PROCEEDINGS AND PAPERS

OF THE

Twenty-Fourth Annual Conference of the California Mosquito Control Association

AT

HOTEL STOCKTON, STOCKTON, CALIFORNIA

JANUARY 16, 17, AND 18, 1956

Edited by

C. DONALD GRANT

PUBLICATIONS COMMITTEE:

G. EDWIN WASHBURN   JOHN R. WALKER   C. DONALD GRANT, *Chairman*

CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC.

P. O. BOX 629   TURLOCK, CALIFORNIA

PUBLICATION DATE: JULY 30, 1956

PRINTED BY: THE TIMES-STAR PRESS, ALAMEDA, CALIF.

1955-56 CORPORATE MEMBERS OF THE

CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC.

Alameda County Mosquito Abatement District
Ballona Creek Mosquito Abatement District
Butte County Mosquito Abatement District
Carpenteria Pest Abatement District
Clear Creek Mosquito Abatement District
Coachella Valley Mosquito Abatement District
Coalinga-Huron Mosquito Abatement District
Compton Creek Mosquito Abatement District
Consolidated Mosquito Abatement District
Contra Costa Mosquito Abatement District
Corcoran Mosquito Abatement District
Corning Mosquito Abatement District
Delano Mosquito Abatement District
Delta Mosquito Abatement District
Diablo Valley Mosquito Abatement District
Durham Mosquito Abatement District
East Side Mosquito Abatement District
Eureka City Mosquito and Rodent Control
Fresno Mosquito Abatement District
Kern Mosquito Abatement District
Kings Mosquito Abatement District
Lake County Mosquito Abatement District
Los Angeles City Health Department
Los Molinos Mosquito Abatement District
Madera County Mosquito Abatement District
Marin County Mosquito Abatement District
Matadero Mosquito Abatement District
Merced County Mosquito Abatement District
Napa County Mosquito Abatement District
Northern Salinas Valley Mosquito Abatement District
Northern San Joaquin County Mosquito Abatement District
Orange County Mosquito Abatement District
Oroville Mosquito Abatement District
Pine Grove Mosquito Abatement District
Sacramento County-Yolo County Mosquito Abatement District
San Joaquin Mosquito Abatement District
San Mateo County Mosquito Abatement District
Santa Clara County Health Department
Shasta Mosquito Abatement District
Solano County Mosquito Abatement District
Sonoma Mosquito Abatement District
Southeast Mosquito Abatement District
Sutter-Yuba Mosquito Abatement District
Tulare Mosquito Abatement District
Turlock Mosquito Abatement District
West Side Mosquito Abatement District

1956 OFFICERS AND DIRECTORS OF THE

CALIFORNIA MOSQUITO CONTROL ASSOCIATION

President: W. DONALD MURRAY
Vice President: HOWARD R. GREENFIELD
Secretary-Treasurer: G. EDWIN WASHBURN
Trustee Member: ROY L. HOLMES
Past President: THOMAS M. SPERBECK

Regional Representatives

Coastal: HAROLD W. BRYDON
Northern: ROBERT F. PORTMAN
Central: JOHN O. STIVERS
Southern: GARDNER C. MacFARLAND

1955-1956 EXHIBITORS AND SUSTAINING MEMBERS

Agriform Company, Inc., Fresno
Automotive Supply Company, Inc., Visalia
B-K-H Company, San Francisco
H. V. Carter Company, Inc., San Francisco
Chipman Chemical Company, Inc., Palo Alto
Fresno Agricultural Chemical Company, Fresno
General Petroleum Corporation, San Francisco
The Hardie Manufacturing Company, Los Angeles
Holt Brothers, Stockton
Moyer Chemical Company, San Jose
Harry P. Raymus Insurance Agency, Turlock
Richfield Oil Corporation, Los Angeles
Rohm-Haas Company, Oakland
F. M. Speekman Company, San Francisco
Sunland Industries, Inc., Fresno
Willys Motors Inc., Los Angeles

TABLE OF CONTENTS

PROCEEDINGS AND PAPERS OF THE TWENTY-FOURTH ANNUAL CONFERENCE OF THE

California Mosquito Control Association

FIRST SESSION, 9:25 A.M., MONDAY, JANUARY 16, 1956

BALLROOM, HOTEL STOCKTON

Stockton, California

The Conference was called to order at 9:25 a.m. by CMCA Chairman pro-tem, W. Donald Murray, of Delta Mosquito Abatement District, Visalia, California.

Chairman Murray: Good morning, ladies and gentlemen. It seems that everyone is here. We should begin.

The President of the CMCA, Dick Sperbeck, wired last night that he was going to have to stay in Marysville to keep watch on the levees and could not be here. As you know, he had to change the meetings to here because of a previous flood. We hope that with the sunshine this flood is not going to materialize.

We welcome all of you who are CMCA members locally, and those of you from out of State. We believe that California has one of the leading associations in Mosquito Control and we hope that these conferences will mean much to all of you. I believe that you will have received, or received if you were present last year, our Conference Proceedings in the silver cover and also, if you are a member, you should have received this little year book.

Now, let's start with the formal meeting. As host for this Conference we have Les Brumbaugh, of the San Joaquin MAD, and Bob Peters of the Northern San Joaquin MAD.

Chairman Murray: Les has some friends we would like to have him introduce.

Mr. Brumbaugh: Thank you, Don.

Ladies and gentlemen, it is a privilege to be one of your co-hosts to try to make this meeting a pleasant one. I would like to introduce our Mayor of the City of Stockton, Fred Bitterman, who will give you a welcome address. Fred?

Mayor Bitterman: Thank you, Chairman Les.

Members of the California Mosquito Abatement Association: May I first apologize for the lateness in starting, as your Chairman has mentioned. This was due to certain conditions. I think you were supposed to meet over at the South Hall at the Civic Auditorium. At least, that is what I had on my memorandum, and, as you all know, the Red Cross at the present time is using the South Hall for rehabilitation purposes, so I apologize for keeping all of you waiting.

I am very proud that this organization has consented to meet here at Stockton. Perhaps our mosquito abatement situation took a little longer to jell than that of some of the other communities, but through the untiring efforts of individuals such as Les Braumbaugh we were able to have a Mosquito Abatement District created here in this particular area, and I think—in fact, I know it is functioning well. I presume, with the tremendous rainfall we have had this year that your program is going to have to become a little more heavy, shall I say, because of the water conditions which now exist. I know a lot of these little creeks we have around Stockton will undoubtedly prove to be troublesome, Les, from the standpoint of your program.

May I extend to you the welcome on behalf of the City of Stockton and I know that your efforts for the coming year will be intensified, and I give my heartiest congratulations to you on behalf of the City.

Thank you very much.

Mr. Brumbaugh: Thank you, Fred, and I know the boys will enjoy themselves while they are here in Stockton. Being in Stockton you can't help but enjoy San Joaquin County and you have come through the County to get to Stockton. We are quite proud of San Joaquin County so we have asked Clyf Bull, Chairman of our Board of Supervisors, to say a few words this morning.

Clyf Bull.

Mr. Clyfford Bull: Thanks, Chairman Les, and I just wonder if you have been up all night or—

(Laughter)

I didn't know that you started out a convention by being up all night, but I know there are a few of you that are going to wind up by being out all night.

At this time I would like to extend the greetings of the people of San Joaquin County to you, insofar as this Mosquito Control Association is concerned. If there is anything that we can do for you, we would be very happy to have you call upon us. I am not going to bore you with a lot of things that I could go on with insofar as the history of mosquito abatement is concerned here in San Joaquin County, because I think you are all a little bit aware of it. I happen to live in Lodi where we have had a very well functioning Mosquito Abatement District for a number of years, and I think that possibly that is one of the big things that helped the southern half of the County finally have a district. We hated to lose our people in San Joaquin County as far as the official people or the official family are concerned because we lost an awfully good man when we lost Les Brumbaugh, but even though we lost him as an employee of San Joaquin County, we gained him as an employee of the Mosquito Abatement District which includes the City of Stockton, and I know you are going to have a Control District here second to none in the State.

Thanks for being here and come back soon.

(Applause)

Mr. Brumbaugh: Thank you, Clyf.

Ladies and gentlemen, we will now turn the meeting back to our chairman, Don Murray.

Mr. Bull: Chairman Don, do you mind if I leave at this time? We have a 10 o'clock Board meeting and I am going to have to go to it.

Chairman Murray: Certainly. Thank you very much for coming.

Chairman Murray: I would like to introduce another very important part of our meeting, Mr. Dan Richardson, of the Stenotype Reporting Company.

We have had some necessary changes in our program as you have seen it. Mr. Freeborn cannot be here because of the potential flood at Davis. Whether he can be here a little later and include his paper at that time, we can't say. With some changes that we make, we will move our program up and call on Mr. Harold Gray, California's Mr. Mosquito Control Emeritus. Now, Mr. Dick Sperbeck, as President of the CMCA, may have had long flowing introductions. I came unprepared. Mr. Harold Gray needs no introduction to any of you. He is the friend of all of us. He has been Mr. Mosquito Control, USA, or World, or whatever you have.

Mr. Gray.

Chairman Murray: Do you wish to use the speaker? You can if you are tired.

Mr. Gray: Well, if you boys can't hear me there is something wrong with my voice. I had better tell the stenotype man that he had better not pay very much attention to what I am going to say about what I am supposed to talk about, and I will give a paper to Ed here and you can publish that; but although the rest of the stuff I put out might amuse you a trifle, don't pay attention to it in the official proceedings.

LET'S THINK A LITTLE HARDER

by

Harold Farnsworth Gray, *Gr. P. H.,*
Honorary Member,
California Mosquito Control Association

Many years ago the British surgeon John Hunter, in a letter to Dr. Edward Jenner, wrote "but why think, why not try an experiment?"

What Dr. Hunter meant was that if one has an idea that a certain concept is possibly true, then the thing to do is to put that idea to the test of an experiment to determine its validity.

For a number of years we in the California Mosquito Control Association have been doing what Dr. Hunter suggested. Indeed, we have even gone beyond his advice; without any specific thinking we have been doing experimental and observational work in several directions for the purpose of finding facts and ideas which will enable us to understand the relationships of various mosquito species to their environment, in order that we may be able to obtain more effective control with less effort and expense.

Frequently we have not had any preconceived ideas which we were testing. We have been motivated by that curiosity which is the essential element of research. As so well put by Kipling

"I keep six honest serving-men
(They taught me all I knew)
Their names are What and Why and When
And How and Where and Who."

I know of no group in the general public service field which is doing a better job in this respect, and the valuable and unusual aspect of the operation has been that it is not something which has been imposed upon the organization by an upper hierarchy of university intellectuals, or by federal or state bureaucracies, but has largely sprung up from and has been aided and abetted by the "grass roots" personnel of the organization.

I am quite impressed not only with the work already accomplished, but also with the spirit and purpose behind it. I am also pleased that I have had, perhaps, a very small part in some of the actual work, and also in stimulating and encouraging other workers. But I am far from satisfied that we have done all that we could do or should do, or that we have gone about our projects in the most effective ways. Somewhere, somehow, we may have been overlooking some things of considerable importance, and probably we ought to stand back and take a good long look at our problems and do some hard pertinent thinking about them.

Therefore I now suggest that we do some basic thinking about our problems. I do not suggest that we reduce our experimental work and investigations; in fact, we ought to increase it. But why, where, when, how, and to what purposes?

For a brief period at least we ought to get away from the close-up view of our individual problems, get away from the details, and take an "overall" look at our work. Suppose for a long time we have been in a forest examining trees, terrain, shrubs, soils, etc., trying to describe the forest. We have examined details, perhaps not exhaustively, but fairly adequately. But we have not looked at the forest as a whole. For that purpose we must climb a high mountain near by, and look down upon it, or fly over it in an airplane to determine its extent, and where the trees are growing vigorously, and where the hillsides are relatively bare. And when we have determined these things, then we should ask "WHY."

