depending upon many circumstances. However, the pasture proper should not be underestimated as a substantial source of *Culex* species since it has been shown that approximately thirty percent of a check area can still be covered with water seven days following an irrigation (7). Figure 1 shows the relative size between ponding areas in drain ditches (Stations 7, 8, 9, and 10) and strip check (Stations 1, 5, 6, 11, and 14). By the seventh day the standing water area shown in Figure 1 will be reduced to one third or less of the area shown, depending upon the amount of water applied.

Figure 2 shows the relationship between irrigation cycles, pond depth, duration of standing water and the production of mosquitoes in Station 1, for three consecutive irrigation seasons. In 1951, with a shorter duration of standing water and less frequent irrigations, fewer *Culex* species were produced than during 1952 and 1953 when standing water conditions were more favorable to such production. The year 1952 shows that at this station water seldom dried up between irrigations, and this favored the continuous production of *Culex* species. During 1953 the frequency of water application and the amounts applied produced irrigation cycles that were generally followed by a complete drying up of the pond area. However, the length of time that water remained standing at Station 1 was increased over 1951, and this resulted in the successful emergence of adult *Culex* species during a majority of the irrigation cycles.

Table 4 shows the result of daily dippings at Station 1 during comparable periods for 1951, 1952, and 1953. At this station aquatic mosquito production reflects the changing ecological conditions that occurred from year to year. This also indicates one of the important values of dipping records since the proof of the improper use of water is gained from such an evaluation. Table 4 also shows the relationship between the frequency of irrigation and species composition. Adult mosquito production that resulted from the successional changes that took place in standing water areas is shown in Table 5. Light trap collections of adult mosquitoes show that the yearly increase in *area* covered with standing water will result in an increase in the numbers of *Culex tarsalis* produced.

TABLE 4—Aquatic Stages Collected at Station 1, Irrigated Study Pasture, and the Frequency and Number of Irrigations during 1951, 1952, 1953.

Species Aquatic Stages	Station 1		
	June 23-Nov. 10 1951	July 2 Oct. 17 1952	June 25-Oct. 18 1953
	Percent	Percent	Percent
Aedes sp.	81	37	67
Culex sp.	19	63	33
Average Frequency of Irrigations in Days	14.1	8.4	10.6
Number of Times* Water was Applied During This Period	10	13	11

* Compares to the peaks of water application, not to number of irrigations shown in figure 2.

As the study pasture aged and as ponding areas increased, the shallow extension of standing water into adjacent areas produced conditions favorable for the survival of pupae that were stranded on damp soil as water receded. Stranding of pupae will result in the successful emergence of large numbers of adults from such areas. Estimates of the numbers of adults produced in pastures by this method show that as high as fifty percent of the *Aedes* species adults can originate from stranded pupae. Because of this factor, mosquito production in-

MOSQUITO ECOLOGY STUDIES IN IRRIGATED PASTURES PROGRESS REPORT — 1953

RICHARD C. HUSBANDS

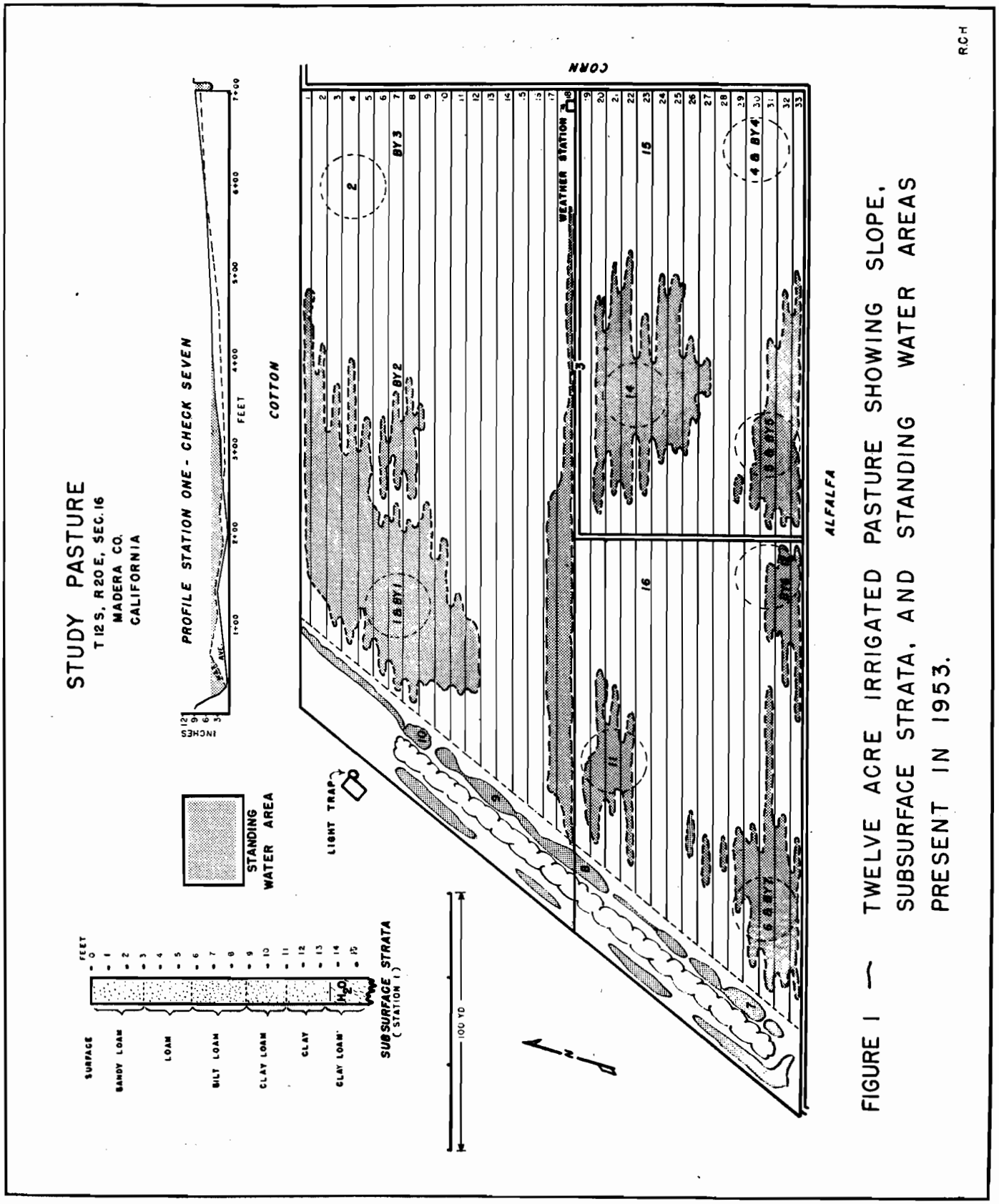

FIGURE 1 — TWELVE ACRE IRRIGATED PASTURE SHOWING SLOPE, SUBSURFACE STRATA, AND STANDING WATER AREAS PRESENT IN 1953.

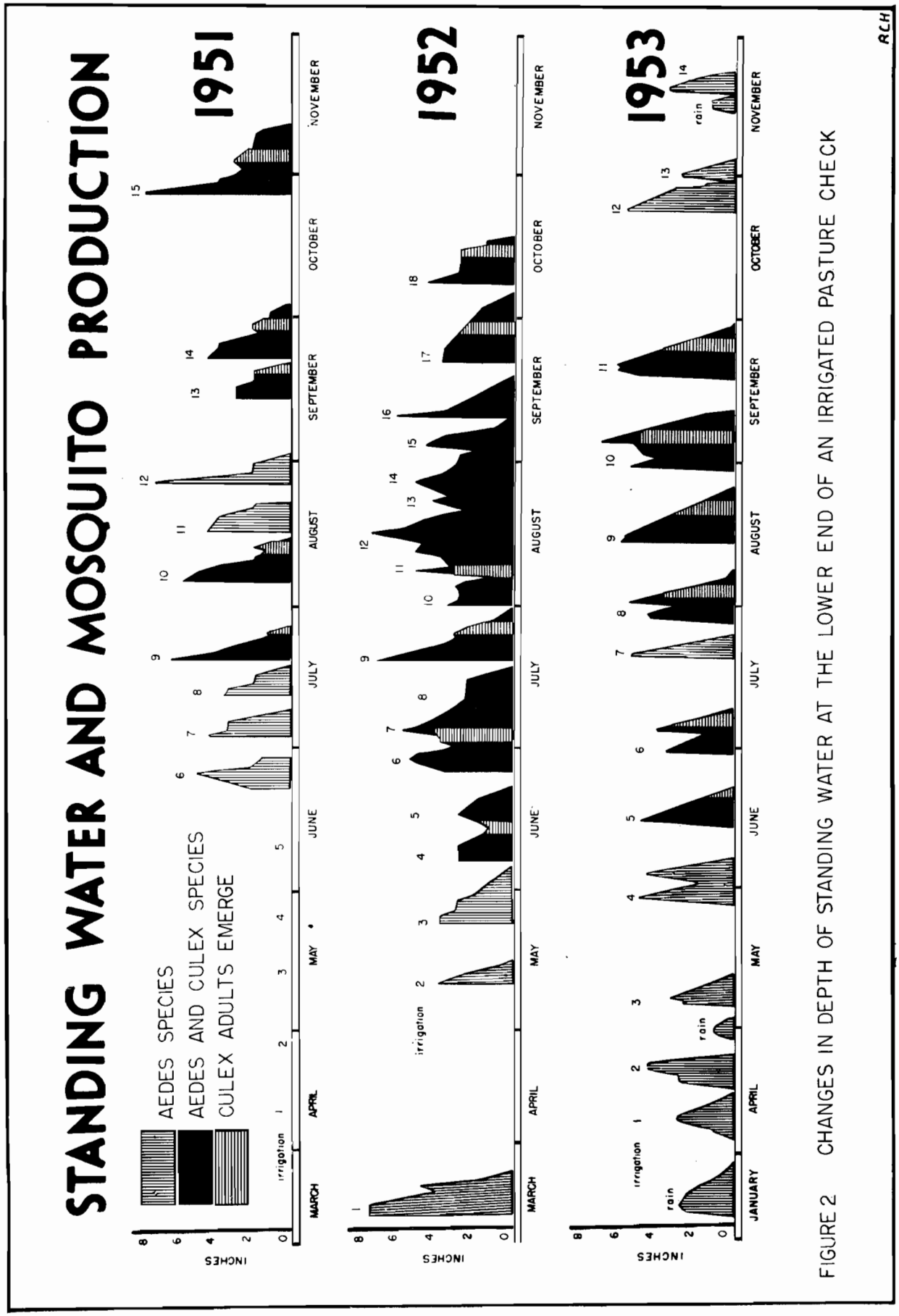

FIGURE 2 CHANGES IN DEPTH OF STANDING WATER AT THE LOWER END OF AN IRRIGATED PASTURE CHECK

TABLE 5—Distribution of Species Determined from Study Pasture Light Trap Collections; 1951, 1952, 1953.

Species	1951 27 July-25 November		1952 2 July-5 November		1953 25 June-5 November	
	Number	Percent	Number	Percent	Number	Percent
Aedes sp.	118,085	96	42,914	87	131,490	94
Culex sp.	4,592	4	6,198	13	8,294	6

volves areas where water will only remain long enough to produce late fourth instar larvae or pupae.

Summary

A selected irrigated pasture with a sandy loam soil, a low water table, and other conditions for good subsurface drainage was studied to determine the relationship between changing environmental factors and mosquito production. During a period of three years, 1951, 1952, and 1953, measurements were made of the successful phenomena that produced gradual changes in pasture grasses, ponding areas, and mosquito production. This study showed that changes occurred that resulted in the lengthening of ponds to approximately three times their original length, the formation of ponds in areas that initially seldom held water, and under favorable conditions, the increased production of mosquitoes. *Culex tarsalis* adults were produced in increasingly greater numbers during the period of study, and this was attributed to the increased *area* and *duration* of standing water in the pasture. Pest mosquitoes, e.g., *Aedes nigromaculis,* are able to survive in increasing numbers as pupae in the shallow extensions of the ponding areas due to stranding on damp soil when water recedes.

Conclusions

The gradual change of areas within pastures from small ponding regions to major standing water areas presents several serious problems. To the farmer it repesents a change in crop type and a loss of feed. It represents soil structural changes and lowered infiltration rates. It represents inefficient use of water and increasing problems of controlling water used during irrigation. To mosquito control agencies the enlargement of such areas potentially increases the numbers of pest and vector mosquitoes produced during the irrigation seasons, and this in turn increases the severity and complexity of the mosquito control program.

A working remedy for the thousands of acres of irrigated pasture presently evolving into major problems for farmers and public health agencies should be realistically achieved. Future research by qualified agencies on the subject of pasture deterioration and reclamation is seriously needed.

Acknowledgements

Very capable assistance was received from the following personnel: mosquito identification, Bettina Rosay, Entomologist CMCA; field assistance, Daniel M. Stephanian, Vector Control Officer BVC; H. Douglas Allen, Geologist, Vector Control Officer BVC; Alfred Ebeling, entomological Summer Assistant BVC; and James R. Holten, equipment development, Vector Control Officer BVC.

Technical advice was received from Dr. Harvey I. Scudder, Scientist (R) USPHS, and Lloyd E. Myers, Jr., A. Sanitary Engineer (R) USPHS.

Program and project proposals were developed under the guidance of the California Mosquito Control Association Committee on Operational Investigations, Theodore G. Raley, Chairman.

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Dr. Markos: The next presentation is concerned with the Rice Field Studies.

RICE FIELDS STUDY REPORT BLUE-GREEN ALGAE — A POSSIBLE ANTI-MOSQUITO MEASURE FOR RICE FIELDS

Richard W. Gerhardt
Entomologist, C.M.C.A.

The possibility of utilizing blue-green algae as an anti-mosquito measure in California rice fields was first put forward by William C. Purdy during the years 1919 and 1920. He found one rice field in the Nelson, California area which showed almost no larval population. In comparing this field with others of the same area which produced many mosquitoes, he came to the conclusion that a heavy growth of blue-green algae, which was present in the Nelson field, may have been responsible for the lack of aquatic mosquito stages.

The possible deterrent effects of blue-green algae on mosquito larvae is also discussed by Bradley (1932). While no conclusions were drawn concerning their possible larvicidal action, the absence of mosquito larvae in water supporting these plants was noted.

Several species of blue-green algae are known to produce toxins which may be lethal, even to large animals, when the water in which they are growing profusely is ingested. (Ingram and Prescott, 1952)

It is further known that some species of blue-green algae exhibit growth-inhibiting effects on other organisms. (Lefevre, Jakob, & Nisbet, 1951)

With this information in mind, the Nelson, California area was revisited by the author. The conditions described by Purdy were found to still exist. While the particular species of algae had changed over the years, the fields in

CHART I

	Condition algal growth	# larvae	Test # dead 24 hours	Control # dead 24 hours	Test % dead 24 hours	Control % dead 24 hours	Final % dead
I	slow winter growth	Test 22 Control 14	9	0	40.9%	0%	100 hours Test 100% Control 60%
II	rapid spring growth	Test 32 Control 31	32	0	100%	0%	48 hours Test 100% Control 0%
III	declining late-summer growth	Test 22 Control 22	22	2	100%	10%	24 hours Test 100% Control 10%
IV	liquor stored 4 weeks	Test 18 Control 10	0	0	0%	0%	120 hours Test 0% Control 0%
Va	culture solution filtrate	Test 12 Control 125	12	1	100%	4%	24 hours Test 100% Control 4%
Vb	washed algal filaments	Test 14	1		6%		6%

the Nelson-Richvale vicinity were found to support large amounts of blue-green algae.

FIELD SURVEY OF THE NELSON-RICHVALE AREA:

During the rice-growing seasons of 1952 and 1953 an extensive field survey was undertaken in order to determine the distribution of blue-green algal species and to correlate with this distribution the abundance of mosquito larvae in rice fields. The area studied was bound approximately by the Grant Road on the north, U.S. Highway 99E on the east, the Richvale West Road on the south, and the Chico-Butte City Highway on the west, in Butte County, California.

A total of 55 rice fields was examined for dominant algal types and for the number of mosquito larvae at the time of the examination. Of this number, 46 fields were found to support a dominant growth of blue-green algae. Without exception, mosquito larvae were virtually absent in these fields. However, larvae could be found abundantly in seepage water associated with these fields. Fields found not to support large amounts of blue-green algae were found to produce many mosquito larvae.

LABORATORY EXPERIMENTAL WORK WITH BLUE-GREEN ALGAE:

Field collections of blue-green algae in the Nelson area were submitted to Dr. Francis Drouet, Chicago Museum of Natural History, for identification. The most abundant species of that area proved to be *Anabaena variabilis* Born. & Flab., *Anabaena unispora* Gardn., and *Aulosira implexa* Born. & Flab. (Drouet, 1953).

Of these species, *Anabaena unispora* was chosen for the laboratory work following since it occurred most commonly in the fields studied.

An attempt was made to culture and maintain *Anabaena unispora* in unialgal culture. A modified Chu 10 solution was used as a medium for culture. (Gerloff, Fitzgerald, and Skoog, 1950) After a suitable period of culture, the algal filaments were separated from the nutrient solution by filtering through ordinary cellulose filter paper. The culture liquor filtrate was then tested for toxic effects by introducing mosquito larvae as outlined in chart I. Controls consisted of a like number of larvae placed in stock algal culture solution or in tap water. In one experiment, larvae were subjected to the presence of washed algal filaments.

The results of the experimental work are outlined in chart I.

Examination of the chart presented reveals that there is some toxic principle present as a component of the nutrient solution in which the algae was grown. The first 24-hour period following the separation of the solution is the period of its greatest effectiveness.

The condition of the algal growth preceding the test is evidently an important factor. In those experiments utilizing the algal media in which rapid and vigorous growth had taken place, the larvae died quickly.

Experiment Vb indicates that the physical presence of the algal filaments themselves does not contribute to the effectiveness of the lethal action.

FIELD EXPERIMENTS USING TRANSPLANTED ALGAE:

During the early spring of 1953 four attempts were made to transplant blue-green algae from the Nelson area to rice fields near the Rice Field Mosquito Ecology Project Center at Lincoln, California.

Four study plots were used, They were portions of rice fields designated by the names of the land owners.

Jones Study Plot: The alga was introduced in one check of the field by distributing five liters of laboratory-cultured algae on the surface of the ground two days before the check was flooded.

Boardman Study Plot #1: The alga was introduced by pouring 5 liters of laboratory-cultured algae into the water as it entered the study check.

Boardman Study Plot #2: The alga was introduced by pouring approximately 30 gallons of natural water in which blue-green algae were profusely growing. These were obtained in the Nelson, California area.

Moore Study Plot: The alga was introduced through the medium of rice stubble mowed and raked from the check floor of a Nelson field known to have supported a dominant blue-green algal growth the preceding season.

This stubble was then scattered on the surface of the Moore rice field. During cultivation of the field, a good amount of the inoculum was turned under the soil surface.

Of these four methods, those of the Boardman #2 Plot and the Moore Plot were successful. Evidently the inoculum must be massive in order to insure a transplant.

The results of the transplant experiments are shown on the graphs of chart II.

Larval population records were recorded for the Dumas #1 rice field and constitute a control for comparison with the study plots.

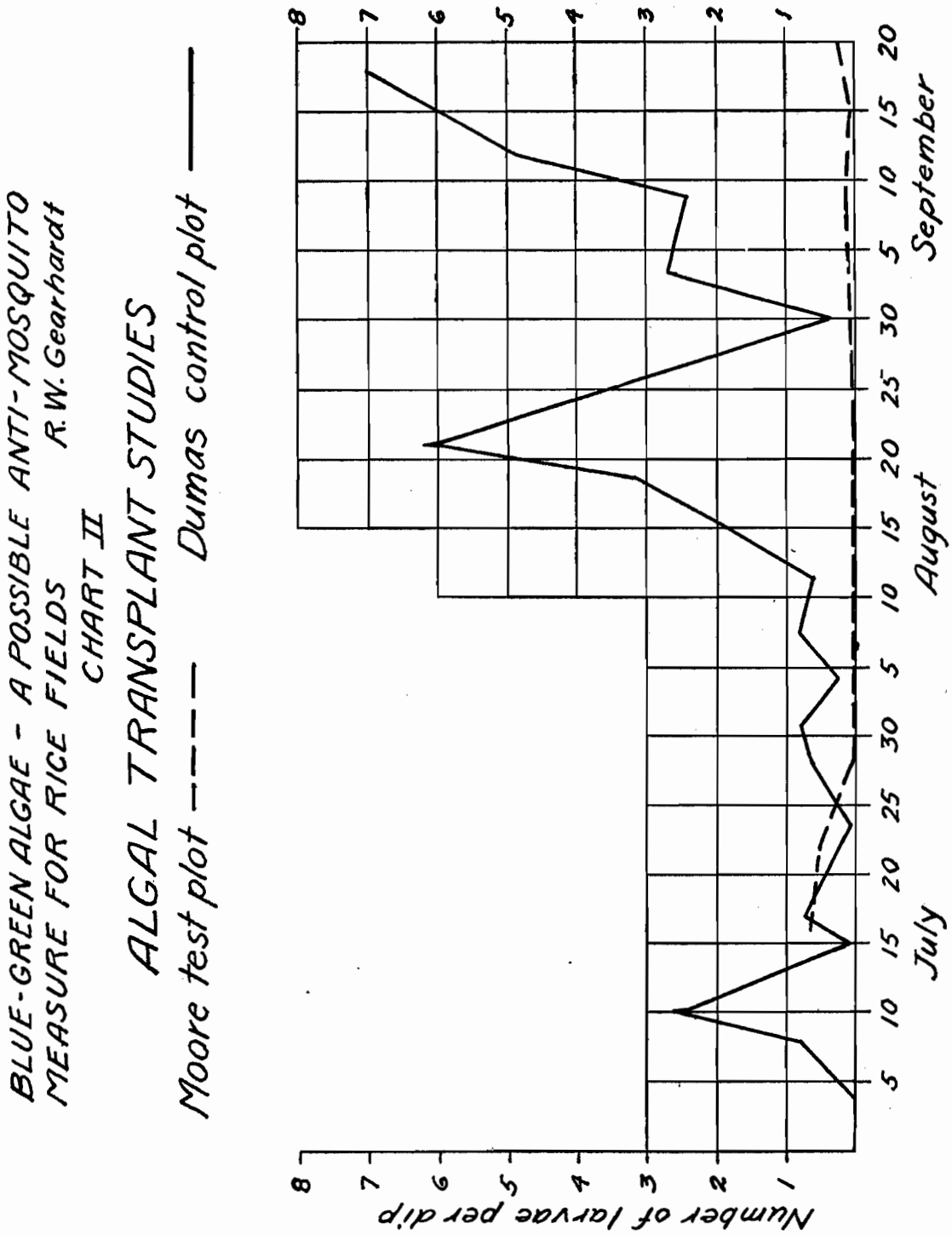
Of the methods tried, the method of utilizing the rice stubble cut from the Nelson field proved most effective.

GENERAL DISCUSSION — ALGAE AS MOSQUITO AGENTS:

That certain species of blue-green algae may constitute a limiting factor in a mosquito larval environment is evident.

The work presented here illustrates their deterrent effect. The work is not without sources of error. Continued investigation will resolve some of them. In short, continued investigation of the practicality of anti-mosquito measures utilizing blue-green algae is strongly indicated.

The depression of the larval population in the Moore Plot was coincident with the ascendance of blue-green algae. For purposes of this study the cause-effect relationship is assumed. This effect is well known to biologists.



It is exemplified by an condition wherein one organism is incapable of existing in the presence of another, dominant organism. The relationship is ordinarily termed "antibiosis."

Thus we may have an antibiotic for mosquitoes.

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Dr. Markos: The next paper is concerned with the embryology of *Aedes nigromaculis,* by Dr. Arnold and Miss Betty Franco of the College of Pacific. It will be presented by Miss Franco.

ANNUAL REPORT OF THE COLLEGE OF THE PACIFIC SUB-PROJECT OF THE CENTRAL VALLEY MOSQUITO ECOLOGY STUDIES

EMBRYOLOGY OF *Aedes Nigromaculis* (Ludlow)

By JOAN FRANCO

Illustrations by Edwin Chin and With General Guidance and Photographic Aid

By JOHN R. ARNOLD

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INTRODUCTION

Due to the fact that all of the previous investigators had to cease work on this embryological mosquito project because they finished their work at the College of the Pacific, there have been four different groups of people working at this project. The first group consisted of Mr. Marion W. Quessenberry and Mr. David Reed, who reported in June, 1951. The second group was made up of Mr. Gilbert Jones and Mr. David Roberts, who reported in July, 1952. The third one to work on this project was Mr. Gilbert White, who reported during the fall of 1952. The fourth group consisted of Mr. Edward Chin and Miss Joan Franco.

Rather than recapitulating the entire work of the previous investigators, the present investigator (Franco) has decided to compile only those parts of the previous reports which are necessary to repeat, in order to illustrate certain points in this report.

Before any explanation or discussion is made concerning the embryology of the mosquito, *Aedes nigromaculis,* some introduction is necessary.

First, in the report of Jones (report in July, 1952), the statement was made that

> "the prospects for the future are very good; the long fight to achieve a workable technique is nearly complete, although continued work will have to be done with the technique we have. The L 30-17 series is an excellent series IN THAT THE CONDITIONS OF DEVELOPMENT ARE KNOWN."

Now these series of eggs were not checked for fertility. Neither Jones nor White experimented with the series L-30-17 because a good technique was holding the experimentation back. No fertility was known until Franco (Summer, 1953) experimented. Much to the disappointment of the present investigator, the eggs of series L-30-17 were infertile!

With this thought in mind the reader now will realize why the present investigator is compiling a report of the embryology of *Aedes nigromaculis* with series of eggs laid by different female mosquitoes. In spite of the fact that the eggs have been laid by different mosquitoes and are not a "perfect" series, one must realize that even though the development may differ according to hours of the different eggs, all eggs must undergo the same development no matter what the length of time.

Very often one embryo may be more advanced than another embryo which is older. The reason for this may be the conditions in which the embryo developed. Higher temperatures hasten the development of the embryo.

Therefore, the age (hours old) of the embryo has been partly disregarded and the ascending development of the embryo has been kept in mind instead.

A METHOD OF CLEARING EGGS

It is the opinion of the present investigator that one of the best agents for removing the chorion of mosquito eggs is Clorox (5% sodium hypochlorite). However, the present investigator does not agree with the previous investigators that 50% and 100% Clorox solution are good agents for clearing eggs of any age. She feels that after experimenting with 425 eggs of different ages that a different percentage should be used with the differnt ages of the eggs. Better results were obtained if a percentage of Clorox quite a bit lower than the age of the egg was used. For example, if the chorion of a 73-hour-old egg is desired to be removed 50% Clorox is used. If one wants to remove the chorion of a egg 34 hours old, 25% Clorox is used; for 27 hours, 25% Clorox is used; for 20 hours, 10% would be about right. The investigator found that if the percentage of the Clorox is kept below the age of the eggs, better results are obtained and there is less

chance of the egg exploding. Using the lower-percentage-of-Clorox-than-age-of-egg method is much slower than using Clorox with a higher percentage than the age of the egg, but better results are obtained.

The definite time limit which any of these eggs should be left in the Clorox is not known, but they should be watched under a microscope constantly while the process is going on. An approximate estimate of the average time the egg is left in Clorox is 15 minutes. Sometimes the egg remains longer and clears, but if the egg remains longer than 15 minutes, the egg usually explodes. Of course, this means that one must always use a lower percentage of Clorox than the hours of eggs. If a higher percentage of Clorox is used, the egg usually explodes immediately. If a *very* low percentage of Clorox is used as compared with the hours of egg, the removal of the chorion is prolonged and the egg usually explodes after the long length of time it has been in the Clorox.

When the chorion is completely removed the action of the Clorox should be stopped immediately with distilled water or tap water if the former is not available. The action of the Clorox is stopped by dropping the distilled water in the deep-well slide where the egg is in Clorox. Then the mixture of Clorox and distilled water is drained out with the pipette, and the egg is washed 3 times to make certain that there is no more Clorox in the slide. The last washing with distilled water is also removed and replaced with 2% formalin which keeps the egg more stable than if left in distilled water. There have been many cases where the eggs were cleared and left in distilled water (for drawing or photographing purposes) but the egg exploded.

Now after all of that buildup about Clorox being a good clearing agent, a warning must be given that it isn't very good for very young eggs. Very young eggs can be classified as being under 15 hours. Up to 15 hours, 10% Clorox may be used with fairly good results, but for younger eggs, 83% aqua regia is better than Clorox.

Aqua regia is made of 2 parts hydrochloric acid and 1 part nitric acid according to DeCoursey and Webster (1952). This is a fair agent for clearing eggs. Its only great disadvantage is the length of time it takes. The biggest advantage of aqua regia is that it is a very stable agent for clearing the chorion of low hours *Aedes nigromaculis* eggs. The eggs have been left in the aqua regia for 48 hours and still will not explode.

THE EMBRYONIC DEVELOPMENT OF AEDES NIGROMACULIS (Ludlow)

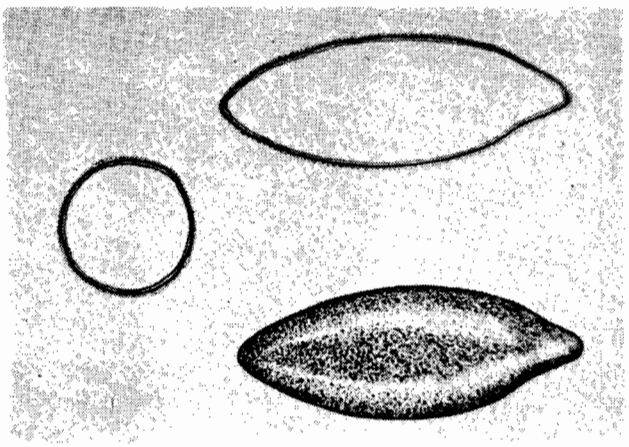


FIGURE 1. WHOLE EGG AND CROSS SECTION

The egg of the *Aedes nigromaculis* is 0.546 mm. in length. It is fusiform in shape with both anterior and posterior ends pointed. The posterior end is more blunt in appearance than the anterior end. The egg is black in color as shown in Figure 1. The *Aedes nigromaculis* egg has three membranes—the outer transparent exochorion, the opaque endochorion, and the transparent vitelline membrane.

A few statements concerning fertilization and maturation should be made here. Fertilization is said to take place after the eggshell has been formed. Descending from the ovary and passing the opening of the spermathecal duct, the ovum receives sperms through the micropyle. These sperms have been deposited by the male in the spermatheca. Usually when polyspermy takes place, the extra sperms degenerate in the yolk. Sometimes polyspermy is too great so that it leads to prevention of further development of the egg.

Many times when the mosquitoes were captured by the investigators and fed, the mosquitoes would not lay eggs or if they did, the eggs would be infertile. It has been noted by Dr. John Arnold, who did more fieldwork than did the present investigator, that many male mosquitoes were present where the female mosquitoes were collected. Of course, this observation does not prove that copulation had taken place, but it is a fairly good indication that it had. According to Johannsen and Butt, these authors seem to think that "if the degree of polyspermy is too great, it may lead to disturbances than prevent further development." (p. 29, Johannsen and Butt, 1941). This very thing may be the cause of so many infertile eggs that the investigator found or these may be from spent females in which the supply of sperms may be gone.

COMPOSITION OF THE CHORION

The chorion is not chitinous but contains sulphur according to Johannsen and Butt and has a higher nitrogen content and less resistant to alkalines. The chorion is formed by follicular cells of the ovarioles. When it is first formed it is soft and plastic and then it adjusts itself to the changing form of the developing egg, according to Korschelt (1887). The chorion doesn't always form all over the egg, but may develop first at the posterior end and then cover the rest of the egg.

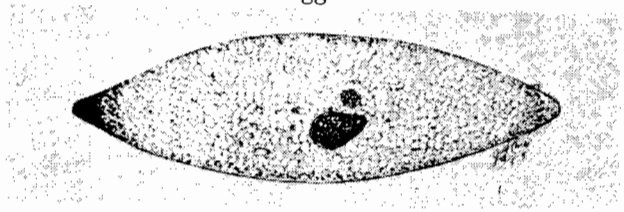


FIGURE 2. FEMALE B 2 HOURS OLD EMBRYO

Notice the net-like pattern (hexagon). This is the chorion partly removed.

This appears to be the meeting of the sperm pronucleus and the egg pronucleus.

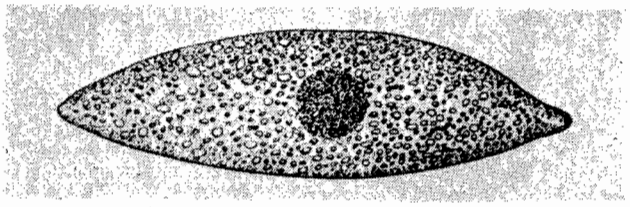
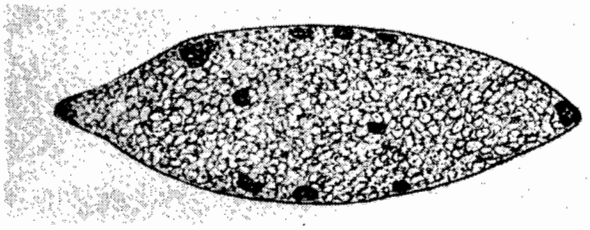


FIGURE 3. FEMALE A (2.5-23 HOURS OLD EMBRYO)

Maturation begins immediately after the entrance of the sperm. The transformation of the head of the sperm

into a male pronucleus takes place at the same time as the formation of the female pronucleus. The centrally placed nucleus of the egg is supposed to be the fertilization nucleus.



FIGHRE 4. FEMALE G (3.5-4.5 HOURS OLD)

The nuclei keep dividing until there is a large group of nuclei in the middle of the egg. All of the nuclei move toward the surface of the egg and finally form an even layer over the surface. The nuclei are buried in the periplasm.

The nuclei are scattered throughout the yolk. The blastoderm encloses the yolk which later breaks up into divisions with a nucleus in the center of each.

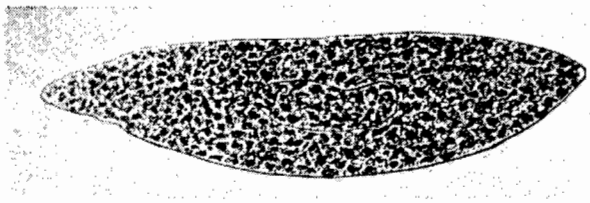


FIGURE 5. FEMALE G (2.5-23 HOURS OLD)

One cell thickness, as shown here, is formed. The outline of cells is formed between the nuclei and the blastoderm. The nuclei have migrated peripherally.

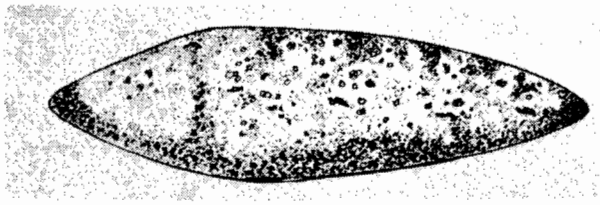


FIGURE 6. FEMALE K (39.5-40.5 HOURS OLD)

Segmentation evident here for the first time.

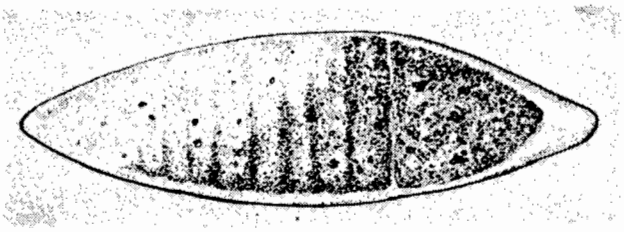


FIGURE 7. FEMALE A (26-52 HOURS OLD)

Segmentation is evident by transverse grooves which appear as shown in Figure 7. There is evidence of a rather broad anterior head region and a narrow posterior portion. Early stages of development as shown in Figure 7, show the body with as many as nine segments.

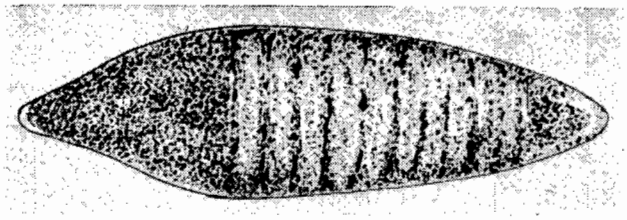


FIGURE 8. FEMALE E (82.5-85.75 HOURS)

Segmentation is much more definite here than before. There are 10 abdominal segments, 1 head segment, and 1 posterior segment.

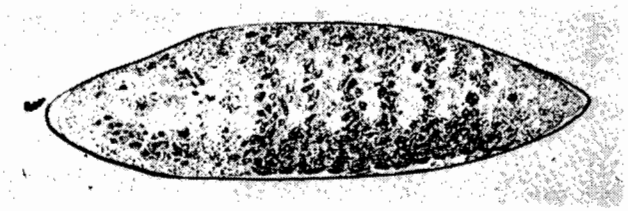


FIGURE 9. FEMALE J (59-61 HOURS OLD)

Evidence is seen in this 59-61 hour embryo of further segmentation. Although at first glance this embryo may appear to be less developed than the previous figure, it is not. When first looking at this embryo it may appear that there are only seven segments plus the head region, if one is counting only the light spaces in between the darker segments. However, upon closer examination of the embryo on the ventral side, one will note that there are 12 abdominal segments, 1 rather larger head segment and 1 large posterior segment.

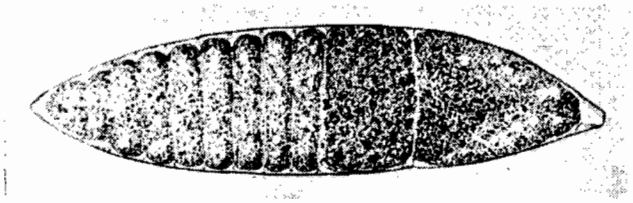


FIGURE 10. FEMALE C (49-53 HOURS) VENTRAL VIEW

Head, thorax, abdomen, and tail region well-differentiated. One head segment, three thoracic segments, seven abdominal segments, and one tail segment.

The line differentiating between the head and thorax region is the intersegmental line. The immediate region behind the intersegmental line is the protthorax.

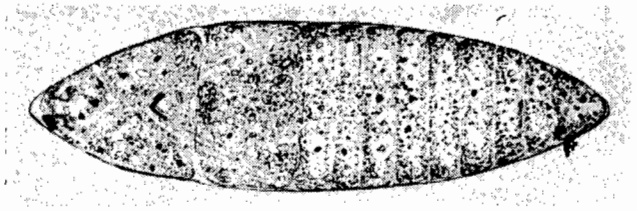


FIGURE 11. FEMALE C (98-102 HOURS OLD) DORSAL VIEW

Head region definite, thoracic region definite, 8 abdominal segments and tail region.

Advancement of last embryonic development: hair tuft within the chorion of the egg.

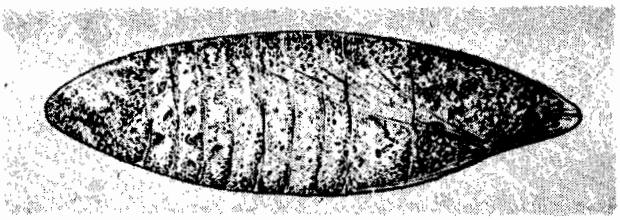


FIGURE 12. FEMALE I (119.5-120.5 HOURS OLD)
LATERAL VIEW

Head region development more advanced. Note the hair tufts. Short hairs in anterior end may develop into bristles. In the ventral median area more longer hairs appear. Seven abdominal segments are visible in this view. Three thoracic segments are visible (dorsal side on close examination shows three segments).

More hair-like structures are visible ventrally in the anterior portion of embryo within the chorion.

On the dorsal region the egg-burster or dorsal hatching spine is visible.

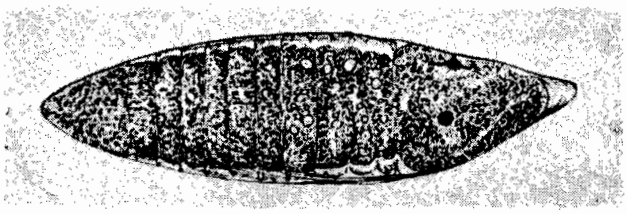


FIGURE 13. FEMALE H (89.5-90.5 HOURS OLD)
LATERAL VIEW

Note well developed head region, egg burster (ventral), eyespot (median) and short hair-like antennae (anteriorly) present.

More advanced in development is the three-segmented thorax. There are seven abdominal segments and the number of segments in tail region not available.

Note the hair-tuft dorsally and few laterally.

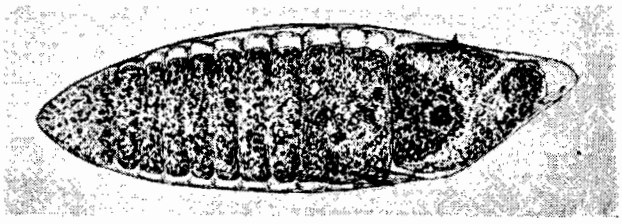


FIGURE 14. FEMALE I (124.5-125.5 HOURS OLD
LATERAL VIEW (UNDERVELOPED)

Note the egg burster and the head which is well differentiated. Mouth parts appear to be present. Hair tufts ventrally and a few anteriorly. Thorax has three segments. Abdomen has seven segments and there is a larger tail segment. Notice the separate layer around the embryo within the outer layer.

At this age the egg burster appears to be breaking the outer layers.

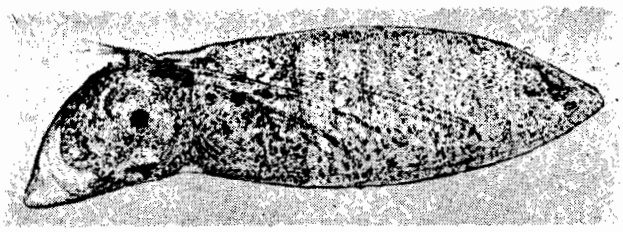


FIGURE 15. FEMALE G (99.5-100.5 HOURS OLD)
LATERAL VIEW

Notice the pointed anterior region and the larger posterior region. The head region appears to be much rounder in this figure and there is more space within the chorion. Note the egg burster and the hair tuft near the egg burster. When the outer shell breaks around the embryo, it breaks out like a cap. It is assumed that the reason there is more space around the head region is to give the embryo more room to wiggle out of the egg shell.

The dorsal hair-like structures may be assumed to be antennae. The egg shell appears to be broken ventrally in part where the assumed antennae appear. No reason is known as to why this happened.

Notice the eyespot which is present at this age.

The hair-like structures which start anteriorly on the embryo and end toward the lateral side forms a definite fan-like pattern. This has been noticed also in other drawings.

The thorax is much larger but little advancement in development is noticed.

Seven segments appear in the abdominal region and the usually one undifferentiated segment appears in the tail region.

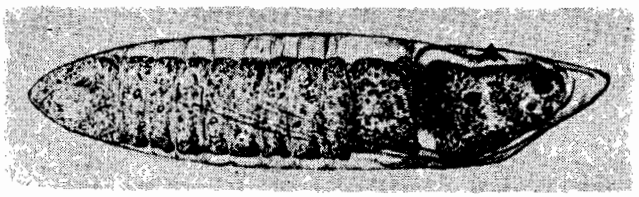


FIGURE 16. FEMALE H (89.5-90-5 HOURS OLD)
LATERAL VIEW

In spite of the fact that this embryo is younger and appears smaller, the advancement in development is greater. The difference lies in the fact that the eggs were laid by different females and the conditions of the environment were different.

Again notice the space around the head region and in this picture notice also the space around the thoracic and abdominal region. It is assumed that the embryo is getting ready to emerge.

Notice the egg burster piercing the outer shell.

The hair-tufts appear again anteriorly and laterally in the same definite pattern.

Eight abdominal segments are present.

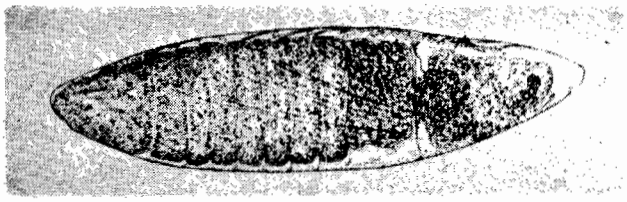


FIGURE 17. FEMALE G (99.5-100.5 HOURS OLD) LATERAL VIEW

In this drawing the mouth parts in the head region seem to be more definite than before.

The egg burster appears again to be piercing the outer shell.

The space all around the ready-to-emerge embryo is present.

The thorax region is more prominent. Segmentation in the abdominal region is as usual-seven segments appear visible.

The hair arrangement is in the usual definite crossed-over pattern.

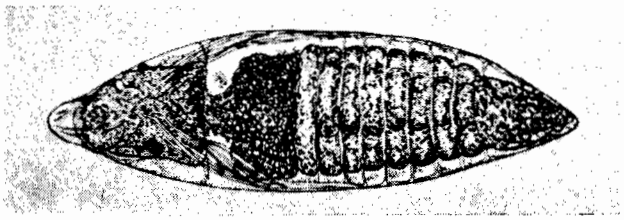


FIGURE 18. FEMALE I (124.5-125.5 HOURS OLD) VENTRAL VIEW

Note the anterior hair tufts. Mouth parts are more defiinite. Egg burster is present anteriorly near the anterior hair tufts. Lateral hair tufts cross ventrally. Thorax well formed. Eight abdominal segments are present. No definite advancement in the tail region is noted.

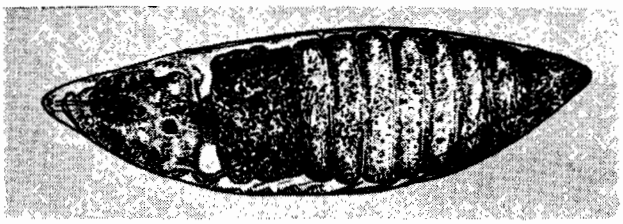


FIGURE 19. FEMALE I (124.5-125.5 HOURS OLD) DORSAL VIEW

Note mouth brush anteriorly. Hair-tufts arrangement usually on lateral sides are not so prominent in this picture. Some hairs are visible ventrally.

Egg burster present dorsally. Eyespot is present.

Thorax well-differentiated from head region.

Seven abdominal segments present.

In spite of the age of the embryo no great advancement in development seems to be made. However, the usual space between the embryo and th shell is present.

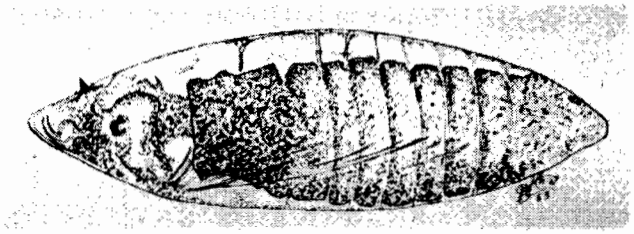


FIGURE 20. FEMALE I (124.5-125.5 HOURS OLD) LATERAL VIEW

Here again, the egg burster is present dorsally and is piercing the outer shell.

Note the mouth brushes, the eye spot, the well-differentiated mouth parts, the definite pattern of the lateral hair-tufts.

A new advancement shown in this picture is the development of the thorax. The tergum or dorsal plate is seen also. Seven abdominal segments are again seen here.

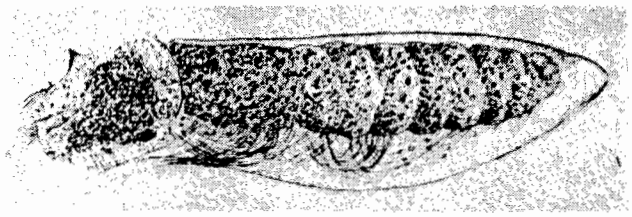


FIGURE 21. FEMALE D A LATE EMBRYO. LATERAL VIEW

Here the head appears to be out of the shell. The hair tufts are longer both laterally and anteriorly. Note the egg burster dorsally. Eyespot present ventrally.

Seven abdominal segments are present. Notice for the first time hair tufts in the posterior region. Note that the bristles are in a spiral pattern around the body of the embryo when the embryo is in the chorion.

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Dr. Markos: The next speaker will consider mosquito population reports as given by the data over the past season. In spite of the fact that this individual represents headquarters, we are very happy to have him associated with the Field Station. I present Mr. Ed Loomis.

EVALUATION OF MOSQUITO MEASUREMENT METHODS IN CALIFORNIA, 1953

EDMOND C. LOOMIS[1] AND THEODORE AARONS[2]

The California Mosquito Control Association Culicidology Committee encouraged the continuation of in-

1 Associate Vector Control Specialist, Bureau of Vector Control, State Department of Public Health.

2 Assistant Manager, Alameda County Mosquito Abatement District.

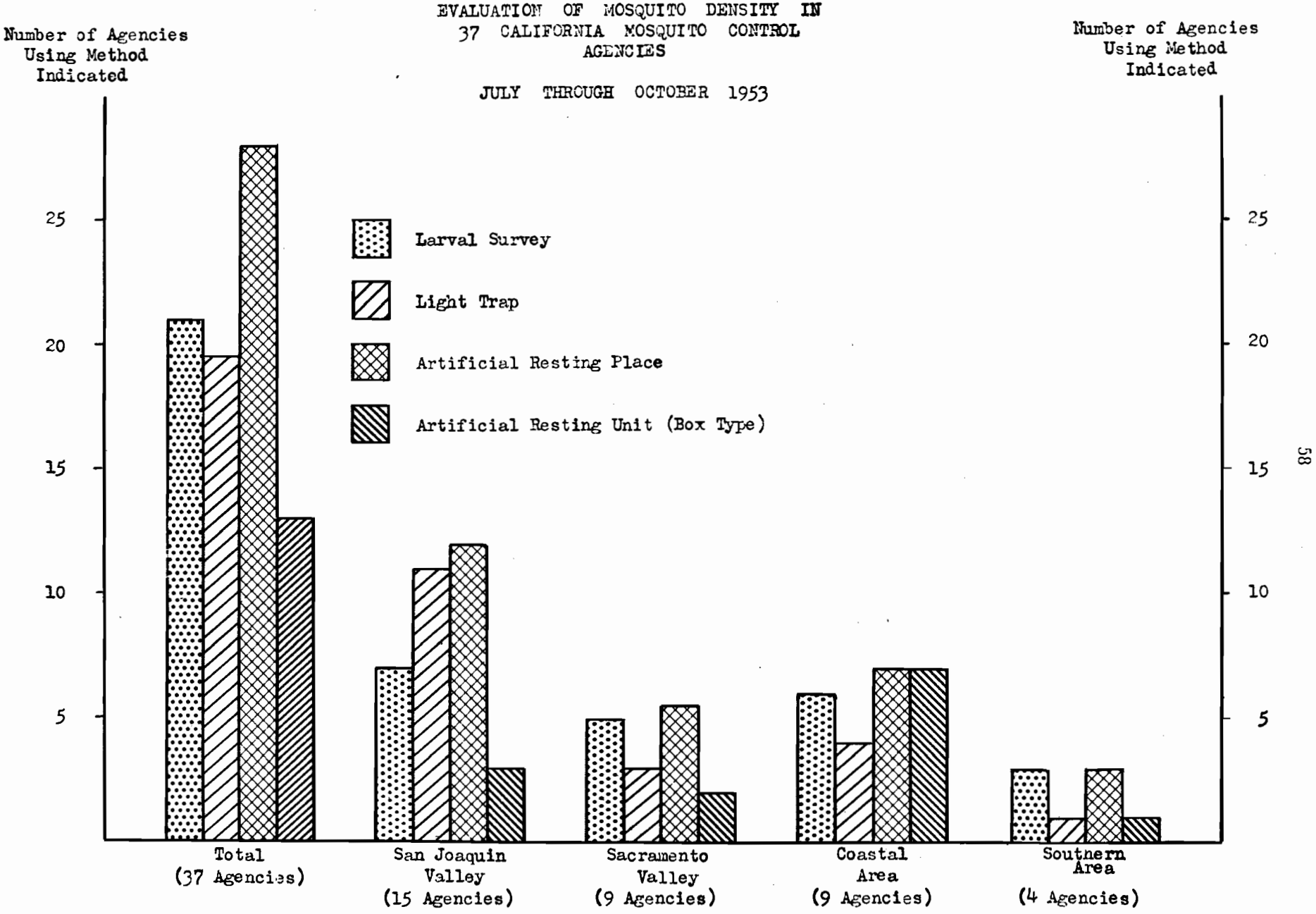
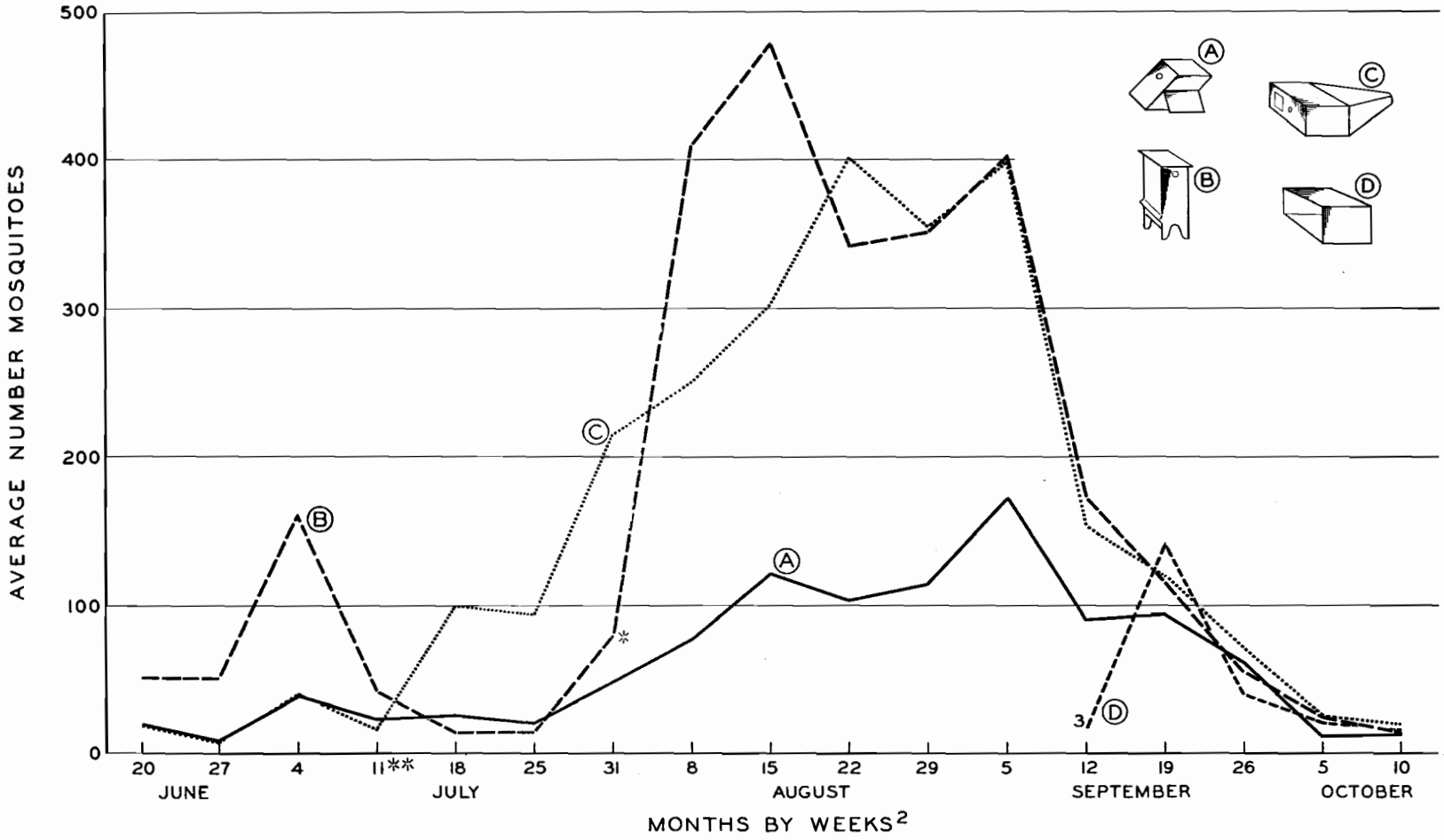

METHODS USED FOR
EVALUATION OF MOSQUITO DENSITY IN
37 CALIFORNIA MOSQUITO CONTROL
AGENCIES
JULY THROUGH OCTOBER 1953
Number of Agencies
Using Method
Indicated
Number of Agencies
Using Method
Indicated
25
20
15
10
5
Larval Survey
Light Trap
Artificial Resting Place
Artificial Resting Unit (Box Type)
Total
(37 Agencies)
San Joaquin
Valley
(15 Agencies)
Sacramento
Valley
(9 Agencies)
Coastal
Area
(9 Agencies)
Soutnern
Area
(4 Agencies)

FIG. 1

FIGURE 2

AVERAGE WEEKLY MOSQUITO COUNTS FROM ARTIFICIAL RESTING UNITS, LINCOLN RICE FIELD PROJECT CENTER, PLACER COUNTY

JUNE 20 – OCTOBER 10, 1953



1 TWO TO FIVE COUNTS PER WEEK
2 WEEK ENDING
3 NOT ERECTED UNTIL SEPTEMBER 6
* PLACED ON SIDE
** PLACED 6" FROM WALL

SOURCE: CALIFORNIA MOSQUITO CONTROL ASSOCIATION, LINCOLN RICE FIELD PROJECT CENTER PLACER COUNTY CALIFORNIA

vestigation in the development of mosquito population evaluation methods in 1953. At the last annual conference it was pointed out that a need existed for standardization of methods used to measure mosquito prevalence throughout the State. At that time the Committee presented to the Association a standard plan for population measurement which included consideration of pre-adult and adult stages. In turn, the State Health Department adopted this plan, in part, as a basis for entomological requirements under the 1953-54 subvention program.

Thirty-seven mosquito control agencies, principally those involved in the State subvention program, participated in the mosquito density evaluation program (Figure 1). Two phases were considered involving the use of four methods of measurement.

I. *Pre-adult Stages*

A. *Subjective larval reports*

Twenty-one agencies maintained larval collection data obtained from permanent inspection stations and/or random samplings. This was a requirement under the subvention program for 1953-54.

Agencies favoring this method emphasized the value in determining the population trends, particularly that of *Culex tarsalis*, during the late spring and early summer months.

II. *Adult Stage*

A. *Light traps*

The American Model light trap was employed by nineteen agencies. Use of this measurement technique was required under the subvention program. Criticism has been directed against running the trap from 7:00 a.m. to 7:00 p.m. It has been suggested that the traps should be set to operate one-half hour before sunset and cease operating one-half hour after sunrise. Standard techniques for processing trap material should also be followed to expedite recording of data and minimize man hours employed in checking trap material. (See appendix for operation and sampling techniques.)

The next two methods of measuring adult populations were not required by the subvention program, but recommendations were made to initiate or continue investigations in order to verify or support the forementioned methods.

B. *Artificial resting places (A.R.P.)*

A more recent term which may be substituted for "Natural Resting Places or Stations" and refers to any man-made shelter which is *not located* for the sole purpose of attracting or collecting mosquitoes. Twenty-eight agencies maintained various resting places, inasmuch as this method was inaugurated at the onset of their control program and continuity of such records were desired.

C. *Artificial resting units (A.R.U.)*

This term designates any man-made shelter which is located for the *sole purpose* of attracting and collecting mosquitoes. Only thirteen agencies investigated this method of measurement. The following values have been brought forth by those agencies using this method: 1) Fifty percent reduction in time spent for inspection of and processing of stations and specimens respectively in comparison to the artificial resting place method; 2) reduces the error of the human factor in collecting; 3) of all mechanical units designed to attract and collect mosquitoes, the A.R.U. is the cheapest and most easily assembled; 4) this unit and method may be used in areas or locations which do not lend themselves to other types of collecting methods.

A majority of agencies tested the efficiency of the Stone type of box unit, and results were not too promising until the baffle board was removed and the box placed on its side on the ground. With the exception of one agency, all reported inconclusive results based on low numbers of mosquitoes collected. The one exception showed a close correlation of species population trend similar to that obtained from A.R.P. inspection. In this agency the A.R.U.'s were placed inside the A.R.P's.

Two agencies tested the original Lug-type unit, and positive results were obtained only by one agency. Once again, the A.R.U.'s were placed inside the A.R.P.'s, and similar counts were obtained. It was found, however, that the height at which the units were placed played an important part in obtaining numbers of mosquitoes, the greater catch resulting from boxes placed closer to the ground.

One agency tested the Bellamy cubic-foot box apart from A.R.P.'s and, for the short time exposed, resulted in almost pure collections of *Culex tarsalis*. Although the data have not been completed, there is satisfactory evidence of their efficiency in collection from natural habitats.

The California Mosquito Control Association Rice Field Project Center investigated four types of box units placed in two areas. At the project Center, four units (Lug, Stone, Sherman, and Bellamy) were tested side by side in sampling the mosquito population in that area. The results are graphically illustrated in Plate 1. In brief, the Stone and Sherman units were superior as to number of mosquitoes captured; and once again, until the Stone type was placed on its side, this unit did not attract a significant number of mosquitoes. As for ease of collection, the Bellamy and Lug units were superior.

This group also tested the efficiency of the Lug and Stone type units dispersed throughout the rice fields and seepage areas. The final results are yet to be analyzed, but preliminary evidence indicates the superiority of the Stone type in highest numbers of mosquitoes attracted—but only after this unit was placed on its side on the ground. Both units appeared to equally attract *Anopheles* and *Culex* species. In Dr. Bellamy's past experience in Kern County with the cubic-foot box, there was a wide difference in counts from boxes placed relatively close together. There was also a wide variation of results from the Lug and Stone units placed close together in any one vicinity of the rice fields and seepage areas.

The Bureau of Vector Control investigated A.R.U.'s inside A.R.P.'s, the latter all being chicken houses selected within an uncontrolled area. The type of artificial units in this case were ordinary cardboard boxes of similar size and shape and which may be obtained from any grocery store. These units were nailed to the inside walls of the houses with the open end facing out. Preliminary results indicated a positive correlation of counts from these units along with counts made from the chicken houses as well. Speciation also appeared to be the same between such counts.

In conclusion, there is increasing evidence that A.R.U.'s do have value in certain areas and in certain specific locations. Just what type of unit may be the best is difficult to

state. This latter part can only be answered by further testing within individual areas. Our objective will therefore be to continue improvement of the standard plan of population measurement which will provide a reasonably valid correlation of mosquito numbers in relation to disease incidence, public comfort, and economic damage.

Dr. Markos: That concludes the reports of the Operational Investigations.

Mr. Grant: Thank you, Basil Markos, for a very instructive presentation. It is very late; about time to go to lunch. Just one request; that the newly elected Directors and officers meet up here in front. Unless there are any further announcements, we will adjourn until 1:30.

A REPORT ON THE PRESENT STATUS OF CONTROL OF MOSQUITOES OF PUBLIC HEALTH CONCERN TO THE STATE OF CALIFORNIA

JANUARY 1954

Prepared for
THE STATE DEPARTMENT OF PUBLIC HEALTH
By
A SUBCOMMITTEE OF
THE VECTOR CONTROL
ADVISORY COMMITTEE

Foreword

The Legislature of the State of California in 1946 in extraordinary session enacted legislation, subsequently approved by the Governor, entitled "An act to provide State assistance of local agencies for the control of mosquitoes, and making an appropriation therefor, to take effect immediately." (Chapter 704, Statutes 1947.)

This act, directed primarily toward preventing the introduction and spread of mosquito-transmitted exotic diseases into California through returning military personnel, authorized the Department of Public Health "to enter into cooperative agreements with any local district or other public agency engaged in the work of controlling mosquitoes in such areas under such terms, conditions and specifications as the State Board of Public Health may prescribe. . . ."

An appropriation in the amount of $400,000 was made available for direct assistance to the local control agencies on a fund-matching basis. Subvention for mosquito control has since been made available annually.

Since the inception of this State program only occasional localized outbreaks of malaria traceable to military returnees have occurred. However, despite the expansion and progress in mosquito control since enactment of this legislation, mosquitoes have become increasingly significant as a public health and economic problem to the people of California. The most important factors contributing to this situation have been:

(1) The development of vast additional water resources has provided each year additional mosquito sources which are by-products of man's use of water in agricultural, industrial and community developments; and

(2) The rapid population growth of the State and the trend toward suburban and rural residential life has resulted in the exposure of more people to mosquitoes.

(3) The changing pattern of agriculture, which in the past decade has brought a great expansion of irrigated crops without adequate provision for the disposal of waste water, has vastly increased the sources of mosquitoes, including those which transmit malaria and encephalitis.

(4) Mosquitoes have developed a resistance to DDT and related chlorinated hydrocarbon insecticides. This has caused the chemical approach to their control to become more costly and less reliable.

(5) The level of financial support to the State Department of Public Health for a complementary program of operational investigations to support and guide the local control program in this specialized field has been disproportionately low, amounting to less than two percent of the total annual expenditures for field operations.

As a result of these factors, the costs of the mosquito abatement effort, utilizing even the best available procedures, still exceeds the feasible limitations of local financing. That the populace of the area is cognizant of the merit and the needs of the mosquito abatement effort is evidenced through the considerable local funds provided and the initiative of the people in forming new mosquito abatement districts. Since 1945, the number of agencies performing mosquito control has increased from 29 to 53, and the area receiving the benefits of organized mosquito control has increased more than six times, from about 4,000 to approximately 30,000 square miles (see frontispiece). It is significant that cooperative effort has resulted in the direction of special attention toward the Central Valley, thus affording increased protection to citizens from all parts of the State and to tourists in their travels along the extremely important transportation route which traverses the interior portion of California.

The stimulus and coordinating influence arising from the State's financial assistance program have contributed significantly to the advancement of mosquito control in California. It has been reflected not only in the greater area brought into the control program, but also in the vital aspects of efficiency. This added impetus has brought forth a substantial increase in the number of persons professionally trained in mosquito control and has yielded a corresponding improvement in the planning, equipment and techniques of mosquito control procedure. However, in spite of technological advances and a greatly intensified and expanded program in the State, mosquito-borne diseases continue to present a growing threat to the people as evidenced by the outbreaks of encephalitis and malaria in 1952.

Recommendations

On the basis of a review of the mosquito problem in California, the following recommendations are made:

(1) The State of California should continue to provide financial assistance to local mosquito control programs as an effective means of coordinating all available resources toward the mosquito-transmitted disease threat. The State should anticipate this as a continuing need, at least until the popu-

lation and the agricultural and industrial growth, now in transition, become stabilized.

(2) A legislative policy should be adopted which establishes the amount of subvention for mosquito control and the method of allocation. Until appropriate legislative study develops such a policy, the level of State assistance should be maintained at the present rate of $700,000 per year.

(3) Adequate financial provision should be made for a sound investigations program which will obtain the technical information basic to the development of improved equipment, methods, materials and techniques for mosquito abatement.

(4) Epidemiological investigations should be continued and accelerated to further clarify our understanding of the mosquito-borne diseases and thereby offer possible new approaches to their suppression.

(5) If the expanding mosquito problem is to be met, water resources planning must hereafter include mosquito prevention as an essential element; and to that end, there must be coordination of the efforts of all agencies concerned therein.

Scope of the Problem

The program of mosquito control in California was originally undertaken for the primary purpose of satisfying the demands of the people for relief from attack by mosquitoes. While malaria was a significant problem as late as 1920, it was nevertheless a secondary consideration. With the recognition of encephalitis as a mosquito-borne disease in the early 1930's and with the changes that have accompanied the State's growth in the past 20 years, the basic considerations for the development of mosquito control programs have changed to include:

(1) Control of disease-bearing mosquitoes:

Encephalitis is prevalent in the Central Valley, on occasion reaching serious epidemic proportions. It also has been known to occur infrequently outside the Central Valley. The most recent major outbreak occurred in 1952, when there were 813 cases and 52 deaths. (See table 1 in appendix.) The causative viruses (Western and St. Louis types) are transmitted to humans by *Culex tarsalis,* one of the most common mosquitoes in the State.

The *Western Equine* virus is also transmitted to horses by the same mosquito. Cases in horses usually occur at the same season as those in man. In 1952 there were 407 horse cases reported from 44 of the counties of the State. (See table 2 in appendix.)

Malaria in recent years has been infrequently reported. In 1952 there were 35 cases traced to one local outbreak at Lake Vera in Nevada County. Sporadic, locally transmitted cases have occurred elsewhere. This disease is transmitted by *Anopheles freeborni* and *Anopheles punctipennis,* very common mosquitoes in the Central Valley and the Sierra Nevada foothills respectively, occurring elsewhere in this State in significant but smaller numbers.

Other diseases: *Yellow fever, dengue* and *filariasis* are not regarded as likely to become public health problems in California; however, *Japanese "B"* and other virus *encephalitides* remain a potential threat to public health in California. If introduced here from other countries and not promptly recognized and controlled, these diseases could become significant problems.

(2) Control of mosquitoes causing human annoyance:

When present in large numbers in association with human populations, which condition is characteristic of many locations in California, mosquitoes cause severe annoyance. This includes both vector and pest species. The Vector Control Advisory Committee of the State Department of Public Health is in accord with The Surgeon General of the U. S. Public Health Service, who has recognized the importance of pest mosquitoes in these words:

"It is our conviction that the pest mosquitoes should receive more attention from health authorities than they have in the past. Public health has become something more than the absence of disease. Physical efficiency and comfort, on which mental equanimity depends to a substantial degree, may be seriously disturbed by the continued annoyance of pestifeous mosquitoes which may or may not have disease transmitting potentialities."

(3) Economic aspects:

Abatement of prevalent mosquitoes derives beneficial effect in various ways:

(a) By increasing the productivity of crops and livestock;
(b) By improving the efficiency of industrial and farm labor;
(c) By enabling the use and enjoyment of the out-of-doors in residential and resort areas;
(d) By increasing realty and rental values;
(e) By reclamation of marsh lands to agricultural, industrial and community uses; and
(f) By bringing about conservation and better use of water, the State's most vital resource.

Historical and Current Asects of State Financial Assistance to Local Agencies

The 29 local agencies conducting mosquito control prior to 1945 were serving an area of 4,600 square miles and were supported entirely by local funds amounting to $363,000.*

In fiscal year 1946-47, the first full year of State assistance funds, the number of agencies increased to 34, of which 20 participated in subvention; the area became 11,000 square miles; and the total of State and local appropriation reached $1,300,000.00.

In subsequent years, there has been a steady expansion in the organized effort to control mosquitoes (see Fig. 1). For fiscal year 1953-54 there are 53 agencies, of which 30 receive subvention; the total area has increased to almost 30,000 square miles; and the sum total of local and State budgets amounts to $3,304,183.00. See table 4 in appendix.)

The State subvention for direct financial assistance to local agencies, included in the above budget figures, has

remained constant at $400,000 per year since fiscal year 1946-47, except for fiscal year 1952-53, when the local agencies received approximately $130,000 of emergency funds to help combat an encephalitis outbreak, and for fiscal year 1953-54, when the subvention was increased by $300,000 through legislative action. (See table 3 in appendix.)

Coordination and Technical Assistance

Administration of the subvention funds for assisting local agencies is carried out by the State Department of Public Health under rules as set forth in the "Standards and Recommendations for Local Mosquito Control Agencies," adopted as regulations by the California State Board of Public Health, April 8, 1949, and now contained in the California State Administrative Code, Title 17. Coordination of the program and technical assistance to the local agencies is furnished by the technical and administrative staff of the Bureau of Vector Control.

Benefits of the Subvention Program

The interests of the State of California has been served by this subvention in a number of ways as follows:

To an appreciable extent, the requirements for subvention have stimulated the operating agencies to employ personnel better trained professionally for the work to be done; to procure and improvise equipment that is more adequate; to devise operating plans that offer promise of more effective results; and to institute more complete and efficient record keeping procedures.

Some of the tangible results are:

(1) Improved Organization. Although the local resources for mosquito control have been increased materially, they are not yet sufficient to meet adequately the existing or potential epidemic emergency needs of many areas. The lack of over-all planning of water resources development to include provisions for the control of mosquitoes has been a major factor contributing to the present inability of the mosquito abatement effort to keep abreast of the growing problem.