For example, all of us have seen situations which appeared to be suitable for the development of mosquito larvae, and yet none were present—not temporarily under special weather conditions, but continuously. We also see plenty of places which are prolific mosquito producers. Why are certain situations naturally unfavorable to mosquito larvae, or perhaps repellent to oviposition, and others are very favorable? Is the reason to be found in soils, or food supply, or predators, or competing organisms, or what? These are problems in "ecology," and the California workers have been more conscious of ecology as a factor in their operations than any other group with which I have been acquainted. (I of course except individuals such as Sir Malcolm Watson.) But have we done enough along these lines? Have we done all that we can do? I do not think we have.

If my memory is correct, we once had an "Ecology Committee." My recollection is that it did some very good work in assembling much of what is known about the ecology of the more important California species. At your 18th Conference in February, 1950 an excellent symposium on the ecology of California mosquitoes was presented. But this committee was too "puckered up" with details to take a long range, overall viewpoint of the important problems. What we need, in my opinion, is something like a "brain trust" (words with a horrible connotation, perhaps); a group which will delineate the things we do not know but need to know. After they have done the basic thinking, then we can devise and carry out experiments to test their hypotheses, if any.

We might make use of an existing group, such as the Vector Control Advisory Committee of the State Department of Public Health, as there are some very able intellects in that group. But such work is not its function, and I doubt the desirability of using it, as a whole, for this purpose, since I believe that the committee I propose should be a "grass roots" committee of your very own. Furthermore, as I get older I become more and more suspicious of governmental bureaucracies, administrations, agencies, facilities and authorities, etc., with gobbledegook names and alphabetical abbreviations. Similarly, I am not willing to wait on the universiites, for this means an uncertainty until there is a fortuitous juxtaposition of time, genius, and facilities in research. Perhaps we can encourage such research, but we can properly neither direct it, nor hurry it by setting time limits upon it.

How much better it would be if you were to do this job yourselves! Difficult? Emphatically yes! This kind of thinking is the hardest work in the world—and the rarest. Perhaps you will not be equal to this challenge, but who can say that until you have had a real good try at it. You may even surprise yourselves with the abilities you as a group have.

What is it that we do not know about mosquito ecology that we need to know if we are to obtain practically 100% control with minimum effort? If we can delineate this problem, then we can devise experiments which will be useful.

Chairman Murray: Thank you, Harold, very much.

In replacing at least temporarily Dr. Freeborn's talk in the morning, we will now hear Dick Peters' talk which was scheduled at 3:10 on "Significant Features of California Mosquito Control," since Dick Peters is scheduled for the afternoon and since he had a special meeting which he could not avoid this afternoon but could be here this morning.

Dick Peters, Chief, Bureau of Vector Control, State Department of Public Health.

Mr. Peters: Mr. Vice-President, Acting President, and members of the California Mosquito Control Association, and friends and visitors who have come from far and near: Art Geib, as chairman of the Program Committee, asked that I appear here in the capacity of representing the Bureau of Vector Control and talk on something that would be pertinent. Well, this was several months ago, and being rather obtuse at the time as to what would be pertinent, I picked this gem as a title, "Significant Features of California Mosquito Control." As you can see, the latitude is unlimited. I also am, strangely enough, prepared with a written speech. That is unique.

So, having gone to all of that trouble, if you will bear with me while I wade through it, I hope I sha'n't bore you. At least, I will inflect strongly now and then to awaken those who get a little tired.

SIGNIFICANT FEATURES OF CALIFORNIA MOSQUITO CONTROL

Richard F. Peters[1]

The mosquito control program presently being conducted in California has a unique distinction in that it is contributing significantly to shaping the pattern of tomorrow's generalized mosquito control practices. This statement may be difficult for non-residents to swallow, let alone digest, but it cannot be denied that in California today mosquito control agencies are tackling new and different kinds of artificially created problems on a pioneering basis. The scope of mosquito abatement practice within what has been coined in California as mosquito source reduction, is novel, at least on such a large scale —in two ways—the problem itself and the techniques being used in solving the problem. Our California problem is now largely one of man-made origin, arising within irrigated agricultural lands and within industrial and community liquid waste disposal properties, and is coming into existence with dramatic suddenness. The educative —persuasive—cooperative emphasis being employed in mosquito source reduction to correct and prevent problems, is in itself a unique experience in the relationship of government to population served. To be sure, California is also, within this, the largest mosquito abatement program of its kind in the world, performing the usual variety of routine or conventional type operations long identified with mosquito control. Irrespective of the magnitude of our problem today, however, which is approximating the four million dollar mark per annum, we are really only getting started in dealing with the effects of the state's vast water resources development program. We are not yet half way along in experiencing the mosquito production potential of California's anticipated twenty-one million irrigated acres, nor have we yet even reached midway in the state's estimated population saturation point. Again, bearing in mind that our problem is a product of artificial changes, does not this outlook invite sobriety in recognizing the potential impact of mosquitoes in California? Does not this outlook suggest the need for giving mosquito prevention and control highest priority in California's present and future planning? In view of this outlook it seems only appropriate to take inventory of our capacities for meeting the challenge before us.

First of all, let us take stock of our adequacies, our assets, if you will. Outstanding is the sincerity and dedication which mosquito control personnel demonstrate in their intense application to the task, particularly under the most adverse of working conditions. The virility and determination which is evident leaves little to be desired.

Next, let us review briefly the statute under which we operate. The more I read the Mosquito Abatement District Act, the more I am impressed with its flexibility and utility. Its authors most certainly must have been possessed of keen vision in selecting legal terminology to facilitate solution of mosquito problems and at the same time, create harmonious relationship between government and citizens affected by government. Speaking somewhat facetiously, it appears that they developed a legal abatement procedure which is so involved and time-consuming as to practically preclude it ever being used. They supplied powers to a board of trustees enabling them to take virtually any step necessary to neutralize any existing mosquito problem and they also provided basis for effecting sound long-range remedies. Though the language appears at first reading to provide primarily for law enforcement, there is ample implied and inferred basis for employing an educative—persuasive—cooperative emphasis in securing solutions to problems. Borrowing from Teddy Roosevelt, they provided a "big stick" but somehow seemed to dis-

[1] Chief, Bureau of Vector Control, California State Department of Public Health.

courage its use. Thus, we are amiably prepared legally to meet the needs of the present and the challenge of the future.

It has been previously mentioned that mosquito control agencies are employing the mosquito source reduction emphasis. This program philosophy, which aims at reducing existing sources to a minimal point and preventing the many potential sources which could be developed in our changing state, is certainly deserving of mention and conspicuous recognition as a positive feature of California mosquito control. May this healthy philosophy become even more far reaching.

It is particularly gratifying to me to also recognize and express appreciation for what has all the appearances of harmonious local-state teamwork. In this connection I wish to assure everyone that our primary objective in the Bureau of Vector Control is to perform our part to the maximum in serving and assisting local mosquito abatement programs. As our personnel become further oriented to their assignments and to the local program needs, I sincerely believe that this relationship will continue to improve.

Next matter worthy of mention is the good start which has been made on mosquito measurement. This I shall not dwell upon since a discussion will be held tomorrow dealing in detail with its virtues and shortcomings.

Your state Association most certainly is a decidedly positive influence in helping to bring about uniformity and standardization of practice to the extent such is possible. Likewise mention-worthy is its important function of documenting the Proceedings and Papers of these annual conferences. The committees of the California Mosquito Control Association have frequently performed valuable service to the state-wide program.

The fine headquarters and depot facilities throughout most of the state which enable personnel to perform their jobs with maximum efficiency and which are convenient and available to the public certainly deserve favorable comment.

The speed and flexibility with which mosquito control agencies can arise to meet emergencies, as exemplified by the 1952 experience, is also in the category of a significant feature of California mosquito control.

Undoubtedly I will be guilty of failing to recognize other attributes and express them, which are probably too obvious, but I shall taper off on the passing out of bouquets with the general observation that nowhere within my knowledge is there any other program as well organized and as well staffed as exists in California today.

Perhaps with that statement I may now undertake the less popular part of this paper by attempting to suggest opportunities which appear to be open to getting the job done even more effectively.

While it is acknowledged that we have made a start in developing inter-agency cooperation toward furthering mosquito prevention objectives, it seems reasonable that further advances could be made in this regard.

Since it is axiomatic that water is the denominator which supports all mosquitoes and since the manipulation of water underlies all mosquito abatement operations, does it not seem probable that increased effects in preventing mosquitoes can be obtained through the medium of other agencies and interests relating to water? How many mosquito control agencies are taking an active part, even leadership, in promoting cooperation among neighbor agencies and the other diverse interests concerned with water? It would appear that unless mosquito control accepts this invitation, it will be falling short of realizing a great potential which is within making use of. By encouraging the development and actively participating on local water use committees or councils composed of representatives of all the interests in each locality, the objectives of mosquito control and the opportunities for cooperation and reciprocal service can be clearly enunciated to one and all. To take leadership in water use planning is in no way presumptuous. Off hand, it appears that no other identity related to water is in a position to be as objective with respect to its use as is mosquito control. This enviable position of neutrality invites leadership. To be sure, the Bureau of Vector Control will render all support possible, particularly in negotiating with state and federal agencies on water use developments.

Next, in no way to deprecate the fine showing most entomologists have made thus far in mosquito control programs throughout the state, it appears that an attitude resembling resignation has developed to some extent concerning the full use of technical and professional skills in mosquito control. There have been several exceptions to this where a number of districts have secured the services of source reduction specialists to facilitate their programs. My real point in bringing up this subject is that of suggesting the desirability of utilizing increased numbers of technical and specialized personnel to most efficiently conduct the educative—persuasive—cooperative programs presently under way and in prospect on an increasing basis into the future. It is apparent that engineering is essential in developing master plans of drainage, in performing individual source reduction projects with maximum efficiency, and in coordinating the area-wide source reduction effort. Education specialists to employ the variety of educational methods and techniques available in putting across the message to the public, are visualized as desirable in performing the job before us. The use of entomologists in entomological and toxicological capacities rather than administrative support functions will also pay dividends in meeting the needs of the present and the future programs. Increased use of agricultural specialists in effecting agricultural solutions to problems arising in irrigated agriculture appears to be an obvious mosquito abatement expedient.

No doubt you have been wondering how long it would take me to get around to pointing out the inadequacy and insufficiency of present provision for research on mosquito ecology and control technology. In this regard it is heartening to observe the wheels appear to be turning from above, slightly more so in sympathy with such a program. I remain firm in my belief that there exists no sounder course open to mosquito control in solving its many difficult problems than that of utilizing capable and efficient scientists who are permitted and encouraged to work scientifically at solutions to these problems. Under the newly reorganized subvention setup which now places the responsibility for investigations in the hands of the Bureau of Vector Control, we are sincerely applying ourselves to the task before us and only wish it were possible to have the degree of wherewithal by which to expedite the turning out of results. This is not a report in the negative, but rather a positive outlook on a significant subject which needs support.

Next item is in the nature of calling attention to the need for extraordinary administrative judgment in applying the new toxic phosphate insecticides. Mosquito control cannot maintain its accepted professional status if confronted through negligence, with the unhappy experience of personnel intoxication from insecticides; nor can the public or domesticated animals be carelessly exposed to hazards from these materials and have public respect for mosquito control endure. We must be extraordinarily certain that all precautions are taken by personnel in storing and mixing phosphate concentrates, whether they be malathion or parathion, and that every protective measure is observed in protecting operators as well as the public. A re-examination of procedures and practices in use is urged to assure that every administrative step possible has been taken to ascertain that all possible precautions are being incorporated..

Probably one of the most threadbare of subjects which accordingly will receive but brief mention, is the wide discrepancy in record keeping among mosquito control agencies. Without dwelling specifically on any individual form or practice, it is my observation that record keeping by mosquito control agencies generally is considerably under the standard practiced by other governmental agencies accountable to the public. The C.M.C.A. Committee on Records and Statistics has made an important stride in seeking to develop forms and invoke standard patterns for keeping meaningful records. It of course follows that records which are gathered and not used are worse than none at all. Perhaps the greatest deficiency is the failure to utilize the data obtained from records in sharpening control operations. In this regard only several agencies have thus far effectively employed cost analysis appraisal practices in helping to guide administrative decisions. Such a use of records in itself more than justifies the time spent in gathering data.

My last item on the debit side is really a preventive statement intended to encourage and stimulate an exploratory attitude and the maximum use of imagination in meeting the changing problems confronting mosquito control. We must head off any tendency toward complacency. It is easy to follow a routine pattern of operations once established and contrarily difficult to engage in new and modified techniques and approaches to our problem. For example, administration might well examine or re-appraise: the present pattern of zones with respect to magnitude, personnel suitability, and distance; the logistics in present operations with a view toward streamlining; the kind of equipment being employed with respect to the peculiarities of areas served; the merits of the wand versus the shovel; the value of pre- and post-operational inspection; the merits of the insecticides in use; the feasibility of measuring witch elevations and stream flows as guides to locating and timing of irrigation and hence insecticide applications; the enlisting of cooperation of farmers and irrigators in raising flags or using various indicators of some kind on properties recently irrigated; the full use of aerial reconnaissance to guide control timing; etc. Above all, we want to avoid creating a rut—it could fill up with water and produce mosquitoes while our backs are turned.

Now, lest anyone believe that this is a one way sermon, I wish to acknowledge that there are a number of shortcomings which exist within the program of the Bureau of Vector Control program which can undoubtedly be improved upon. Aside from the fact that I find it relatively more difficult to get into the field now, with my knowledge about what you do being based mostly on the little you say in monthly reports, I am frankly most aware of our relatively slow progress in getting mosquito control planning across to other state and federal planning agencies which have a primary influence in determining the destiny of water developments. In this respect we are aiming to do more than has been the case in the past. The great variety of interests concerned with water being dispersed in so many locations makes this effort no simple undertaking. Our lack of engineering personnel with which to provide greater engineering assistance in both state and local respects also concerns me deeply. We are also seeking to improve our informational and educational services to mosquito control and through the activities of our recently acquired health education consultant, should be able to expand this service in the near future.

In passing, I should like to mention the subvention program, particularly a trend of reaction toward it which seems apparent in legislative and other state circles. From present appearances the fiscal year 1956-57 may well find only those agencies unable to obtain added local funds within the existing tax structure eligible to receive state funds for operational purposes. If such revised qualifications should be established, it is hoped that the basic allocation will continue to all participating agencies in order to sponsor technical guidance and to support the mosquito measurement program. The operational investigations activities appear in prospect of support with a slight increase to accommodate the insecticide testing activities which the Kern Mosquito Abatement District has so generously done in the years previous. It can be expected that the legislature will continue to look critically at the propriety and amount of state participation if any is considered appropriate. It seems detectable that growing appreciation exists of the need for state activity in conjunction with mosquito control, but the exact manner and amount in which it will be expressed appear to be the uncertainty. One thing is certain—it will not be in the field of routine mosquito control operations.

Lastly, what is in store for us in 1956? We have indeed experienced a grave winter thus far. If the precipitation and snow pack continue into March, the effect mosquito-wise might certainly be unpleasant to contemplate. Since we have misplaced our crystal ball, it can only be asked that each and every agency be particularly vigilant toward appraising and reporting to the Bureau of Vector Control the buildup of mosquitoes as the season advances. It can be promised that if emergency conditions appear to materialize, any emergency action to be taken will correspond to the early conditions when and if they occur. We join you in hoping that such is not necessary.

Chairman Murray: Thank you, Dick. I would like to be able to say that you took the words right out of my mouth. I think adding all of us together, you did.

According to the program, there is a slight recess before we proceed further. Before you go I would like to call your attention again, as I see a number of chemical people here who may not have received this year book, which gives you a clue to all the districts where you can go and try to sell your products; but it is strictly yours.

As you gather to your seats will you please arrange yourselves so that you can see the screen.

First, we have several brief announcements we would like to make before we start our formal program. Especially apropos, following the paper by Dick Peters, I think the entire group should be informed of the activity of a committee. This committee has been extemporaneous and as of the next fiscal year it will be a definite committee with responsibilities. One introductory paragraph I would like to read to all of you is this:

"Mosquito Control Agencies in California presently use large quantities of insecticides, including some materials of high toxicity to man and domestic animals. During the past ten years, the increased difficulty of killing mosquitoes, due to the development of a tolerance to various insecticides by the mosquitoes, has led to the use of much larger dosages of the older insecticides, particularly the chlorinated hydrocarbons, and the increasingly extensive use of newer materials of great potential hazard, particularly those of the phosphate group.

"State regulations, and the recently enacted Federal 'Miller Bill,' which provides for specific residue tolerances, make it imperative that mosquito control agencies use insecticides within the permissive limits.

"Therefore it appears desirable that there be prepared a guide and recommendations for Mosquito Control use in California."

It is that plan that will be discussed at our business meeting tomorrow morning, to have a committee which will pursue this thought.

Ed, did you have an announcement or so?

Secretary-Treasurer Washburn: The Nominations Committee tomorrow will make their full report, but in order that you may know the procedure in case other nominations are desired, I should like to read from the Constitution the following: "The Nominating Committee: . . . shall also receive before the beginning of the second session of the Annual Meeting, nominations made in writing and signed by not less than three (3) Representatives of Corporate Members, for any elective office in this Association. Nominations may not be made in any other manner."

In other words, there are not nominations from the floor. Nominations must be made through this procedure or through the Nominating Committee. The Nominating Committee has made its report and you as members, at least District members, have been notified of that.

For those of you who have come in late, we would like to again remind you of our court reporter system that we are using this year in taking down the proceedings of this Conference. Dan Richardson, of the Stenotype Reporting Service of San Francisco is here and is doing that job for us. We hope, as Don said earlier, that we will have the proceedings out much sooner than we have ever been able to in the past, so everything you say, Brother, he has it.

I think that at this time I would like to call on two persons to make announcements regarding—I hope this is the right time—meetings scheduled for those organizations.

Dick, would you like to make any announcement regarding the American Mosquito Control Association meetings?

Mr. Richard Peters: I should be pleased to announce that the American Mosquito Association is holding its 12th Annual Meeting at Beaumont, Texas. The Santa Fe train leaves Oakland at 11:25 a.m. the 3d day of February. There is going to be a migration from California to Texas to find out what all that braggadocio is about down under, so anybody who is in any way foot loose and fancy free for about eight or ten days about that time of the year and who can gather together about $200, it is going to take about that of the taxpayer's or of your money, is welcome to join the caravan from California to Texas. The meetings are from the 5th day of February through the 8th, two days in Beaumont and one day in Galveston.

Secretary-Treasurer Washburn: Thanks, Dick. In case some of you don't happen to know, our own Dick Peters is President of the American Mosquito Control Association.

I would like to call on Glen Collett, if he would make an announcement regarding the coming Utah meetings.

Mr. Glen C. Collett: Thank you, Ed. March 16 and 17 in Midvale, Utah, the Annual Meeting of the Utah Association will be held and I am sure many of you have been down there before. Midvale is just out of Salt Lake City about ten minutes' drive and we certainly invite each and every one of you to attend if possible.

Chairman Murray: Thank you, Glen. Let us proceed with our program.

The next paper is by Dr. Donald Rees, Director of the Department of Zoology, University of Utah, Salt Lake City. Now, Dr. Rees could not split himself every way but he had qualified assistance, a person who has been in California, knows what California experiences, and is now in Utah. Mr. Glen Collett will take this paper by Dr. Rees. Glen?

Glen C. Collett: Mr. President, and members of the California Mosquito Control Association, it is certainly a privilege for me to be here today, and even though Dr. Rees is unable to be here, he sends his regards and he is certainly sorry that he couldn't make it this year, but with his being head of the Biology Department he is very busy at this time.

Now, I am going to read this paper that he prepared and this paper is on the "Mosquito Abatement Activities in Utah during 1955."

MOSQUITO ABATEMENT ACTIVITIES IN UTAH DURING 1955

Don M. Rees and Glen C. Collett
University of Utah

In Utah during 1955, the work conducted in the study of mosquitoes and accomplished in their control attained an all time high for the state, and plans are prepared for a more extensive program in 1956.

In Utah there is a strong Mosquito Abatement Association. There are eight organized mosquito abatement districts and a number of cities and towns not included in the organized districts that conduct some mosquito abatement work. The staff of the Logan Field Station of CDC, USPHS under the capable leadership of Dr. A. D. Hess has done much to strengthen the program in Utah. In addition members of the staff of the University of Utah, Utah State Agricultural College, Brigham Young University and Weber College have continued with an active part in the program. Officers and staff members of other agencies such as state, county, and city governments, health, fish and wildlife, reclamation, conservation, agriculture, irrigation, utilities, and industry have been actively engaged in the mosquito investigation and abatement program in Utah during the past year.

The Annual conference of the Utah Association was held in Farmington, Utah, on March 17-18, 1955, with the Davis County MAD serving as hosts. The meetings were attended by representatives of six of the organized districts and all of the above mentioned organizations. A large delegation from California were in attendance and did much to contribute to the success of the conference.

Mosquito abatement workers in Utah are very appreciative of the assistance and support we have always received from our colleagues in California. We take this opportunity to extend to all of you an invitation to attend the annual meeting of the Utah Association which will be held in Midvale, Utah, on March 16-17, 1956, with the South Salt Lake County MAD serving as hosts.

Available reports from the abatement districts in Utah indicate that we had a very successful season in abating mosquitoes. Reports from the two districts organized in 1953 are not available. These districts are located in the southeast part of the state in the "uranium center." There is a rumor that all the mosquitoes down there are radioactive, and the new districts do not want foreigners in on the find.

Control work against mountain or "snow" mosquitoes in the Wasatch Mountains of Utah was continued in 1955. This program has been conducted yearly since 1935 by the Salt Lake City district under the supervision of the Zoology Department at the University of Utah. Not only has this program been extremely effective in making certain that mountainous resort areas are virtually mosquito-free, but it has also afforded an opportunity to study intensively these mountain species.

The Logan Field Station of CDS is conducting an extensive research program on mosquitoes which will be reported by a representative from that station.

Investigations on mosquito taxonomy, biology, ecology, and control are continuing at the University of Utah. We are also continuing our field training program at the University of Utah where we require six months' employment with a mosquito abatement district of our graduate students majoring in entomology. This helps to provide the districts with reliable men during the active mosquito season when seasonal help is necessary, and it also provides supervised field training as well as part time employment for students majoring in entomology.

The development of a cooperative program of mosquito abatement among all agencies concerned with water management has made rapid progress during the past year. For a number of years a cooperative drainage program has been in operation in Salt Lake County where in the Salt Lake County Commission, the Salt Lake City Commission and the Board of Trustees of the Salt Lake City district have each contributed $10,000.00 to a joint fund to maintain the drainage system in Salt Lake County. This program was very effective during the past year and the results obtained were highly satisfactory to the agencies participating and the citizens of the county.

In planning the 70 million dollar Weber Basin development and management project in northern Utah, the Bureau of Reclamation has consulted with representatives of all agencies concerned with water problems in the area affected. Many of the results of these discussions are being incorporated into the construction of this project, including source reduction of mosquitoes. As a considerable part of this reclamation project is in Davis County, DeLore Nicholes, until recently County Agriculture Agent and the man largely responsible for directing mosquito abatement work in Davis County, has organized a Davis County Correlation Committee. The purpose was to correlate the activities of all agencies engaged in water management in Davis County. Representatives of all governmental and private agencies interested in such a program were invited to attend the meetings. Practically all agencies concerned have participated. At the first meeting, committees were appointed to study different aspects of the problem and prepare reports and recommendations for the committee as a whole. This work is still in progress. The results of the work of this committee should be very beneficial to mosquito abatement in the area and may have far reaching effects in establishing a precedent in planning water management programs in Utah in the future.