(2) Mosquito Suppression. Mosquitoes have been temporarily suppressed by chemical insecticides, while increasing attention is being given to long range methods for mosquito source reduction through the application of improved land and water management methods.

(3) Technical Development. Mosquito control agencies have participated in state-wide investigations for measuring more accurately the mosquito populations, mosquito behavior, and mosquito infection with disease agents as a guide for the control oerations to be performed.

Summary

The mosquito problem and the mosquito-borne disease potential of California are increasing as by-products of the rapid development of the land, water, agricultural, industrial and community resources of the State.

Local mosquito control agencies have vastly expanded their programs to meet the increasing needs and have correspondingly increased expenditure of locally derived public funds, but a considerable number are still unable to keep abreast of the increasing problem without the assistance of State aid.

The State subvention provided is serving the interests of the State by encouraging the expansion of organized mosquito control to areas where a need exists, by providing a coordinating influence tending to improve the quality of the service being performed, by supplying technical information necessary to the efficient conduct of this highly complex program, and by providing substantial financial aid to local agencies as a step toward obtaining adequate mosquito abatement.

The technical difficulties of providing adequate mosquito control are increasing. There exists an urgent need to provide additional facilities and personnel for conducting investigations into existing problems for the purpose of developing greater effectiveness and economy in mosquito abatement operations.

Adequate financial support is essential for local mosquito control agencies and also for the State Department of Public Health to accomplish the protection of the people of California from mosquitoes and mosquito-transmitted diseases. Such support should be continued until the development of the State's agricultural and industrial resources shall have become more stabilized and solutions of the attendant problems shall have been more nearly achieved.

References

Additional factual information relating to the control of mosquitoes and mosquito-borne diseases in California may be obtained from the following sources:

1945—"A Report on Investigation of the Disease-Bearing Mosquito Hazard in California," Submitted to the Governor and to The Fifty-Sixth Session of the California Legislature Pursuant to Senate Concurrent Resolution No. 11, by the State Department of Public Health. January 1945. (California State Printing Office)

1949—State of California Administrative Code; Title 17, Public Health; Subchapter 3, Vector Control; Sections 30001-30051, "Standards Concerning State Aid to Local Mosquito Control Agencies." (California State Printing Office)

1951—Health and Safety Code, State of California, Chapter 5, "Mosquito Abatement Districts;" Chapter 5.5, "Mosquito and Gnat Control." (California State Printing Office)

1951—"Mosquito Abatement in California," Bulletin No. VC-1, issued by the State of California, Department of Public Health.

1953—"A Research Report on Encephalitis in California," issued by the Subcommittee on Encephalitis, Assembly Public Health Committee, H.R. 91, 1953, Regular Session, California State Legislature.

Additional detailed information related to the material presented in this report may be obtained from:

The California State Department of Public Health.
The University of California
The California Mosquito Control Association, Inc.

* A report on Investigation of the Disease-Bearing Mosquito Hazard in California. January 1945.

APPENDIX — TABLE 1

California State Department of Public Health

CASES OF HUMAN ENCEPHALITIS REPORTED IN CALIFORNIA

By Year of Onset and County — 1945 - 1953

COUNTY	1945	1946	1947	1948	1949	1950	1951	1952	1953
Alameda	5	7	7	5	3	3	1	7	6
Alpine	..	..	..	..	..	..	..	..	..
Amador	..	..	..	..	..	..	..	1	..
Butte	..	1	1	1	2	8	3	9	1
Calaveras	..	..	..	..	..	..	..	..	1
Colusa	..	..	1	..	..	1	1	2	3
Contra Costa	..	1	1	3	1	2	3	14	2
Del Norte	..	..	..	..	..	..	..	..	..
El Dorado	..	..	..	..	..	..	..	..	..
Fresno	66	31	19	15	4	34	20	137	11
Glenn	1	..	3	..	2	6	..	1	1
Humboldt	..	..	..	..	..	1	1	2	1
Imperial	..	..	..	1	..	11	2	..	4
Inyo	..	..	..	..	..	..	..	2	..
Kern	109	52	16	21	28	73	35	222	35
Kings	4	7	5	5	4	9	2	21	1
Lake	..	..	..	..	..	2	1	3	..
Lassen	..	1	..	..	..	..	..	1	..
Los Angeles	5	2	3	..	2	..	1	3	8
Madera	3	12	..	..	..	7	7	23	1
Marin	..	..	..	..	..	1	..	1	1
Mariposa	..	..	..	..	..	..	..	1	..
Mendocino	..	1	1	..	1	1	1	1	..
Merced	1	1	1	..	1	2	..	25	1
Modoc	..	..	..	..	..	..	..	..	..
Mono	..	..	..	..	..	..	..	..	..
Monterey	3	1	..	1	2	3	3	1	4
Napa	..	..	..	..	..	..	..	..	..
Nevada	..	..	..	..	..	..	..	2	..
Orange	1	1	..	..	..	..	1	1	1
Placer	..	..	1	..	..	4	..	4	..
Plumas	..	..	..	..	..	2	..	..	..
Riverside	6	1	..	1	8	3	5	4	10
Sacramento	8	2	3	1	..	19	14	66	7
San Benito	..	..	..	..	..	1	1	2	1
San Bernardino	2	5	1	..	3	11	5	1	7
San Diego	2	2	4	2	..	3	3	7	1
San Francisco	2	1	3	4	3	3	5	1	5
San Joaquin	11	6	10	2	3	51	12	92	7
San Luis Obispo	..	..	1	..	..	1	..	2	..
San Mateo	..	..	3	..	1	..	1	..	3
Santa Barbara	2	1	..	..	..	2	..	..	..
Santa Clara	1	1	2	..	2	6	1	4	5
Santa Cruz	..	..	..	..	..	1	..	..	..
Shasta	1	..	2	1	1	..	..	..	..
Sierra	..	..	..	..	..	..	..	..	..
Siskiyou	..	..	..	..	..	2	..	..	..
Solano	3	1	1	..	..	2	2	8	2
Sonoma	1	1	..	..	..	2	1	2	..
Stanislaus	4	4	1	2	2	23	2	42	2
Sutter	3	..	2	..	..	14	..	16	3
Tehama	4	..	14	1	..	1	..	1	2
Trinity	..	..	..	1	..	..	1	2	..
Tulare	45	8	8	..	3	10	5	44	4
Tuolumne	..	..	..	..	1	..	..	..	..
Ventura	1	..	..	..	..	..	..	1	..
Yolo	4	6	8	1	2	16	3	20	11
Yuba	3	..	1	2	..	10	1	11	1
Not Allocated*	11	3	4	1	1	10	1	3	3
TOTAL CASES	302	160	127	71	80	361	145	813	156

* Cases "Not Allocated" Charged to California-Persons Whose Infections Were Contracted Outside the State or Who Were Transients and Sources Could Not Be Given as Any One County.

Revised 1/15/54

APPENDIX

TABLE 2

CASES OF EQUINE ENCEPHALOMYELITIS

Reported to
California State Department of Agriculture
By County
1947 - 1953

COUNTY	1947	1948	1949	1950	1951	1952	1953
Alameda	..	1	..	2	..	15	..
Alpine	..	..	..	..	..	..	..
Amador	1	..	..	1	1	2	..
Butte	11	4	13	..	7	5	..
Calaveras	2	..	1	..	..	2	..
Colusa	4	5	6	5	1	..	..
Contra Costa	1	..	..	1	..	18	..
Del Norte	..	..	..	..	..	..	..
El Dorado	..	..	..	..	..	1	..
Fresno	24	3	13	3	3	12	2
Glenn	16	8	13	4	1	4	..
Humboldt	1	..	2	..	..	2	..
Imperial	..	8	45	14	27	4	1
Inyo	..	..	..	..	..	9	..
Kern	8	1	16	5	6	33	1
Kings	4	..	4	..	..	4	..
Lake	..	..	3	4	2	2	..
Lassen	2	..	2	1	1	3	..
Los Angeles	..	..	2	9	1	19	..
Madera	8	..	1	3	..	10	1
Marin	..	..	..	1	..	2	..
Mariposa	..	..	..	..	..	1	..
Mendocino	5	..	5	2	..	13	..
Merced	17	..	5	4	1	4	..
Modoc	5	..	10	6	..	5	2
Mono	..	..	..	..	..	3	..
Monterey	..	..	..	1	1	16	3
Napa	..	1	1	4	..	8	..
Nevada	..	..	1	4	..	..	..
Orange	..	8	2	..	..	4	..
Placer	2	..	..	3	5	7	..
Plumas	..	..	..	2	..	..	1
Riverside	..	2	1	..	3	20	1
Sacramento	19	5	7	3	2	10	..
San Benito	..	1	..	1	1	5	1
San Bernardino	..	4	3	1	..	4	..
San Diego	..	2	4	34	3	3	2
San Francisco	..	..	..	1	..	..	..
San Joaquin	18	3	5	7	8	25	..
San Luis Obispo	..	..	3	1	1	16	..
San Mateo	..	..	..	2	..	4	..
Santa Barbara	..	3	1	3	1	2	..
Santa Clara	1	4	2	1	1	24	..
Santa Cruz	..	..	..	..	..	1	..
Shasta	10	..	20	9	..	11	1
Sierra	..	..	..	..	..	..	..
Siskiyou	..	1	4	7	..	7	3
Solano	5	1	5	..	1	3	..
Sonoma	5	..	1	4	2	4	..
Stanislaus	19	1	8	30	5	17	1
Sutter	..	..	7	2	2	..	..
Tehama	21	1	17	4	1	5	..
Trinity	..	..	..	..	..	4	..
Tulare	2	..	8	5	3	22	1
Tuolumne	..	..	..	2	..	3	..
Ventura	..	2	3	..	..	2	..
Yolo	2	1	11	1	1	3	..
Yuba	5	..	13	6	4	4	3
TOTAL CASES	218	70	268	203	96	407	24

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APPENDIX

TABLE 3

SUMMARY OF DATA RELATIVE TO MOSQUITO CONTROL AGENCIES
RECEIVING STATE AID FUNDS
FY 1946-47 through FY 1953-54

Fiscal Year	Number of Agencies	Area Square Miles	Local Funds	State Funds	Total Funds
1946-47	20	8,921	$ 789,330.49	$395,718.98	$1,185,049.47
1947-48	19	12,846	902,302.04	378,823.37	1,281,125.41
1948-49	19	12,908	991,377.57	326,083.38	1,317,460.95
1949-50	24	16,507	1,160,312.92	400,000.00	1,560,312.92
1950-51	24	16,469	1,256,868.39	400,000.00	1,656,868.39
1951-52	28	19,160	1,558,400.00	400,000.00	1,958,400.00
1952-53	29	19,463	1,731,016.00	400,000.00	2,131,016.00
1952-53				123,546.20 1/	123,546.20 1/
1953-54	30	20,392	1,931,554.59	700,000.00	2,631,554.59
TOTALS			$10,321,162.00	$3,524,171.93	$13,845,333.93

1/ Emergency *Culex tarsalis* control funds allocated to local agencies from total of $250,000 emergency funds appropriated to combat encephalitis outbreak.

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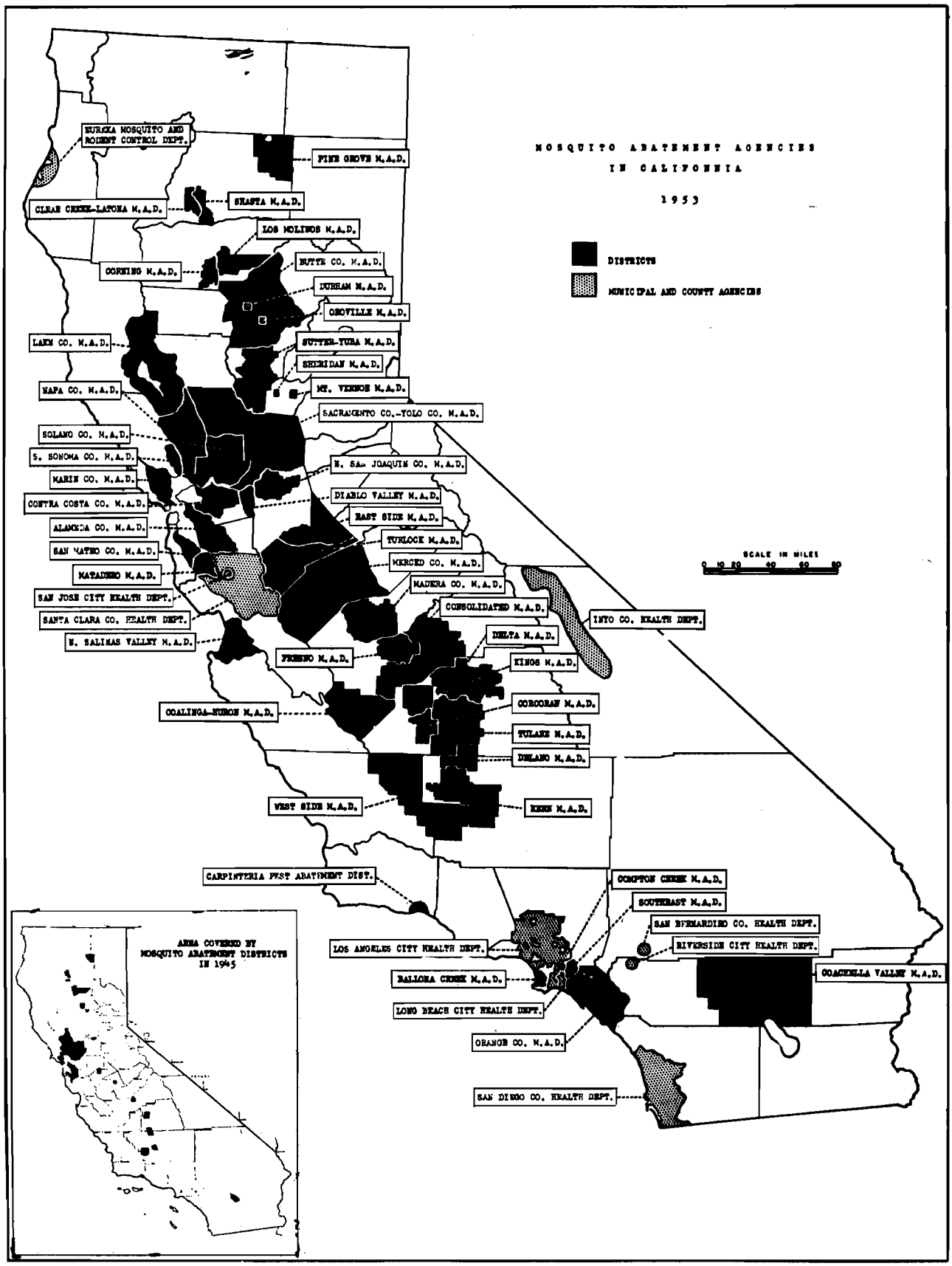
TABLE 4

CALIFORNIA MOSQUITO ABATEMENT AGENCIES

Fiscal Information FY 1953-54

AGENCY	Area Sq. Mi.	Population 1953 (Est.)	Assessed Valuation	Tax Rate Per $100	Local Budget	State Subsidy	Total Budget	Cost Per Sq. Mi.	Cost Per Cap.
Alameda County MAD	445	755,000	$ 827,439,445	.013	$123,669	$ ..	$123,669	$278	$ .16
Ballona Creek MAD	26	150,000	139,200,250	.0124	17,500	..	17,500	673	.12
Butte County MAD	1612	65,500	76,218,655	.15	105,544	56,200	161,744	100	2.47
Carpinteria (PAD) 1/ 3/	10	3,800	7,279,471	..	2,600	..	2,600	260	.68
Clear Creek MAD	30	4,500	4,950,000	.20	8,910	5,100	14,010	467	3.11
Coachella Valley MAD	2084	35,000	58,080,520	.15	77,571	19,300	96,871	46	2.77
Coalinga-Huron MAD	900	12,558	168,091,370	.02	32,227	..	32,227	36	2.57
Compton Creek MAD 3/	25	40,000	41,402,230	.0154	6,000	..	6,000	240	.15
Consolidated MAD	1048	130,000	114,436,925	.15	153,210	45,700	198,910	190	1.53
Contra Costa #1 MAD 3/	471	135,000	195,000,000	.028	43,000	..	43,000	91	.32
Corcoran MAD	90	12,000	10,497,790	.15	12,104	9,000	21,104	234	1.76
Corning MAD	75	3,500	6,425,914	.15	7,068	7,000	14,068	188	4.02
Delano MAD	350	15,000	25,200,000	.15	34,980	16,700	51,680	148	3.45
Delta MAD	705	80,000	78,936,740	.15	100,644	36,500	137,144	195	1.71
Diablo Valley MAD	136	12,300	11,540,790	.15	10,700	7,000	17,700	130	1.44
Durham MAD	64	2,000	4,055,210	.15	6,525	5,100	11,625	182	5.81
East Side MAD	520	92,000	79,531,580	.12	97,905	23,500	121,405	234	1.32
Eureka (PAD) 1/ 4/	..	..	..	..	..	..	..	..	..
Fresno MAD	337	250,000	194,586,270	.0575	95,104	26,300	121,404	360	.49
Inyo County H.D. 2/ 4/	..	..	..	..	..	..	..	..	..
Kern MAD	972	150,000	307,837,515	.08	202,108	31,000	233,108	240	1.55
Kings MAD	185	25,000	29,784,720	.15	39,280	13,300	52,580	284	2.10
Lake County MAD	1256	14,000	22,000,000	.07	10,188	9,800	19,988	16	1.43
Long Beach City H.D. 2/ 4/	..	..	..	..	..	..	..	..	..
Los Angeles City H.D. 2/	454	2,050,000	2,971,452,080	..	32,379	15,500	47,879	106	.02
Los Molinos MAD	284	3,000	2,977,840	.255	7,009	7,006	14,015	49	4.67
Madera County MAD	650	35,000	46,657,295	.15	59,500	35,100	94,600	146	2.70
Marin County MAD	181	101,000	84,673,510	.04	34,000	..	34,000	188	.34
Matadero MAD	65	75,000	113,903,500	.022	36,000	..	36,000	554	.48
Merced County MAD	1995	76,000	73,061,040	.15	115,000	70,000	185,000	93	2.43
Mt. Vernon (Inactive)	..	..	..	..	..	..	..	..	..
Napa County MAD	787	52,000	47,548,780	.03	19,561	..	19,561	25	.38
No. Salinas Valley MAD	500	65,000	104,000,000	.10	140,535	11,360	151,895	304	2.34
No. San Joaquin Co. MAD	191	35,000	58,032,570	.086	39,100	11,800	50,900	266	1.45
Orange County MAD	777	225,000	463,818,200	.012	79,224	..	79,224	102	.35
Oroville MAD 3/	13	12,500	6,222,761	.11	12,000	..	12,000	923	.96
Pine Grove MAD	206	1,900	2,890,000	.40	9,423	8,500	17,923	87	9.43
Riverside City H.D. 2/ 4/	..	..	..	..	..	..	..	..	..
Sacramento-Yolo Co. MAD	2013	400,000	403,786,834	.05	202,100	45,700	247,800	123	.62
San Bernardino Co. H.D. 2/	100	355,000	344,633,200	..	3,784	..	3,784	38	.01
San Diego County H.D. 2/	400	700,000	520,000,000	..	22,129	14,000	36,129	90	.05
San Jose City H.D. 2/ 4/	..	..	..	..	..	..	..	..	..
San Mateo Co. MAD	144	210,000	310,000,000	.017	51,000	..	51,000	354	.24
Santa Clara Co. H.D. 2/	1240	270,000	373,294,840	..	27,825	23,000	51,125	41	.19
Shasta MAD	58	25,000	17,400,000	.18	26,620	9,000	35,620	614	1.42
Sheridan MAD (Inactive)	..	..	..	..	..	..	..	..	..
Solano County MAD	911	120,000	114,296,415	.03	40,470	12,100	52,570	58	.44
Southeast MAD 3/	170	400,000	406,000,000	.0183	63,000	..	63,000	371	.16
So. Sonoma Co. MAD 3/	196	17,000	11,554,700	.08	12,173	..	12,173	62	.72
Sutter-Yuba MAD	722	60,000	64,000,000	.15	99,326	52,700	152,026	211	2.53
Tulare MAD	562	54,000	50,544,155	.14	56,487	25,100	81,597	145	1.51
Turlock MAD	966	75,000	64,451,475	.19	91,800	44,400	136,200	141	1.82
West Side MAD 3/	1214	28,000	163,865,175	.05	80,000	..	80,000	66	2.86

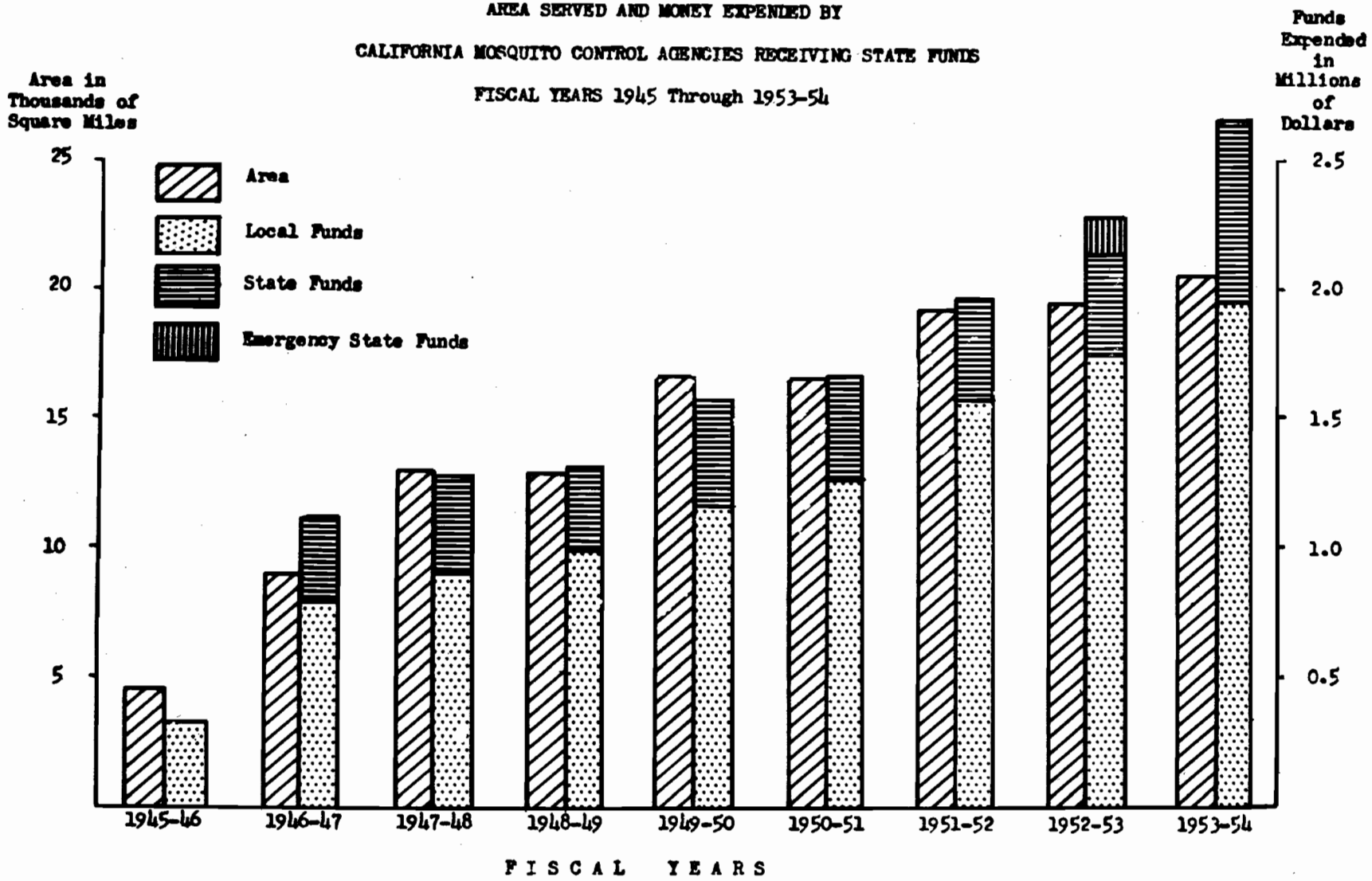
1/ Pest Abatement District
2/ Local Health Department
3/ 1952-53 Figures
4/ Figures not yet Available


MOSQUITO ABATEMENT AGENCIES
IN CALIFORNIA
1953
DISTRICTS
MUNICIPAL AND COUNTY AGENCIES
SCALE IN MILES
0 10 20 40 60 80
EUREKA MOSQUITO AND ROBERT CONTROL DEPT.
PINE GROVE M.A.D.
SHASTA M.A.D.
CLEAR CREEK-LATONA M.A.D.
LOS MOLINOS M.A.D.
BUTTE CO. M.A.D.
CORNING M.A.D.
DURHAM M.A.D.
OROVILLE M.A.D.
LAKE CO. M.A.D.
SUTTER-YUBA M.A.D.
SHERIDAN M.A.D.
MT. VERNON M.A.D.
NAPA CO. M.A.D.
SACRAMENTO CO.-YOLO CO. M.A.D.
SOLANO CO. M.A.D.
S. SONOMA CO. M.A.D.
N. SAN JOAQUIN CO. M.A.D.
MARIN CO. M.A.D.
DIABLO VALLEY M.A.D.
CONTRA COSTA CO. M.A.D.
EAST SIDE M.A.D.
ALAMEDA CO. M.A.D.
TURLOCK M.A.D.
SAN MATEO CO. M.A.D.
MERCED CO. M.A.D.
MATADERO M.A.D.
MADERA CO. M.A.D.
SAN JOSE CITY HEALTH DEPT.
CONSOLIDATED M.A.D.
SANTA CLARA CO. HEALTH DEPT.
INYO CO. HEALTH DEPT.
W. SALINAS VALLEY M.A.D.
DELTA M.A.D.
FRESNO M.A.D.
KINGS M.A.D.
COALINGA-HURON M.A.D.
CORCORAN M.A.D.
TULARE M.A.D.
DELANO M.A.D.
WEST SIDE M.A.D.
KERN M.A.D.
CARPINTERIA PEST ABATEMENT DIST.
COMPTON CREEK M.A.D.
SOUTHEAST M.A.D.
SAN BERNARDINO CO. HEALTH DEPT.
LOS ANGELES CITY HEALTH DEPT.
RIVERSIDE CITY HEALTH DEPT.
COACHELLA VALLEY M.A.D.
BALLONA CREEK M.A.D.
LONG BEACH CITY HEALTH DEPT.
ORANGE CO. M.A.D.
SAN DIEGO CO. HEALTH DEPT.
AREA COVERED BY MOSQUITO ABATEMENT DISTRICTS IN 1945

AREA SERVED AND MONEY EXPENDED BY

CALIFORNIA MOSQUITO CONTROL AGENCIES RECEIVING STATE FUNDS

FISCAL YEARS 1945 Through 1953-54



FOURTH SESSION
THURSDAY, DECEMBER 3, 1953, 1:30 P.M.
CLAREMONT HOTEL, OAKLAND

Mr. Grant: First on the program for this afternoon will be panel presentations of the Regional reports. I will call on Sacramento Valley first and turn the meeting over to George Umberger of the Sacramento-Yolo County Mosquito Abatement District.

(Editor's Note: Mr. Umberger projected slides showing the booth sponsored by the California Mosquito Control Association at the California State Fair in September, and the medal it received. He then presented by title the following reports from the Sacramento Valley region, except that Mr. Bollerud's report was presented in person.)

MOSQUITO SOURCE REDUCTION IN RIVER AND STREAM OVERFLOW AREAS IN THE SHASTA MOSQUITO ABATEMENT DISTRICT

J. D. Willis, Manager
Shasta Mosquito Abatement District
P.O. Box 331, Redding, California

Many of the problems in regard to source reduction in the Shasta Mosquito Abatement District are in overflow areas along the Sacramento River and smaller tributary streams throughout the District. The regulation of water from the Shasta Dam is far from being an ideal mosquito control situation. More water is released during the summer month, increasing our larviciding program in overflow and low seepage areas—many of them being a considerable distance from the river itself. During the winter months, water is sometimes released in enormous quantities, causing flood-like conditions which may take some continual source reduction work necessary in the future. This was brought to us very plainly during the winter of 1952-53, when somewhere between 70,000 and 80,000 second feet of water were released.

In the future years, when the irrigation needs in the valleys become greater and more water is needed, there may be 18,000 to 20,000 second feet or *even more* released during the summer months instead of the present 13,000 to 14,000 second feet. Foreseeing this increase in flow is one of the reasons which makes necessary some type of definite source reduction program.

During the past five years we have been attempting to start a permanent source reduction program where it will do the most good for our district. In all phases of our planned source reduction program we are trying to eliminate or reduce the extent of water in which mosquitoes develop. It is indeed unfortunate that a mosquito abatement district such as ours, formed in 1920, was not able to foresee the future so that much of the present source reduction work would not now be necessary.

In former years we have attempted to do some of this work by contract, but this proved to be very expensive since the District eventually paid most of the cost of the work. We also decided that while we did not want to compete with any private heavy equipment operators in our area, very little if any of the work we are doing in our program would ever be done by private individuals. With this in mind we purchased a D-4 Caterpillar tractor with accessories this past spring, and we have started on our own source reduction program.

We have four reasons for starting our source reduction program in overflow areas. The first has been explained above in regard to the increase in flow of the river.

Second, probably the easiest part of a source reduction program, will be the elimination by filling of costly breeding areas, many of them costing $25, $50, or even $100 per year to control for the past 20 to 30 years. In years past, it has been necessary to do a great deal of maintenance work in these breeding areas so that the operator could get in for inspections and treatment where necessary during the larviciding season. By this we mean that in many cases maintenance work such as burning, brushing, and in the past few years the use of 24-D's, were much more costly than the actual larviciding program.

Third, source reduction will allow us more time for work in our irrigated pastures and urban areas during the larviciding season.

Fourth, it will eventually cut down the cost of operation to the taxpayer. Taxes are one thing which people seem to be very interested in these days.

We have planned our source reduction program on a long range basis. As soon as we have completed as much work as we can do in the overflow areas, it is planned to do as much source reduction work on ranches and elsewhere as the property owners are willing to pay for.

SOURCE ELIMINATION IN AN OLDER DISTRICT

By William Bollerud, Manager
Durham Mosquito Abatement District

Perhaps the best way to cover this topic is by way of an historical sketch.

Durham Mosquito Abatement District was established in 1918 with an area of 64 square miles. They made them small in those days, thinking to catch only the hot spots. And let there be no mistake, the Durham Area was a hot spot. It was one of the places prospective settlers were warned against. Broad and unqualified statements about clouds of mosquitoes hiding the sun were no facetious gag. If you hadn't had malaria you were a rank outsider and suspect. If you hadn't had malaria three times you were not admitted to the inner circle.

Rice culture was still in its infancy. But as an opportunity crop grown on land unfit for anything else it was already a major mosquito source. The disposal of its surplus water was haphazard, unplanned and unpredictable. Full recognition had not been given to the principle that water runs down hill.

Every one of our natural drainage courses was befouled with bad things—humps and hollows, sand bars, pockets, tule patches, button willows, beaver dams, fallen trees, dead livestock and so on and so on and so on.

It must be borne in mind that at this time there were but two weapons—drainage and stove oil. It took 30 gallons of stove oil to larvicide one acre of water surface.

We had no planes or jeeps nor power sprayers nor Tifas.

We had no DDT or Toxaphene or wettable powder or emulsible concentrates. We had no collecting stations nor adulticiding nor residual spraying nor vector control specialists. We had no regional conference nor state conference nor state subvention nor state auditors. Our outlook was stuffy indeed.

But, we had a drainage program. With a budget of $1200, one man, a model T pick-up and a half dozen hand tools, we strode forth to conquer the world. We hacked and pecked at our drainage courses. Cutting here

and filling there and brushing somewhere else. Slow work. It would take a millenium to accomplish anything.

Then came the millenium. The Thirties. The depressing Thirties. With them came the S.E.R.A., the W.P.A., the P.W.A., and all manner of work relief designed to aid and assist worthy and needy bretheren. Our one-man staff suddenly found himself in command of crews—large crews. Hungry and shivering they were, but with stout hearts and willing hands. (These W.P.A. workers must not be confounded with the poor but honest winos, or George Umberger's recruits from the county jail.)

With these crews and some machinery which we borrowed from the county highway department, we whipped our drains into such shape that all our surplus water wound its merry way to San Francisco Bay and everybody lived happily ever after. The drainage problem was licked—almost. The rice growers began to learn better how to manage water. We put Gambusia in their more permanent pools, such as borrow pits or slow moving drains. The livestock men began to learn that a squirt of stove oil in a pasture pool wouldn't kill their cattle. Things began to shape up.

Then advancing civilization caught up with us and knocked us into a cocked hat.

Advancing civilization brought us septic tanks and cesspools to replace the benighted privy.

Advancing civilization brought us permanent pasture with its multitude of headaches.

Advancing civilization brought us the modern farm dairy layout that uses oceans of water which is carefully drained only far enough to appease the dairy inspector. From there on it is our baby.

We still have untold acres of irrigated pastures leveled with a tumble bug and Fordson.

We still have farmers who irrigate pasture as they would rice.

We still have dairy drains which don't drain.

We still have busted out septic tanks.

Fifteen thousand years ago the ancient Hebrews and kindred Orientals learned to put water on their arid fields. After 15,000 years, advancing civilization has not yet taught the agricultural gentry the importance of draining these fields. Therefore, do not expect too much of us in our brief 35 years.

THE INCREASE OF CULEX TARSALIS IN THE SACRAMENTO VALLEY

By L. L. Hall, Assistant Entomologist,
Butte County Mosquito Abatement District

During the spring of 1952 there was noted throughout the State an increase in *Culex tarsalis,* our main vector of encephalitis. The southern part of the State, particularly the San Joaquin Valley, had an alarming build-up of this species while the northern area through the Sacramento Valley experienced an increase not nearly so pronounced.

In the summer of 1952 *Culex tarsalis* began moving into areas and breeding sites of the Sacramento Valley where they were previously found only in small numbers. Several places such as pasture ponds where *tarsalis* had previously been found occasionally became heavily infested and only the extensive control through this period of the emergency encephalitis program prevented them from becoming a major problem.

In the spring of 1953 there was no early indication of a *Culex tarsalis* increase although records indicated scattered breeding in fair numbers in late March and early April. As the season progressed *Culex tarsalis* became more and more evident in field collections, and observations by trained personnel showed that by the middle of June they were increasing at an alarming rate. This breeding continued in almost all likely water, and in some instances in sources not conducive to their species, such as polluted logging ponds.

Pastures which in previous years had produced few *Culex tarsalis* were readily re-infested with them following the normal spraying for *Aedes* larvae, this requiring a second larviciding to prevent the emergence of *tarsalis* adults. At times the *tarsalis* larval concentration produced by this re-infestation would outnumber that of the preceding *Aedes* species.

In a few instances where a .3 percent dieldrin emulsion containing 2 percent lethane by volume was used at the rate of 4 gallons per acre by plane to control the *Aedes* and *Culex tarsalis* larvae infested ponds within the field, it was found that there was an excellent control on *Aedes* without any apparent reduction of *Culex tarsalis.* This failure to control *C. tarsalis* required a respraying with an oil base 5 percent DDT insecticide containing 2 percent lethane by volume with a spreader, at the rate of 1 gallon per acre to complete the job.

Entomological samplings during the years of 1952 and 1953 indicated the increase in *Culex tarsalis* over other years with a much higher increase during the later year. Light traps during 1953 collected many more *tarsalis,* trap for trap. Adult collecting stations show a decided increase with a definite jump beginning with June, 1953. Periodic rice field inspections revealed *Culex tarsalis* larvae in greater numbers in a comparison with *Anopheles freeborni* larvae than in previous years. They also continued to be about as numerous as *freeborni* during the fall rice field draining period.