The Salt Lake City MAD, the University of Utah, State Fish and Game Department and the Logan Field Station of CDC have entered into an agreement to conduct a study of the Farmington Bay Waterfowl area, managed by the State Fish and Game, to determine the most effective means of regulating the water on this area in order to create conditions most favorable to water fowl and other wildlife and least favorable for mosquito production. If the results of this experiment are satisfactory, they may be used to interest other federal, state, and private agencies engaged in similar enterprises to adopt the principles in their programs.

Concerning equipment, we have another effective piece of equipment now in use in Utah in mosquito abatement work. It is an air-propelled boat. These boats have been used on the marshes in Utah for several years by scientists and sportsmen concerned with the study, management and hunting of waterfowl. In 1954 Box Elder County Fly and MAD constructed and used an air propelled boat. The Salt Lake City and Davis County MAD's jointly rented an air-propelled boat in 1954 to make a few inspection trips. During 1955 the Salt Lake City MAD purchased an air-propelled boat. This boat has now become standard equipment. The boat can be operated by one man. It will carry several men and their equipment over marshes, meadows, and mud flats covered with but a few inches of water. It works equally well in deep water and is capable of speeds up to 35 miles an hour. The boats make it possible to inspect with ease certain areas on marshes and mud flats that were previously inaccessible or impracticable to inspect or to treat with ground equipment.

The only undesirable features detected to date in these air-propelled boats are the difficulties experienced in steering the craft in high cross winds and the overheating of the air-cooled airplane motor after prolonged runs at high speeds. These are obviously only minor difficulties, but they must be considered in the operation of the boat.

An article on the use of this boat will appear in the December issue of *Mosquito News*.

I brought a couple of slides along to give you an idea of what this air-propelled boat is. The hull is aluminum and it is 16 feet long and 6 feet wide. It has an 85-horsepower Continental airplane engine on the back and it does operate very effectively.

This is one of the gun clubs in our District and the boat is being lowered into the water there. It requires about four feet of water to float this off the trailer. Once you get in the water, and once you have launched it, it only requires damp or slick mud or a few inches of water. That is all that is necessary.

Now, this next slide shows the boat out in some of this area. We have thousands of acres of water-fowl country, and it is impossible for me to walk out in these areas. You can't get out to them any other way, since these areas are repeatedly flooded during the summer and every rain storm where the irrigation water is turned loose raises the levels out on this lakeshore area; but this boat, we have found, has been able to get us out to such places, and this year we have treated many areas that I don't think a

Mosquito Abatement man has ever been in before. These areas have been treatd by airplane previously and it gives us an idea of where the breeding is going on. We hope to equip this boat with a mister or power-sprayer of some kind so we can do the work by spraying the area thoroughly.

Thank you very much.

Chairman Murray: Thank you, Glen. I can repeat what Glen suggested, that if you can get to Salt Lake City for their meetings they will welcome you. A group of us went last year and had a very interesting and worthwhile time.

Next we have a paper by Mr. M. H. Buehler, Technical Director, Mosquito Control Section, City-County Health Department, Eugene, Oregon, on "Significant Developments in Mosquito Control in Oregon."

MOSQUITO CONTROL ACTIVITIES IN THE STATE OF OREGON DURING 1955

By

MILTON H. BUEHLER, *Tchnical Director, Mosquito Control Section, City-County Health Dept., Eugene, Oregon*

Mosquito control in the State of Oregon has made several noteworthy advancements during the year of 1955. The existing mosquito control programs have enlarged their spheres of operation; new programs have been started; the State Board of Health has established a new department for vector control; scientific studies have been made on two aspects of mosquito control; and the Oregon Mosquito and Vector Control Association has been officially formed.

A year ago five counties in the State of Oregon were engaged in mosquito control. Coos, Douglas and Lane Counties have individual programs conducted under the jurisdiction of the county health departments. Clackamas and Multnomah Counties cooperate in a program conducted by the City of Portland. Each of these counties has increased the effectiveness of its program by either increasing the scope of its activities, enlarging the area treated, or by increasing the amount of equipment in the field. In my own County of Lane, the greatest forward stride was made when funds were made available for drainage works to facilitate the control of mosquitoes as well as provide adequate storm drainage in lowland areas. It is anticipated that funds for drainage works will be increased next year and it is our ultimate hope that all drainage will be coordinated or possibly combined with mosquito control activities.

Jackson County, under the jurisdiction of the county health department, started an organized mosquito control program in the early part of the 1955 mosquito season. The program experienced a successful season in spite of the fact that they were delayed by a lack of equipment at the very beginning of the season.

The State Board of Health established a Vector Control Section in the Division of Sanitation and Engineering to satisfy a long existing need. LaVerne Miller, formerly in charge of Mosquito Control in Douglas County, is now head of the new section. The activities of the Vector Control Section will be directed almost exclusively toward mosquito control during the summer months and should prove to be a great help to those of us in the field.

Scientific studies on the use of granular insecticides were conducted by the City of Portland-Multnomah County Mosquito Control Project in cooperation with the USDA, Bureau of Entomology and Plant Quarantine. Two separate experiments were conducted; one early in the season for pre-larval aircraft application in areas of *Aedes* flood water hatching and the other during the late summer for Culicine larvae control. A report of these experiments may be found in the proceedings of the First Annual Meeting of the Oregon Mosquito and Vector Control Association. Preliminary studies have been started in Douglas County in cooperation with the United States Public Health Service to determine the ecological factors involved with log pond mosquitoes and their control. The greatest mosquito breeding problems we have in the State of Oregon are assocated with log ponds. Efforts will be made to determine why two adjacent ponds which seem to have the same physical characteristics will show a completely different mosquito fauna, one of which will require chemical treatment at ten day intervals while the other needs to be treated once every three weeks. We are hopeful that this study will be continued and that we may find a weak link in the ecological chain which may greatly simplify control measures.

To many of us the most outstanding advancement in the cause of mosquito control was the formation of the Oregon Mosquito and Vector Control Association. Our Constitution states, "The objectives and purposes of the Association shall be to promote close cooperation among those directly and indirectly concerned with or interested in mosquito and/or vector control and related work, to provide for advancement of members, and to extend and develop the public interest in the control of disease transmitting and pestiferous insects and other pests as an adjunct to public health and comfort. The Association may also encourage and undertake such other problems as the Association or Executive Committee may determine."

As I stated last year, Oregon is relatively new in the field of organized mosquito control; however, we feel that we are making considerable headway toward becoming a State which may be just proud of its organized mosquito and vector control program. We are endeavoring to the best of our ability to establish our mosquito and vector control programs on a sound financial footing under the direction of aggressive and scientifically trained leadership. Through the efforts of the Vector Control Section of the State Board of Health and the Oregon Mosquito and Vector Control Association, we hope to provide factual and helpful information to communities or governmental units interested in establishing mosquito or vector control programs.

Existing mosquito control units are trying to improve their effectiveness and efficiency by studying available literature relative to their problems, by experimentation, and by unselfishly sharing ideas and experiences with others engaged in mosquito and vector control, not only in the State of Oregon but also those outside the borders of our state.

As President of the Oregon Mosquito and Vector Control Association, I would like to express my appreciation on behalf of myself as well as our association for the privilege you have extended to us by inviting us to participate in your meeting. We most sincerely hope that the members of our association may attend your future meetings, and that members of your association will attend our meetings, thereby creating a relationship conducive to a free exchange of ideas and experiences, cooperative efforts toward the solution of mutual problems, a united front on regional problems, as well as provide for the enrichment of personal experiences of our individual members by knowing personally other leaders in their field.

Chairman Murray: Thank you very much, Mel.

Dr. A. W. Lindquist, the head of the Insects Affecting Men and Animals Section, Agricultural Research Service, U. S. Department of Agriculture, Beltsville, Maryland. He is an old-timer to us. He is perhaps a long way off but he comes back repeatedly and he will give us a little bit on the "Control of Mosquitoes under Irrigation and Water Impoundment Conditions."

Dr. A. W. Lindquist: Mr. Chairman, members and friends of the California Mosquito Control Association: About three months ago I received an invitation from Art Geib, who is the Chairman of the Program Committee, to participate in this meeting. My first reaction was to decline the invitation since I have an enormous number of other duties, but upon reflection I decided I just couldn't turn it down. I might not have too much to present but I had to come to the old stamping ground and then, furthermore, we feel a duty when we are asked to participate in meetings.

Art Geib asked if I would discuss a little bit about the Control of Mosquitoes under Irrigation Conditions, but quickly we got a title together which differs just a little bit from what is on the program. It is called "Control of Mosquitoes under Irrigation and Flood Water Conditions." Well, you can tell in just a moment that you could write a book on that and I can't possibly do anything except make a few minor comments on this immense subject.

Perhaps at this time it would be appropriate to make some comment about the weather.

(Laughter)

In December I followed the newspapers and the radio reports of the flood conditions here in California very, very closely. Of course, we don't get the same stories back East of what is going on here, but I think we got a pretty general over-all picture, and for days and weeks my thoughts were out here because I have a lot of friends here. I was wondering, for one thing, what was happening to Clear Lake, since that is subject to flood conditions, and it was a disaster of major proportions; but I have heard since of the great progress that has been made in picking up the pieces. I came in on Saturday night to San Francisco and it was raining buckets. I have never seen anything like it. Coming from a drought condition—you may not be familiar with it, but for three months in the Washington area we have had one of the most extended and severe droughts on record. Up until a few days ago there hadn't been any rainfall for a period of time, so it kind of looked good to see rain again.

Now to get down to the subject at hand.

CONTROL OF MOSQUITOES UNDER IRRIGATION AND FLOODWATER CONDITIONS

A. W. Lindquist, *Entomology Research Branch, Agr. Res. Serv., U.S.D.A.*

The mosquito problem resulting from irrigation of meadows and pastures is an old one, but it is as important today as 25 years ago. It promises to become of concern to many more people during the next few years because of greater emphasis on the use of water for growing grass and other crops. Citizens in areas now free of mosquitoes will soon become aware of the difficulties associated with mosquito control when water for irrigation purposes is brought to their land.

During the last 15 years progress has been made in understanding the various facets of controlling mosquitoes that are either directly or indirectly the result of irrigation. Much knowledge has been obtained on the ecology of these pests. The research here in California has contributed to a better appreciation of the relation of these pests to their environment. Studies by State and Federal scientists on how to manage water on agricultural land so as to minimize mosquito breeding have contributed to the overall program. Great strides have been made in the development of effective and low-cost insecticides. The use of these chemicals to control mosquitoes has its drawbacks, as we well know, but everyone must admit that since they have become available, it is possible to achieve control which would have been difficult or impossible before.

Even though excellent advances have been made, persons conducting research on the biology and control of mosquitoes realize that much more needs to be known in order to achieve the best possible protection at low cost. Research must therefore be permitted to expand, and those of us engaged in practical activities to reduce the pests must constantly encourage the scientists laboring on their biology and measures to eliminate mosquitoes and related species.

The personnel of the California mosquito control districts have had years of experience in fighting mosquitoes under all sorts of conditions. These people have a tremendous amount of knowledge in combating those pests that arise from irrigated farmland. No group in the United States has such a fund of practical experience in combating irrigation mosquitoes. Their combined knowledge should be brought together in an illustrated book.