The general picture resulting from the data and observations of the technical personnel throughout the Sacramento Valley for the past two seasons indicates that *tarsalis* has moved in and presents a continued problem for the future. Pastures are requiring more work on *tarsalis* and they may become a problem in the rice fields during the fall comparable to that of *Anopheles freeborni.*

THE RICE FIELD MOSQUITO PROBLEM

Herbert P. Herms, Entomologist
Sutter-Yuba Mosquito Abatement District

Rice fields either directly or indirectly can cause mosquito trouble from the time they are flooded in late April or May until the fall harvest. But a lot if not most of this I believe is unnecessary and can be avoided without affecting rice production.

However, rice can't be blamed for all the mosquito troubles in an area. Some people point vaguely in the direction of a rice field several miles away as their mosquito source when actually they are raising mosquitoes in their own back yard. But in some areas rice may be responsible for all the mosquitoes.

To control mosquitoes around rice fields is an expensive job and takes a lot of time. In addition the sources are often hidden by heavy weed growth difficult to find and spray.

Rice acreage has doubled in the last 10 years and is 412,000 acres now. Rice (directly or indirectly) produces the two vector mosquitoes—*Anopheles freeborni* and *Culex tarsalis* as well as *Aedes nigromaculis* and several other species. Rice is often grown very near to populated areas. In other words we have more water now, an increased mosquito and disease potential and also the taxpayers demand fewer mosquitoes. We know we can't do it with chemicals alone or even drainage alone—that it has to be a combination of these and we must in addition develop a program that will recommend practices in growing rice—practical and economical to the grower.

Such practices as pouring water out of a field without providing a drain of any sort or draining into some inaccessible railroad borrow pit certainly aggravate the mosquito situation. With no drain, water often spreads around the border of a field or floods an adjacent field.

Seepage is one of the most important problems around a rice field. Water leaks through the borders and fills the narrow ditch-like borrow pits where dirt was gouged out for the borders. Some fields don't have complete borders and water feathers out into shallow grassy edges—an ideal *Culex* habitat.

Near a field there are usually deadend ditches that fill up with seepage, and many other nearby sources could be eliminated that produce *Culex* and *Anopheles* mosquitoes.

Rice fields themselves can't be ignored, of course. The poorly graded fields with low, tule spots, those with heavy weed growths, incompletely cultivated fields that are partially flooded—all tend to produce more mosquitoes than those that are comparatively free of weeds, well cultivated and well graded.

Most of this water around rice fields and the practices that create the mosquito hazard could be corrected to the benefit of the grower in increased production with little if any extra expense. Any recommendations also can be tied into a rice grower's need for good drainage, aquatic weed control, and water conservation.

Here are some suggestions that I believe could be considered:

1. Build a complete, strong border check around the entire field to hold the water within the field and reduce seepage.
2. Drain directly from the spill box into a definite ditch adequate in size, graded, and clean to run to a free flowing main drain.
3. Flatten the area around the outside of a field and fill in the border borrow pits—some men have built equipment roads for their own convenience around the whole field.
4. Eliminate the standing water in unused ditches and borrow pits near a field before it's cultivated—they either produce mosquitoes or will fill up with seepage.
5. Completely cultivate and grade the field before planting so that there will be as few tules and weeds as possible and each check will be evenly flooded.

Mr. Grant: I will now ask Howard Greenfield to present the report from the Coastal region.

Mr. Greenfield: I would like, at this time, to briefly summarize the activities and accomplishments of the Districts in our region, and also mention a few trends (if I may use the word) that have taken place in the Coastal and Bay Areas.

From the reports received and the conversations I have had with our Bay Area managers, I believe it can be truthfully said this year has been an extremely successful year in the overall control of mosquitoes in a given area. Whether this situation is due in part to weather conditions, increased awareness of basic control methods, such as drainage, filling, or making water sources untenable for mosquito life, or just luck, I wouldn't want to say. Probably, a combination of the above factors has made possible the claims of a successful season.

Aside from the successful year we have had, it should be noted that a goodly amount of eliminative control work has been accomplished. Paul Jones mentioned the reclamation of 175 acres of salt marsh and, by using the dragline as a bargaining tool, has induced the farmers to plow and level marsh breeding grounds. In the Salinas area, the cleaning of approximately 25 miles of an old tule and junk filled drainage canal (average width 35 feet) has been a major accomplishment. City, County and industrial holding ponds have been cleaned and redyked through inter-agency cooperation. There is little need to mention Alameda County in relation to eliminative work—we all know the work Harold Gray has done in this phase of mosquito control.

Another important contribution to come forth at this time is a "hand book" or "Manager's Manual" prepared by Harold Gray, setting forth administrative procedures followed in the Alameda County Mosquito Abatement District. Although I have not, as yet, seen the book, it is my understanding there are over 400 pages recording the experiences and practices accumulated by Mr. Gray during the past twenty-three years.

Now, let us look for the moment at the so-called "trends" which seemingly are in the process of occurring.

Salt marsh mosquitoes, according to various district managers, are disappearing and may eventually pass completely out of the picture. Certainly, Gordon Mapes, Manager of the Matadero District which is one of the three oldest districts in the State, can tell how his District's expenditures for fresh water mosquito control, over the years, have gradually increased to the point of tripling those expenditures for salt marsh mosquito control. This being true in the Matadero District, I feel certain other Districts, actively engaged in salt marsh control, are experiencing the same disappearance of *Aedes squamiger* problems, as is Mr. Mapes.

Two other divergent trends can also be noted. To the North, there seems to be an increase in the production of pasture mosquitoes. Bill Rusconi tells me his District, next year, will have new pasture area developments equal to the present area now in pasture. This will, undoubtedly, increase the production of mosquitoes with the principal species being *Aedes nigromaculis, Aedes dorsalis* and *Culex tarsalis.*

The Central and Southern areas are, seemingly, experiencing a shifting of emphasis from agricultural source problems to industrial problems with the accompanying newly created sources in residential develoments.

One other trend might also be mentioned and that is the development of a policy which places more responsibility upon individuals and large and small commercial operations to either assist directly in the control of mosquito sources on their premises or, through educaton and District guidance, doing the actual work themselves.

This trend is noteworthy in that the spirit and letter

of the Mosquito Abatement Act is being more closely followed than heretofore.

Other activities, such as: completion of the new depot and laboratory facilities in Salinas, completion of depot and laboratory facilities in San Mateo, completion of a new depot in the Pleasanton division in the Alameda County Mosquito Abatement District, purchase of new equipment, increases in salaries and wages, and reductions in some budgets, indicate, to me at least, that mosquito control in California is a dynamic, progressive movement. Let us hope we can continue in this fashion.

I will present additional District reports for inclusion in the Proceedings of this meeting.

LABORATORY TESTS OF SURFACTANTS AND THEIR POSSIBLE USE IN MOSQUITO CONTROL

JOHN W. ISAAC, INSTRUCTOR OF LIFE SCIENCES*
Washington Junior High School
Salinas, California

During the summer of 1953, in the laboratory of the Northern Salinas Valley Mosquito Abatement District, a number of tests were run to determine pupacidal and larvacidal effects of certain surfactants on *Culex tarsalis* and *Culex stigmatosoma*. Determinations were made using several methods of application.

*John W. Isaac was employed by the Northern Salinas Valley Mosquito Abatement District during the summer of 1953.

MATERIALS

The following surfactants were tested: Red Top Wetting Agent, H²OK, Oronite Slurry, Multifilm and Mettanol C.W.

METHODS

A. The mosquito larvae and pupae were introduced into one gallon glass jars containing 3000 cc of tap water. A wetting agent of known dilution was sprayed onto the surface by means of a medicinal atomizer in order to simulate field conditions as near as possible. By measuring the amount of surfactant discharged from the atomizer in one squeeze of the bulb, it was possible to determine parts per million of final dilution. To increase the strength of the final dilution, two or more squirts of the atomizer were employed. To determine if method of application altered the effectiveness of the surfactant tested, the above method was compared with the two following methods of application.

B. The water samples were sprayed just prior to the introduction of larvae and pupae.

C. The surfactant was dropped on the surface of the water sample and stirred in before the larvae and pupae were introduced.

		Control I		Control II		13.9ppm		20.8ppm		31.2ppm		41.6ppm	
		pup.	lar.	pup.	lar.	pup.	lar.	pup.	lar.	pup.	lar.	pup.	lar.
Mehtod	Hr.												
A:	1	0*	0	0	5	80	25	100	50	100	75	100	10
	24	0	0	0	5	85	45	100	50	100	80	110**	40
B:	1	0	0					70	5	90	15		
	24	0	0					70	5	95	35		
C:	1	0	0	0	5	0	0	0	0	5	0	25	0
	24	0	0	0	5	0	0	0	0	10	5	25	15

*All figures represent percent mortality.
**Percentages over 100 indicate larvae transformed into pupae and then died.

In the following tests Method A was used.

		Control I		Control II		3.5ppm		7ppm		10.5ppm		14ppm		17.5ppm		21ppm		25ppm		50ppm	
		pup.	lar.	pup.	lar.	pup.	lar.	pup.	lar.	p.	l.	p.	l.	p.	l.	p.	l.	p.	l.	p.	l.
Oronite	1	0	0	0	0	60	8	80	8	100	8	100	8	100	0	95	8				
Slurry	24	20*	4	20	0	60	12	90	12	105*	20	100	16	100	16	95	12				
Red	1	0	0	0	0	7	0	7	0	60	4	66	4	80	28	80	16				
Top	24	0	0	0	0	20	16	40	24	87	8	100	8	115**	28	100	16				
H²OK	1	0	0	5	0	5	0	10	4	10	4	15	4	15	4	20	12	25	12	100	20
	24	0	4	5	0	5	0	10	4	10	4	15	8	15	8	20	12	25	12	100	36
Mettanol	1	0	0	0	0	0	0			40	5					75	25				
C. W.	24	0	0	0	0	25	25			80	35					100	35				
Multi-	1	0	0	0	0	15	0			35	0					40	5				
film	24	0	0	0	0	45	5			95	20					105	10				

*All figures represent percent mortality.
**Percentages over 100 are due to mortality of pupae introduced as larvae.

Results

In the following tests an 8.3% dilution of Oronite Slurry was used.

Method A: Spraying of water sample in which larvae and pupae had been previously introduced.

Method B: Spraying of water sample followed by introduction of larvae and pupae.

Method C: Dropping of equivalent amount of surfactant as in above methods, mixing thoroughly in water sample followed by introduction of larvae and pupae.

Since it was impossible to ascertain the percentage of active wetting agent in some of the commercial products tested, the marketed product was considered to be one hundred per cent for the purpose of these tests.

The Red Top wetting agent was the only one in which the percentage of active ingredient was actually known. For the purpose of the test the Red Top was diluted 1 part to 1 part of tap water resulting in a dilution of 12.5% active ingredient.

The Oronite Slurry was found to discharge uniformly through the atomizer in an 8.3% dilution.

The H²OK was reduced to a 25% solution for spray application, while Mettanol and Multifilm were applied in concentrations of 12.5%. The consistency of solution and uniformity of application was used as the criteria in determining dilutions used.

Conclusions

1. More work should be undertaken to determne how surfactants kill mosquitoes.

2. Additional surfactants should be tested and compared with previously tested wetting agents.

3. Tests should be made in saline and sewage polluted waters and results compared with results in fresh water.

4. More work should be done using sub-lethal doses of present known toxicants mixed with surfactants to determine if the combination of the two increases the effectiveness of each used separately.

Summary

1. The pupae are more susceptible than larvae to weak dilutions of all surfactants tested.

2. The best results were obtained when the surfactant was sprayed on the surface so as to make direct contact with the breathing tubes of larvae and pupae.

3. In weak concentrations where few pupae were killed, numerous adults drowned while emerging.

4. When India Ink was added to water sample and sprayed with surfactant, the trachial systems of dead larvae were stained with the ink.

5. Since surfactants, in themselves, are not as effective for larvae as the toxicants now being used, their use would be restricted to situations where a toxic substance could not be used and where control of mosquitoes is important.

6. Because of the pupacidal effects, surfactants could be used to prevent emergence of adults.

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NOTES ON THE OCCURRENCE OF ORTHOPODOMYIA CALIFORNICA BOHART

C. Donald Grant, Manager
San Mateo County Mosquito Abatement District

In the decade following Reeves' publication on the occurrence of *Orthopodomyia signifera* (later described as *O. californica* by Bohart, 1951) in southern California, scattered records have been forthcoming which have extended the range of this tree-hole mosquito northward through much of California's central valley. The incidence of this mosquito appears to be relatively low in California, since the records are few and usually represent single sources. This year *O. californica* was found to be relatively prevalent in a limited area in San Mateo County, which represents its first record for the San Francisco Bay area.

The routine checking of tree-holes in residential sections for the purposes of mosquito abatement has demonstrated the presence of *O. californica* in 15 of 45 collections brought in from the Menlo Park-Atherton region. This same area has a high prevalence of *Aedes varipalpus,* and these two species were often found together in the same source. Adequate sampling was not done to determine the total range of this local occurrence of *O. californica,* but the similar environmental factors prevailing southward would indicate a good chance for its presence in Santa Clara County.

In keeping with this species' preference for warmer regions, it was found that during the rearing of specimens, the adults emerged only after high outdoor temperatures had been attained. Where *Aedes varipalpus* larvae were also present, this species was usually pupated and gone before *O. californica* developed beyond its fourth larval stage. In accord with the long larval period of the latter, it was noted that in all cases the tree-hole sources were large and capable of holding water well into the summer. All of these tree-holes were in oak trees and contained exceptionally strong, dark water with a large accumulation of decomposed organic matter at the bottom.

Fourth stage larvae were collected as early as March 16 and as late as mid-June. One adult female specimen was picked up in a light trap in mid-July.

PROBLEMS IN THE TREATMENT OF RESIDENTIAL CATCH BASINS

Thomas H. Lauret, Entomologist
San Mateo County Mosquito Abatement District

One of the major problems of the San Mateo County Mosquito Abatement District this past summer has been the large numbers of *Culex pipiens* Linn. developing in the catch basins throughout the District. The mosquitoes are produced in great numbers and go through their aquatic cycles quite rapidly in this ideal situation.

This species has given rise to the majority of our service requests this year. The close proximity of the source to the populace affords a high population of adults in a residential area in a very short time. The characteristic habit of this pest of biting inside a dwelling at night is also quite a nuisance to the residents.

The great number of catch basins and their locations produces a complex problem. The District has some nine thousand catch basins with more going in all the time. Not all of these catch basins hold water all the time, but at any time the lines may become stopped up and the catch basins filled with water. It is a difficult task, as well

as time consuming, to check and treat every individual catch basin. During the summer months almost fifty per cent of the employees' time is engaged in this or closely related work.

Some of the reasons water stands in the catch basins are poor grade in the drainage system, large sand traps, and the outlet pipes put in higher than the inlet pipes so that improper drainage results. These facts, plus other construction errors, afford the mosquito with a good water supply.

Leaves from trees and shrubs, and all manner of debris find their way into the catch basin, which not only hampers drainage, but affords the larvae a rich food source from the decomposing organic matter. The blanket of leaves also complicates adequate treatment.

People of the area often find the catch basin a superb place to rid themselves of lawn cuttings and the like. Children find the catch basin a choice place to insert boards, paper, and even as a hiding place for toys.

The city street departments occasionally clean out the catch basins but often the basins become choked up with debris before they can complete their rounds. In some cases sewage seeps into the catch basins from nearby breaks in the sewage lines.

The District has endeavored to find a suitable control for this problem. We have sprayed the problem catch basins with varying amounts of DDT and Diesel oil, but this didn't give us any better control than spraying with 1/3 kerosene and 2/3 Diesel oil. We then tried a cloth bag filled with coarse shavings and soaked in Diesel oil and DDT. These sacks worked very well for a period of three months, then the cloth started to disintegrate and the shavings were flushed out. We then decided to try an aluminum wire cage which would resist rotting and could be salvaged for re-use. They were filled with coarse shavings and soaked for 24 to 48 hours in a 10% DDT and Diesel oil solution. These cages were placed in the drains and anchored so that the cage would float at the surface of the water. These cages gave good control for three months except in the foulest water and then began to fail, through exhaustion of the insecticide. Some cages were also impregnated with 5% Aldrin, but failed to give any better results.

Since a high organic content of the water rapidly reduces the action of the toxicant in such cages, thus rendering successive change or replacement necessary, the extensive labor involved does not prove them efficient in spite of the possible insurance against mosquito production. Therefore present study is being made of methods wherein disposable containers may be introduced at no extra labor expenditure and designed for a shorter period of residual toxicity which is made practical by the reduced distribution problem.

Present efforts have been with stabilized paste emulsions of high insecticide contest which permit a slow release of emulsion through effective baffling and which at the same time prevents exposure of the main bulk of the material to the reducing action of the foul water.

High speed agitation of the emulsifiable concentrate with a small portion of water forms an emulsion of dissociated droplets of one to five microns diameter which may persist with little breakdown in an enclosed container for a considerable period of time. Diffusion of these droplets into the water is fairly rapid and adequate for 100% kill in such places as catch basins. The problem lies in baffling the outlet in such manner as to let out enough material to promote adequate kills and yet retard the action so as to ensure prolonged release over a period of two or more weeks.

Since there is no apparent resistance to DDT in this area as yet, it has been used primarily in these tests. Other insecticides may prove to yield much better results in coping with this problem in the future.

SUMMARY OF ACTIVITIES OF THE MATADERO MOSQUITO ABATEMENT DISTRICT FOR THE CALENDAR YEAR 1953

GORDON W. MAPES, SUPERINTENDENT

1953 EXPENDITURES ACCENTUATE GROWING IMPORTANCE OF FRESH WATER MOSQUITO CONTROL

Due to the fact that the Calendar Year 1953 is incomplete at this date, final figures of various expenditures are not available for a basis of comparison with previous Calendar Years.

Generally speaking, the Calendar Year of 1953 thus far has been one of routine expenditure with no radical departure from the previous five-year period. Apparently it has been a normal year with the accentuation of *Culex* expenditures gaining ground over expenditures for control of Salt Marsh mosquitoes. This is explained by the rapid urban growth in the Santa Clara Valley and along the Peninsula.

This picture is clearly defined in the Matadero District, which is one of the three oldest Abatement Districts in the State of California, having been organized in 1918. In the earlier years practically all of the expenditures were used for control of Salt Marsh mosquitoes. In the Calendar Year of 1952 *three times as much money* was spent for control of Fresh Water mosquitoes (mostly *Culex*) as compared with Salt Marsh mosquitoes. In fact, if the present trend continues, the time is approaching when Salt Marsh mosquito control will resolve itself into a minor problem in the Matadero District.

USE OF TOXAPHENE AS A LARVICIDE IN DAIRY CONTROL UNSATISFACTORY

In the Annual Report of 1952 of the Matadero District, the various phases of Fresh Water Mosquito Control are listed in their following order of expenditures:

1)	Dairies (rural)	$877.83
2)	Storm Sewers & Catch Basins (Urban)	671.37
3)	Creek Channels (rural)	539.15
4)	Cesspools (rural & urban)	431.13
5)	Surface Ponds (rural & urban)	366.45
6)	Draws (rural)	242.21
7)	Commercial Yards (urban)	100.80

With twenty-four operating dairies in the District, mosquito control over these areas has become of prime importance due to the breeding of *Culex tarsalis* mosquitoes, the vector of Encephalitis.

The problem in dairy control is intensified due to the daily flow of dairy drains, the presence of organic matter, and the great difficulty of securing any residual effect from larvicides.

The larvicide generally used by the Matadero District in dairy control is a 1% solution of DDT combined with Diesel oil and kerosene. Apparently dairy mosquitoes have developed a resistance to the DDT poison and most of

the killing properties in the solution used are to be found in the Diesel oil and kerosene.

(The DDT 1% solution is made up in 50 gallon lots, 15 gallons of Diesel oil, 4 gallons of kerosene, and 2 gallons of DDT 25% concentrate added to 29 gallons of water. Mechanical agitators are used in the tanks of the power sprayers.)

The killing effect of the DDT 1% solution has been fairly good, but a drop in mortality of larvae due to lessening of residual properties of the DDT has been noted.

Decision was made to experiment with a 1% solution of Toxaphene. Applications revealed a "slow" kill, and the use of it in areas daily flushed with water has proved to be unsatisfactory.

Salt Marsh Mosquito Control Effected in Salt Pond Through Constant Level Flooding

In the early Spring of 1953 the Leslie Salt Company dredged a new Salt Pond on the marsh lands of South San Francisco Bay in the area to the rear of Moffett Field. The Salt Company began flooding shortly after the 15th of July. By early August infestation (larval) developed in a portion of the Pond known as the "old Port Channel."

After consultation with the District, the Salt Company decided to continue flooding the Pond (nearly 500 acres in area) but not to put it into operation for a period of one year. This action resulted in a maximum inundation level of water for the balance of the Summer of 1953, and aside from a small amount of marginal emergence—all breeding in the Pond ceased.

Installation of Sanitary Facilities at the District Garage, Including Shower With Hot and Cold Water

In the month of October 1953, the City of Palo Alto excavated a trench between its outfall sewer line and the District Garage Building for a distance of approximately 700 feet and installed a sewer line.

At the Garage Building, the services of a licensed plumber were secured to install sanitary facilities including a shower with hot and cold water. The cost of complete installation for this Capital Outlay item will approximate $1,400.00.

Mosquito Control in Matadero District for 1953 Satisfactory

In conclusion, in 1953 the over-all picture of mosquito control in the Matadero District has been satisfactory. The general absence of adult mosquitoes (particularly the Salt Marsh species) is credited in part to the excellent control activities carried on by the San Mateo County Mosquito Abatement District (to the north) and the Alameda County Mosquito Abatement District (to the east). Both of these regions profoundly affect the Matadero District due to the direction of the prevailing winds by day and the variable winds by night.

Report from Alameda County Mosquito Abatement District

In 1953 we had a relatively successful year. The mild winter tended to produce an above normal prevalence of *Culex pipiens* and *Culex tarsalis* during the winter months, but the cool summer helped toward a below normal prevalence. Particularly noticed was the very low incidence of *Aedes squamiger* larvae; this species is apparently dying out on our marshes and may become extinct in a few more years. The cemeteries required mist spraying as early as mid-March. The first *Aedes varipalpus* adults were observed on March 18, but this species was much below normal prevalence, particularly in Alameda and Oakland, as a result of our operations in filling tree holes with a sand-cement mixture. The first *Aedes nigromaculis* larvae appeared in April, but this species has been kept at a low incidence and confined within a few small areas. During the year there were a number of intense local nuisances due to faulty plumbing.

The District budget for 1953-54 is $123,699 (excluding the Cash Basis Fund) the largest heretofore. Pay increases of about 5% were given to all employees July 1. Because of an appreciable increase in the assessed valuation of the District we were able to reduce the tax rate from 1.4 cents to 1.3 cents.

A new depot was constructed at Pleasanton by our own forces during the winter, to the point of usability, and in May a new Division was activated for Pleasanton Township. We are now (December) in the process of completing this construction. An additional Jeep and pickup truck were purchased for this new division.

Considerable difficulty was experienced in 1953 with the sewage lagoons at the Parks Air Force Base. The Base is now improving these lagoons to minimize the mosquito problem.

Our new policy toward the duck clubs has worked reasonably well. We now require the club operators to control the mosquitoes themselves.

We cooperated with the Camp Fire Girls' executives, and the Bureau of Vector Control, in mosquito abatement measures at Lake Vera in Nevada County. The control campaign was effective.

A major project has been the preparation of a Manager's Manual, setting forth the administrative practices of the District. It comprises over 400 pages of typed matter, but commits to record much of the experience and practice accumulated over the past 23 years by the present Manager, but up to now available only in his head. This Manual should be of considerable assistance to the new Manager, when the present Manager retires about the end of 1954.

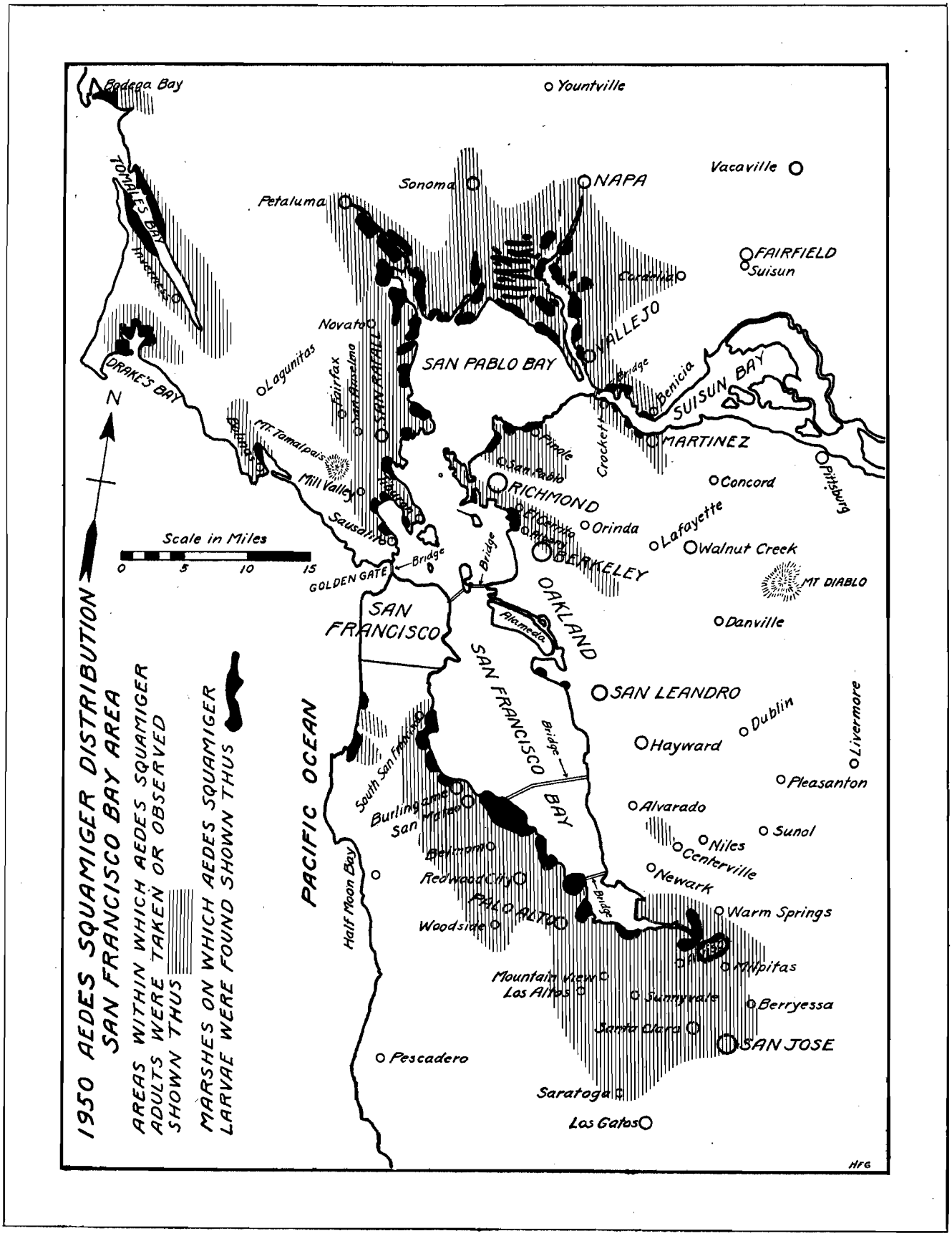
SALT MARSH MOSQUITO SURVEY IN THE SAN FRANCISCO BAY AREA 1950-53

By Theodore Aarons, Assistant Manager,
Alameda County Mosquito Abatement District

Since the onset of organized mosquito control activity in the San Francisco Bay Area in 1903, regional workers have maintained the practice of gathering at frequent intervals for the purpose of evaluating their major problems. Natural and man-made changes affecting larval development on the salt marshes have been elaborated on in the many reports concerning mosquito control progress in this area, and accordingly, *Aedes squamiger* (Coq.) and *Aedes dorsalis* (Meig.), the two species co-inhabiting the salt marsh environment, are relatively well known.

Recently detailed attention has been given to both larval development (Bohart, et al., 1953) and adult dispersion (Aarons, et al., 1951) which aided in the understanding of certain ecological aspects of the species and dispelled or confirmed various theories held by workers which had not been demonstrated through field experimentation.

Prior to World War II, *A. squamiger* was considered one of the region's more important species in terms of population density, flight dispersion and general annoy-


1950 AEDES SQUAMIGER DISTRIBUTION
SAN FRANCISCO BAY AREA
AREAS WITHIN WHICH AEDES SQUAMIGER ADULTS WERE TAKEN OR OBSERVED SHOWN THUS
MARSHES ON WHICH AEDES SQUAMIGER LARVAE WERE FOUND SHOWN THUS
Scale in Miles
0 5 10 15
N
PACIFIC OCEAN
SAN FRANCISCO BAY
SAN PABLO BAY
SUISUN BAY
Bodega Bay
Tomales Bay
Drake's Bay
Petaluma
Sonoma
Yountville
NAPA
Vacaville
FAIRFIELD
Suisun
Novato
Lagunitas
Fairfax
San Anselmo
SAN RAFAEL
Mt. Tamalpais
Mill Valley
Sausalito
GOLDEN GATE
Bridge
VALLEJO
Benicia
Crockett
MARTINEZ
Pittsburg
Concord
Pinole
San Pablo
RICHMOND
Orinda
Lafayette
Walnut Creek
BERKELEY
MT DIABLO
Danville
OAKLAND
Alameda
SAN FRANCISCO
SAN LEANDRO
Hayward
Dublin
Livermore
Pleasanton
Alvarado
Sunol
Niles
Centerville
Newark
Warm Springs
Milpitas
Berryessa
SAN JOSE
Santa Clara
Sunnyvale
Mountain View
Los Altos
PALO ALTO
Redwood City
Woodside
Half Moon Bay
Pescadero
Saratoga
Los Gatos
South San Francisco
Burlingame
San Mateo
Belmont
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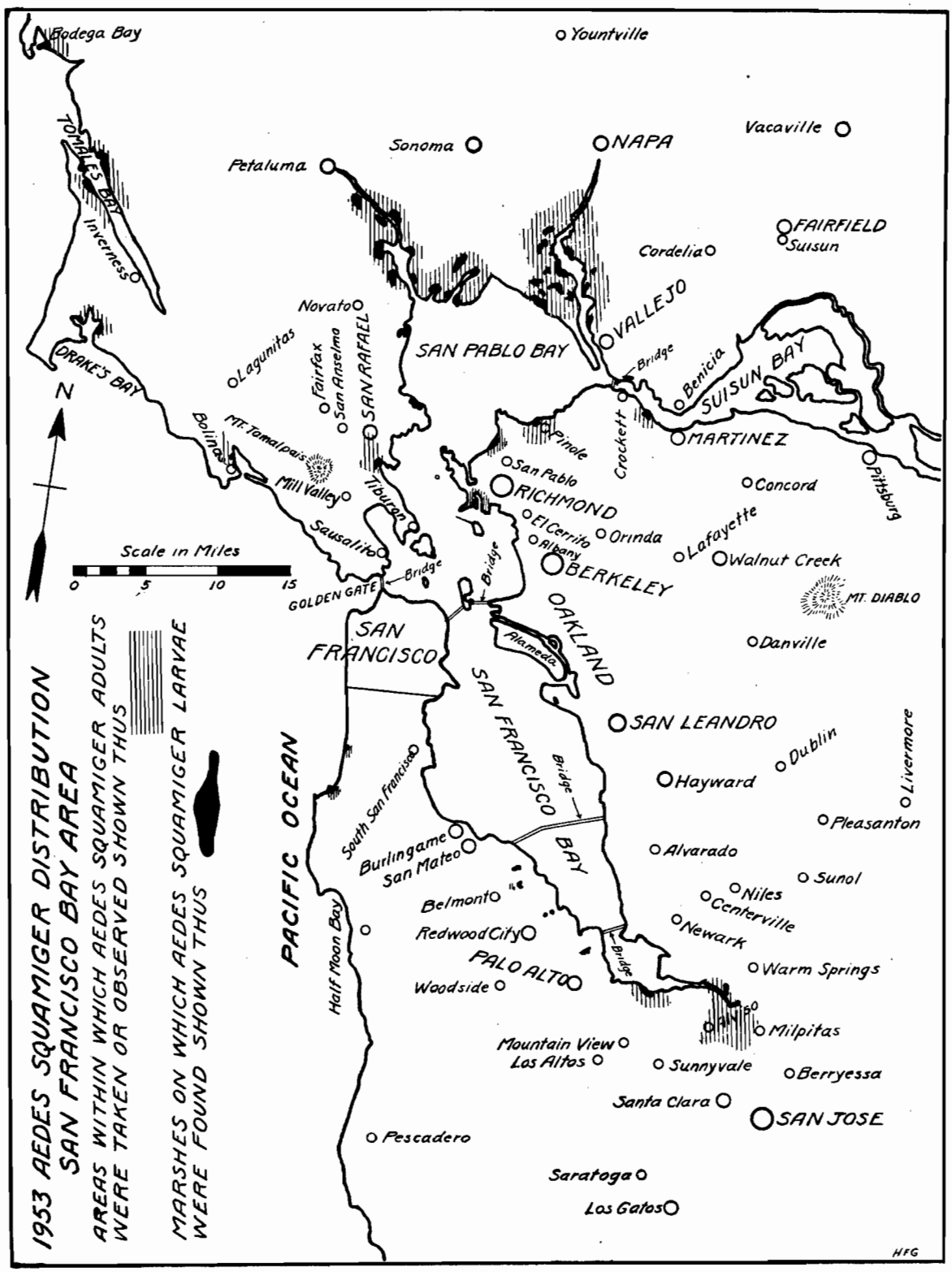
1953 AEDES SQUAMIGER DISTRIBUTION
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MARSHES ON WHICH AEDES SQUAMIGER LARVAE WERE FOUND SHOWN THUS
Scale in Miles
0 5 10 15
N
Bodega Bay
Yountville
Vacaville
Sonoma
NAPA
Petaluma
FAIRFIELD
Suisun
Cordelia
TOMALES BAY
Inverness
DRAKE'S BAY
Novato
Lagunitas
Fairfax
San Anselmo
SAN RAFAEL
VALLEJO
SAN PABLO BAY
Benicia
Bridge
SUISUN BAY
Mt. Tamalpais
Bolinas
Mill Valley
Tiburon
Pinole
Crockett
MARTINEZ
Pittsburg
San Pablo
RICHMOND
Concord
El Cerrito
Orinda
Lafayette
Albany
Walnut Creek
Sausalito
GOLDEN GATE
Bridge
BERKELEY
MT. DIABLO
SAN FRANCISCO
OAKLAND
Alameda
Danville
SAN LEANDRO
Dublin
Livermore
Hayward
Pleasanton
South San Francisco
Burlingame
San Mateo
Alvarado
Sunol
Belmont
Niles
Centerville
Redwood City
Newark
PALO ALTO
Warm Springs
Woodside
Milpitas
Mountain View
Los Altos
Sunnyvale
Berryessa
Santa Clara
SAN JOSE
Pescadero
Saratoga
Los Gatos
PACIFIC OCEAN
Half Moon Bay
HFG

ance. Larvae are found primarily in salt marsh pools that have been diluted by fresh water from the winter rains. The species may be recovered from water half as salt as sea water, although its optimum aquatic conditions are much less saline. The larval development period ranges from about November to March, major hatches having been observed following early heavy rains. A marsh site, observed in 1950 at Lakeville, Sonoma County, was estimated to contain over 1,600,000 larvae per acre. Some uncontrolled larval sources have contained populations ranging from 5 to 10 million per acre. The minimum development period for the aquatic phase has been noted by Bohart being 48 days at Bolinas Bay, Marin County. Successive larval hatches may occur through the winter and early spring but evidence thus far indicates that only a single generation occurs each season.

Aedes squamiger adults appear from approximately March to May and have a longevity of about three weeks. During this time the species has a tendency to disperse many miles and cause considerable discomfort. The report of Gray (1936) established this mosquito as the longest flighted species in California.

The mosquito control agencies of the San Francisco Bay Area in 1950 organized a cooperative dispersal study, gathering data that had not been analyzed regionally for a number of seasons. Throughout the entire area a thorough check was made of larval sources. This was followed later in the year by an area-wide adult distribution survey.

All larval and adult data of the 1950 survey have been compiled from the respective counties and assembled on Map A. Larvae were rather abundantly distributed over salt marshes in Marin, Sonoma, Napa, Solano and Contra Costa counties and in eastern San Mateo and Santa Clara counties.