It would be presumptuous for me even to list the various problems the districts have and how they solve them. However, I should like to point out one interesting part of their job. This relates to the establishment of drainage systems to carry off excess water from the lower ends of irrigated pastures. The object is to reduce the area of mosquito breeding from dozens of acres to perhaps an acre or two, which can be easily and quickly treated with larvicides. With hundreds of pastures in a district, the problem of drainage is immense. No single group could pay for all this work, but by education and enlisting cooperation with county governmental units district officials frequently induce farmers to build drainage systems on their property with a minimum cost to the taxpayers. Smith (1952) reported excellent progress in inducing this type of cooperation. The importance of proper drainage lies in the fact that the control obtained is somewhat permanent. The farmer who assists in drainage problems has helped to reduce mosquitoes that affect himself, his family, and his livestock. Furthermore, he has done a public service in that fewer of the pests will plague his rural and urban neighbors. Other benefits accrue, such as increased yield to the farmer.

I believe that, regardless of our efforts to effect control by filling, ditching, and drainage, we shall have to use insecticides as supplemental controls for many years to come. If so, what can be done about providing lower cost and more effective insecticides? We are now in the period of adjusting to the new group of materials known as the organic phosphorus insecticides. They are replacing DDT, toxaphene, TDE, and others in some places. Recent research indicates that they will have an important part in areas where mosquitoes have developed resistance to the chlorinated hydrocarbon insecticides.

Pioneer work has gone forward here in California on the use of these phosphorus compounds for both larval and adult control. EPN, parathion, malathion, and others are used to destroy larvae, especially resistant strains. The cooperative experimental work between C. M. Gjullin of our Corvallis, Oregon, laboratory, and the California Bureau of Vector Control, and the districts on the use of malathion and other phosphorus insecticides for control of adult mosquitoes shows considerable promise. At the present time malathion appears to be the only insecticide that could be used satisfactorily to reduce adult abundance of *Culex tarsalis* in the event of an encephalitis outbreak. We can feel more secure now than two years ago if large-scale attacks against *tarsalis* are needed. The most difficult aspect of air spraying for *tarsalis* control is to get the insecticide into protected and secluded shelters where this species rests. Perhaps the addition of a chemical that will immediately activate the insect to fly into the open is needed. Or possibly, research should be directed toward use of residual sprays in outbuildings, under culverts and bridges, and in other places where the insects rest.

Another promising chemical-control method appears to be the use of water-soluble or solubilized insecticides in irrigation water for destruction of larvae. This approach to control is far from perfected, but it seems to merit field trials by control districts. Cooperative work between James Gahan of our Orlando, Florida, laboratory and personnel of the Bureau of Vector Control, and the districts indicated that Bayer L 13/59 applied at 1 p.p.m. into the irrigation canal with a simple gravity-flow dispenser destroyed all mosquitoes in the field. Later, work in rice fields in Arkansas indicated that parathion (non-water-soluble) was effective at 0.01 p.p.m. against *Psorophora* larvae. The concentrate contained 4 parts of an emulsifier, Triton X-100, to 1 part of technical parathion. The mixture was completely miscible in water and did not settle out after flowing ½ mile through a canal and over 400 feet into a field. The cost of such a treatment in water less than 4 inches deep appears favorable.

Mosquitoes resulting from floodwaters are more widespread in the United States than any other group. I am referring to flooding that occurs when streams go over their banks and permit water to stand in swales and low places. Every stream, regardless of size, overflows at some time or other. Many streams overflow regularly under normal rainfall or snow-melt conditions. Heavy rainfall may flood immense areas and create mosquito-breeding conditions on a grand scale. It is difficult for control workers to do much about preventing the large disaster floods. In time, no doubt, the flood menace along the larger river systems will be reduced.

The normal overflow of streams, especially the smaller ones, is frequently amenable to correction. The mosquito control in such situations is commonly considered permanent and involves straightening and deepening channels and diking. These measures are expensive and for that reason are rarely employed. Frequently it is possible to amortize the expenditure over a period of 10 or 20 years. Occasionally the reclaimed land obtained by flood prevention has enormous value as industrial sites or for agricultural use. Aside from the fact that useful land is reclaimed, there is a new source of tax revenue which probably will help pay for the flood control. More consideration should be given to permanent control along streams by mosquito workers.

It is gratifying to see the emphasis on mosquito-source reduction associated with floods here in California. There are fine examples of rich agricultural land resulting from the clearing and straightening of streams. Large and troublesome areas have been eliminated in the same operation. Wider acceptance of this type of control is bound to come in the future, and mosquito workers should advocate it wherever the project appears feasible.

In most floodwater areas insecticides are relied upon for control. Larvicides are applied from ground equipment, boats, or airplanes. As far as is known, most of the floodwater mosquitoes can be controlled with DDT and similar materials, since these species have not yet shown marked resistance to them. For conventional larviciding oil solutions are used more widely than emulsifiable concentrates. In many situations prehatching treatments have been found highly effective and comparatively low in cost. Such treatments involve the application of an insecticide a few days or weeks before the area floods. Emulsions, granules, or oil solutions have been used.

I should like to dwell for a moment on possible new approaches to control of mosquitoes. These are mainly ideas for research and have no practical use at this time. They should be considered, however, since we may be interested in new methods and ideas in the future. You have heard about our success with eradication of the screw-worm on Curacao by release of sterilized males. The species was eradicated from their 170-square mile island by weekly releases of reared sterile males for a period of 5 months. About five times as many irradiated males were released as existed in nature, and the total number released was approximately 300,000. These males mate with normal females, but the eggs are infertile. We believe this method of control may have use against other insects under certain conditions. Time will not permit a full discussion of the problems to be considered in research of this nature. The method is not very promising for elimination of mosquitoes except in isolated areas where the population is low at some time during the year or can be reduced by other means. However, we are exploring its possibilities.

Another idea deals with attractants. These may be chemicals, lights, or sounds. A powerful attractant that would draw mosquitoes to some sort of killing device or chemical might aid in control. Although work has been conducted along these lines off and on for several years, nothing practical has been developed. Further research might bring information of considerable value. I would not eliminate the idea of possible control with lights or sounds but rather encourage people who are qualified and equipped to explore the problem rather thoroughly.

Insecticides will be used for a long time to come, but we need to know how to use them in new ways. A material that could be added to irrigation or other water to destroy mosquito eggs would be extremely useful in control. I believe chemicals that are highly ovicidal are now available or will be in the future. It is doubtful that researchers have given sufficient attention to finding chemicals that will destroy eggs.

REFERENCES

Smith, Edgar H. 1952. Drainage for mosquito source reduction. Calif. Mosquito Control Assoc. 20th Ann. Conf. Proc. and Papers, pp. 62-63.

Gahan, J. B., G. C. Labrecque, and J. R. Noe. 1955. Laboratory studies with water-soluble insecticides for the control of mosquito larvae. N. J. Mosquito Extermin. Assoc. 42nd Ann. Meeting Proc., pp. 131-137.

———— and Thomas D. Mulhern. 1955. Field studies with water-soluble insecticides for the control of mosquito larvae in California pastures. Mosquito News 15(3): 139-143.

———— G. C. Labrecque, and C. V. Bowen. 1955. An applicator for adding chemicals to flowing water at uniform rates. Mosquito News 15(3): 143-147.

Chairman Murray: Thank you, Art.

There is a definite trend by the speakers so far to get us to think, a very worth-while idea if we can do it.

I might mention a special matter which is not shown on your program, but Art mentioned the desirability of a book on the irrigated mosquito problem. There is none in contemplation so far as I know, but our District has just finished a movie which is on that problem, about a 28-minute movie, and at the close of our program, if there is time this afternoon, we would like to show that. It is still in a developmental stage. The movie is complete but the sound is not. However, there is sound on it to show the eventual development. It might be a sequel to this.

Next, Lloyd E. Myers, Jr., Irrigation Engineer, Soil and Water Conservation Research Branch; Agricultural Research Service, U. S. Department of Agriculture, Reno, Nevada. He will talk on the "Western Soil and Water Management in Relation to Mosquito Control."

Lloyd is an old-time Californian and has been here for some time and we welcome him back.

Lloyd?

Mr. Lloyd E. Myers, Jr.: Mr. Chairman, members of the California Mosquito Control Association, I am very happy to be here not only because of my own personal feelings, but because my presence indicates a material interest on the part of an agency responsible for research in soil and water management in mosquito control. It is a subject very dear to my heart. It is also a subject that would do justice to several books, so we will use the shotgun pattern and hope that we hit a few things of interest.

SOIL AND WATER MANAGEMENT IN RELATION TO MOSQUITO CONTROL[1]

By

LLOYD E. MYERS, JR., *Irrigation Engineer*

Soil and water management, as practiced in the Western United States, is a very broad field. Soil management practices include reclamation, cultivation, crop rotations, fertilizer application, erosion control, soil structure improvement, and a host of related topics. Water management practices relate primarily to irrigation and include storage, conveyance, measurement, application, drainage, recharge of underground aquifers, and so on, almost ad infinitum. All of these practices are either directly or indirectly related to ponding of water on soil surfaces, and so are of concern to mosquito control agencies and personnel.

We are concerned with water which stands upon the surface of the ground long enough to permit mosquito production. We might therefore discuss several questions concerning such standing water. Why do we not design irrigation systems which permit the farmer to easily apply exactly the amounts of water required by the plants? Why do even careful farmers apply more water than the plants actually need? Why does the excess water stand on the surface of the soil? What is the agricultural significance of such standing water? What can be done to improve the situation?

The design of good irrigation systems is frequently a difficult task, complicated by the necessity of considering a number of interrelated factors. Perhaps the most complicating of these is the variability of infiltration rates. If the rate at which water soaked into the soil remained constant, design of an irrigation layout would be a comparatively simple matter. For sprinkler irrigation we could readily determine that a given nozzle size, used on a given spacing and at a given water supply pressure, would give satisfactory results. For border strip methods we could easily design the combination of stream size, slope, width of strip, and length of run which would give satisfactory results. The design of furrow irrigation systems would not be difficult. Unfortunately, the infiltration rate is not constant. It changes during a given irrigation, decreasing at any given spot in the field as the length of time water stands or runs over that spot increases. It changes during the season for a given crop. It changes when the type of crop grown is changed. It changes when the cultivation methods are changed. The basic factors responsible for these changes in infiltration include seasonal and long-term deterioration of soil structure, occasional improvement of soil structure, variations in soil moisture content, changes in plant root and foliage density, soil compaction, quality of water, temperature, and barometric pressure. Because of the complex inter-relationship of the factors responsible for variations in infiltration rates, it is most difficult to predict the magnitude of the changes which will occur. For this reason, it is usually not possible to design an irrigation system which will be perfect under all conditions. Basin-type irrigation systems are less affected by changes in infiltration rates than are other types, but basin irrigation is not adapted to many crops and cannot be used in many localities because of the heavy leveling required. Practical considerations frequently demand the development of compromise designs which will permit reasonable, but not perfect, irrigation efficiency under any foreseeable set of conditions which may occur.

A most important part of irrigation water management is the determination of the amount and frequency of water application. Ideally, the frequency is determined by the rate at which water is removed from the soil by evap-

[1] From the Western Soil and Water Management Section, Soil and Water Conservatiton Research Branch, Agricultural Research Service, U.S.D.A.

oration and transpiration, and the quantity is determined by the water holding capacity of the soil. The rate at which plants use water is not constant throughout the season but varies according to the plant growth stage and the conditions of temperature, wind velocity, and humidity which prevail. Different soils have different capacities for holding water which is available to plants. These capacities can be expressed as inches of water per foot of soil depth, and range from about one-half an inch for some sandy soils to over two inches for some clay soils. Good water application practice involves delaying water application until the available moisture in the soil has been depleted to some quantity dependent upon the crop being grown, and then applying only as much water as the soil will hold in the plant root zone. When salt problems exist the quantity of water applied should be increased, but the principles of determining frequency and quantity of water application remain the same. In actual practice the frequency of irrigation is often determined by the dates on which water is made available to the farmer by his irrigation district. Quantities applied are frequently governed by the amount of water available, or at best by estimates of the degree of soil moisture replenishment required. Many farmers are not familiar with the techniques for determining irrigation frequencies and quantities. Others do not believe it feasible to take the soil samples presently required for such determination. Work is being done at a number of locations by the Agricultural Research Service, in cooperation with other agencies, to overcome this latter difficulty. A correlation has been found to exist between the rate of water use by plants and the rate of evaporation from open pans. This relationship is not direct and the various factors affecting it must be worked out. It appears highly probable that at some time in the not too distant future it will be possible for a farmer to determine proper irrigation frequency and quantity of application by measuring evaporation from a standardized pan.

The information just presented has dealt with some of the difficulties involved in attempting to obtain perfect application of irrigation water. It should be emphasized that even under ideal conditions water cannot be applied to an irrigated field with 100% efficiency. Sprinkler irrigation seldom exceeds 70% efficiency and 65% is considered excellent for surface flooding methods. We might refer to an often referred to publication, USDA Agriculture Information Bulletin No. 8 entitled, "Conservation Irrigation" (McCulloch and Criddle, 1950). One statement in that publication reads as follows: "An irrigator practicing conservation irrigation has control over his irrigation water from the time it enters the ditches and on down until a small part leaves as waste water." In view of the evidence it seems reasonable to expect some over-application of water to irrigated lands, with the resultant development of irrigation waste water. It would also seem reasonable to expect that adequate planning of an irrigation system should also include facilities for the collection and proper disposal of such water.

We all know that, despite application of excess water to irrigated fields, if water always soaked into the soil at a reasonable rate, we would have few mosquito problems within intermittently irrigated fields. We are all well aware of the importance of infiltration, which is the process by which water moves downward through the surface and into the soil.

Water moves into and through the soil in passages between the soil particles. Flow through the larger passages is motivated by gravitational forces, or by the weight of the water itself. Flow through the smaller passages is motivated primarily by capillary forces. Many authorities consider that infiltration due to capillary forces is negligible and that any appreciable quantity of infiltration must occur through soil passages which are large enough to permit gravitational flow. Sandy soils ordinarily have high infiltration rates due to the relatively large size of the individual soil particles with the resultant relatively large size of the passages between them. Passages between individual clay and silt particles are so small that gravitational flow does not occur readily. Appreciable gravitational flow can occur in clay and silt soils only when the individual soil grains are bound together, or aggregated, so that they act as larger particles. The size distribution of these aggregates determines the soil structure. Good infiltration of water into soils containing appreciable amounts of silt and clay is dependent upon good soil structure.

Generally speaking, soil structure is good when the grains of sand, silt, and clay are bound together into water-stable crumbs or aggregates and these soil crumbs are in turn held together in larger units. Soil structure is poor when the soil crumbs, if any, disintegrate into their component grains upon submergence in water, or when the aggregates are tightly cemented by the clay colloids into an amorphous or non-porous mass.

The exact processes involved in the development of good soil structure have not yet been exactly defined in a manner acceptable to all soil scientists. It is generally agreed, however, that the desirable finer aggregates are produced by the action of soil fungi, actinomycetes and bacteria, by the interaction of some humic fractions with clay particles, and by the action of plant roots. (Russell and Russell, 1950.) No single one of these factors acting alone is capable of producing a permanent, good soil structure. The continued and combined action of all of them is necessary. (Hubbel and Staten, 1951.)

Soils which are saturated for long periods of time not only favor mosquito production, but suffer structural deterioration. Continued saturation of the soil results in the breakdown of unstable aggregates and hinders the processes by which they might become stabilized. Most soil fungi and actinomycetes require conditions of good aeration and few, if any, other than yeasts have been recognized as anaerobes. Certain soil bacteria grow under anaerobic conditions, but it has been shown that under prolonged saturation of the soil these bacteria not only fail to improve soil structure but actually seal the soil pores and drastically reduce infiltration of water.

No agriculture can be permanent which does not maintain an adequate soil structure and failure to maintain it has resulted in the failure of many farming ventures. The much heralded soil additives have proven uneconomical for improving soil structure in actual farming operations. In the absence of short-cuts and magic wands, it appears that good soil structure must be obtained through natural processes. It appears certain that in the future we must not only pay attention to superficial practices favorable to plants grown as crops, but must also pay attention to creating conditions favorable to the growth of beneficial soil organisms.

Water which stands long enough to permit mosquito production is also, as we well know, harmful to most beneficial plants. Root systems of most plants grow vigorously only in well-aerated soils. Aeration of the soil affects the roots through its influence on three factors: the oxygen content of the soil air; the carbon dioxide content; and the content of by-products of anaerobic decomposition, such as methane, hydrogen, and hydrogen sulfide, which accumulate in the soil. The relative effect of these factors on different plants is variable. Sometimes the effect is indirect and plants which could survive the chemical and mechanical effects of soil saturation for a short period of time are so weakened that they die because of subsequent attacks by pests or disease. Regardless of the mechanisms involved, we know that most plants are harmed by periods of soil saturation. We do not, however, know very much about the degree of harm. We need more information concerning the relative tolerance of various plants to periods of intermittent soil saturation. We need more information concerning the effect of intermittent soil saturation on the yields of these plants.

All factors associated with soil and water management are so inter-related that one cannot be evaluated without considering the others. Irrigation design must consider infiltration rates which are affected by soil structure. Irrigation frequencies and quantities are related to plant rooting depths which are frequently affected by soil structure. Aeration of plant roots is affected by water application practices and by soil structure. Soil structure, in turn, is affected by water application practices, tillage practices, fertilization, plant root growth, and so on. As we examine the factors involved, it became obvious that we cannot effectively solve one problem if we ignore the others. All the factors associated with soil and water management must be considered by any effective research program and by any effective educational program.

Agricultural research is conducted by both Federal and State agencies. On the State level research is carried on by Agricultural Experiment Stations. The University of California has a number of excellent Experiment Stations which devote their attention to problems which concern agriculture in the State of California. On the Federal level research in the field of soil and water management is now concentrated in the Soil and Water Conservation Research Branch of the Agricultural Research Service. This Research Branch is divided into five sections. The Western Soil and Water Management Section conducts research in the 17 Western States in cooperation with other interested agencies, including Agricultural Experiment Stations and the Soil Conservation Service. Research conducted by our Section is designed to be of a regional nature. The work is of benefit to the State in which it is done but is also intended to be of benefit to other States as well.

Cooperative projects directly related to mosquito control have been initiated in California and Montana. The California project is a joint effort on the part of the California Bureau of Vector Control, the California Mosquito Control Association, and the Agricultural Research Service. This project was described at the joint AMCA-CMCA Conference in Los Angeles last year and the results of the past irrigation season will be presented to this Conference by R. C. Husbands and N. A. MacGillivray. In 1955, U. S. Public Health Service and Agricultural Research Service cooperative field studies were initiated in the Milk River Valley, Montana, to determine if improved fertilization and irrigation practices could be developed which would increase bluejoint *(Agropyron smithii)* yields on heavy Bowdoin clay soils and at the same time decrease mosquito production. Results indicate that a five-fold increase in bluejoint yields is possible when heavily fertilized with nitrogen and 60 percent of the available moisture within the root zone is allowed to deplete prior to irrigation. Mosquito production under these conditions was eliminated, whereas adjacent flooded borders representing former irrigation practice in the area produced an abundance of *Aedes* and *Culex tarsalis* mosquitoes.

REFERENCES

Hubbel, D.S. and Glen Staten; Studies on Soil Structure; Tech. Bul. 363, Agr. Exp. Sta., New Mexico College of A. & M.; State College, New Mexico; 1951.

McCulloch, A. W. and W. D. Criddle; Conservation Irrigation; Agriculture Information Bul. No. 8, Soil Conservation Service, U.S.D.A.; Washington, D.C.; 1950.

Russell, Sir E. J. and E. W. Russell; Soil Conditions and Plant Growth; Longmans, Green and Co.; New York, N.Y.; 8th ed., 1950.

Chairman Murray: Thank you, Lloyd.

Next on our program is Dr. A. D. Hess, Director of the Logan Field Station, U. S. Public Health Service, "Field Investigations by the Logan Field Station." Dr. Hess has been in California many times. Since he has slides to show, please arrange yourselves so that you can see these pictures.

Dr. Hess, when you are ready, we are ready.

Dr. A. D. Hess: Thank you. I am going to run this machine myself so I will be talking with you instead of to you.

INVESTIGATIONS OF THE LOGAN FIELD STATION

A. D. Hess, *Chief*

Logan Field Station Section, CDC

Logan, Utah, is headquarters for the Logan Field Station Section, Technology Branch, Communicable Disease Center, U. S. Public Health Service. The three major research activities of the Logan Section are: (1) distribution, ecology, and control of plague; (2) natural history and control of encephalitis; and (3) vector problems associated with the development and utilization of water resources.

The plague research is centered at San Francisco, where the Public Health Service has maintained a plague station for a half century. The encephalitis research is carried out in the intermountain area around the Logan headquarters and at Bakersfield, California, the latter being a cooperative project with the School of Public Health of the University of California. Some of the laboratory work of the Section is done at Greeley, Colorado, Field Station of the Epidemiology Branch of the Communicable Disease Center. The work on vector problems associated with water resources development is nationwide in scope, but research activities are currently concentrated in the irrigated areas of the West. A field unit is maintained at Chinook in the Milk River Valley of northern Montana. Other study areas are in the log pond region of the Northwest, the Angostura irrigation project in southwestern South Dakota, and the deep-well irrigated area in the Southern High Plains of the Texas Panhandle.

A detailed account of the activities of the Logan Field Station will appear in the Proceedings of the Tenth International Northwest Conference on Diseases in Nature Communicable to Man, held at Moscow, Idaho, August 29-31, 1955.

Chairman Murray: Thank you very much, Dr. Hess, for this interesting and informative series of pictures and talk.

As it is now 12:20 we will adjourn until 1:30.

AFTERNOON SESSION — 1:45 P.M.

JANUARY 16, 1956

Chairman Murray: We are about ready to start our program. We may be a little late but then we are not all here so it comes out about all even.

As you know, Dick Sperbeck, our President, is still missing with the flood. We are going to find out if he can't be here at least later on today or tomorrow.

We have another missing person in the form of Art Geib, Manager of the Kern District. Some of you have already heard, and some of you may not have, that he wasn't feeling too well and in view of his past health experiences he cannot take chances; so he could not make it to the panel of which he was moderator, which puts us in a very awkward spot. However, we have a most capable substitute who can take over, Ed Washburn, who will do that.

Bob Portman, also on this panel, hasn't shown up. Has anybody heard from him? Ed Washurn is here and John Stivers, if you will come up and if you will gather around so we can talk into this microphone it will be better.

Now, substituting for the Kern Mosquito District, Gordon Smith will present that information. The rest of us are here.

AIRCRAFT SYMPOSIUM

Mr. Washburn: Thanks, Don. I think Don must have kissed the Blarney Stone. We knew last night, of course, that Art would not be here today, so some of us are pinch-hitting on this particular panel of the discussion of aircraft, which are used in Mosquito Control in California.

Since the moderator is not here, none of us know exactly what he had in mind. We were given an outline some time ago and each one of us has worked out our independent thinking and materials on it. Some of the questions I will relate to you so you can be thinking about them, because I think this might be a good point in our conference for more audience participation than we have had.

Some of the questions that Art is asked are:

First, "What is the actual value of airplanes in the existing operations in various Districts?" And "What is the cost of control with various types of planes?"

"Is it cheaper to contract for airplane operations or to own and operate your own ships?"

Also, "What types of ships can be operated most cheaply yet effectively?"

And "What types of ships are the most satisfactory?" And, "The advantages and disadvantages of light vs. heavy-type planes."