The four bays north of San Francisco bordering the Pacific Ocean: Bolinas, Drakes, Tomales and Bodega were positive for larvae as were a few isolated marshes along the coast of San Mateo County.[1]

A direct relationship can be seen between the 1950 dispersion pattern of adult mosquitoes and the distribution of larval sources. *A. squamiger* adults were recovered in Saratoga, Santa Clara County, some ten miles from the nearest known larval source.

Aedes squamiger development in 1950 was considered to be about that of an average recent year. Since 1949, however, a definite population reduction was noted throughout the entire region. This trend was attributed principally to an increase in emphasis on salt marsh mosquito source reduction and accordingly more and more marshes became "non-productive." The general progress of operations directed against salt marsh mosquitoes had reached the threshold of control on a regional basis and had been established along lines that insured a continuation of this favorable condition within economically feasible limits.

Survey data were again obtained from records of the control agencies in 1953 for the purpose of making a population trend evaluation. It became strikingly apparent that *A. squamiger* had been all but extirpated from some marsh regions, particularly in Alameda and San Mateo Counties. The situation, in the San Pablo Bay region, as illustrated in Map B, was somewhat similar but still contained a moderate number of larval sources.

The explanation for the reduction of *A. squamiger* included at least in large part in the following groups:

1. Primary emphasis of mosquito control programming has been directed toward source reduction through drainage practices. The consequent separation of salt water from the marsh has drastically altered the environmental balance required for the species.
2. The economic development of the Bay region has included reclamation of many marshes which formerly constituted mosquito production sources. This improvement has been more advanced in the southern San Francisco Bay area.
3. Remedial spray operations properly timed have been an important adjunct to source reduction. The single generation characteristic increases the vulnerability of *A. squamiger*.
4. Since *A. squamiger* populations have been on the decline, *Culiseta inornata* has become more common in the salt marsh environment. It appears that this latter species is now successfully competing for dominance in this environment.
5. Predators and various algae were more conspicuous in 1953 than in the few previous years. Cyclic reduction trend.

The Bolinas marsh in Marin County had, in 1953, an *A. squamiger* larval density which was approximately half that of the previous year. On this marsh, which was used for observational purposes, insect predators, algae and scum were extremely conspicuous.

In summary, the *A. squamiger* population surveyed in 1953 by the mosquito control agencies in the San Francisco Bay region showed a drastic decline as compared with a similar survey in 1950. This is attributed largely to the "drainage source reduction" program carried out on a long term continuing basis. Another similar survey is proposed in two years. At that time there may be an opportunity to review the concept of applied species sanitation.

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Mr. Grant: We will now have the report from the San Joaquin Valley region.

Dr. W. D. Murray: In the interest of saving time, I will not make my general summary of regional operations in the San Joaquin Valley, and will submit the following reports for presentation in the Proceedings:

COSTS OF OPERATING SOURCE REDUCTION HEAVY EQUIPMENT

LLOYD E. MYERS, JR., MANAGER
Merced County Mosquito Abatement District

Questions have been asked concerning whether or not heavy equipment, such as tractors and draglines, can be

1. A survey of the north coastal marshes between Jenner, Sonoma County, and Humboldt Bay was carried out by J. R. Walker, E. G. Mezger and T. Aarons during February 1952. The survey followed a heavy rainfall period which resulted in a flushing action on many marshes. Various mosquito species were collected, however *Aedes squamiger* was not found. The northern-most established range of the species is Bodega Bay, Sonoma County.

self-supporting in a mosquito source-reduction program. Records kept by the Merced County Mosquito Abatement District show that it can be.

One of the most important factors determining the self-sufficiency of heavy equipment in a mosquito source-reduction program is the establishment of the correct hourly rate to be charged landowners who utilize the equipment. The rate must be low enough to encourage maximum useage and yet must be high enough to make the income equal costs. A close approximation of the proper hourly rate can be obtained by summarizing all known costs and converting them to hourly costs. These costs can be obtained from other operators of similar equipment. An example, using costs for 1952, is presented below for the Allis-Chalmers HD-7 tractor operated by the Merced County M.A.D. No depreciation was figured because the tractor was purchased second-hand and the money spent for overhaul has actually increased the value of the tractor. It should be noted that fire and theft insurance is a fixed cost and the hourly cost of this item decreases as the number of hours the tractor works increases. The operator's salary is listed somewhat high because foremen sometimes operate the machine. All other costs are actual.

	Hourly Cost	
Operating Expense:		
Fuel—2 gal./hr. @ $0.14 gal.	$0.28	
Oil—12 qts./100 hrs. @ $0.25 qt.	0.03	
Grease—$0.24/8hrs.	0.03	
Oil Filter—$1.50/100 hrs.	0.015	
Fuel Filter—$1.00/200 hrs.	0.005	
		0.36
Repairs and Overhaul: $1,500.00/3,000 hrs.		0.50
Operator's Salary: $350.00/160 hrs.		2.18
Insurance:		
Fire & Theft (tractor & tools) $43.06 annual premium/ 128 hours tractor worked	0.34	
Liability & Compensation $4.41 per $100.00 salary $4.41 x $2.18/$100.00	0.10	
		0.44
Net Cost of Operation:		$3.48
Contingency:		0.52
Hourly Charges:		$4.00

After equipment has been operated long enough, usually at least six months, for costs to be reasonably representative, the actual expense can be compared to actual accounts receivable to determine whether or not the established hourly rate is producing sufficient income. For example, an hourly rate of seven dollars per hour was determined by the above described process for the Merced County M.A.D.'s Link-Belt LS-51 dragline. Expenses charged to this dragline include a straight-line depreciation item of $100.00 per month, since the machine was purchased new and the actual value will decline for several years, despite maintenance. Over a period of twenty-three months, from November 1951 through September 1953, total expenses for the dragline were $11,905.33 and accounts receivable were $11,660.25. The dragline worked seventy-one hours for which no charge was made and the District absorbed the cost. When the total hours worked during the period (1,736.75) are multiplied by the hourly charge ($7.00) the result is $12,157.25 which exceeds the total expense by $251.92, showing that the hourly charge is satisfactory.

The above information is necessarily brief and many aspects of equipment costs have not been discussed. Regardless of brevity, the data presented above show that it is possible to establish for District-owned equipment a reasonable hourly rate of charge which will enable the equipment to pay its own way.

(Editor's Note: Approximate hourly costs of operation of mechanical equipment in the Alameda County Mosquito Abatement District in 1953 have been established by cost analysis methods as follows:

½ yd. Insley dragline	$8.00
D-4 Caterpillar bulldozer	4.50

The above includes all costs—operator and helper, moving in and out, interest, depreciation, insurance, etc.

For other equipment, the basic rates established are:

Oliver HD wide tread power sprayer	$2.00
Lawrence L-40 mist blower	1.00
Homelite mist blower	0.80

(To the immediately above basic hourly rates must be added salaries of operators, cost of insecticides, and transportation charges.)

SUSPECTED INSECTICIDE POISONING IN TULARE MOSQUITO ABATEMENT DISTRICT

MARVIN C. KRAMER, MANAGER
Tulare Mosquito Abatement District

Early in September of this year three ranchers in the Tulare Mosquito Abatement District ordered the M.A.D. operators off their properties. This action was provoked by the loss by one of the ranchers of a heifer. The rancher claimed that our spray activities were responsible for the death of the heifer and had caused nine others to become ill. The two other ranchers who refused our operators access to their properties were friends of this man.

Interviews with these three ranchers got us nowhere, so we asked the District Attorney of Tulare County to cite these men into his office to read pertinent features of the law to them and to try to effect a settlement of the dispute.

Partially for moral support but we suspect also in an effort to discredit the District, the three ranchers who were cited invited approximately thirty friends to appear with them.

This setting had the makings of a sounding board of public opinion, and considering the temper of some elements in the District, was potentially dangerous. However, by the same token, it was a medium by which the District could also air its views.

The purpose of the meeting, then, were threefold: 1) to familiarize the ranchers with the law and the community-wide nature of the problem. 2) to give the ranchers a chance to unload their grievances, and 3) to expose the ranchers who were most acutely interested to the latest information regarding toxicities of insecticides, methods of testing warm blooded animals for insecticide poisoning, and the rates of application of insecticides by the MAD, and their attendant hazards.

The State was represented by Mr. T. D. Mulhern of the Bureau of Vector Control, Dr. S. A. Peoples of the

Toxicology Division, School of Veterinary Medicine, University of California at Davis, and by Drs. George L. Humphrey and L. C. LaRue, Bureau of Vector Control and Bureau of Livestock Disease Control, respectively. Mr. Mulhern and Dr. Peoples contributed very heavily to the technical and operational phases, and lent authority to our arguments.

Mr. Mulhern gave us a picture of mosquito control throughout the entire valley, outlined the aims, methods, and precautions used by the Districts, and established the relationships of the people of the District, the individual ranchers, and employees of the District. He poured oil on the troubled waters by what he said and by the manner in which he said it. He brought the meeting back to a sensible consideration of the facts when it threatened to become a mud-throwing brawl.

Dr. Peoples reported on the results of tests run in his laboratory on samples of the heifer that had died, and also answered many questions regarding the nature and accuracy of the tests. He answered the important questions in this case—whether the heifer had died of insecticide poisoning. She definitely had not. We are indebted to Dr. Peoples for the accurate, unbiased testimony he gave.

No agreement was reached at the hearing, but the next day Mr. Mulhern and the writer visited the three principals, and each agreed to allow our operators to spray where necessary.

This all happened one week after my arrival in Tulare, and might very well have been a test case by the ranchers involved. However, the same men who had been tough and unremitting on their own ranches and when talking to me, became submissive when confronted by a battery of experts and the District Attorney. They showed great respect for the court. The fact that they would listen gave us opportunity to explain what we are trying to do and a chance to demonstrate our sincerity, and we feel a much better understanding is now prevalent throughout the District.

A PROGRESS REPORT OF THE AEDES FLIGHT RANGE STUDIES IN KERN COUNTY

By Billy A. Newhouse, Entomologist

Kern Mosquito Abatement District

The work done by Gordon Smith on the flight range of *Aedes* species in Kern County prior to the summer of 1952 had established the fact that periodic migration of adults were moving into the Bakersfield urban area from some point outside the Kern District. These flights were definitely correlated with specific weather conditions and the pattern was traced as far into the foothills as the communities of Woddy and Keene. In 1951 an attempt was made, with the cooperation of the Bureau of Vector Control and the Central Valley Ecological Study Unit of the C.M.C.A., to tag adult *Aedes* with radio-active phosphorus in an area outside the Kern District and recover them within the Bakersfield area. Although several recoveries were made at points ranging up to seven miles from the release point, the project was considered unsuccessful because no recoveries were made within the Bakersfield area.

Before graduating to the position of manager, Smith outlined a program of tagging for the 1952 season based on the use of fluorescein, a dye compound that fluoresces under ultraviolet light. Fluorescein is water soluble, permitting the sprayed adults to be washed either singly or in groups and the wash water to be examined for fluorescence rather than individual mosquitoes.

Another factor favoring the use of fluorescein was the relatively low cost of the material. The district had acquired several pounds of the material from war surplus stocks which had been used by the Navy in sea rescue kits for marker dye.

Our first problem in 1952 was to determine the minimum concentration of the dye at which fluorescence could be detected. Concentrations of 100,000; 10,000; 1,000; 100; 10; 1; 0.1; 0.01; and 0.001 parts per million were prepared and examined under ultraviolet light. A water blank was included to check any natural fluorescence in the tap water used to make the dilutions. Fluorescence was readily detected in all dilutions through and including 0.1 ppm. The level of fluorescence in the 0.01 ppm sample was so low as to be doubtful and no fluorescence was noted in the 0.001 ppm sample or the water blank.

The urgency of the *Culex* situation during the summer of 1952 prevented more than one preliminary field trial of fluorescein. This test consisted of one spraying of *Aedes* adults on an area of approximately ½ acre located about one mile west of Pond. The pupae were watched until they were ready to emerge. The day following the initial emergence of adults, three gallons of solution containing one pound of fluorescein was sprayed through a Spraying Systems Co. ⅛ SS1 nozzle. This equipment produced a fine mist-spray in a hollow cone pattern. The adults were sprayed as they rested on the grass around the breeding water. The purpose of this test was to determine whether or not a sticker such as gum arabic would have to be added to get the dye solution to adhere to the adult body.

Twenty-five adults were collected prior to spraying for determining any possible natural fluorescence. Twenty-five were collected immediately after spraying and an additional twenty-five collected 45 minutes later. The following day a sample of 10 adults was taken. All of these were washed individually in 10 cc of tap water and examined under ultraviolet light. No natural fluorescence was noted in those adults collected before spraying. All of the two 25 adult samples taken after spraying exhibited fluorescence and eight of the ten collected the following day were positive.

Work was continued during the summer of 1953 to determine the most economical dilution to use in the field. Two ounces of dye per gallon of water gave adequate fluorescence and this dilution was used for the first field run on August 17th. Approximately three acres of breeding area located 12 miles west of Shafter was sprayed with 10 gallons of dye solution. Collections of live adults were made on the mornings of August 18, 19, 20, 21 and 22 in the Oildale area north of Bakersfield. Light trap collections of adult *Aedes* taken during the same period were processed separately.

The collections of the 18th and 20th became contaminated with fungus growth because of inadequate drying before storing. These were discarded. The adults collected on the 19th and a portion of those collected on the 21st were washed in batches of five. All showed varying degrees of fluorescence. The remainder of the collection of the 21st was washed singly. Here again all showed fluorescence. It was decided that due to the prescence of fluorescence in all samples, including those processed singly, that the presence of some other agent was giving us interference.

The following week another sample of adults was collected in the field which were known to be free of the dye. These also exhibited fluorescenc when processed in the lab. It was decided to delay further attempts until a more satisfactory procedure could be worked out.

Mr. Grant: We will now have the report from Southern California, by Norman Ehmann.

Mr. Ehmann: In spite of the tremendous bouquets that were heaped upon the Southland by Harold Gray this morning, I hasten to assure you there is a group of people in Southern California which is very interested in mosquito control, and whose programs are on a sound footing. As evidence of this fact, I would, at this time, like to introduce to you some of the members of the Boards of Trustees from agencies in Southern California that have taken time out and given three days of their own time to attend this meeting. As one of them put it, "because our Board of Trustees believes that since we are in the mosquito control business, we as members of the Board of Trustees should know just a little bit more about mosquito control." Now if they would stand when I call their name, then maybe we can give them a hand when all of them are up. The first one is Mr. C. M. Garrison of the South East Mosquito Abatement District; Mr. Peckenpough, from the South East Mosquito Abatement District; Mr. Wilson, who is the Mayor of Placentia, and on the Board of Trustees of the Orange County Mosquito Abatement District; Mr. Steiner from Newport Beach, and his wife; Mr. Steiner is a member of the Orange County Mosquito Abatement District Board of Trustees; Mr. Owen from Costa Mesa, who is also on the Orange County Mosquito Abatement District Board of Trustees.

The Southern California Section of the California Mosquito Control Association experienced a new surge of interest in local mosquito control problems during 1953 and a growth in membership consisting of agencies closely allied to mosquito abatement districts.

Two meetings were held during the year, one at the Bellflower Health Center, a Los Angeles County Health facility and the other at the Southeast Health Center, a Los Angeles City Health facility. The program of the first meeting included panel discussions of (1) Public Relations in Mosquito Control at the Field Operators' Level, (2) The Recent Encephalitis Epidemic and its effect on Mosquito Control Operations in Southern California.

In the afternoon, those in attendance participated in a tour of the recently acquired facilities of the new South East Mosquito Abatement District.

The program of the second meeting included panel discussions on (1) Adult Mosquito Population Measurement Techniques, and (2) Mosquito Source Reduction Programs as practiced in (a) Mosquito Abatement Districts, (b) in Health Departments.

There were eighty-seven (87) people in attendance at this second meeting representing seventeen (17) different jurisdictions interested in mosquito control in the Southern California area. The discussions of source reduction programs were of sufficient general interest to warrant discussing them at this time as part of our Southern California Section Report to the California Mosquito Control Association.

In view of the time element, the several papers from Southern California will be presented for publication in the Proceedings and not read.

ORANGE COUNTY MOSQUITO ABATEMENT DISTRICT'S APPROACH TO MOSQUITO SOURCE REDUCTION

JACK H. KIMBALL, MANAGER
Orange County Mosquito Abatement District

The liberal definition of mosquito source reduction suggested by the Bureau of Vector Control presents clearly and concisely eight specific methods of approach to our ultimate goal—Mosquito Source Reduction. The following remarks will briefly outline how the Orange County Mosquito Abatement District has analyzed its particular mosquito production problems, and how it has been working towards source reduction during the past six years the District has been in existence.

I. CERTAIN MOSQUITO BREEDING SOURCES ARE A PUBLIC NUISANCE

The legal definition of a mosquito breeding nuisance is stated by Section 2271 of the Mosquito Abatement Act in the California Health and Safety Code and is quoted as follows:

> "Any breeding place for mosquitoes which exists by reason of any use made of the land on which it is found or of any artificial change in its natural condition, is a public nuisance."

The act places the responsibility for the abatement of a mosquito-producing nuisance on the property owner. However, there are sources such as salt marshes, river bottoms, etc., that occur in nature which do not qualify as a "public nuisance" under the act, and the control or abatement of which is left up to the discretion of the District.

II. THREE CLASSES OF MOSQUITO-PRODUCING SOURCES

For the purpose of programing our source reduction program, our mosquito-producing sources are classified as follows:

(1) *Natural Sources* are those sources which exist in their natural state, and which are not the responsibility of the owner of the property on which they exist. Source reduction in this District has been limited to the estimated cost of temporary control prior to future development of these natural areas by private enterprise.

(2) *Minor Sources* are those sources which are created by community development and by the use of water, which can be controlled by routine District operations at a minimum cost.

(3) *Major Sources* are those sources which are created by improper land usage, or by use or misuse of water applied to land and which require expensive control operations.

Accurate mapping and consistent record keeping of each source over the past five years readily identifies the Major Sources in terms of mosquito species, number of visits, gallons of insecticide and man hours. This information is quickly converted into the cost for temporary control of each source.

III. SOURCE REDUCTION PROGRAM FOR MINOR SOURCES

The reduction of minor sources is dependent on the awareness by the general public, and by other public agencies, of the fundamental principles of mosquito production and control methods. The public must know the basic facts of these fundamental principles, and it

Example No.	Assessed Valuation 1952	Mosquito Tax Paid 1952	Total Area Acres	Producing Source Acres	1952 Control No. Visits	Gal. Insect.	Total Cost
1	$176,500	$22.00	366	197	84	1937	$1,095
2	25,700	2.46	95	79	102	2775	779
3	79,700	10.50	162	130	40	334	485
4	58,500	2.46	60	53	63	712	443
5	107,000	15.10	105	65	62	719	387

is the responsibility of all District personnel to present and explain these principles at every opportunity. The following methods are used by this District to develop this type of public education:

(1) Personal contact by each District employee with persons responsible for creating a mosquito-producing source.
(2) Personal contact by each District employee with the person reporting a mosquito annoyance.
(3) Illustrated talks on mosquitoes before elementary, high school and college classes.
(4) Furnishing class study material such as larvae, mosquito fish, and visual aids to interested schools.
(5) Arranging tours for school classes to inspect the District headquarters, equipment and specific field problems.
(6) Formal presentations on mosquitoes and District operations before service clubs and other interested groups.
(7) Annual educational exhibit at the Orange County Fair.
(8) Radio programs and newspaper releases on significant occasions.
(9) Active support of the Orange County Agriculture Round Table, a group of representatives from local, state and federal agencies interested in agriculture in Orange County.
(10) Development of good working relationship on mutual problems with other public agencies that have regulatory powers over the use and disposal of water and industrial wastes, such as the Sanitation and Dairy Divisions of the Health Department, Flood Control, Drainage Districts, Street and Highway Departments, Agricultural Weed Control Divisions, Industrial Waste Regulating Agencies, Land Use regulatory agencies such as County Planning Commission, etc.

IV. Source Reduction Program for Major Sources

The methods just described for promoting public education on mosquito control are applied to the major producing sources as well as to the minor sources. However, it has been found that special attention must be given to these problems in order to convince the responsible person that improvements, sometimes costly, must be made to minimize an existing public nuisance. The procedure which this District is following is as follows:

(1) Special Attention to Most Costly Problems

The annual cost to the Dstrict for controlling each major source is determined from the inspection-treatment records that have been maintained for the past five years. Special attention is given to the most costly operations, examples of which are presented herewith:

(2) Cooperation Offered by Repeated Personal Contacts. Special attention is given these major sources by repeated personal contact with the responsible party during the mosquito season to point out the exact cause and location of the nuisance; to suggest methods of correcting the problem with reference to similar operations in the District; and to suggest available sources of technical information and/or economic assistance such as the University of California Extension Service, the U. S. Department of Agriculture Production and Marketing Administration, Soil Conservation Service, and suitable literature.

(3) Notice to Abate Nuisance by Specified Time. If the responsible party is not receptive to this special attention, the entire history of the mosquito production problem is presented to the Board of Trustees for their review. If the Board decides that improvements are desirable, the Manager is instructed to notify the responsible person in writing to correct the nuisance by a specified time. The person is also invited to discuss the problem with the Board at any of its regular meetings if he so desires.

At the end of the grace period, the Board reviews the progress in minimizing the nuisance. If the person has shown concern over the problem and has made some progress, the Board will extend the time set by the abatement notice.

If the person has made no attempt to prevent the recurrence of the nuisance, the Board can take one of the following legal actions to abate the nuisance. Although the Orange County Mosquito Abatement District has not had cause as yet to use legal enforcement, the District's Source Reduction program is based on the premise that such action may be required.

(4) Legal Procedures to Abate a Public Nuisance Caused by a Mosquito Breeding Source. Sections 2272 and 2273 of the Health and Safety Code provide that a nuisance may be abated in any action or proceeding, or by any remedy provided by law, and any remedy provided in this chapter for the abatement of a nuisance is in addition to any other remedy provided by law.

Three procedures are available. Use of any particular procedure depends on the type of mosquito-producing source involved, and on the receptiveness of law enforcement officials.

a. *By Litigation under Sections 2271-2289 of the Health and Safety Code, known as the Mosquito Abatement Act.* This procedure for the abatement of a public nuisance is described in detail by Administrative Memorandum No. 6 pre-

pared by Harold F. Gray, Engineer-Manager of the Alameda County Mosquito Abatement District, and published by the Bureau of Vector Control for the Operations Manual of the California Mosquito Control Association. The use of this procedure is not applicable to land use operations such as irrigated pastures, because the Board of Trustees is required by law to take appropriate measures to prevent recurrence of mosquito breeding after the property owner has failed to comply with the Board's notice to abate the nuisance. (Editor's Note: This last statement may not be strictly correct.)

b. *By Prosecution under Sections 370 to 373a of the Penal Code.* The Mosquito Abatement District can file a complaint with the District Attorney, who in turn can issue a citation to the offender to appear before him and show cause why he should not be prosecuted for maintaining a public nuisance. If the offender does not heed this explanation and warning, the District Attorney can file suit in the proper court on a public nuisance complaint. Since the Penal Code states that each day's maintenance of a public nuisance is a separate and distinct offense and is a misdemeanor, the offender can be fined or jailed if convicted.

c. *By Writ of Injunction under Sections 370 to 373a of the Penal Code.* This rocedure provides that either the District Attorney or the Attorney for the Mosquito Abatement District can apply to the Superior Court for a Writ of Injunction against the maintenance of a mosquito breeding nuisance. If the court grants the injunction, then the offender must abate the nuisance or be in contemt of court.

METHODS IN MOSQUITO SOURCE REDUCTION AND VINDICATIONS OF THEIR COSTS

By Ernest R. Tinkham, Ph.D., Manager
Coachella Valley Mosquito Abatement District

Mosquito Source Reduction, also known as Permanent Mosquito Control is just the opposite of Temporary Mosquito Control. Temporary Mosquito Control attempts to control mosquitoes by the application of chemicals sprayed onto breeding areas for the control of larvae in water or as a fog or mist into infested areas for the control of adults. Since mosquitoes are fast breeders, having one or two generations per week in Coachella Valley during the hotter months of the year, Temporary Mosquito Control becomes repetitious in nature. Control then by chemical means is purely Repetitive or Temporary with no efforts made to achieve longer lasting control.

Mosquito Source Reduction or Permanent Mosquito Control is the very antithesis of Temporary Control. Temporary Control employs costly manufactured chemicals to obtain short-time control. Mosquito Source Reduction employs natural methods to achieve long-time control. Temporary Control attempts to control the product of man's often indiscriminate wasteful water practices. Permanent Control gets at the source of the problem by the elimination, control or change in water practices which will achieve natural control of mosquito pests. One method tries to control the results of poor agricultural practices; the other tries to establish improved agricultural practices which will not only control or eliminate mosquitoes but in so doing will save the farmer and the taxpayer sizeable sums of money as well as improve his land.

A Mosquito Source Reduction Program will help protect the district against public complaints and lawsuits that will arise when the public becomes more conscious of the chemical residue problem on vegetables, forage and even in milk. A chemical control program only, on the other hand, will leave the district wide open to public complaint and criticism.

A mosquito Source Reduction Program is a cooperative educational one between the mosquito abatement district and the farmer or taxpaying resident to establish more economical means of controlling mosquitoes. By so doing, agricultural practices of the farmer are improved resulting in saving of water, better soil and better crops. Temporary control aims at the control of mosquitoes with or without the cooperation of the farmer or taxpayer and without any concern for establishing more economical methods of control or correcting the causes producing the mosquitoes. The quintessence of Permanent Mosquito Control by Source Reduction Methods, is simply the application of good agricultural principles in the rural and urban areas of any mosquito abatement district.

We are now ready to examine by what ways and means a Mosquito Source Reduction Program can be accomlished by the application of good agricultural practices and at what cost.

1. *Efficient Irrigation*—this is of first and prime importance since there will be no waste water in any efficient irrigation system. Efficient irrigation is a very difficult feat to accomplish. Irregularities in soil can upset the best calculations. Irrigation under excessive heat can be most trying and the good irrigator with sweat filling his eyes and soaking his body on a torrid summer day may give up in exasperation and let the water waste.

Assuming then that there will be waste water, and there usually is, several important ways are available to take care of that waste water.

2. *Sump-Pump or Return Flow System.* This system employs a sump or reservoir with a lift pump to return the collected water or runoff irrigation water for reuse again on the high sides of the field for reirrigation.
   The sump or reservoir for a 40-acre field need be no larger than 30x40 by 6 to 8 feet deep. The two or more H.P. motor should be equipped with a float so that when a certain amount of water collects in the sump, the float will automatically trip the switch and set the machinery in motion for recirculation of the water to be used in re-irrigation. The water can be returned to the high side of the field or fields by open ditch or in concrete pipe or concreted ditchings.

The cost of this system varies with the size of the field to be irrigated and the cost of the pump. In Coachella Valley where well pumps have been replaced by canal irrigation, second-hand pumps are relatively cheap and serve excellently on these sumps to lift the water (see sketch 1. The cost would vary.

sump excavation @ 20¢/cu. yd.	small	$20	large	$200
pump — 2nd hand		300		500
new		500		1000
concrete pipe		20		200
Total Cost		$340 to $540		$900 to $1400

Actual Cost:

Sam Elledge Draining 130 acres	
Excavation (sump 56x13 x 3 yds.) @ 20¢/cu. yd.	$195
Used pump	500
Concrete pipe	25
Total	$720

Savings:

20% savings on water bill @ $18/acre per year on 130 acres	$468
Mosquito bill estimated	100
Liquid fertilizer—Quick Grow 50% saved by test. 2 treatments (75 acres @ $5/acre) $750.00. Savings	375
Total	$943

Other benefits: prevents water logging, protects roads, keeps neighbors friendly.

There are many modifications of this sump-pump system.

Nagata and Rutherford in Coachella Valley use a long open sump or broad ditch respectively which deepens towards the upper end so that the water will collect at the upper end where a small 3 H.P. pump can pump directly into the main ditch for re-irrigation.

Cost:	pump	$250
	hose	50
	excavation	$30 to 100

Cost ranges from $230 to $330 to irrigate 13 to 26 acres (See sketch 2.)

Bob Bowlin built a concrete sump along the lower side of his field and leads the water from both sides into the shallow end where the water runs down the inclined bottom. A pump at the deep end pumps into a concrete pipe system which returns the water to the higher side of the big fields. (See sketch 3.)

Such a type, however, is expensive but has its advantages in that there are no weed control costs to this system during the years.

3. *Sumps* only (see sketch No. 4) are sometimes used to collect water on the lower end of the field without any return system. Such practices are improvements over the general one of wasting water (into borrow pits or new land) but the sump-pump system is naturally the preferred method.
4. *Relevelling of land.* Relevelling of land to eliminate poorly levelled fields is one certain method to control waste water and establish an efficient irrigation system. Costs of relevelling can be accomplished at $50/acre. Tapering of grade at lower end of field to hold more standing water is helpful: 2/10 to 1/10 to .05/100 feet.
5. *Contour Irrigation.* Where feasible, diagonally placed dykes across a field can do much to eliminate waste water caused by straight line irrigation where the drop exceeds 2/10 inches per 100 feet. Contour irrigation if feasible is relatively inexpensive to install. Contour irrigation can be used in alfalfa fields, field crops and even in date orchards. (See sketch 5.)
6. *Drainage of Swamps.* The drainage of swamps and low areas must often be resorted to in permanent Mosquito Control measures. The cost depends, of course, on the size of the depression or swamp to be drained. Some swamps are extensive and may cost thousands of dollars to drain, others may be relatively small. In this particular case cited below on the Wagner alfalfa field the tule swamp covered only 2-3 acres of a 45-acre field. Our District spent from May to August 14 the following in actual mosquito control not including cost of surveys.

Chemical sprays and Hep. granules	$110.95
Operator ($1.42 - $1.75/hr.)	54.29
Operating costs @ $3.00/hr.	40.50
Other equipment charges	7.00
	$212.74

Against these charges Mr. Sam Keoseyan, farmer, who cooperated most excellently with us spent the following in drainage of these swamps. He did what Mr. Wagner had been asked to do and refused.

Tractor 30 hrs. @ $3.50/hr.	$105.00
Hand ditching	
50 hrs. @ 70¢/hr.	35.00
54 hrs. @ 85¢/hr.	45.00
	$185.90

In mid-August Wagner finally put in a ditch requested in early June and from then on there were no other mosquito control expenses.

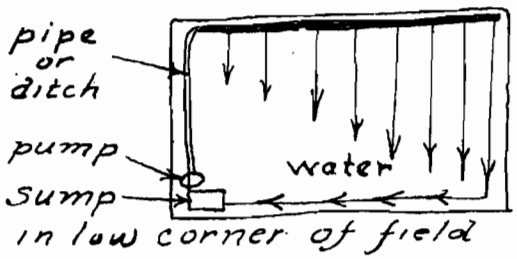
From these figures it is evident that Mosquito Source Reduction costs are vindicated even on a short time basis, and naturally over a long time period of several years the draining of these small swamps will save many times the initial expenditure of approximately $200.00. One other item should be mentioned here of considerable value. We gave Farmer Keoseyan a good "write-up" in the local papers praising his fine cooperation. Result—he has been greeted by many taxpayers as: "Hi, good citizen." This is of great worth to our District in our Mosquito Source Reduction Program.

7. *Fill In.* Fill in of low depressions, wherever they exist is a recognized method of mosquito source reduction. One of our worst mosquito breeding areas in Coachella Valley is the Avenue 52 Wasteway. In this wasteway the water stands three feet deep at the supposedly higher upper end and our mosquito abatement bill for the 1953 season amounted to $909.50. Fill in or other methods will have to be resorted to to eliminate this problem.
8. *Subterranean Drainage System.* The Laflin Ranch near Thermal has devised an ingenious drainage system. A 1700-foot length of 24" concrete pipe serves to drain 130 acres of dates, citrus, grapes and other crops. The water is collected by 8" screen vents at the low side of the ranch and these vents drop the water in the 1700-foot 24" pipe system 2 feet below ground surface and these pipes carry the waste water to the Whitewater Storm Drain. The cost of this system was:

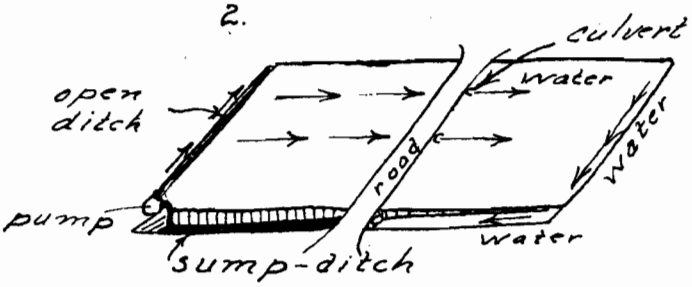
Excavation 1700 ft. @ 10¢/ft.	$170.00
1788 feet of concrete pipe	697.32
25 sacks cement @ $1.25	31.25
Labor	279.90
Total Cost	$1178.47

Sketches Illustrating Mosquito Source Reduction Methods

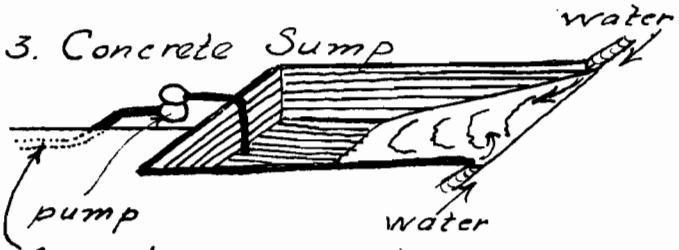
1. Sump-Pump System



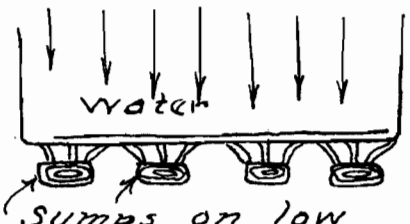
2.



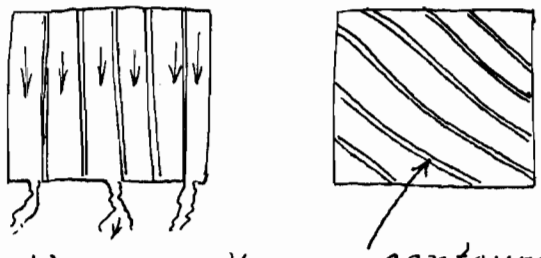
3. Concrete Sump



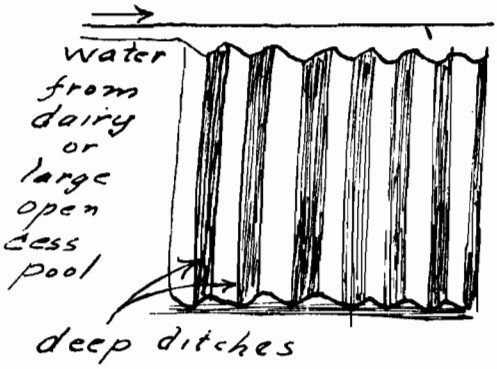
4. Sumps Only



5. Contour Irrigation

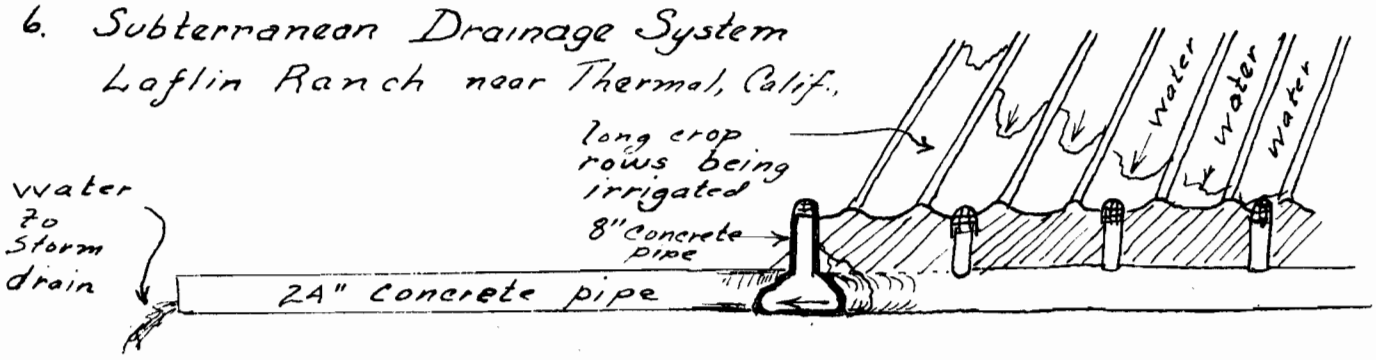


7. Evaporation Plots



6. Subterranean Drainage System

Laflin Ranch near Thermal, Calif.