Actually, in aircraft terminology, the ones detailed here are not heavy aircraft by any manner of means. It so happens that in California mosquito control work there are three separate distinct types of aircraft operations. Some of the Districts own and operate their own ships, other Districts contract with independent operators for all of their aircraft services, and of course, both entail different features. There is a third one where some of the Districts not only own their own aircraft but at times find it necessary and essential to employ a private operator.

I would like to start the panel discussion, by turning it over to the District that originated the program. Gordon Smith of Kern Mosquito Abatement District will start with this particular phase and will discuss the operational costs and factors involved in the aircraft work of their District.

The Kern Mosquito Abatement District, as you probably know, owns its own craft.

Gordon?

GORDON F. SMITH, *Technical Director*
Kern Mosquito Abatement District

As you know, Art Geib developed and was to moderate this symposium. At the last minute, he could not be here due to a bad cold. I am therefore pinch-hitting with not too much of an idea just what he wanted to cover and how he planned to go about it.

As I understand it, the greatest interest seems to be centered about the economics of using aircraft for the control of mosquitoes and the advantages of districts owning and operating their own ships as compared to contracting such work with commercial operators.

Members of this panel have all had a number of years' experience in the use of planes in their respective districts. Some own and operate their own ships, while others have their work done under contract by commercial crop dusters.

Most everyone is familiar enough with the use of planes in mosquito control to know that it is most difficult to compare operations from district to district as well as different types of planes, because of the non-controllable factors which affect such operations. Perhaps we should mention a few of the more important—ferrying time, size and number of locations treated, swath width, availability or use of ships for all types of applications, etc. Nevertheless, over a period of years, these cost figures under varying operating conditions in different districts with different ships should be of considerable interest and reasonably valid.

For example, in the Kern District we now have the complete and detailed cost of operations for the airplane application of insecticides covering a nine-year period. It is this data I will refer to in our discussions on this symposium.

The planes we use in the Kern District are Stearmans with 220 h.p. Continental engines. Actually, we have boosted the horsepower a little by installing dome pistons. They are, otherwise, a conventional type plane. We use 18 nozzles adjusted to put out a gallon per acre, 90 miles flying speed, and a sixty-foot swath width. We are using spraying system nozzles with diaphragm shut-offs.

Actually, as far as the value of the airplanes to our District is concerned, we feel we couldn't possibly get along

SUMMARY OF AIRPLANE OPERATIONS
KERN MOSQUITO ABATEMENT DISTRIST
1946 - 1955

	Square Miles in District	Year	Number Flights	Acres Treated	Hours Flight Time	Average Ac. per Flight	Average Ac. per Flight Hr.	OPERATIONAL COST Per Hr.	OPERATIONAL COST Per Ac.	INSECTICIDE Cost per Acre	Insecticide Used	Total Cost per Acre	Gross Cost
	766	1946	101	4,491	94.6	44.5	47.5	$40.00	$.84	$.35	DDT	$1.19	$ 5,347.*
(1)	826	1947	414	24,527	228	59.2	85	28.49	.34	.32	DDT	.66	16,256.
	826	1948	466	26,445	273	56.7	96	28.36	.29	.22	Toxaphene and DDT	.51	13,448.
(2)	884	1949	550	34,525	332.7	63	106	32.00	.30	.18	Toxaphene and DDT	.48	16,534.
	884	1950	662	42,175	371	63	113	27.30	.24	.20	Toxaphene and DDT	.44	18,607.
(3)	962	1951	625	37,878	372	60.6	101.8	25.99	.25	.25	Toxaphene and DDT	.50	19,321.
											Aldrin and Dieldrin		
	962	1952	543	23,477	341	43	74	32.38	.47	.36	E.P.N. and Aldrin	.83	19,465.
	962	1953	472	20,939	304	45	69	40.74	.59	.41	E.P.N.	1.00	21,232.
	962	1954	505	24,070	350	48	68	42.50	.62	.30	Parathion and Chlorthion	.92	22,119.
	962	1955	455	23,104	331	51	73	33.20	.47	.30	Parathion	.77	17,736.
9 Year Average			521	28,571	330	54.4	89	$32.36	$.396	$.282		$ .68	$18,302.

* All Flights on Contract at a rate of $40.00 per hour Flight Time. This year not included in averages.

DETAIL ON OPERATIONAL COST

Year	SALARIES Pilot	Helper	%	Insurance	%	Hangar Rental	%	Vehicle Expense	%	Gasoline And Oil	%	Repairs	%	Airplane Rental*	%	Total Cost
1947	$4,800.	$259.	61.5	$1095.	13.3	$ 81.	1.0	$?		$1081.	13.1	$ 897.	11.0	$...		$ 8,215.
1948	4,584.	100.	60.4	1083.	13.9	300.	3.8	72.	.92	1215.	15.7	387.	5.0	...		7,743.
1949	5,305.	107.	52.2	1025.	10.0	500.	4.8	50.	.5	1417.	13.6	1931.	18.6	...		10,354.
1950	5,540.	26.	55	1034.	10.2	500.	4.9	229.	2.2	1551.	15.3	1252.	12.3	...		10,136.
1951	5,914.	49.	59	1197.	11.9	300.	3	145.	1.4	1660.	16.4	401.	4.0	428.	4.2	10,096.
1952	6,236.	...	55.1	1179.	10.4	300.	2.6	158.	1.4	1681.	14.9	1463.	12.9	294.	2.6	11,312.
1953	5,820.	49.	47	1219.	9.8	400.	3.2	164.	1.3	1326.	10.6	3339.	26.7	181.	1.5	12,494.
1954	6,339.	...	42.5	1363.	9.1	600.	4	346.	2.3	1823.	12,2	3931.	26.4	492.	3.3	14,896.
1955	6,560.	...	57.7	1016.	8.9	469.	4.1	101.	.89	1698.	14.9	1422.	12.5	99.	.01	11,365.
Average	$5,743.			$1134.		$383.		$158.		$1494.		$1669.		$293.		$10,734.
Average %		53.5			10.6		3.6		1.5		13.9		15.5		1.9	

* Airplane Rental for Aerial Inspection Purposes
(1) Shafter Area; Annexed 60 square miles, January, 1947.
(2) Wildwood Area; Annexed 58 square miles, October, 1949.
(3) Wasco Area; Annexed 78 square miles, January, 1951.

without them. We just couldn't do the job, primarily because of speed of operation. You are all acquainted with the speed with which *Aedes* develop in the San Joaquin Valley. It doesn't need to be mentioned.

We probably fly places of considerably smaller acreage than many of the districts using contract ships do. I will let Don Murray argue that point if he wants to. We fly locations as small as four or five acres on up, using emulsifiable material. We don't use solutions of any type. We have done some experimenting with granules, but very little, primarily because we could not get contract ships when we needed them. I don't have any data on that. However, we are converting one of our two planes this winter to a dust-hopper ship so that we can do more extensive work with granules.

We have averaged 521 flights a year with an average acreage treatment of 28,571. Acreage has varied from 42,175 maximum to 23,104 minimum. The acreage in general has been reducing somewhat over the years, but during the last four-year period, it hasn't varied too much.

The flight hours averaged for that acreage 330 hours per year. The average acres per flight has shown a wider range or variation than most data through the years. A maximum, which was 63 acres per flight for 1949, down to an average of 43 acres during in 1955. I bring that in as a plug for source reduction, as source reduction work has materially reduced the acreage requiring treatment. The average acres per flight hour for the nine-year period has been 88, which is quite a bit. This is considerably below the maximum of 1950 of 113 acres per flight hour. Our overall operation cost per hour has been $32.26, which is a pretty fair average, and we have done this over nine years while doing just about everything with planes. We have re-covered them, had majors on the engines, bought new engines, and everything else. This amounts to an average cost per acre of $.396.

Insecticide cost per acre has varied, from 18 cents for toxaphene up to 41 cents for EPN.

On the operational cost, I think probably the percentages in the various categories will mean more than the actual figures. These data are prepared in tabular form, which I presume will be included in the proceedings. I should, perhaps, report a little more from this tabulation at this time.

The salary percentage is, of course, the highest, 54.6% of the total operation cost on a nine-year average. Insurance ran higher, I think, than we thought it would: 10.8%. That includes the Compensation, P.L. and P.D., all insurances carried on the airplane operation. Hangar rental, 3½%; vehicle expense, 1.3%; gasoline and oil, 13.7%; and repairs, 14.4%. There is another item on here which brings it up to a hundred percent. It actually shouldn't be here, since it is not operational. We have an item for airplane rental, 2.5%, which is primarily observation and not operational rental. There are a few operational flights in there.

That is about all I can offer offhand. I would be happy to answer any questions that you may have about our operation of the planes.

Mr. Robert Peters: What is your insurance cost?

Mr. Smith: The percentage cost on insurance is 10.8 per cent. Our average cost of the nine-year period was $1134 on insurance. You can apply those percentages to a figure of$10,719, which is the total average cost figure over the nine-year period. It averages $10,719 a year for those categories.

Mr. Washburn: Thanks, Gordon.

We'll now hear from a District which owns more than one aircraft, and I think we will find some comparative costs which will be interesting. The Merced Mosquito Abatement District owns and operates three craft of their own. Again, we are in the same category as previously, District-owned aircraft, and in this case three ships.

John O. Stivers, *Manager*
Merced County Mosquito Abatement District

I am in the same category as Gordon Smith in more ways than one, although I have got one jump on Gordon in that I have got the questions even if I haven't got the answers. I probably spent as much time as he has in writing this up, although I did spend quite some time in summarizing some data. We unfortunately do not have a nice nine-year backlog of statistics, as Kern County has. We have only been keeping good figures on this operation for about three years and our operation has changed so much during that time that we made no attempt to average them. The figures which I will give you are all entirely for the past season, that is, the 1955 calendar year.

I, like Gordon, will refer to Art Geib's questions here in an attempt to get those covered in the summary. The first thing Art asked was, "What is the actual value of airplanes in the existing operations in various Districts?"

I will have to second Gordon's motion. We couldn't get along without them, either. That situation varies greatly, however, from one District to the next. There are some Districts which would have, obviously, no use for an airplane. There are other Districts, including Gordon's and ours, in which they are an extremely important part of the program.

In the Merced District, 91 per cent of our larvaciding program last year was performed with the airplanes, leaving just 9 per cent to be done by hand sprayer and truck application.

That aerial larvaciding program comprised 64,477 acres sprayed. I am rather surprised—I didn't get a chance to compare notes with Gordon previously—but I am surprised how close our figures come to his, despite the fact we are using completely different airplanes. Gordon quoted .396 cents per acre sprayed by airplane, excluding insecticide cost. Our last year figured out to .415 cents per acre, a very close comparison in spite of the differences in planes.

We made 1,843 separate applications of larvacide with the airplanes this past season. In making these we averaged 35 acres per application. That is, the average size field sprayed was 35 acres.

This is one of the points, incidentally, in which Art was particularly interested, that is, the relative size of the fields which we were treating with the planes. We worked that out a little farther. In addition to getting the average size of the field of 35, we found that fields less than 10 acres in size compared 26 per cent of our total job; fields 11 to 20 acres in size comprised 25.9 per cent; and fields 21 to 40 acres took up 23 per cent more. In other words, three-quarters of our work is in fields less than 40 acres in extent. Carrying that out a little farther, in the fields 41 to a hundred acres in size, there were 21.1 per cent more, and in fields greater than 100 acres, only 3.7 per cent was comprised in our operation. We are getting into fields hardly bigger than the airplane. We are getting in some places where we don't have bad obstructions, into fields as small as an acre and a half or two acres and doing it economically—in fact, cheaper, we think than we can do it with a man and a truck.

I will give you a few more statistics and some general information. On these flights we averaged 8.7 minutes ferry time. That is a rather extremely reduced figure from what it would have been several years ago and we have accomplished it by spotting air strips which we either own or lease or get permission to use throughout the county so that at no time do we have any lengthy ferry trips to make unless we are moving a ship from one strip to another in order to take care of another area. As I say, we averaged 8.7 minutes in ferrying both ways on these jobs and the length of ferry time, which includes the long trips between strips, was 13.1 miles average.