Cost per acre $9.06. The Laflins are well pleased with the system and absolutely no waste water is possible. The Thermal area contains much salt in the soil—hence the inadvisability of re-using irrigation water. (See sketch 6.)

9. *Contour Sprinkling.* Contour sprinkling of alfalfa fields levelled or unlevelled permits water to sink slowly into the soil without runoff.
10. *Evaporation Plots.* Overflows from dairies and sometimes large open cesspools can be run on to a parcel of land that has been plowed into deep parallel ditches with high inter-ditch banks. By rotating the waste waters into different ditches every day or two, the large evaporating surface of such ditches and banks reduces or eliminates the presence of such waters highly impregnated with organic materials most suitable to mosquito breeding. This system is recommended especially for heavy soils. When the function of the plot has ceased due to deposition of organic materials, a new plot is formed and the old can be used for producing crops or vegetables, thus serving the twofold purpose of restoring to production often infertile soils. (See sketch 7.)

In summary we can say:

1. Mosquito Source Reduction methods should save the cost of the system installed the first year in most cases, certainly in two or three years depending on the size of the project involved.
2. A Mosquito Source Reduction Program helps prevent the build-up of chemical resistant strains of mosquitoes.
3. A Mosquito Source Reduction Program encourages other departments or organizations, such as County Road Department, Water District and town and city sanitation offices to cooperate and carry out similar programs.
4. Helps keep mosquito populations low and thus assists in keeping *Culex tarsalis* below epidemic levels.
5. Helps mollify the public as to the dangers of chemical sprays thus helping to prevent libel suits against the District which are certain to develop as the public hears more and more about the injurious effects of chemicals in the human body obtained from residues on or in vegetables, in meat and even in milk.
6. Assures taxpayers that their monies are being used in the best possible way.
7. A Mosquito Source Reduction Program assists the farmer in many ways:
   a. By protecting his cattle and reducing weight losses.
   b. Helps develop improved agricultural practices.
   c. Improves the farmer's land by preventing the formation of water-logged and salt-impregnated soils.

In conclusion we can say that a Mosquito Source Reduction Program properly conceived and executed is the true answer to the mosquito problem.

Mr. Grant: I appreciate the cooperation of the Southern California Section in holding the time down and permitting us to go ahead with the rest of the program, for which we are overdue now. It is a panel discussion entitled "Educational Methods in Mosquito Control," moderated by Harold Gray.

Mr. Gray: Aren't you going to give them a little breather before we go to work on them?

Mr. Grant: Oh, yes. Due to the limited time, I hope that you can reduce this recess to a ten minute time period.

Recess

Mr. Grant: Will the meeting please come to order? First, I would like to call on Dr. Sessions, who has an announcement.

Dr. Sessions: During the last couple of days I came to the impression that you might be interested in entomology. The annual convention of the American Entomological Society is to be held next week at the Biltmore Hotel in Los Angeles. It has been many years since this convention was held in the west, and it promises to be one of the biggest and best entomological meetings that has ever been held. I thought it should be announced to this group.

Mr. Washburn: I have two announcements. One, I think, has been made, and the other partially made. We would like to urge all who can, and should, to attend the New Jersey meeting at Atlantic City this next March 7-12. On your way home from the meeting you might just as well, and you should, stop off at the Utah meetings, which will be on March 19-20. We can get both of those groups in one one round trip. I know Don Rees would like to have you in Utah, and some of us would like to see you back in New Jersey.

Mr. Grant: Now I present Harold F. Gray, Engineer-Manager of the Alameda County Mosquito Abatement District.

Mr. Gray: President Don, members and friends, the Moderator of this panel on "Educational Methods in Mosquito Abatement" is quite cognizant of the definition of a Toastmaster. He is merely "the little punk who sets off the fireworks." This particular symposium will be conducted within the time limit, if possible, and we hope to have a little time for a few questions from the audience afterward.

The first speaker on the panel will discuss the general basis and philosophy of the educational process, particularly in relation to the education of a mass population. Then we will have a discussion on the use of the press as a news and educational medium. Following that we will have a discussion on the use of photography and visual aids. There will then be a discussion of radio and television in this particular field. Finally we are going to have a discussion of the education of the people who are going to apply this material in actual practice in mosquito abatement. I take great pleasure in introducing Dr. Morey Fields. He is really a New Yorker, but he is out here at the present time as Visiting Professor of Health Education in the School of Public Health at the University of California. He will talk on education as a solution to problems in mosquito abatement.

Dr. Fields: I am glad to be here from the sunny shores of New York City to the unsunny shores of California. As a matter of fact, they told me that it never rains here. I guess they were referring to another part of California.

Unfortunately we also have mosquito problems in New York City. I think they come from New Jersey. If any of you are here from New Jersey, then I apologize. I hope to, in the next five or six minutes give you my ideas of Public Health Education in Mosquito Abatement Operations.

PUBLIC HEALTH EDUCATION IN MOSQUITO ABATEMENT OPERATIONS

MOREY R. FIELDS, ED.D., *M.P.H.*
Visiting Professor School of Public Health
University of California
Berkeley, California
and
Director, Bureau of Public Health Education
New York City Department of Health

Health education is a means of getting people to act in the right way on health problems. While its main purpose is to encourage persons to live healthfully, it tries to accomplish that through giving information, and helping people to understand so that they will want to carry out good health behavior.

There are difficulties in health education. We realize that knowing *what* to do does not guarantee that people will do it; and we cannot be certain that because we have repeated a health practice that it will be permanent. For example, if people know that they can prevent mosquitoes from breeding by making sure that there are no breeding places, it will not insure that all breeding places will be done away with. Furthermore, because people have removed possible sources for mosquito breeding once or twice, we cannot be certain that they will remove them again under different circumstances.

What are some possible reasons why that is so? Sometimes we do not carry out a practice because it doesn't give us satisfaction. We like to enjoy what we are doing; and removing breeding places is hard work. Yes, it gives us satisfaction to know that if mosquitoes are not around it will be a more pleasant and healthful place to live. But for the moment we think of the work involved. Some people have prejudices or are superstitious. That may prevent them from carrying out good health practices. I know some persons who say that pools of stagnant water are good for the soil, and they refuse to drain or do away with these pools. There is still another reason, wanting to do what is right, but just not finding the time.

In the past the practice in health education was to give information. We set down rules of proper living and we expected people to memorize these rules, feeling they would be carried out if they were known. We tried to influence people by controlling their thinking. So, all media at our command, newspapers, radio, meetings, posters, exhibits, and pamphlets carried the good rules for living. But we failed to realize that we couldn't think *for* people. Somehow, we coudn't understand why people were not practicing what we professionals thought was good for them.

Today we have an idea why that is so. We feel that merely giving information and encouragement through mass media are not enough if we want to develop a citizen who is self-reliant and responsible for his behavior. People must work together in groups so they can democratically solve their health problems.

Health problems cannot be solved by suppressing people or by controlling their thinking, or through using any other negative ways. The most effective method is to get the person working in and with a group so that he can recognize what his problem is and so that he can contribute to group thinking and decisions. The more the citizen works with others, the more self-dependent he becomes, and the quicker he is able to see his problems and want to do something about them.

Planning, learning, and action through the group is important in our democracy. In this way, goals are seen more easily; the wishes of the group are clearer; prejudices are reduced or done away with; and those who don't want to change because they resist new ideas are helped to understand how worthwhile these new ideas can be. If a person has the chance to say what is on his mind while he is in a group, he is apt to feel that the group is a good thing and that he belongs to the group because others get a chance to hear him. This means that he may want to share in the decision made by the group. Furthermore, if he feels responsible for taking part in the group decision, he is more likely to carry out what the group has suggested.

We cannot assume that groups are collections of people and people act for themselves. Everything we do in our society is in relation to others. We belong to many groups: home, school, church, industry, fraternity, lodge, club, or friends. If we take part in the friendships and understanding within these groups, we want to be responsible for doing what the group feels is good for it and the community.

If it is a real group decision, the persons in the group must plan and act in harmony. Each must give the other a chance to think and talk; each must help the other understand what he believes so that the final choice of action will involve all of the group thinking.

The end of every health education experience is action or behavior, but satisfaction in that action takes place only when people understand why they are behaving that way. We cannot transfer information about mosquito abatement from one person to the next and expect these persons to understand. Neither can we expect effective behavior through the same transfer of information. We must encourage the citizen to work with a group on mosquito abatement problems. Thus, he may be more willing to carry out the group plans of action in which he has had a part in developing.

In mosquito abatement operations, mass media are good tools for spreading information and for developing attitudes. While through the use of those media a professional worker may encourage desirable behavior in citizens, more effective results come about through group decisions.

Mr. Gray: Thank you very much, Dr. Fields. What you said reminds me very much of a little quatrain I heard a short while ago. It goes to this effect. "I'm just like any other man, I like the things I help to plan. The guy that tells me what to do makes me as mad as he does you." Now then one of the mass media that we have, that Dr. Fields spoke of, is the modern newspaper. I have great pleasure in introducing Mr. Raymond Spangler, who is the owner, manager and publisher of the Redwood City Tribune. Mr. Spangler.

WHAT IS NEWS, AND HOW MAY IT BE USED AS AN EDUCATIONAL DEVICE IN MOSQUITO ABATEMENT OPERATIONS?

RAYMOND L. SPANGLER, PUBLISHER
Redwood City Tribune

The subject assigned is first a definition of news and second how may it be used as an educational device in mosquito abatement operations.

We might well take the entire time allotted to define this ill-defined word: news.

We in the newspaper business have spent many thousands of dollars to determine what our subscribers read and I suppose that each reader has his own definition of news. An examination of various newspapers demonstrates with equal certainty that each editor has his own definition.

News is fresh information concerning something that has recently taken place. News may be whatever the editor decides to print. News may be what the reader decides to read.

News is the unusual. It is the story of the man that bites the dog. It may also be the story of the dog that bites the man, particularly if the injuries are serious, the man is prominent, or if the dog has rabies.

Controversy makes news, but it is also true that such non-controversial items as the weather make news, primarily because they affect everyone. So we may arrive at a definition for our purpose along the following lines:

News is that which interests a large number of people and is related in a manner that large numbers of people may understand it.

How may news be used as an educational device in mosquito abatement control operations?

Let us look for a moment at the manner in which news is gathered. The mass communication media have posted sentries at the points most likely to produce news. They have reporters at the United Nations, at Washington and Sacramento, at Berkeley and for all I know in this very meeting hall. The number of these watchers for the news is limited by the ability of the mass media to staff and supply this army of observers. It is also limited by the amount of material which can transmit over our facilities; and it is likewise limited by the time whch you as readers, as listeners and as viewers, are willing to devote to the task of observing the news of the day by radio, television and newspapers.

Yet, despite these limitations, you have at your command a vast network of communication available whenever you have material of sufficient news value to command the use of these facilities. They are yours without a fee; they are yours for the asking with the sole requirement that what you have to say be of interest to a large number of people and that it is said in language that these people can understand.

Remember that such remote discussions as "The problems of insect vectors of yellow fever in the Anglo-Egyptian Sudan" do not become news until you translate such information in terms of a pressing local problem. You must divest yourself of the scientific lingo which most every specialized activity develops as its own. Remember that your news must compete with all other items in the flow of the day's information. It must compete for space and time in the media which will present it and while the New York Times may publish all the news that is fit to print the more usual situation is that which we have on our Redwood City Tribune where we print all the news that fits. And finally remember that you are competing with a thousand distractions and hundreds of news items for the time of the person to whom your message is addressed.

As a subject the mosquito is a universal nuisance and at the outset has almost universal interest. As a transmitter of malaria and encephalitis the mosquito is a hazard to public health. This gives the mosquito a rating of serious and deep public concern. The breeding places of the mosquito, particularly in the residential sections, often serve to disclose unhealthy public health situations: septic tanks, sewage overflow, stagnant water and poor drainage to mention a few.

Your contact with the news gathering agencies may originate with them. In times of epidemics our reporters will be asking questions of you. At such times it may appear that our definition of news is something you want kept out of the papers. In such periods it is well to remember that when called upon for the story that you would like to suppress, don't try it. Be frank, even with embarrassing facts. Your temporary embarrassment will be rewarded by long term confidence both by the reorter and through him by the public.

I have in mind a situation in our county some seasons back when the mosquitoes were particularly pestiferous. We called on C. Donald Grant, the manager and entomologist of our mosquito control district. From past experience and previous managers we were prepared for alabis. We expected to learn that the mosquitoes originated outside the district, perhaps as far away as Napa. But we were treated with frankness. Mr. Grant told us that his men had blundered by overlooking several acres of salt marsh which produced the hordes of mosquitoes which were annoying us.

Even without his assurance we knew that this blunder would not be repeated and because of his frankness we believe him now when he says that mosquito abatement in San Mateo County is 99.9% effective.

If it is necessary for you to seek out the newspaper with your information, contact the reporter on your beat. If he is not available visit the newspaper office. Tell your story frankly and simply in terms that a layman can understand and I am sure that you will win not only the assistance of the newspaper but the public support and understanding without which you simply cannot abate the mosquito.

It is my belief that only with public understanding can you win the cooperation of the individual and of industry; the coordination of the various public agencies involved and finally the righteous public indignation which comes when the job of abating mosquitoes is not well done.

Mr. Gray: Thank you very much, Mr. Spangler. I can see that was much appreciated by the audience, and there may be some questions afterwards.

The newspapers use other things than the printed word. Somebody once said that one picture is worth a thousand words. Many of us make use of illustrative materials of all kinds in trying to get over the idea of the mosquito and what can be done to get rid of it. So we have asked Dr. Arthur C. Smith, of the State Bureau of Vector Control, who is quite a photographer in his own right, to discuss the use of photography as an educational device in mosquito abatement.

PHOTOGRAPHY AS AN EDUCATIONAL DEVICE IN MOSQUITO ABATEMENT METHODS

ARTHUR C. SMITH, PH.D.
Associate Vector Control Specialist,
Bureau of Vector Control,
State Department of Public Health

There are few fields of human endeavor in which photography cannot be a very valuable educational tool, if properly used. Mosquito abatement is no exception. There are many opportunities for profitable use of photographs

in a progressive mosquito abatement program. We can mention only a few at this time. In this discussion we are primarly concerned with photographs that educate. Depending upon the definition of what is educational, this could still encompass all uses of photography in this field.

We can set up several general categories that may be useful in taking a quick glance at the various possibilities:

1. Visual aids that may be used in giving talks and lectures. These talks may be presented to grammar, high school or college audiences, businessmen's organizations, or farmer groups.
2. Photography for use in exhibts at fairs, conventions, public schools week, etc. Such occasions offer excellent opportunities for presenting the work of your district to the public.
3. Photographs for use in publications such as leaflets, bulletins, annual reports, etc.
4. Public relations use of photographs in newspapers and magazines.
5. To document the program of mosquito abatement.

The actual photographs used may be in the form of prints ranging in size from a small contact print to an 8 x 10 glossy (which are the most widely used) and may include giant "blow-ups" of 20 x 24, 30 x 40 or larger.

The photographs may be made into lantern slides or film strips and projected on a screen. The pictures may be taken on color film and used as color slides.

There are many other methods of using photographs in educational work. We will mention just one other. This method is especially useful in demonstrating to a lay audience some of the more technical phases of mosquito abatement. Concepts such as mosquito life history, transmission of encephalitis, and development of resistance to insecticides can be shown clearly by the flannel-board technique.

(Dr. Smith then proceeded to present a series of photographs of various types, illustrating his points.)

Mr. Gray: Thank you very much, Art Those of you who would like to see some of these exhibits after we are through with the panel, if you have a little time, can come up and look some of Art's material over. We do want to keep inside the time limit, and we have just ten minutes left. I believe we can do it. The next speaker will discuss the use of television and radio in mosquito abatement operations. I would like to present Alton Wilson, Public Health Education Consultant, Bureau of Health Education, State Health Department.

TELEVISION AND RADIO IN MOSQUITO ABATEMENT OPERATIONS

ALTON WILSON, HEALTH EDUCATION CONSULTANT
Bureau of Health Education
California State Department of Public Health

In the days of radio's infancy a famous university president was asked whether his institution would care to present a series of educational programs. He refused, labeling radio as "just another gadget," adding that it would be forgotten in a few years.

Those few years have passed and the "gadget" is still with us. To it we have now added another and greater gadget—television, which some have said holds more promise for education than anything since the invention of the printing press. Today radio and television are vital forces in our way of life.

Here we are considering the educational methods in mosquito abatement. The importance of using radio and television to reach our educational goals is obvious for many reasons.

Radio and television reach a large percentage of our public. It is a rare home in America today that does not have a radio, and the day is fast approaching when the same will probably be true of television sets.

There is complete radio coverage in California and television stations are being added one by one. They now reach most centers of our population. At the moment there are commercial television stations in the metropolitan areas of the San Francisco Bay Region, Los Angeles and San Diego; in Bakersfield, Tulare, Fresno, Sacramento and Chico in the Valley; in Santa Barbara, San Luis Obispo, Salinas, Monterey and Eurekat along the coast, and in Winterhaven, Imperial County. One of eight educational television stations allocated by the Federal Communications Commission to California is now in operation in Los Angeles, a second is about ready to go on the air in San Francisco, and the other six will no doubt be built eventually.

As effective methods in our educational approach to mosquito abatement, radio and television have much to offer. Radio goes one step beyond the printed word—by adding sound. Television—with right reinforcing sound—carries communication a long step closer to real experience. The closer we can approach real experience the more dynamic the learning process. This is the way to better public understanding of mosquito abatement problems and to improved practices by individuals—without which the official abatement activities would fall far short of the goal.

Both radio and television stations are eager for real news and willing to give time in the public interest. They are serving local areas and will give a high rating to good local programs, because in that way they can build local audiences.

Thus we have the very potent facilities of radio and television open to us. We have a vital story to tell, a story that can enhance our public relations, and gain for us the support of individuals and communities.

In using radio and television we must think in terms of the listener and viewer at home. With this always a prime consideration, then comes the question—what should our message be so that our public can better understand our abatement program, the problems of mosquito control and the responsibilities they as individuals must carry in this matter.

Here are a few examples of what our radio and television programs might be about:

Backyard inspections to seek out and eliminate mosquito-breeding places.
Spraying operations.
Methods of land and water management.
How to identify larvae and adult mosquitoes.
How disease is carried by mosquitoes and how to break the chain of infection.
Encephalitis problems in the state.
The place of research in mosquito abatement—the use of light traps in collecting mosquito pools, carried into the laboratory for the steps in virus isolation.
The dollars and cents value of good mosquito abatement is the economic and social loss without it.
What are the appropriate channels for telling our story?

In radio:

News items of current and related events. Let the public know what the situation is, what control measures are being taken and what the individual and the community can do.

Spot announcements—e.g., how to eliminate backyard breeding places.

Interviews—which are inexpensive to present and need little preparation. They should be informal and *never read.*

Discussion programs.

Non-dramatic 15 or 30 minute programs—much more difficult to prepare, but effective if done correctly.

In television:

Straight news items.

Illustrated news items.

Interviews—with appropriate visual props.

15 to 30 minute programs—like Science in Action, which the California Academy of Science presents, or Dr. Tom Groody's Science Laboratory.

Film short or films—e.g., of spraying operations.

The great value of television is the opportunity it provides to stimulate real experience by the use of motion picture film, slides, photographs, charts, maps, diagrams, models and a wide variety of other visual devices. Fifteen-second strips of film, or the appropriate use of a slide, photograph or any of the multitude of visual aids available to us can do a lot in emphasizing a point.

In passing, I might mention what a whole new horizon is opening in television with the development of a technique which places pictures on tape just as we can now place sound on our tape recorders at home. The potential this holds for spot coverage of activities such as mosquito abatement is unlimited.

Perhaps our problem in using radio and television is not so much a matter of having material to offer, but *how* we can present it. For news items and spot announcements, the problems are minor, but for longer interpretive programs the job may not be so easy. That involves scripts, talent and, on television, props. The more elaborate a program, the more time it will take to develop it. Quality must be good, because we are competing with commercial programs for valuable air time. There is also the problem of rehearsal time. Production costs may also be a factor.

But don't be discouraged. There are ways around these limitations. There are resources in every community that can help us. The stations may not have the staff to do the job for you, but they can advise you on how it might be done. Then there are commercially sponsored programs, such as Science in Action and Science Laboratory, that would work with you in developing a program. Farm reporters are a good source of help. If there is a state or junior college in your area there are classes in radio and television that would help in developing script and planning and constructing props.

One resource you cannot afford to neglect. An inexpensive way to obtain motion pictures and still photographs for television use is to seek aid from amateur photographers. The local photography club will be eager to help. Art classes or clubs will help develop other visual aids.

When you approach the station's program director you should have in mind what you want to do. The first visit might be just a preliminary contact, but it would be to your advantage to have an outline in hand—the basic information for a news item, spot announcements or longer program. For television you should be able to describe the appropriate visual materials, if you do not have them in hand.

You can learn a lot by listening to radio programs and watching television shows for techniques of presentation. What do you yourself like? Probably most people like the same sort of program.

But there is more to radio and television relations than the program alone. Relationships must have continuity. If you have a news story going to the newspapers, send a copy to the radio and television stations. Know who the newscasters and the sponsors of news programs are. If you have a program scheduled, get some publicity out in advance so that you can build a local audience.

As you well know, mosquito abatement is a community matter. To do the job you must have the support, understanding and participation of your public. Radio and television are excellent educational methods available to you. The time and energy you devote to radio and television will repay tenfold in helping you reach your program objectives.

Mr. Gray: Thank you very much indeed. We will finish almost on time, not quite. We have been talking about means of educating the general public, but who is going to educate the educators? Furthermore, who is going to educate the man who does the work? I could go into a very long discussion on this thing because I could speak very feelingly about it, but I am going to let Dr. Duncan from San Jose State College do all of the remainder of the work here. I have the pleasure of introducing as an old friend whom I have not seen around for quite a while, Dr. Carl Duncan. I hope he stays with us a little more frequently in the future.

EDUCATION AND TRAINING FOR MOSQUITO ABATEMENT WORK

By Carl D. Duncan, Ph.D., Chairman
Division of Natural Science
San Jose State College

This paper embodies the consensus of the entomological staff at San Jose State College on the education of persons preparing to enter the field of vector control with especial emphasis on mosquito control. Our thinking is centered around the type of person who is endowed with the qualities for advancement through the full range of positions and responsibilities in vector control work. Such persons should acquire, during their formal training, a broad foundation of general education, special education in the particular fields that are pertinent to vector control through suitable field work, and enough basic experience in the applied aspects of vector control and the supporting sciences to establish a reasonable measure of performance competence. Sound training in both the theoretical and applied areas of vector control science is essential. I use the word "applied" rather than the proverbial "practical" as it is my conviction that there is nothing so practical as genuine theory. The man who has his theory well in hand, which is to say, the one who understands what he is doing and why, is the one who contributes most to the solution of problems of practice. I would stress the mastery of principles far above learning by rule of thumb, valuable as the latter may be in specific instances.

The necessary curriculum divides roughly into the areas of general and special education. General education requirements comprise the following: groundwork in mathematics and in the fundamentals of the major natural science disciplines: physics, chemistry, and biology. Mathematics is necessary for the handling of all matters in which quantitative considerations enter: managing the finances of a district on a job, the making of formulations, the operation of equipment, etc. Chemistry through organic, and physics, are essential for understanding the behavior of materials, the physiology of organisms, the factors of weather and climate, and many others. Biology, broadly conceived, is essential because it is the science of living things. It is our central concern throughout the entire program of vector control.

Required general education includes psychology, for it has been pointed out that man is not a logical but a psychological animal. It is important for the vector control worker to understand human behavior as it is the behavior of mosquitoes.

The social sciences of history, economics, sociology and government all have a place in the needed general education, for vector control is a field of endeavor in which elements from all of these spheres of human interaction are in continual interplay. All bear on and influence the success of vector control work. Along with the social sciences proper in an ideal program there should be at least minimal training in the principles and procedures of business. Finally, the general education of the vector control specialist is not complete without thorough training in the communicative arts. Facility in written and spoken English are essential. Some training in report writing is highly desirable. Somehow, also, the prospective vector control worker should learn to use a typewriter.

And in this connection, also, photography as an instrument of communication, needs mention for completeness of presentation. Probably there is no more effective technique that can be added to the communicative arma-mentarium of the vector control worker than photographic knowledge and skill.

In discussing the specialized education needed for mosquito control and other forms of vector control, I wish to deal with both subject matter and the teaching methods through which the mastery of subject matter should be attained.

Fundamentally, mosquito control and other phases of vector control consist of applied ecology. More and more, successful control work requires the ecological approach and point of view. The prospective control worker, therefore, must have thorough training in ecology and in all of the basic sciences that contribute to ecology. He must study zoology and botany so that he may know and recognize the multitude of life forms that people the areas in which he works and with which he must deal. He must understand their classification, their patterns of growth, development, and transformation, their habits, and behavior, their dependence on, reactions to, and influence on the physical and chemical factors of their respective habitats. Limnology, as a specialized branch of ecology, has much to contribute in developing essential knowledge in these areas. The vector control worker must understand the multitude and variety of interrelations between living things of all types in the area of his operations, whether they be expressed as competition, predation, parasitism, mutual benefit, host and reservoir status, scavenging, or what not. And he must know and understand man's place in the total ecological picture as well as that of the particular mosquitoes or other pests he seeks to reduce or exterminate.

Essential academic course work includes: taxonomy, without which species could not be identified; morphology, which is the handmaiden of taxonomy; and physiology, which throws light on behavior and on the reasons for and the effectiveness of control materials and procedures. General courses in parasitology and bacteriology, for obvious reasons, are highly desirable. Microtechnique, which will equip the worker to make his own slide mounts of mosquitoes and other small organisms for microscopic study is valuable, though less critically important than other disciplines.

Special work in entomology should include a broad course is general entomology, taken early and followed by as much work as time permits in taxonomy, morphology, economic entomology, and medical entomology, with, of course, much special work on mosquitoes.

The academic program of instruction and training should include not only lectures, textbook study, and library work; there should be a large component of laboratory and field work beginning with the first course of a biological nature and continuing until the worker takes his place on the job after graduation. Laboratory work should include observational exercises of many sorts; the performance of experiments both simple and complex, in a part of which the student bears more or less of the responsibility for planning; a thorough exploration of insect morphology; the making and interpretation of dissections and demonstrations; and much practice in identification. It should include also the care and rearing of living specimens, preferably collected by the students themselves; the making of an insect collection of sufficiently varied characters to require the mastery of diverse curatorial techniques; and the recording of data in proper form.

Correlated with lecture and laboratory work, there should be systematic study of reference materials, including library books, professional journals, farm journals, bulletins and special reports. The student should have practice in extracting and summarizing the essential content of reference materials. He should write reports and special papers, he should prepare compilations, he should interpret and evaluate. Attention should be given, all along the way, to the building of a functional vocabulary, not only for purposes of comprehension and exchange of information with professional co-workers but also for the translation of technical knowledge into everyday speech of the farmers and businessmen with whom he constantly deals.

Field experiences throughout the educational program should be frequent and varied. They should be directed toward the development of fundamental biological knowledge and toward familiarity with actual practices in the control of pests. In the pursuit of basic knowledge, field work should involve the exploration of all types of habitats, the making and recording of field observations, the utilization of a variety of collecting equipment, the planning and performance of some field experimentation. It should lead to knowledge of what to expect in a particular habitat, how to judge habitats as mosquito producers, where, how and what to collect, how to care for living materials, how to preserve specimens and incorporate them in a collection, and how to record significant data in permanently usable form. The end result of such field work should be a detailed knowledge of all aspects of mosquito ecology in terms of field conditions.

In the area of actual practice, field work should include visiting established abatement districts, contacting and interviewing employed personnel, and observation of routine operational procedures. In conjunction with class work, field work should be a lead to sound knowledge of the principles of control as these pertain to drainage, filling, regulation of water flow, the selection and use of insecticides (including the calculation of dosages in particular situations), the operation of equipment, the development of resistance and other biological factors, and the enlistment and maintenance of cooperation on the part of the public to be served.

The educational program thus envisioned will put men in the field equipped with confidence based on knowledge, and prepared to assume the responsibilities inherent in their work with a minimum of directon and supervision. They wll give a good account of themselves. They will earn and receive the confidence of the public whom they serve. Such a program is a large order, but with judicious planning and wise counselling most of it can be accomplished within the standard four years at college.

A summer or two of employment with an abatement district and a year of graduate work with or without the master's degree will accomplish the balance.

Mr. Gray: Thank you very much, Dr. Duncan. I was particularly happy to see that you included some of the cultural education in your prescription for a good mosquito control man. After all, mosquito control is a function of government. Government is simply a phase of human relations. Human relations depend upon communication, and communication depends upon ability to express yourself. I cannot go along with the old wheeze about the value of a classical education. That is, that it teaches a man to despise the wealth which it unfits him for acquiring. I personally wish to express our very great thanks to the members of the panel, and although it is five minutes to five, if anyone wishes to leave they may, and if anyone wishes to direct any questions to any member of the panel, they now have the opportunity. What? No questions? Then let's go home.

ADJOURNMENT

FIFTH SESSION
FRIDAY, DECEMBER 4, 1953, 9:00 A.M.
CLAREMONT HOTEL, OAKLAND

Mr. Grant: Will the meeting please come to order? I would like to make an announcement. We had a Board of Directors meeting last night, at which time we requested the present chairmen of the various committees to maintain their functions until January 7th, when there will be a Board of Directors meeting held at 404 West Pine Street in Lodi, at Bob Peters' offices. That will be at two o'clock in the afternoon for all who wish to attend, and for the Board of Directors, for whom it is mandatory that they attend. We have also taken one action in appointing a Legislative Committee, Chet Robinson as Chairman, with Dick Sperbeck, Harold Gray, and George Umberger on it, to function, in the meantime, for any legislative action needed during this time. It will be independent of the Ways and Means Committee, so it can act freely. At this time I would like to turn the meeting over to our Vice President, George Umberger, for today, as is customary procedure.

Mr. Umberger: Thank you, Mr. President, and thank you for the applause. I don't know whether I am being heckled. Ed, do you have an announcement?

Mr. Washburn: I have two or three announcements. One is that I would like to make another pitch along with Tommy Mulhern's of yesterday for anyone who wants to become members of the American Mosquito Control Association. As I indicated yesterday, our annual conference is in conjunction with the New Jersey meeting March 8th to 12th, in Atlantic City. Ted Raley has blanks, and Tommy Mulhern and several of us do. On top of that I would like to especially urge Associate Memberships in our own California Association. Almost all of the Districts of course are corporate members, but some of us who are managers and other personnel within the districts are not members of the Association just because the District is. I, in my own case, am not the representative of my District. That is up to some of our Board members, as is the case with some of you. By being an Associate Member, you have the right to copies of the Proceedings, notices of the meetings, and the material that comes out from our office. I have available this morning additional copies of the 21st Proceedings, that is of last February's meetings. If you want more copies than were sent to you, please try to pick them up here, since it is quite expensive to mail them.

Mr. Umberger: Before we start our program, I make a last request that those mosquito abatement districts which are interested in the pamphlets that we are planning to have printed, or those that would like to order any, to please contact the Secretary. We have requests for about 20,000 of them, and we would like to get as many as we can so that we can bring the price of the printing down.

The first item on the agenda is the panel discussion, "Answers to Your Questions on Encephalitis." The Moderator will be Dr. William C. Reeves of the School of Public Health, University of California, who will introduce the other panel members.

Dr. Reeves: As I introduce the members of the panel, I request that they take their places. Their credentials and their official positions are listed fully on your programs. The first of these will be Dr. W. A. Longshore, from the Bureau of Acute Communicable Diseases, State Department of Public Health. The next one is Dr. Ben H. Dean, Veterinarian of the Bureau of Acute Communicable Diseases, State Department of Public Health. Next is Dr. E. H. Lennette, Chief of the Viral and Rickettsial Disease Laboratory, State Department of Public Health; then Dr. R. E. Bellamy, Scientist, CDC, Officer-in-Charge of the U.S.P.H.S. Encephalitis Research Unit at Bakersfield; and Mr. R. F. Peters, Chief of the Bureau of Vector Control.

When the problem came up as to how we might best handle the panel on encephalitis at this meeting, I had the idea that rather than having this well-informed group of individuals each present a paper or a summary of their particular interest in this field, we might do a little differently this year. I know that you folks have questions on encephalitis, so we thought that we would try having you submit questions which might be answered by this panel group. I was a little discouraged at first, but when the thing really started rolling, we had questions. Gentlemen, we have questions aplenty! We have an hour in which to cover them so we're going to try to present them as quickly as possible. I'm going to throw these questions

to various members of the panel. If we have time when we get through, you may have some additional questions. So we're going to go right ahead on these questions and see where the chips fall, and believe me, there are going to be some chips on a few of these! The first question is referred to Dr. Longshore. "What is the difference between encephalitis, encephalitides and encephalomyelitis?" We read all of these in the newspapers; we see them in releases. Dr. Longshore, what is the difference?

Dr. Longshore: These terms are used sometimes interchangeably and frequently become misleading and confusing. I will try to clarify, rather than confuse, in this explanation.

The term "encephalitides" is the overall plural term which includes *all* of the conditions producing the syndrome or the symptoms of encephalitis, regardless of the many etiologic or causative agents involved, whether bacteria, viruses, fungi, etc. When all types of encephalitis are talked about in one group we speak of them as "the encephalitides." It is an all inclusive term, taking in all of these agents.

"Encephalitis" refers to the symptomatology which the physician sees in the patient. The term itself means "inflamation of the brain," and the symptoms which we see, and which tell us the patient has an "encephalitis," are those referable to the central nervous system, e.g., headache, stiff neck, tremor, stupor, etc. "Encephalitis" may be caused by many disease agents: measles, mumps, influenza, St. Louis and Western virus, Japanese B virus, Eastern equine virus and various exotic viruses. Viruses which are little known and understood may produce an encephalitis. When we speak about encephalitis in California we mean the known encephalitides due to Western and St. Louis virus, mumps, measles, and some which are unknown or of undetermined etiology.

"Encehalomyelitis" is the term which was used to refer to the disease in horses, and is derived from the pathologic findings in horses. Examination of the spinal cord and the brain of a horse which has died of Western Equine encephalomyelitis usually reveals changes both in the brain and in the cord. Thus instead of a strict encephalitis or inflammation of the brain only, we add "myelitis" which means inflammation of the spinal cord. There is considerable controversy as to whether there is an encephalomyelitis in humans, as in horses, or whether it's a pure encephalitis. Last year, Dr. Huntington in Kern County reported he found evidence of pathology in the spinal cord, reflecting damage due to the virus, so perhaps we may have an encephalomyelitis in humans. The discussion as to whether we should say Western Equine Encephalitis or Western Equine Encephalomyelitis referring to humans will continue. You have to specify the causative agent when you speak about the disease, encephalitis. In the United States that narrows the mosquito-transmitted group down to Western, St. Louis and Eastern, and in California to the first two.

Dr. Reeves: What Dr. Longshore didn't tell you was that when one of us gets up in the morning, it depends upon how tired we are, whether we use the term "encephalomyelitis" or "encephalitis." If it seems that I'm unduly using several members of the panel to begin with, it's because I've arranged these questions in order as far as subject is concerned, and you submitted a surprising number of questions on some of the medical and laboratory aspects of the problem. Dr. Lennette has to get away from here by ten o'clock, so Dr. Longshore and Dr. Lennette are going to be questioned rather heavily in the beginning.

Next question: "Dr. Longshore, what are the present aims and anticipated possible applications of the skin test?" Everyone must be prejudiced here, asking a question about a skin test!

Dr. Longshore: I would like to express my appreciation for your excellent cooperation in this skin test evaluation and to tell you that we would like to make the 48 hour reading at the ten o'clock break.

The reason for our interest in the skin test is that it may be a survey tool to determine how many people in California (and this will apply to other areas of the country as well) have had contact with the various viruses which produce encephalitis. At the present time the only survey tools available have been either the complement fixation test or the neutralization test, which are run on a sample of blood taken from an arm vein, making it difficult to carry out these survey techniques on children or any other group. The neutralization test has to be done on mice, which makes it an expensive test. It would be much easier to apply a skin test that can be read in 24-48 hours without taking blood from the vein. The procedure is easier to do, much less expensive, can be done rapidly and with large numbers of individuals. It is very desirable to have some mechanism for testing for contact with these viruses. The results will be based on exposure, immunity or susceptibility as they are related to the presence or absence of circulating antibodies in the blood, and the relation of circulating antibodies to skin sentitivity. We are now checkng these skin tests aganst serologic survey techniques. If the skin test proves feasible, we will more readily be able to determine the extent of th problem in each area of study. It would show the frequency of infection, the susceptibility of the population, and the geographical distribution of the infection. It would also give us a basis for adding to our knowledge of when and where infection could be expected to occur; the time and place; the age and duration of residence in relation to the time and frequency of infection, the sex distribution and the underlying exposure and susceptibility factors, occupation factors, etc.

I think all of you, if you stop and think about it a minute, will see how much epidemiologic information can be afforded us if this tool is successful. It could be applied very rapidly, very easily and quite inexpensively compared with our present methods. So in submitting to this test at this meeting, you have given us another test group in which we can evaluate the usefulness of this test and its application as a survey tool.

Dr. Reeves: Congratulations, guinea pigs! We hope that your contribution is going to be something to be thankful for in the future. Now we are going to go into another area of discussion. Vaccination against encephalitis viruses has been of great interest apparently to this group. The first of these questions which I'm going to refer to Dr. Lennette is, "What are the necessary characteristics for an effective human encephalitis vaccine?"

Dr. Lennette: This is essentially what we ask about all vaccines. I think we can summarize it by saying that it should be a fairly simple vaccine which is potent, so that you can give one inoculation and have immunity produced. At the present time there are vaccines available

which are used primarly on horses. They are rather crude, but they do give some stimulation of antibodies, and during the war years some of the material was tried in large numbers of people, about 3,000 or so, and was found to produce antibodies. However, the critical test of any vaccine is not whether it produces antibodies, but whether it produces protection, and that is the reason for having all these current field trials with the poliomyelitis vaccine.

Western Equine virus vaccine should be one which is composed of fairly pure material: the virus which is present in it should be such that it will produce immunity or antibodies against a whole spectrum of virus strains which are related. In other words, it should produce a very broad immunity. Secondly, in this connection the antibody titers should be related to immunity, as demonstrated by protection against the disease. We'll have to study such a problem for years before we can find out whether or not true protection is produced. We have every reason to believe that a good vaccine can be produced which will not have to be given every year, but only, perhaps, every two to three years. We are hopeful that such a protection can be worked out within the next year or year and a half.

Dr. Reeves: The next question is a very logical follow-up to the statement which Dr. Lennette has just made, and I'm going to ask him to discuss it also. This question is: "Assuming that an effective and safe vaccine against Western Equine encephalitis is developed, what percentage of the human population in an endemic or potentially epidemic area must be vaccinated to prevent an epidemic of the Western Equine disease?"

Dr. Lennette: This is exceedingly difficult to answer. I don't think we can answer it, because we don't know much about the infectivity of the agent for man. About the best example we have with these encephalitides is a comparison with what occurs in yellow fever, because of our methodology, our techniques, for studying Western Equine and St. Louis encephalitis are based on the methods first used for studying yellow fever. In the case of so-called "classical yellow fever," which occurs in cities, one would have to immunize virtually the entire population because the infection is spread by *Aedes aegypti,* which is a domestic or "house dwelling" mosquito. In the case of "jungle" yellow fever this is not necessary, because the vectors are jungle mosquitoes and infection occurs only among those relatively few people who are exposed to jungle conditions.

First we will have to ascertain (and this would be done by serologic methods or by skin test methods as Dr. Longshore pointed out), how many people are immunized subclinically. Then we will know how infective the agent is for man. And then we would have to go into an area and immunize and determine what proportion of individuals in that area have to become immunized to have the disease disappear. We have some precedent for this. For example, in diphtheria we don't have to inoculate everybody. If we immunize about 80% of the population of a community, the disease ceases to spread. When it's transferred to a person, it generally hits a dead end and it doesn't go any further. So I would suspect that in the case of encephalitis, if this is a highly infective agent for man, and man is highly susceptible, you would have to immunize everybody. However, only field trials will determine that.

Dr. Reeves: We will kick this next question over to Dr. Longshore, in terms of Dr. Lennette's reply to the previous question: "In view of current experience with immunization against smallpox, diphtheria, etc., is such a percentage of immunization within the range of practicable attainment?"

Dr. Longshore: That's a good question too. We already have great difficulty getting people to accept diphtheria, smallpox, whooping cough and tetanus immunization. We try to drill into the patients that they should get the child immunized early, and even with an intensive educational approach we are unsuccessful in having enough people immunized against these diseases which were so prevalent at one time, and which will become common again if we don't keep up our protective barriers. When we take on a new disease with a new vaccine, it's going to have to be a pretty good vaccine and we're going to have to convince the people that it's going to be useful to them before they are going to accept it. We have special problems in the Central Valley because of migratory labor and the transient character of that population. If Dr. Lennette can produce only a vaccine that requires three separate immunizations to reach the effective level, it will likely be impossible to secure good immunity levels. If he can provide us with one like that for yellow fever and we need to give only one shot for adequate immunity, I think we could reach the effective level without too much difficulty. It therefore depends on the nature of the vaccine and how many shots are needed. We will be able, undoubtedly, to immunize special groups. We know that with the Western Equine encephalitis, 50% of our cases were under the age of 10 and 30% were under the age of one year. Perhaps we could immunize the group under one year of age, and we might even have to immunize the pregnant mother to make sure the baby gets the protection early enough, because most of the infant cases were under six months of age. That we could immunize 80% of the 2,000,000 people in the Central Valley certainly seems to me highly improbable.

Dr. Reeves: I can't help but be reminded of some of the experiences that I'm sure Dr. Dean has seen, and that I've seen a number of times, with regards to the effectiveness of vaccination in the horse population. We're dealing here with an infection which is not apparently being transmitted from man to man, as in the case of diphtheria and smallpox, of from horse to horse. Frequently out in the field, a farmer will have a veterinarian come in to vaccinate his horses. Let's say he has 20 horses in the herd and he'll say, "Well, go ahead and vaccinate all of them but that mare. I don't want her vaccinated. She's going to foal one of these days and she's pretty valuable animal and I don't know what this vaccination is going to do to her." And very frequently, just the one or two horses out of a herd that haven't been vaccinated are the ones that come down with the infection. So anyone who was not vaccinated, or who did not have immunity from an inapparent infection previously or from the mother, would be at some risk and would continue to be so because the infection chain in nature is unrelated to the infection in man. This is an extremely difficult problem and it is going to be an extremely dfficult one to implement without considerable regimentation, which, in turn, is going be impractical.

The next question logically follows the one on vaccination. I'm going to refer to Dr. Lennette once again. "If a person is shown serologically to have immunity to one of

the encephalitis viruses, what assurance do they have of protection if exposed to re-infection?"

Dr. Lennette: From the present state of our knowledge I would say that if they are infected with one virus they have a pretty good immunity to the same virus, because insofar as laboratory studies have gone in this country and elsewhere, there is every indication that those strains of virus which have been isolated are identical or closely related to each other. We have found no difference in antigenic properties among these strains. Those differences which have been reported have been generally in virus strains that have been passaged in the laboratory over many years and so have been changed because they have been adapted to a mouse, but freshly isolated human strains are virtually identical. So we are hopeful that we will have to get only one strain which is a good antibody producer and this strain, if it produces good antibodies, will protect against any strain in the field. This also brings up the necessity, as mentioned by Dr. Longshore, for having a good tool such as a skin test to determine who is immune and who isn't, because if you can weed out by a skin test those people who have antibodies, then your problem of vaccination becomes much simpler. That's one of the big problems in poliomyelitis today. There is no method of determining the immunity of the individual except by very intricate laboratory methods, and so you have to vaccinate everybody. It's costly and wasteful, if you remember that poliomyelitis in man is a very mild disease: only about one person in 500 to 1,000 becomes paralyzed, and many children probably acquire immunity very early in life. So in the great preponderance of cases this year we are going to be vaccinating children who already have poliomyelitis antibodies. We would certainly like to avoid that in Western Equine if it is possible. If you've got 2,000,000 people and you can weed out ¾ of them as already havng acquired antibodies by sub-clinical infections of Western Equine or St. Louis, then your vaccination problem is considerably simplified.

Dr. Reeves: If one has had an infection due to St. Louis, does that give protection against Western?—and vice-versa?

Dr. Lennette: No. If you had a Western Equine virus infection, either the frank disease or a sub-clinical infection, or have antibodies produced by a vaccine, this does not protect against the St. Louis virus. These viruses are distinct immunologically, that is, they are absolutely different organisms and are unrelated to each other. The antibodies consequently are quite different too. You must have antibodies specific for each virus in order to protect against each virus, i.e., antibodies to the one virus will not confer protection against the other.

Dr. Reeves: Here is a good question and one that very definitely falls in the realm of the laboratory: "In the titer positive serological test, results which the laboratory obtains in testing these bloods, can you differentiate in any case between actual previous encephalitis infection and previous immunization from a vaccine?"

Dr. Lennette: No, we cannot differentiate on the basis of antibodies alone.. That has always been the problem with vaccination. If you confer immunity on an individual and subsequently he is bled during the course of an illness and you are trying to make a diagnosis and find those antibodies present, it is impossible to tell whether that represents the results of vaccination or experience with the virus in the naturally occurring disease. We need some method for differentiating, but I don't know that one will soon be available. The only example I know of refers to yellow fever, where individuals who have been immunized with a vaccine do not produce what we call a complement fixing antibody, whereas in a naturally occurring disease they do, so that the complement fixation test in yellow fever is a valuable tool. It will distinguish recent infections from old infections or distinguish among people who have been vaccinated, but I don't think we will be able to do that with the Western Equine and St. Louis viruses at any foreseeable time in the near future.

Dr. Reeves: And the same thing would be true of all people that have inapparent infection, not the clinical disease or vaccination. The majority of people infected with these viruses here have an inapparent infection with only sub-clinical disease.

Here's a good question: "Will a vaccine be available for Western Equine encephalitis before next season for use in man?" Dr. Lennette is facing this problem in an attempt to develop a vaccine. Is there going to be a vaccine available for use in man before next season?

Dr. Lennette: Off hand I would say "No," because while we could make a crude vaccine, I am afraid that we would make too many people sensitive to egg material. We would prefer to go slowly. We never place any deadline or "D-Day" or target date on a research problem. We do the best we can and wait until the answer comes. You just can't decide that on May 31st you are going to have a vaccine. It doesn't work that way. But I would hope that something would be available in a year from now and perhaps sooner, if the current information on other diseases is correct. We have just heard announcements on radio and TV that the poliomyelitis vaccine will be given in three doses, which indicates the first hopes for a one-shot vaccine were too optimistically evaluated, and a new approach is necessary. One must be cautious and patient, and not act prematurely or precipitously.

Dr. Reeves: The answer is that patience is a virtue. Now we are going to go into some of the field problems that have been posed in these questions. I am going to address this first question to Dr. Longshore. "We have heard of the encephalitis intelligence program begun this year. Would you outline its purpose and the preliminary findings?"

Dr. Longshore: I think most of the mosquito abatement people are familiar with this because they have been receiving copies of the bulletins issued by our Bureau. The purpose of the information sheet and intelligence is to gain adequate and accurate information regarding the occurrence of encephalitis in California during the current encephalitis season. In order to do this we set up mechanisms to collect various types of information that we thought would be helpful, either in telling us what was going on or in helping us to predict what might come in the latter months of the season.

First, information on human cases. As an index to encephalitis activity, we employed two medical students, one at the Fresno General Hospital, and one at Kern General Hospital, to keep us informed of all hospital admissions showing central nervous system symptoms with fever. This type of information affords data much earlier

than the official morbidity reports which await a final diagnosis.

Official morbidity reports. These reports originate with the private physician or county hospital and are sent to the local health departments, which in turn sends them to the State, where they are counted. The State Health Department requests additional information, such as place of contraction, and laboratory findings, on all encephalitis cases. We have had reported to us in this fashion this year some 294 cases of encephalitis, of which only 35 were confirmed by a laboratory as due to St. Louis or Western Equine virus. A large number of these were mumps (115). Out of this picture of clinical encephalitis seen in the hospitals, a very high percentage previously recorded as encephalitis, possibly mosquito-borne, is found to be mumps when the bloods are tested by the Virus Laboratory.

Another index we attemted to use was the fact that the laboratory receives many blood specimens sent by physicians when they attempt to diagnose these central nervous system diseases. They do not officially report the case until they have made a diagnosis. In order to make the diagnosis, they send the laboratory specimens, which therefore precede the morbidity cards. We arranged with the laboratory to have these laboratory request slips sent to our Bureau to be tabulated by the area from which they originated, to see if the physicians in any particular area were suspecting encephalitis in any large number of patients. This informaton might gve us a clue as to what illnesses were occurring. This was done in 1953, but the pattern observed was not similar to that followed in 1952. There was an average of about 24 laboratory specimens per week coming in for encephalitis examinations while in August of 1952, we were receiving 103 per week. It appears possible that if there is a lot of this type of disease in any area the laboratory work load will reflect these conditions. This may then be a valuable clue as to what is happening in the State, and will come to us much ahead of the actual diagnostic morbidity reports.

Another index we attempted to establish, and to which many of you contributed or were concerned with, was the virus isolation from mosquitoes. Dr. Reeves has been doing this in Kern County for many years, but he has not been doing it on a current basis. We wanted to know if we could find infected mosquitoes during June, July and August, and what type of virus they might have. We then might compare these findings with the number of human cases, and we might be able to predict, if we found mosquitoes infected in May, that we were going to have a heavy season of human cases, or if we didn't find infected mosquitoes until July we might have a light season. In order to begin work on this cycle of activity, the Bureau of Vector Control, with the cooperation of the mosquito abatement districts and the Hooper Foundation, collected mosquitoes during the season in Fresno and Kern Counties. These mosquitoes were tested in Dr. Lennett's laboratory for virus isolation. Out of some 386 pools of 50 mosquitoes each, there were 75 isolations of virus. Forty-six of these were St. Louis and 29 were Western Equine. Fifty-two were from Kern County and 23 from Fresno County. It is evident from this data that there was plenty of virus around even though we apparently did not see this reflected in the number of human cases this year. This is a very interesting observation, and we hope that we will be able to continue such observations for several more years. It is desirable to increase the areas to at least cover representative areas of the State so that we may study this further as a possible index of what we might expect or predict as to encephalitis incidence in California. Unfortunately we didn't get our program under way early enough in 1953. We did operate the last two weeks in June, with no virus isolations until the first week of July.

Dr. Reeves: The next question is very directly related to the material which Dr. Longshore has been discussing and I am going to direct this question to Dr. Lennette. This is the question: "The rate of encephalitis virus isolations from *Culex tarsalis* collected and tested on the California surveillance program in the summer of 1953 from Fresno and Kern Counties was surprisingly high, was it not? How do you account for this, particularly when compared to the extremely low incidence of St. Louis and Western Equine human cases in the counties from which the mosquitoes were collected this summer?"

Dr. Lennette: I think we can answer it in part, especially since we have some mosquito data on what the densities were in these areas. I would say that having had these few cases in 1953 we would be inclined to suspect that in major part the outbreak of last year in the Valley had served to immunize large segments of the population, so what you had in effect is what I mentioned about vaccination. If you produce a large degree of what we call "herd immunity" by immunizing a lot of people, then the agent doesn't get a hold in the population, so we would have suspected that we had a high degree of herd immunity produced by the outbreak last year. However, knowing that the prevalence of mosquitoes, the densities, were considerably lower this year (at least that is the interpretation I got from your reports, Dick) one would say that there is another factor in this picture and that is that with fewer mosquitoes you have these vectors feeding upon their normal hosts, and that the spilling over to feed on man as an accessory source of food is a necessary corrolary to heavy mosquito populations. As happened last year, these vectors spilled over to the towns for the first time, as I understand it, because large numbers were seeking additional sources of food, but this year the relatively smaller numbers of mosquitoes had ample food in the field, and did not therefore attack outside of their natural hosts, that is, they didn't go over to man or to horses. I think that that is a very important factor too, but which of these two is more important from a relative standpoint I can't say. I would suspect, however, that reduced density of mosquitoes is a very important one, because I don't think, on the basis of serologic surveys that have been made in the past, that a very high proportion of the population was immunized—not to the extent where the disease would virtually disappear.

Dr. Reeves: I certainly concur in Dr. Lennette's opinion on this rather strongly, especially this latter point that serologic evidence doesn't indicate that a sufficiently large proportion of the population, at least in the areas we have been studying in Kern County, have become immune so as to eliminate all those susceptible people that would still be there, and I think the factors which you expressed are very pertinent and a point which you should keep in mind. It isn't just infection rate in the vectors which controls this situation but the population of the vectors is of equal or greater importance. We can have a lower infection in vectors and if you have a very high population you are going to have ample opportunity for transmission. A very good question and I am very glad that it came up.

The next question, when you first hear it is really going

to sound loaded, and I have a feeling you are going to be surprised at the answer. "Why with the great numbers of *Culex tarsalis* breeding in the rice field areas of the Central Valley, were there not more cases of encephalitis in those rice field areas as compared with areas along U.S. Highway 99 in the San Joaquin Valley in 1952?" That is a good question! Dr. Longshore, what is the answer to this question?

Dr. Longshore: I think that some of the information has been overlooked to give this impression. We find if we look only at the *number* of cases that the statement made is quite true—that the lower San Joaquin Valley predominated with the heaviest number. But if we look at it on an attack rate based on the population, we find that Kern is the number one area with 97 per 100,000, but the second area is Sutter County with 61 per 100,000, the third, Madera with 56; the fourth, Fresno; the fifth, Yolo County with 49 per 100,000; the sixth, Kings; the seventh is San Joaquin and the eighth is Yuba with 45 per 100,000. Therefore, out of the 20 counties in which we had the majority of our cases, those in the northern part of the valley were pretty well represented when you report it on an attack rate basis. I don't believe you can say that you didn't have it in proportion to your population. I think you did.

Dr. Reeves: Isn't it amazing what statisticians can do? The only answer you need is more people up in the Sacramento Valley and you can run the San Joaquin number of cases off the map—it's that simple and is one of those factors we have a strong tendency to forget and yet basically it is very important. The number of people has a great deal to do with how many cases we are going to see. I don't think there is anyone from the Chamber of Commerce here, so we won't have any trouble in that regard.

The next question I am going to address to Dr. Longshore also. "How do you explain the extremely low incidence of human clinical cases of encephalitis in the Central Valley of California during the summer of 1953, following particularly as it did the epidemic of Western Equine in the summer of 1952, which should have left an ample source of virus for initiating a 1953 epidemic season?"

Dr. Longshore: I think both you and Dr. Lennette have partially answered that in talking about the previous questions. In the first place, I don't know where the virus goes over the winter, or if there is a lot or a little left over from the preceding season. If there was a lot of virus left over from 1952 I don't know where it went. Dr. Reeves has been working on this and if can tell us, I know he will answer that. I do believe, in spite of the fact that we do have numerous susceptible people in the Valley area, that it is only natural following the number of clinical cases which we saw that there were undoubtedly many more sub-clinical infections with Western during our 1952 epidemic, and that there would be many less people susceptible in these areas the very next year. I think partially that this would account for the cyclical arrangement we seemed to see, prior to the floods and epidemic of 1952, of Western and St. Louis occurring in a five-year cycle. You have to have a large percentage of susceptibles to get epidemic possibilities. Following an epidemic you have many less susceptible people to be attacked the next year. I think the main reason we didn't have more human cases this year is due to the fact that the mosquitoes were down in number, and we did not experience the environmental conditions similar to those which we were unable to control in 1952. I think it is a combination of less susceptibles following the epidemic and fewer mosquitoes with a more normal environmental condition.

Dr. Reeves: This is the last question I have for Dr. Lennette, and I think there is someone here whom he wishes to introduce after he has paid the price of this question.

Dr. Lennette, "what is the probable prevalence of strains of mosquito-borne encephalitis in California other than Western Equine and St. Louis?"

Dr. Lennette: We have some evidence on that from the work of Dr. Reeves and Dr. Hammon with the so-called California virus, and I think the possibilities that other arthropod-borne viral agents are present is fairly reasonable. As you probably are aware, the Rockefeller Foundation for several years has been operating laboratories in various parts of the world—in Africa and more recently in India, and very recently, within the last few months, in Trinidad. The purpose of these laboratories has been to look for arthropod-borne viruses which are responsible for the encephalitides. A large number have been found in South America and in Africa. We feel that there are probably other viral agents present in the Central Valley because we have a very wide spectrum of clinical pictures, one end of which is poliomyelitis with all the paralyses which occur, and at the other end is the frank encephalitis, in many cases of which we found the Western Equine or St. Louis viruses to be responsible, and sometimes a very high proportion of mumps virus, as was mentioned by Dr. Longshore, and then we have a large residuum of patients, all of whom have had a clinical picture of encephalitis or encephalomyelitis, from whom we can find no etiologic agent. Therefore, we are inclined to believe that these agents must be present. They have not as yet been identified and we have looked for some of them. As a matter of fact, in some 180 patients from the Central Valley, primarily from the Kern area, last year we have tested these against some 12 or 14 so-called "exotic" viruses from South America and the tests have all been negative. So perhaps we are more convinced than before that we are dealing with some as yet unknown agent present in that area. There may be more than one. We are hopeful that with adequate assistance we might be able to attack this problem, and rather recently the Rockefeller Foundation has become interested in this problem, and perhaps with their assistance we may be able to conduct in the department a fairly large scale investigation on a rational basis over a period of time and try to work out some of these peculiar diseases which we are seeing. I think that this question is very pertinent, because there is good evidence and every reason to believe that other agents are present.

Since I have to leave, I should like to take this opportunity to present a guest sitting back there—Dr. Leslie Alm of Sweden. Dr. Alm is a fellow virologist. I am only sorry that Dr. Alm's schedule is so rushed. Dr. Alm is a member of the Swedish delegation at the United Nations Repatriation Commission in Korea and I am sure that there are many tales that he could tell us of what has happened in the past four months. His schedule being what it is, he won't have opportunity to spend much time except today in the Bay Area.

Dr. Reeves: We are very happy to have you with us, Dr. Alm.

We are now going to go on to some of the veterinary phases of this question. Dr. Dean, how can we explain the occurrence of Equine encephalomyelitis in horses rather commonly outside the Central Valley areas frequently in the absence of human cases?

Dr. Dean: There have been several explanations given for this occurrence. Probably one of the most logical can be made on the basis of the amounts of infection in the mosquitoes or the density of the mosquito population. We have talked here about the attack rate in people being 40 to 80 per hundred thousand. In horses it will run as much as 500 per hundred thousand in the Valley, in spite of the vaccination of horses, which isn't done in people. We also have a much higher attack rate in horses than in people in the fringe areas. If there is a low number of mosquitoes with perhaps a low amount of virus in the mosquito population, there are likely to be horse cases before you have human cases. First, in the fringe areas there is little vaccination of horses; second, there is a much larger area of biting space available on horses than on people; and third, horses are out at night in fields where irrigation is being done and are thus subject to a long duration of exposure. This is the best explanation I have for it.

Dr. Reeves: This question has come up many times, particularly in some of the southern counties, and it is certainly going to be very interesting to see if we can obtain additional data in the future.

The next question I would also like to address to Dr. Dean: "Do horses ever experience a clinical attack from the St. Louis encephalitis virus which produces a disease in man?"

Dr. Dean: As far as I know there has never been a reported case of natural infection in horses with the St. Louis virus. There has been produced in Montana and I believe in Colorado, under challenge conditions, clinical symptoms when the St. Louis virus has been inoculated inter-cranially or inter-cerebrally. We tried here at the University about four or five years ago with a virus we obtained from Dr. Reeves and Dr. Hammon. We inoculated some horses with the St. Louis virus subcutaneously and intradermally. Anti-bodies were produced but no clinical signs. Under natural conditions we have St. Louis infection in horses with antibody production, but apparently no clinical symptoms.

Autopsy specimens have been collected from horses which have died from encephalitis, and no evidence of St. Louis virus has been found. There has never been an isolation of the St. Louis virus from naturally infected horses, and it appears on the basis of this evidence that if this occurs, it is an extremely unusual type of thing.

Dr. Reeves: I certainly concur with Dr. Dean. This is a question which is not infrequently asked of us in the field and it is one that is of potential importance in understanding these infections. I am going to ask Dr. Dean the next question: "What evidence is there, if any, that cattle do or do not experience a viremia or clinical disease when inoculated by a mosquito bite with the virus of Western Equine or St. Louis encephalitis?"

Dr. Dean: First, during the past five or six years we have asked veterinarians to report to us clinical cases of encephalitis in cattle, with the idea that we may find Western Equine Encephalitis virus. We have never found, in specimens submitted, any evidence of Western Equine Encephalitis. Under artificial conditions, or laboratory conditions, I think Dr. Reeves and others have challenged cows with St. Louis virus and with the Western Equine Encephalitis virus and have not produced a viremia, although they have produced antibodies. Antibodies in cattle have been found under natural conditions in Kern County. There is no evidence of Western Equine Encephalitis virus causing a clinical illness in cattle.

There has really been little research work done on this particular problem. There would be room for a great deal of additional work on whether they circulate virus in the blood or not. It just hasn't been done as extensively as it might have been.

Dr. Reeves: This is another question for Dr. Dean. "Often when a horse case of equine encephalitis appears in a rural neighborhood there is concern on the farmer's part for the welfare of his children. He would like to know just how much chance there is of their being infected with the same disease."

Dr. Dean: This question is similar to one we had about six or seven years ago. Whenever a case of equine encephalomyelitis occurred in a horse the health officers usually wanted to quarantine, kill, isolate or get rid of the horse immediately, based on the theory that the horse represented a hazard to people in that area. We carried out experiments to determine the duration of the viremia. We inoculated the horses with the Western Equine Encephalitis virus and got a picture similar to this: For the first four or five days following inoculation, we could demonstrate a viremia. The viremia then disappeared. About the seventh or eighth day, or two or three days after the viremia had disappeared, antibodies started developing and about the ninth day we began getting a rise in temperature. Clinical symptoms began about the tenth or eleventh day. On the basis of these experiments, the viremia disappears at least four or five days before clinical symptoms begin. We therefore don't believe that a horse sick with Western Equine Encephalitis represents any hazard. The hazard, if any, from the horse, must be during the first four or five days as a maximum after the horse was exposed to the virus. It is possible, although it hasn't been shown, that mosquitoes could bite the horse during that period and then transmit to the children or humans, but it would be before clinical symptoms became recognizable. So if you do anything after clinical symtoms show on a horse you are closing the barn door about five days too late. Your hazard, really, occurred probably at the same time the horse initially became infected with Western Equine encephalitis.

We certainly also have to keep in mind that the population of horses in an area is fairly small in number as compared with the other sources of mosquito infection, and that there are many other sources of virus that are probably playing an equal if not a greater role.

Dr. Reeves: Now we are going to go into some of the mosquito phases. I am going to have to pick out certain questions because we are short of time. The first of these questions is for Dick Peters. "With the data of the 1952 epidemic of encephalitis in California available, is there any clue as to the relative completeness of *Culex tarsalis* control (proportionate number of vectors to human hosts or actnal numbers of vectors to unit area, etc.) which will be required in the future to prevent the epidemic transmission of Western Equine or St. Louis virus?"

Mr. Peters: The data is very regretably inconclusive, and yet to be obtained, as to what level of mosquitoes is a

dangerous level. We are still attempting, as you mosquito abatement people well know, to establish standard sampling methods by which to get quantitative data with respect to infective mosquitoes in proximity to the majority of humans. The studies that were done last year with respect to obtaining the prevalence of infected mosquitoes in certain areas, we hope to be able to double at least next year. Such might give us more qualitative information as to how many infective mosquitoes occur with respect to the human population. The ratio between the quantitative consideration of numbers and the qualitative considerations of infected mosquitoes is still, I believe, in large part yet to be determined and this even more emphasizes the need for further study on this subject.

Dr. Reeves: The next question is really a lulu—I am tempted to tell you who submitted this one. "Has any attempt been made to estimate by mathematical probability methods, similar to Ronald Ross' computation for malaria in his book, 'The Prevention of Malaria,' 1910, the approximate number of vector *Culex tarsalis* females per capita of humans below which number either St. Louis or Western Equine encephalitis cannot be expected to be successfully transmitted to man?" I don't have the courage to pass this question on to a member of the panel, so I'll try it myself.

The question is whether we have an epidemiological pattern here that is very similar to malaria. For those of you who don't remember Ross' work, in an Asiatic area he was able to compute for malaria in a particular locality which he was studying, there were about 40 *Anopheles* per person and malaria could be transmitted if there were 40 or more. The chances of a mosquito biting a person that was infected and then subsequently at the right time biting a susceptible were sufficient that the disease would continue at this level. Below this level, the infection chain was broken. Well, with encephalitis we are not dealing with a disease transmitted from man to man as far as we know. We have an infection in nature in which the mosquitoes are being infected by feeding on birds, and then if they happen to feed on a man in their broad feeding range, they may transmit the infection. Certainly the index of 40, such as Ross had, and has been shown in malaria, would not fit in this particular case. As a matter of fact, if we take a look at some of the population figures which we have we can see that at the endemic level of the average year when we have relatively few cases, the index of *tarsalis* mosquitoes must be very high, and we still have very little in the way of human clinical disease. This is an important factor because the majority of the people infected do not become ill. They have an inapparent infection a counterpart for which we do not have in malaria. Take a look at the study that we did in Kern County a few years ago in the City of Bakersfield. In an entire summer of collecting we were able to get only a little over 100 female *tarsalis* and believe me, we were trying to find *tarsalis*. Yet in that very small sample of *tarsalis* we were able to show that there were infected mosquitoes, so we could have had a very low index with this population, and still have had a potential area. We had clinical cases in Bakersfield, but the people don't stay in Bakersfield. They have a tendency to get out into other areas and be exposed. So, really, we don't have quite the type of a unit situation that we do with malaria, of a village where the transmission is taking place in a very small unit. We have instead an area problem with potentially infected mosquitoes infiltrating from the outside and a susceptible human population infiltrating outwards, and we have certainly been concerned with attempting to develop an index of the type inquired about. Our first problem is to develop adequate indices of infection in the mosquito vector, and that problem has proven to be able to put the statisticians on the ropes, which gives us some satisfaction. I'm sorry that we can't give a more complete answer. What we need very badly is an area of very complete mosquito control, with adjacent areas where nothing is being done, where very carefully controlled and detailed studies can be made. I would say in regard to another question here that such a calculation is possible, but we have a great deal to learn before we are going to know all the factors that are involved so that we really can determine accurately what this index is, and it will probably vary under certain conditions in different parts of California. I doubt very much if the same index might be serving in the rice field areas as it would in the San Joaquin Valley area—there would probably be some material differences in that regard.

I would like to ask Dr. Bellamy the next question in two parts. First, "Dr. Bellamy, do you believe that a *tarsalis* index would be of value in predicting encephalitis?" Second, "How about a snow-pack index? Have long-term weather forecasts a possible application in this matter?"

Dr. Bellamy: Well, I would answer the first question "Yes." I think a *tarsalis* index would be a very important thing to use as a tool in planning control work against such appearances as the 1952 epidemic. However, I don't think it is something that can be established on the data that are available at the present time. I think the present efforts to gather data on *C. tarsalis* population levels in relation to virus infection rates in mosquitoes, in relation to clinical attack rates in humans, to attack rates in horses (for Western Equine), and perhaps in relation to annual neutralizing antibody levels in various animals including humans may, over a period of a few years, provide important answers to the question "What index of *tarsalis* abundance is likely to be associated with human infection with encephalitis?" I believe that such an index will have to be applied within broad limits, particularly at first, and that the significant indices probably will not be the same for all areas and, therefore, will have to be applied locally where they are determined.

The second part of the question is one which I think is pretty generally associated with the 1952 epidemic. There was a tremendous snow-pack on the Sierras and it was followed by a tremendous population of *C. tarsalis* in the valley when the snow melted. This was followed by many human cases of encephalitis. Those things seem to fit together quite well like the hand in the glove, and I think that we must beware in the future of any such tremendous snow-pack on the Sierras during the winter period. It might be very well to go back through the years and attempt from the data on hand to relate such things as virus rates in mosquitoes and proven clinical cases in humans in the valley areas to such things as the amount of snow pack on the Sierras in each corresponding previous winter. There might be a lead here that would be nearly as important, or possibly even more important, than a *C. tarsalis* index to predict encephalitis. Certainly, a snow-pack index would give forewarning earlier in the season. You could start planning for work earlier than if you waited until the *C. tarsalis* population had occurred.

Dr. Reeves: I would like to ask the next question of Dick Peters. "Should mosquito vector control in California as opposed to general mosquito control be expected to receive priority in the local control program?"

Mr. Peters: I am going to make a true confession at the outset. I wrote that question! I have had it thrown at me from many directions. This question is loaded; there is no doubt about it. It has, in my mind, three aspects. It has a psychological aspect as to the public reaction; it has an economic aspect as to the ability—the where-with-all—to accomplish the objectives; and, it has lastly a natural history aspect. I do want to emphasize the latter aspect in my answer to this particular question. In my judgment, we have come to accept vector control to be the conduct of arthropod species sanitation, on the basis of a specialized control endeavor, directed at selected habitats, and, if done efficiently, resulting in an absence—a virtual eradication, of a disease. I do want to make clear and evident that it is not that simple with respect to *Culex tarsalis* and encephalitis. *C. tarsalis* is probably the most liberally distributed mosquito, habitat-wise, in California. I am eternally impressed from the surveys I have made (I used to get out in the field) that in estimating the amount of *C. tarsalis* in a general way, I am convinced that the vast majority of the mosquito habitats are capable of producing *C. tarsalis* and do so in great numbers! Secondly, *C. tarsalis* has adapted beautifully to the situations that man has created, but it is primarily a mosquito of nature—you find it in high elevations, you find it in stream bottoms, you find it in lakes, you find it in all of the outlyng areas. Man has come in and changed the whole scheme of things and it has adapted itself to the new conditions. I do want to make it very, very evident that *C. tarsalis* is certainly not a simple problem involving the mere application of specialized habitat control. It is without doubt a comprehensive problem, a problem that involves hitting every source of *C. tarsalis* within range of its flight to humans.

Now, in response to the question: "Should *C. tarsalis* control be given priority over general mosquito control?", I think it inevitably has to be given top priority because it is the most fundamental part of the mosquito control program, and its habitat is growing more and more as time passes. Furthermore, it has shown itself to possess probably the highest resistance to chlorinated hydrocarbon insecticides of any mosquito in California. We have certainly been awakened by what it did last year, and we know full well that it could happen again. Therefore, I am of the conviction that in most instances the control of *Culex tarsalis,* and there are some exceptions, is an integrated and interlocked function with the conduct and performance of the generalized mosquito control program. However, one thing ought to be borne in mind very expressly. The majority of the mosquito control programs in California were organized to alleviate public torment from mosquitoes. The other principal reason was malaria control. It has only been recently that *C. tarsalis* has been brought into focus. Thus, it is important to bear in mind that the public has at least two other reasons why it wants mosquito abatement. The public health aspect expressed as encephalitis is certainly of tremendous importance, and I do not propose to underestimate it. We'll also accept, I think, the public comfort problem. The public doesn't know whether it is a pest mosquito or a public health mosquito that is biting. But, in fulfilling our responsibilities, we as technical people in this field must certainly apply every technical device and means at our command in order to obtain the desired level of prevalence that can be had within the economics available to us, and thereby restrict the disease of encephalitis to the minimum possibility of being manifested.

So, my answer is briefly, I believe that the subject of *C. tarsalis* control and the generalized program are integrated and interlocked. Gradually we are becoming more aware of the special ways required by which to control *C. tarsalis.* No doubt if we knew more about *C. tarsalis,* we could make its control more precise by utilizing certain logical methods in keeping with a more specialized type of program.

Dr. Reeves: I might make a suggestion: Next year I think this would be a very excellent subject for a symposium all by itself. We could spend an hour on this subject without any trouble.

I am in a great dilemma—we have run over an hour. It's all your fault. I still have questions here and I don't know what to say. Shall we close it off now or do you want me to pick a few questions and have us go ahead?

(Audience signified its desire for more questions)

"Do you believe Western Equine virus goes south with the birds in the fall and returns north with them in the spring, Dr. Bellamy?" Answer "Yes" or "No."

Dr. Bellamy: Yes.

Dr. Reeves: Well, that is an opinion, and I can't agree with such an unequivocal answer. It's a very interesting question, though—the relationship of migratory birds to these encephalitis viruses. It is one that we are investigating to some extent.

In order to save time, I'll answer this next question: "Does present field or laboratory evidence indicate that there are important encephalitis vectors other than mosquitoes in California?"

We have no evidence today that there is any other important encephalitis vector, especially with regard to transmission to man. We have no evidence that mites are playing an important role in this regard.

"Are there other areas in the country where encephalitis is of as great an interest as in the Central Valley area?" Yes. There are extensive areas of the United States where these viruses are posing a problem, not annually on the same basis as they are here in California, although this past year there was an outbreak in North Dakota and in the Southern Canada area. I noticed in a recent report that Western Equine virus was appearing in Tennessee and there are a number of areas in this country where these viruses are really of concern today One or more of these viruses occur in every State.

"What other agencies are engaged in encephalitis research work?" There is a very large number of them. You know the ones that are working here in this State. Outside of California, the national Institutes of Health at the Rocky Mountain Laboratory in Hamilton, Montana, have a rather large research unit under Dr. Eklund, which is investigating encephalitis in the midwestern and northern midwestern areas. The Communicable Disease Center of the U. S. Public Health Service has a research unit, somewhat the same as the one in Kern County, in Greeley, Colorado, studying encephalitis. The Communicable Disease Center has a large laboratory and research group in Montgomery, Alabama. There are other private research and university organizations and experiment stations throughout the United States that are studying one or another of the phases of this problem. There are a num-

ber of the biological houses that are concerned with the production of vaccine, and which have done some basic work on viruses. Dr. Lennette mentioned the Rockefeller Foundation. It is carrying on extensive studies in Africa, South America, and India. The Armed Forces are making extensive studies in Japan and Korea, and in Australia there are two research groups studying the problem. So, there really is a very widespread program of considerable interest and importance to a large number of people.

Here's a question Dr. Bellamy might answer: "What approach is the Bakersfield encephalitis unit taking in attempting to discover the over-wintering reservoir mechanism of St. Louis and Western Equine viruses?" This has been referred to a number of times, and perhaps very briefly he can tell you the very general approach which we are taking towards this.

Dr. Bellamy: The viruses of Western Equine and St. Louis encephalitis apparently occur mainly in mosquitoes as arthropod examples, although they have been found occasionally in other arthropods such as bird mites, etc. Occurrence of the viruses in vertebrates is primarily in wild (and to some extent domestic) birds, although encephalitis virus is found in humans and horses and there is evidence that the viruses occur in other animals. Since the virus is known to occur in these two places, the arthropod vector, and the vertebrate animal, it's natural to assume that the overwintering reservoir may be the body of one of these two types of animals. Preponderent evidence is that *C. tarsalis* is the arthropod involved so we naturally look for an overwintering reservoir in *C. tarsalis*. Similar preponderent evidence from the standpoint of the involvement of the vertebrates is that primarily wild birds are hosts to the viruses, so we would seek a vertebrate virus reservoir in the wild bird population. There is a difference of opinion as to which is the most likely, and it may possibly be that both (mosquitoes and wild birds) serve as reservoirs. We are attacking both problems, both the *C. tarsalis* mosquito and the wild bird, attempting to find evidence of virus overwintering in either one. This will explain my answer of "Yes" to the question "Do you think the virus goes south with birds in the winter?" I have been inclined to feel that the arthropod vector, *C. tarsalis*, might be the overwintering reservoir. However, if evidence is found that the virus overwinters in wild birds (some other virus diseases do have reservoir capacities in vertebrates), and certainly the larger part of our bird population is migratory, it would follow that the virus is carried south in the winter in the migrating birds and is brought back when they return in the spring. Thus, if the theory that migratory birds are the virus reservoir is correct, it would follow that the virus migrates with the birds.

Dr. Reeves: Here is the last question: "After about ten years of study and observation, do you believe our existing mosquito control program practices will ever be adequate to braing about effective Western Equine control?" I would like to include St. Louis along with Western Equine in discussing this question. I am rather surprised at the emphasis shown on Western Equine in your questions. I suppose the 1952 epidemic explains this.

I think that we have a very excellent chance of achieving control and it is inevitable that in the future our control techniques and practices, which are being carried out, are going to result in control of these infections. I think the primary problem which we have it that frequently we expect to accomplish everything in a year. But I can't believe that, with the enormous capacity and ingenuity that this group has, over a period of time we aren't going to have the same situation with encephalitis that we have had with any other arthropod-borne disease in any other part of the world. We are going to evolve a program that is going to result in effective control and probably largely through vector control; that it is actually going to take care of this problem; that it is going to take all the ability and capacity of every one of us to do this, and I think the main thing is that we keep plugging away at this job; that we don't forget the objective and that we will accomplish it. There is no question in my mind at all about that.

I want to thank you so much for this really beautiful set of questions which you submitted. I apologize very, very humbly for taking so much time, but they were your questions and I thought that you would like to have the answers to them. I certainly want to thank the panel very much for their excellent contributions.

Mr. Umberger: Thank you very much, Dr. Reeves and members of the panel. We will now take a brief recess of no more than ten minutes.

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Mr. Umberger: We are a little behind time, so please come to order. Ed Washburn, do you have something?

Mr. Washburn: We have had a message from Art Gieb. The other day we informed the group about Art's illness and he is apparently doing very well. We sent him a telegram the first day of our meeting and the reply came back this morning:

> "California Mosquito Control Association
> Blue and Gold Room
> Claremont Hotel
> 'Your kind and thoughtful expression gratefully
> appreciated. Recovery progressing satisfactorily.
> Art Gieb"

Mr. Umberger: We are going to have a panel discussion and I think it is very appropriate to the times. Usually we think of a problem as having a key, and in this particular discussion the panel is going to consider really two keys. The title of the panel discussion is "Mosquito Reduction through Private Assumption of Responsibility." We are all thinking in terms of source reduction, as the first key but the second key which we will have to turn to more and more is the private assumption of responsibility. I will call on Mr. Frank Stead to moderate the panel.

Mr. Stead: I wish to announce to you that our panel is following a pretty tough panel, but I am thoroughly convinced that my team can lick them. Coming on the field are Messrs. Raley, Murray, Smith and Hudson; let's really give them a hand!

This is an absolutely unrehearsed performance and I am now passing out the assignments. We propose to go rapidly through three of the Codes in this State and consider Sections of those Codes that relate directly, we believe, to this problem of land owner responsibility, or the person actually operating the land and the assumption of responsibility by that person. We will begin with the Health and Safety Code and we are going to consider certain sections and have comments on those sections by our panel. When we finish the Health and Safety Code, then it will be in order for questions from the audience.

We will then proceed to the Agricultural Code and the Water Code:

Health and Safety Code, Section 2271, Mosquito Abatement Act, which reads as follows:

"Any breeding place for mosquitoes which exists by reason of any use made of the land on which it is found or of any artificial change in its natural condition, is a public nuisance."

I am going to ask Mr. Raley if he will comment on that section with particular attention to the distinction between mosquito situations resulting from land use and man's activitis, as distinguished from natural breeding situations.

Mr. Raley: The point of natural vs. man-made situations is perhaps one of the most difficult that we have had to determine. Our concern has been one of greater emphasis in placing responsibility upon the person or persons creating a mosquito source within the District. We have found that it has taken us at least the first year of our intensive agricultural source reduction program to even begin to get an understanding of where natural water resources leave off and man-made waters begin. We realize that it is a very fine line to work on, a very treacherous line, particularly when you are asking people responsible for mosquito sources to expend their own funds to correct the condition they are creating. Other than to say it is a very narrow line to define, I can only state that some place we must all begin to try to separate natural waters from man-made waters.

Mr. Stead: Would you say, Ted, that it is unquestionably the duty of a mosquito abatement district to cope with natural problems, but that the District should examine very closely before it accepts the responsibility of using tax money to cope with man-made problems?

Mr. Raley: Very definitely. I feel so strongly about it that our District has adopted that policy, and we are now operating on that basis, hoping eventually to control the mosquitoes within the boundaries of our District.

Mr. Stead: We proceed to the first method of remedy set forth in the sections under the Mosquito Abatement Act, that of notice to a property owner or land owner. The sections begin as follows:

"2272. The nuisance may be abated in any action or proceeding, or by any remedy, provided by law.

"2273. Any remedy provided in this chapter for the abatement of a nuisance is in addition to any other remedy provided by law.

"2274. Whenever a nuisance specified in this chapter exists upon any property either in the district or in territory not in the district but so situated with respect to the district that mosquitoes, flies, or other insects from such territory migrate into the district, the district board may in writing notify the record owner, or person in charge of in possession of the property, of the existence of the nuisance.

"2275. The notice shall direct that the owner shall, within a specified time, abate the nuisance by destroying the larvae or pupae that are present.

"2276. The notice shall further direct that the owner shall within a specified time, perform any work that may be necessary to prevent the recurrence of breeding in the places specified in the notice.

"2277. The notice shall be served upon the owner of record, or person having charge or possession of the property upon which the nuisance exists, or upon the agent of either.

"2278. The notice may be served by any person authorized by the district board in the same manner as a summons in a civil action."

Dr. Murray, would you give us your reaction to this responsibility?

Dr. Murray: We have used these particular sections and find that they work. It's not easy. It places a lot of responsibility upon the Board of Trustees and, frankly, the Board of Trustees prefers not to have to personally face all the responsibilities in these sections. I guess you don't want me to mention about going over to the Penal Code right here.

Mr. Stead: This is unrehearsed and unrestricted.

Dr. Murray: If we are to operate to any appreciable extent with legal proceedings, my Board of Trustees has recommended that we work with paid public employees rather than calling upon the Board to face the embarrassments involved in following the legal procedures. Following the first section which Ted already has brought up, that any breeding place is declared a public nuisance, if we have a routine type of case we simply take it to the District Attorney and he then proceeds to pass over to the Penal Code which declares that a public nuisance is a misdemeanor, which places it in his jurisdiction. In that way the Board of Trustees is not held to a large amount of time. The Board sets the policies and public employees, including the District Attorney's office, take over.

Mr. Stead: Don, you said that the section which Ted answered says that "any breeding lace is a nuisance." May I correct that immediately. The law says that "Any breeding place for mosquitoes which exists by reason of any use made of the land on which it is found or of any artificial change in its natural condition, is a public nuisance." You have given us some comment on the attitude of your Board toward utilizing these powers which are set forth. Would you, in the remainder of your first comment here, give us your reaction to what the land owner's responsibility is under the interpretation of legal duty?

Dr. Murray: The land owner is held responsible for those situations which he creates, regardless of which way we go.

Mr. Stead: Does he buy that?

Dr. Murray: He has had to so far. However, we have been very tolerant and have not pursued this procedure to any great degree. We have made sure that where we have used it, the case has been so clear-cut that the defendant would have a hard time wiggling out. Where the Board of Trustees has pursued this, it has followed the procedure of calling the man in, following all the necessary routine, and has held the man responsible for the mosquitoes which he created through his practices and has ordered him to make the necessary changes. In one such case the man proceeded to follow the recommendations to the letter and there was no longer a problem. It has worked and we still believe that the owner has the responsibility.

Mr. Stead: While we are still on this use of the power of notice from the mosquito abatement district and the

success of that method in securing corrections, or the percentage of cases in which it is appropriate, I now give an opportunity to any other panel member to speak.

Mr. Raley: Frank, I can't sound off on the use of the mosquito code, but we did have an experience that may be interesting. I personally had the experience of serving warrants on two individuals, and one agency, using the Penal Code. We found that much more effective and much easier to work with, rather than to go through the more cumbersome and slow process of bringing action under the Health and Safety Code, and the Mosquito Abatement Act. These warrants were processed through the District Attorney's office and through the regular courts.

Mr. Stead: The second chapter of this remedial legislation has to do with what happens if the private owner does not comply with the notice or the directive from the mosquito abatement agency. These sections begin with Section 2282:

"2282. In the event that the nuisance is not abated within the time specified in the notice or at the hearing, the district board shall abate the nuisance by destroying the larvae or pupae and by taking appropriate measures to prevent the recurrence of further breeding.

"2283. The cost of abatement shall be repaid to the district by the owner.

"2284. All sums expended by the district in abating a nuisance or preventing its recurrence are a lien upon the property on which the nuisance is abated, or its recurrence prevented.

"2285. Notice of the lien shall be filed and recorded by the district board in the office of the county recorder of the county in which the property is situated within six months after the first item of expenditure by the board.

"2286. An action to foreclose the lien shall be commenced within six months after the filing and recording of the notice of lien.

"2287. The action shall be brought by the district board in the name of the district."

In either order which you prefer, I would like to hear from Messrs. Murray and Raley on this point briefly.

Dr. Murray: We have never used this. It's very awkward, unwieldly and likely to create troubles.

Mr. Raley: In the case of the Alta Irrigation District, legal history was made in Fresno County when the Judge instructed that agency to perform and complete the corrections specified before they even had the right to be heard in court. If these corrections had not been made before they appeared in court, they would have been in contempt before they were even heard.

Mr. Stead: Does any other panel member have anything to say?

Mr. Smith: I'd like to add one comment. I wonder if there is one point we might be overlooking. Perhaps these provisions of the Health and Safety Code, which are admittedly cumbersome and long drawn out, are additional protection for the property owners and lean over backwards in being fair to them. And perhaps if they are carried out through the process of discussions with the Manager and hearings before the Board of Trustees, it may be a better educational process and may make for better cooperation throughout. If you can accomplish something through sitting down and talking about it, quite often it is longer lasting than if you accomplish it by hitting the owner over the head with a law.

Mr. Stead: There are just two more short sections to sum up this body of law in the Health and Safety Code and I ask you to listen carefully because they are not entirely consistent with the language of preceding sections. We now jump to Section 2270, Parts A and B, which is on the front sheet of this Health and Safety Code excerpt. The first remedy for the abatement of mosquito breeding is as follows:

"2270 (a) The district board may:
"Take all necessary or proper steps for the extermination of mosquitoes, flies, or other insects either in the district or in territory not in the district but so situated with respect to the district that mosquitoes, flies, or other insects from such territory migrate into the district."

The first one says the District Board may attack the mosquitoes; the second one says:

"2270 (b) The district board may:
Subject to paramount control of the county or city in which they exist, abate as nuisances all stagnant pools of water and other breeding places for mosquitoes, flies or other insects either in the district or in territory not in the district but so situated with respect to the district that mosquitoes, flies, or other insects from such territory migrate into the district."

Nothing is said about whether they are artificial or natural in origin. This section appears to give the district the power to abate as nuisances all water resulting in mosquito breeding. Now I would like to hear from one, two or all of the following panel members on this subject, Messrs. Raley, Murray and Smith. Which pattern, that's the question—A or B?

Mr. Smith: Well, I think I'm in a unique position in that having just changed to a new job I have an opportunity to benefit from all the mistakes that I've been making for the last five years. During the past couple of weeks I've been discussing some of these policies that are involved here. In Santa Clara County we have just recently set up a pattern which we hope to follow—I don't know how successfully—which says, first of all, we will accept the responsibility of spraying natural sources, and we have gone ahead and listed those we consider as natural sources. Secondly, and this hasn't been brought out yet, we also decided we would accept the responsibility of doing the control of the pests on all county property, working with the county agencies at the same time to abate the source. And thirdly, on private property we would not do that type of spraying but would attempt to get the private owners to accept that responsibility themselves and only do spraying in those cases in emergencies.

Mr. Stead: Any other comments? I invite pointed and answerable questions from the audience. Dr. Tinkham.

Dr. Tinkham: The Mosquito Control Department of the Coachella Valley Mosquito Abatement District is not

quite three years old. Hence, we are quite inexperienced when it comes to those problems concerned with farmers who defy us rather than cooperate with us.

Our first case was turned over to the County Counsel just last week for processing. In this particular case we gave the farmer several verbal notices plus a written notice in early June requesting that certain mosquito control work be accomplished within two weeks. It was pointed out that failure to do so would mean that we would have to control the mosquitoes and send him the bill. He did not attempt to cooperate until mid-August by which time the bill was $223.00. We had him before the Board in October when the bill was presented, which still is unpaid.

In this respect I would like to point out certain inconsistencies in the law that provide a loophole for such offenders. Sections 2274 to 2277 of the Health and Safety Code says that "the notice shall be served on the owner of record or the person having charge or possession of the property upon which the nuisance exists"—in this case the farmer leasing the land. Section 2283, however, says: "the cost of abatement shall be repaid to the district by the owner." There is the loohole for the farmer to get out. Now if Section 2283 was in accord with Sections 2274 to 2277 and read: "the cost of abatement shall be repaid to the district by the owner or party leasing said property, etc." the law would be much stronger and leasing farmers couldn't squirm out so easily. Can something be done to strengthen this particular section of the code?

Mr. Stead: Let me take a try at being an amateur attorney. This, as you indicated, goes to any of the people involved in the operation. The lien goes against the owner and I believe a lien must attach to the owner. But what I think you overlooked is, that there are two charges which could be brought, one against the owner, and one against the operator. There has been a failure to obey a legal notice, and it seems to me that you could proceed under criminal law against the farmer who failed to comply with a legal notice. In this instance, you have not been able to collect from the farmer and therefore may not collect from either. Does the panel have any different views on this matter?

Mr. Gray: I noticed this problem in Dr. Tinkham's monthly report, and wrote him a letter about it. His intentions are good, but he's wrong as to procedure. In the first place, he is trying to collect some money and he has not followed the correct procedure to collect that money. He did not give the persons involved, both the owner and the man leasing the land, an opportunity to appear and be heard by the Board of Trustees and be confronted with the evidence. Therefore the whole basis of this lien proposition is rendered invalid. Both the owner and the lessee can tell you to go jump in the lake and get away with it. Dr. Tinkham, you can't collect that money since you did not follow the necessary procedure. You did not give them their day in court. You did not establish any real basis as a public nuisance, because you had no hearing. Until you have done that you can't go ahead and file a lien.

Mr. Stead: You are saying, "It's time we read the law."

Mr. Gray: Yes.

Mr. Stead: I agree. Are there other questions on the general subject?

Mr. Kimball: In following the Health and Safety Code, with respect to filing a notice, Don Murray mentioned that they go to the District Attorney. What notice do you give the property owner in writing, or what steps do you take, prior to going to the District Attorney?

Mr. Stead: Don, will you read Section 2279 and also 2280 and then answer that question?

Dr. Murray: "If the property belongs to a person who is not a resident of the district and is not in charge or possession of any person, and there is no tenant or agent of the owner upon whom service can be made, who can after diligent search be found; or if the owner of the property cannot after diligent search be found, the notice may be served by posting a copy in a conspicuous place upon the property for a period of ten days, and by mailing a copy to the owner addressed to his address as given on the last completed assessment roll of the county in which the property is situated, or, in the absence of an address on the roll, to his last known address."

2280. "Before complying with the requirements of the notice the owner may appear at a hearing before the board at a time and place fixed by the board and stated in the notice."

In our particular case, where we have gone to the District Attorney, our position has been to go there first for guidance and assistance, not to prosecute. The District Attorney is asked to write a letter, explaining to the person that he is in violation of the Health and Safety Code, and he is requested to come before the District Attorney to show cause why he should not be prosecuted. He comes at a designated time and talks with the District Attorney, and only then, if necessary, would the matter be carried farther. We've never had to go farther.

Mr. Kimball: My question is, "What do you have to show the District Attorney what you've done before he'll consider the case?"

Dr. Murray: We have lots of records, lots of letters that we have already presented to the farmer, copies of which we show the District Attorney.

Mr. Stead: The section that Don Murray read begins "before complying, the receiver of a notice may ask for a hearing" and probably we should have had him read the following section:

"At the hearing the ((mosquito) district board shall determine whether or not the owner shall abate the nuisance and prevent its recurrence, and shall specify a time within which the work shall be completed." This is the responsibility of the mosquito board, not the District Attorney. He is your lawyer, as I understand it. Any further comment on this particular point?

Mr. Umberger: We had experience on a rather large case. In fact it's a large agency and our procedure was to get the larvae, have them classified by our entomologist, and have the material sealed and properly labelled and an affidavit attached as to time and place of collection. Also, we took pictures. In other words we made a case history, and with the help of the U.S. Public Health Service, and the Bureau of Vector Control, we were successful in getting a correction.

Mr. Stead: Now I hope we've opened this subject, and I'm sure we can do nothing more with it. We have two other Codes that are equally significant. May I proceed, with your permission, to the Agricultural Code?

Mr. Gray: Before you do that, Frank, may I interject this statement? In your California Mosquito Control Association Operations Manual you will find the complete procedure laid out for operating under the Health and Safety Code. All you've got to do is to take that and follow it, and you won't go wrong.

Mr. Stead: Thank you, Harold. Now for the section of the Agricultural Code that I think we'll want to begin with. If you will look in the major Codes of the State you will see that in the 100 and the 200 series are always the general delegations of authority and responsibility, followed later in the Code with more specific assignments. Never forget to read those first chapters. Section 100 of the Agricultural Code is as follows:

> "As used in this chapter, pest means any of the following that is, or is liable to be dangerous or detrimental to the agricultural industry of the State.
> "1. An infectious, transmissible or contagious disease of plants.
> "2. Any form of animal life.
> "3. Any form of vegetable life."

(and if you've played 20 questions, you know that doesn't leave much out). Next section:

> "Any treatment which may be required under the provisions of this Chapter shall be at the risk of, and at the expense of, the owner or persons in charge or in possession thereof at the time of treatment unless otherwise provided";

and there are other provisions. Next, "Each *(County Agricultural)* Commissioner is an enforcing officer of all laws, rules and regulations relative to the prevention, or the introduction into, or the spread within the State of pests, and as to such activities is under the supervision of the Director of Agriculture." Next, "The Commissioner, whenever he deems it necessary, may enter and make an inspection of any premises, plant, conveyance, or thing in his jurisdiction and if found infected or infested with any pest, he may in writing notify the record owner or person in charge of said premises, plants, conveyances or things, that the same are infected or infested with pests and require such person to eradicate, control or destroy to the satisfaction of the said Commissioner, said pest, within a certain time to be specified within the notice."

Now, although Mr. Hudson is not with the Department of Agriculture, I am sure his associations have been close, and I'd like to have him give us his thoughts as to how much of a lever this is for mosquito control.

Mr. Hudson: As you say, I am not with the Department of Agriculture, but I could mention some educational opportunities in which we are engaged which may be helpful to you in your mosquito control activities. With respect to this point, I've been an onlooker, probably like the rest of you, for a good many years in the San Joaquin Valley and Fresno County. I've seen the Agricultural Commissioners proceed under this Code. Usually the procedure has been used only when a pest has been either newly introduced, considered dangerous or something that, whether it's newly introduced or not, is worthy of the setting up of a District, for instance, the red scale control district in Tulare County. I remember when the Agricultural Commissioner in Kern County spent time and money and abated ground squirrels at a time when ground squirrels were infected with sylvatic plague. In that case the State Department of Public Health also became involved, so this Code has been used for the abatement of a variety of things. For example, camel thorn as a weed, the ground squirrel as an animal, and red scale on citrus fruit as an insect.

Mr. Stead: Do you know of any instances yourself of its use in mosquito control?

Mr. Hudson: I haven't any information about that.

Mr. Stead: I mean outside mosquito abatement districts? Does anyone on the panel have knowledge of the use of this section outside of mosquito abatement districts? We'll proceed now to Section 133, Agricultural Code:

"In case pests," *(remember how "pests" are defined)* "are found to exist on property subject to the control of any irrigation, drainage, flood control, reclamation or levee district or other political sub-divisions of the State, *(including of course cities)* the notice shall be served on the Chairman of the governing body of such district or political sub-division, or in case such chairman be absent from the county for any reason and cannot be served, etc. "in the case of infestations of pests in or on irrigation canals or ditches including the lateral banks thereof, not subject to the control of any district or political subdivision of the State, then the notice to eradicate or destroy or control such pests shall be served on all users of water from the irrigation canal or ditches described in said notice." We haven't heard from you, Bob Durbrow. What do you think of this one?

Mr. Durbrow: Friends, I am sure that I am here to be educated rather than to educate. This convinces me. I have seen some of these sections and I feel that the Irrigation Districts in most instances will cooperate readily. We have tried to encourage that sort of cooperation and we have heard that they are in most instances giving it. We hope that's the case. It should be remembered that a noted philosopher once said, "There are only two major urges for exertion; one is personal gain, and the second is necessity." Now if you are going to throw the man in jail, it may be his personal gain to stay out, or it may be that he considers it necessary to take action, but in any case I think that when you begin to point out to him that some personal gain is to be accrued to him, he will take the action necessary. I certainly prefer the personal gain approach.

It is apparent from the questions and answers here that occasionally you need to point out the necessity to a man that needs to be given a little stronger treatment, but I believe that in the cases in our districts, these provisions will readily apply. Some of the provisions are rather general in their terms and as someone pointed out, a clever attorney may wiggle out of them. I think the best method is to point out the section and ask for some cooperation.

Mr. Stead: Mr. Hudson, what do you teach your agricultural students as to their future responsibilities under this section?

Mr. Hudson: We deal of course with farm people of all ages, mostly with adults, in respect to these problems. We are now producing a circular at the University which should be helpful to mosquito districts because it will be a circular on the control of mosquitoes on irrigated lands. Some of our county offices have, in cooperation with local mosquito control districts, prepared little leaflets. When our county farm advisors go out to discuss irrigation they go out with information provided by irrigation specialists to help discuss this matter of efficient irrigation

in a way which will not result in the creation of a mosquito problem. These thngs are parallel because the proper kind of irrigation, with the proper arrangements for drainage, is both good for the client and also good from the standpoint of mosquito abatement. We're anxious that our country people shall weave into their programs of education in the field, things that will help with mosquito abatement. We're glad to have your comments as to ways in which, by publications or otherwise, our educational forces can help you in this problem.

Mr. Stead: Thank you. We'll ask Ed Smith to comment on these two sections and then proceed immediately to reading a commenting on Section 135:

Mr. Smith: "Any premises, plants, conveyances or things infested or infected with pests, or premises where pests are found, are hereby declared a public nuisance, and shall be prosecuted as such in all actions or proceedings whatever, and all remedies which are or may be given by law for the prevention and abatement of a nuisance apply thereto, and it is unlawful to maintain the same. The remedies hereinabove provided shall be in addition to the remedy by way of abatement provided in this chapter."

I'd like to go back here for a minute to the definition given of a pest, in the Agricultural Code. "Pest means any of the following that is liable to be dangerous or detrimental to the agricultural industry of the State." I couldn't help speculating as to what might happen if we try to draw a definition there by saying that *Aedes nigromaculis* has been claimed to be responsible for a drop in milk production by as much as 20%, or perhaps a drop in weight of beef cattle of maybe 50 pounds per animal per year. Maybe then it could be defined as a pest under the Agricultural Code. So perhaps this means of abatement could also apply. Then perhaps we could get additional support. At any rate speculation on that matter is very interesting.

*Mr. Stead: I'*m going to read two more sections and then really toss a ringer in for answer by anybody on the panel! Section 136.5 says:

"Whenever such nuisance exists and notice therefor has been served as herein provided, and the Commissioner determines that such nuisance constitutes an immediate hazard to an adjoining or nearby property, and a great or irreparable injury would result from a delay until expiration of the time required by law for constructive notice, he may forthwith cause such nuisances to be abated by eradicating, controlling or destroying said pests. The expense of such abatement shall be a county charge, payable out of the general fund of the county. The amount incurred or expended shall be a lien on the land"—etc., etc. The question is this: Let's say there's something wrong with the Health and Safety Code provisions. There's an escape hatch here somewhere, but it's clearly under the definition of an agricultural pest. Suppose the Agricultural Commissioner were to order it abated and on failure to abate, and the finding that it is an immediate hazard to adjoining property, he abates it by contracting with the mosquito abatement district in that area, and he handles the collection of the charges from the county, what's the result? Does anybody want to try a hand at that one? Is it possible? Are there any comments from the audience?

We have no answer to this question, so we must proceed to our last body of law, namely the Water Code, Section 100:

"It is hereby declared that because of the conditions prevailing in the State the general welfare requires that the water resources of the State be put to beneficial use to the fullest extent to which they are capable, and that the waste or unreasonable use or unreasonable method of use of water be prevented, and that the conservation of such water is to be exercised with a view to the reasonable and beneficial use thereof in the interest of the people and for the public welfare. The right to water or to the use of flow of water in or from any natural stream or water course in the State is and shall be limited to such water as shall be reasonably required for the beneficial use to be served, and such right does not and shall not extend to the waste or unreasonable use or unreasonable method of use or unreasonable method of diversion of such water." Bob, will you kick this one off?

Mr. Durbrow: Frank, I'd be delighted. This one is a dandy and I would accuse Frank of overlooking the important body of law from which it was taken. This is cited word for word from the Constitution of the State of California. This Article was put in there a long time ago, in 1928, because some of the lands down in the San Joaquin Valley were being irrigated annually by the floods that came down the river. It was occurring in other parts of the State too, but this was where the action was. The people in that area, where the land was flooded annually, benefited by the flow of water over their lands and the silt the floods brought, so they demanded the right to continue that type of thing. When irrigation increased in the area, water began to be used above their lands and then they sued to have the water continue to flood their land. You can see what an odd situation that would create, because these people did have, under our old law, riparian rights to those waters, and if they flooded their land annually it appeared that they had a right to demand the right to continue to flood their land every year. This would mean that one couldn't use any of the water up-stream, store it, or use it for irrigation or other things. So that was the background. Now you will note from Mr. Stead's intonations that there are some broader implications which might be imputed to this same section. You might bring it right down to cases and say that where there is additional water, or waste of water, as perhaps when some flows out of the end of an alfalfa check, you might actually start an action under this section of the Water Code or under the Constitution. I think that's something which the farmers, the users of water, are going to have to consider in view of the more or less current implications of danger accruing to such wasteful use of water.

Mr. Stead: Thank you, Mr. Hudson, do you want to discuss this one?

Mr. Hudson: I'd like to make one comment. There are situations in the State where it is desirable, at least once a year, to leach the soil. That means using water, over and above the amount required to wet the roots of a plant, for the prevention of accumulation of alkali and other soluble salts about the roots of the plants. So in using this law, I should think those who attempted to use it would want to be pretty careful about the definition of this term "unreasonable use."

Mr. Stead: Thank you. I want to introduce one more specific requirement from the water law, Section 275:

"The department shall take all appropriate proceedings or actions before the executive, legislative or judicial agencies to prevent waste, unreasonable use, unreasonable

method of use, or unreasonable method of diversion of water in the State."

Bob, what is your comment on this section?

(Editor's note—the transcription of the first part of Mr. Durbrow's comment was lost. The remainder follows.)

Mr. Durbrow: I would like to cite one case. When Dick Peters addressed our Irrigations Districts' convention a couple of weeks ago, many of us had been convinced that you people had the mosquito situation pretty well under control in the State, and I think that there is a multitude of people in California who feel that way. Now I think that you have a real educational job to do to let us know that, in spite of all you people are doing, we may be losing the mosquito battle. That was the very statement that he made to our Association the other day. So, if it is that imporant, if it is that vital, then all of us are going to have to cooperate, and I think that by letting the seriousness of the situation be known you'll get a lot more cooperation in many cases than by enforcing some of these laws.

Mr. Stead: Thank you, Bob. Let me regale you with one little section in the Water Code that I read for the first time this morning. It is in Section 22264: "In areas where the service rendered by the (irrigation) district is primarily agricultural and domestic service is only incidental thereto, the Department of Public Health may prescribe reasonable and feasible action to be taken by the district and the consumers to insure that their domestic water will not be injurious to health." Now are there more points that will contribute to the development of this subject? Not that we can wrap it up, but have we opened it up sufficiently for full consideration? Or are we ready to sum it up at this point?

Mr. Hudson: Mr. Chairman, there's one other item you might mention. One time, years ago, I ran a study in Kern County and found that on the same type of soil in the same area, with the same crop harvested within one or two weeks, the use of water by individual farmers ran all the way from 28 to 96 acre inches. So this question of efficient use of water is another approach whereby you might interest people in benefits that might accrue to themselves. I remember when a new manager was put in charge of the operations on the Sierra Vista Ranch, including irrigation, he succeeded in reducing the use of water an acre foot over that 4,000 acres. That saved the company a lot of money. By more carefully controlling water, the farmer can save himself money, and that's an interesting thing to him.

Mr. Stead: May I be permitted an opportunity to attempt to sum up some of these thoughts? First of all we are facing a belt-tightening decade. Money is going to be hard to get. As far as our own Department is concerned, federal sources are drying up, State sources are tightening up. I imagine the same thing is true of mosquito abatement districts, and just as last year we talked about more water with less mosquitoes, it seems to me this year we've got to talk about more program with less money. If that is the case, it seems to me that it behooves us to exercise all of our opportunities to enlist cooperation program-wise and budget-wise by the application of these or similar sections of law that make it appropriate for other agencies of government to consider mosquito prevention as part of their natural and normal program. Mr. Geddes, the day before yesterday, said he is impressed by the paucity of the law, by the sketchiness of the sections. We tried to point this morning that there is no lack of words on the subject. I think we also fairly well demonstrated that the Legislature of our State not only in the laws, but (with compliments to Mr. Durbrow for the information) in the Constitution of this State, has taken a pretty broad-minded look at the public welfare as related to mosquito control and all other pests. Possibly these laws are not sufficient. Maybe if you tried them out you would merely run into hopelessly long drawn out law suits, and then lose them in the end. It seems to me, however, that that can't end the discussion. We must do one of two things. We must either demonstrate that the sections are not workable, or secure competent advice that they are faulty in the first place. Following either of those steps we must take the logical constructive steps to get a sound, adequate, intelligent, symmetrical and workable body of law that can be used by all the agencies in the State interested in mosquito control, to cope with the mosquito problem. One of the early sections in the Health and Safety Code says that it is the duty of the State Department of Health annually to report to the Legislature on those changes and amendments and additions to the law that are needed to protect the public health. This refers to the substance of the law, not merely the appropriations part of it. Therefore I wish to end this panel on the note that we are not only interested, we are tremendously anxious, to cooperate with your Association in a continuing study and evaluation of the body of law related to mosquito control, making available to that discussion the advice which we enjoy from the Attorney General's office, and the advice which you can bring from your District Attorneys and in some cases from private attorneys. Is it not time that we looked at the tools of our profession, legal-wise, and make sure that we are properly equipped to do a job that we all know we've got to do? We are now ten minutes over our allotted time, so this concludes this panel.

Mr. Umberger: I want to thank Mr. Stead and the panel. I know for myself that I've got new food for thought, and I think we're now looking into the crystal ball to the future.

We skipped one item on our program, a film strip, "Mosquito Problems in Irrigated Areas," and we'll now have that.

Film strip projected at this time, after which Mr. Umberger turned the chair back to Mr. Grant.)

Mr. Grant: Thank you, George, for taking over this morning's session. A job well done! Ed Washburn says he still has some copies of the Proceedings here for those that are supposed to receive them and have not yet done so. I request that anyone who hasn't had their skin test read yet, please stop on the way out and have that done. Also, for the San Joaquin Valley areas, there's some time available on the new television station there and Mr. Marvin Kramer can make arrangements for utilizing it. I suggest that they get together in a regional meeting and plan out a TV program.

Thank you all for your attendance and cooperation in this rogram. We sincerely appreciate the efforts of all the speakers who made it a very great success. The meeting is adjourned.