I have gotten off Art's questions a little bit, I am afraid. The next one after the general cost of control was as to a comparison between the operating of a District's own ships, and contracting.

I have had no experience whatsoever in contracting ships in the area so I can't make that. You will have to draw that conclusion yourselves after hearing the rest of these talks.

Art's next question here is, "What types of ships can be operated most cheaply yet effectively?"

As I say, I am rather surprised at how close our average figure comes to that of the Kern District. Our airplanes are, as I say, completely different from those which they are using. The Stearman, which the Kern District utilizes, is, of course, the standard spray rig in the State, as well as the rest of the world. We are using a somewhat smaller plane. As Ed said, it is rather hard to draw the line between light and heavy airplanes. None of us are using heavy airplanes, yet I don't believe we are down to the really light category. Our ships are, for the most part, Aeronca sedans, which are 145 horsepower 4-passenger airplanes. I think, if you are talking about really light ships, you are probably in the category of 65 and 85 horsepower Cubs and Aeroncas, the little 2-passenger ships. So, as I say, we are more or less in a middle-size category with the planes. The pilot can slow them down, they are extremely maneuverable, they are economical to operate, they have a standard 145 horsepower engine, which gives good service and is in the smaller category where you don't go broke when you have to overhaul them. I am not too familiar with the 220's which Kern uses, but I know overhauling a Stearman engine costs about $2,000.

Mr. Gordon Smith: On 220's it is cheaper to buy new engines than it is to overhaul them.

Mr. John Stivers: It won't always be that way, I am afraid, Gordon. In case you didn't hear that, on the 220's, it is cheaper to buy an engine than it is to overhaul it. Unfortunately that situation can last only as long as the supply of WWII surplus 220's. We know it is cheaper for us to buy a new 145 or 150 h.p. engine than it would be to overhaul a 450, particularly using our own mechanics, which we try to do.

To get a little more description of the planes themselves, as I say they are standard 4-passenger—that is, two seats forward and two seats aft, high-wing monoplanes, with 145 horsepower Continental engines. They do not have flaps which are one advantage which might well be added to them. They will spray down to about 45 miles an hour ordinarily without getting into stalling trouble. They will cruise, with the spray gear hanging from them, at about 90 miles an hour. We put a hundred-gallon fibre glass tank in place of the rear two seats for our insecticide supply, and, utilizing mostly standard equipment, we have built up our own spare rigs for them. The first rig which the District obtained was a factory-built spray rig which has been modified to a point where the factory would no longer recognize it, I am afraid. For our purpose it is much better than the original one was. We have made a few changes in the last year or so in order to accommodate phosphates and make the planes a little safer for the pilots where we could. We have, for instance, removed all of the insecticide lines and gauges and so on from the cockpit and put the gauge outside on the strut, and all of our controls are run through flex-lines to a central position underneath the cowl of the plane.

One of the things we were worried about in starting out with the phosphates would be the leakage of the phosphates into the cockpit, which would cause the loss of the plane and the pilot in a hurry. We have set up a rather unique situation of a separate control panel for the spray controls which we located underneath the dash of the plane which is within hand's reach of the throttle so the pilot doesn't have to wave his arms like a hula dancer in order to get everything on and off as he sails through the field. We have got everything within a short distance so it can be accomplished by one hand and never more than a few inches away from the throttle. We have equipped them all with quick-dump valves so we can get rid of the load in case we are in trouble. And also we have gone to plastic booms for the most part.

That, I think, pretty nearly covers Art's question on the subject. As I say, our District couldn't get along without the plane, the program which we have and the planes which we have evolved over a number of years of operation. The District at one time contracted all of the spray work by plane. It bought its first airplane in 1948, and we have owned, including the three planes which we now own, eight planes since then. We plan, if possible, to increase, if anything, our air-spray program. We are doing, as I say, 91 per cent of our spraying that way now. I doubt if we can increase that percentage very much, but I do think we can increase our efficiency and our total volume by increasing the air-spray program.

Now I have described the Aeronca sedan rather extensively since that is the plane we have used in the past, and it is two-thirds of our present fleet. Our third plane we only added at the end of the present spray season so I can't speak authoritatively on its performance. I can only say from what little use we did get out of it, it appears to be an excellent airplane and I think possibly, if it works out this spring as it did last fall, it will be the type we will add in the future.

This plane is a Call-Air and it was originally designed as a mountain passenger plane. It carries a pay load of 110 gallons. Its particular features are its extremely good visibility, its sturdiness, and the very efficient highlift wing that it has. The plane is built as a mountain plane essentially and therefore performs very well. It will fly a little slower than an Aeronca when it comes to spraying, and it takes off quicker and lands shorter. As I say, I can't guarantee that airplane until we use it some more, but so far it looks like it may be an even better answer than Aeroncas have proved in the past.

I might throw in just one more thing here. This panel is supposed to defend air spraying in general, but we did make one small comparison between it and the truck operations. We found that it cost us to spray with trucks, approximately $5 per acre as compared with 41 cents per acre which it took with the plane.

Now, those of you who are involved in operational programs will realize it is awfully hard to pin down very accurately the cost per acre of spraying by truck because your truck and the truck operator do so many other things besides spraying. That figure of $5 per hour is somewhat subjective, but we think it is pretty close, $5 an hour for truck treatment, and 41 cents an hour for airplane treatment. The average number of acres per hour with the truck was 3.3 acres, whereas it was 89 acres per hour that we got with the plane.

Dr. A. D. Hess: What is your standard Larvacidal formulation for airplanes?

Mr. Stivers: This past year we used completely .075 pounds per acre of parathion and one-half per acre of malathion, both in water emulsions.

Mr. Orland W. Carrick: O. W. Carrick, Trustee from Orange County.

First, what is the percentage of the private lands sprayed compared to the public lands? Do you have any difficulty in determining how you should bill for the private lands, and do you have any difficulty in collecting from private owners?

Mr. John Stivers: Unfortunately, sir, Merced County is not Orange County. We have, to date, made no real attempt to collect at all for this work except through the contract which we, in common with many of the other Districts, have with the Bureau of Reclamation on their public lands in our county. This is a guesstimate, but 95 per cent of our spraying is on private lands. We have, as I say, made no attempt to charge for this work in the past, although I am afraid that it is not too far in the future. Our plans along those lines are to use these figures which I have here—in other words, for every acre we spray for you, it will cost you 41½ cents to run the plane, and it will cost you the cost of the insecticide which went on there. And in addition, we will do the inspecting for you free.

Dr. Hess: In your airplane application it is entirely larvacidal, or do you sometimes take a shot at a brood of adult mosquitoes coming on?

Mr. Stivers: Almost exactly as you put it. We sometimes take a shot at a brood of adults coming off. We found, in our experience—that may not agree at all with some of the other results—but we found that Malathion is extremely effective as a larvacidal or adulticidal material in the field, and we have used it that way very frequently. We didn't set out to do that and it wasn't planned at all, but when we found out what a good job it was doing, we continued it. One actually involved was this: With our three-day leeway, fields which had gone to the point where the larvae were late thirds or fourths and it was beginning to get a little hard to kill them as larvae, there has been a tendency among my operators—I don't know if I could get them to admit it—to let them ride another day and get them as adults before they went out.

Mr. T. G. Raley: Ted Raley, from Consolidated MAD.

We have used Malathion in the same level as indicated by John for larvaciding and we have done a lot of adulticiding and find we can work with a smaller dosage using Malathion.

Dr. Hess: What is the dosage per acre?

Mr. Raley: Around two-tenths, we figure, and it is equally effective as an adulticide.

Commander J. M. Hearst: Commander J. M. Hearst. I have four questions and if you would answer "Yes" or "No" it would help me considerably.

Do your costs include overhead, overhaul, and depreciation?

Mr. Stivers: They include depreciation, overhaul and such overhead costs as insurance, salaries, and so on. They do not include the clerical end of it. That is, what work the general office does on the payrolls and so on.

Commander Hearst: The cost you gave is the airplane and the operator but not the inside?

Mr. Stivers: That is correct.

Commander Hearst: You mentioned flaps would be desirable. Is that to give better efficiency?

Mr. Stivers: Yes, sir. I am not myself a licensed pilot. Perhaps Ed could better answer that, but the idea is to util izethe flaps to slow down your speed through the field.

Commander Hearst: Do you ask your spray-pilots to attend meetings of Mosquito Association groups?

Mr. Stivers: Where it appears to would be beneficial to them.

Commander Hearst: Are there any here today?

Mr. Stivers: There are not.

(Laughter)

Mr. Stivers: Just to get myself off the end of this long, long limb, that is no fault of the meetings, it is the fault of my pilots. My chief pilot is on vacation and the others, I feel, would benefit more in learning it from him or I than from the meeting. There is no offense meant to any pilot in the room. The pilots just listen better to other pilots than to any one else.

Glen C. Collett: Glen C. Collett.

I was wondering about the percentage kill on this airplane work, something about 90 per cent, or what do you consider a good kill with the airplane?

Mr. Stivers: I think the problem is to achieve the maximum possible kill with the insecticide. We feel the way we are doing it we are accomplishing as much as we can with Malathion and Parathion, and we have—now don't start throwing things—we figure we are getting a hundred per cent. With the DDT-Toxaphene mixture which we used before, we switched to the phosphates, we sometimes dropped as low as 50 per cent. We don't consider that a good kill by any means, but it was the best we could do with the material. I think personally—and I don't know how well this compares with the experience of the other people here—but personally I think that the airplane is a tool that will do, if you use it right, a hundred per cent job if your insecticide is capable of doing it.

Anybody else, or can I sit down?

Mr. Washburn: It looks like you can sit down for awhile.

Mr. Stivers: Thank you.

Mr. Washburn: Thanks a lot, John. We didn't mean to put you out there on that long, long limb, but you got there anyway.

Mr. Stivers: I can usually manage to, Ed.

Mr. Washburn: I had a long series of questions I was going to ask but the audience has taken care of that and I will move to the next speaker on the program, and it is a little change from what we have had previously. Remember, these two we have had from Kern and Merced have been District-owned aircraft and now we move into the other type of operation by a District that contracts for their aircraft services. Don Murray, of the Delta District.

W. Donald Murray, PhD., *Manager*
Delta Mosquito Abatement District

I think one of the points we need to consider here is the cost involved, that is, the cost per acre.

Kern MAD—$.396 per acre

Merced MAD—$.415 per acre

Delta MAD—$.375 per acre

Now this set of figures does not necessarily mean a thing—(laughter)—if you don't get the job done. You may have a contract with a private company but if their planes are busy spraying alfalfa aphids you may wish you had your own plane. Conversely, if you have an airplane or two and they crack up, you may wish you had a contract. Most important is to get the job done at a reasonable rate. Figures can be juggled and they can be made to lie. I feel that the set of figures shown here indicates we are all very close together costwise.

Let me illustrate very quickly how one can influence these cost figures: (Whereupon Dr. Murray stepped to the blackboard). Total airplane time can be broken down into three major parts: ferrying, turning and spraying. Since ferrying time is an uncontrolled variable, we will eliminate it from further consideration here. In an 80 acre field ½ mile long, spraying time is about 11 minutes and turning time is 9 minutes. If we take ½ of this field, making it 40 acres, ¼ mile long, our spraying time is 5½ minutes but our turning time is still 9 minutes. Let's cut this in half again, giving us a 20 acre field ¼ mile long. Our spraying time is reduced to 2¾ minutes, but our turning time is not halved, reducing only to about 5 minutes.

Our actual cost per acre is therefore going to depend to a considerable extent on how many fields of each size and shape we happen to have in our District. Once again, however, I would repeat, it is necessary first to get the job done, and if there is no other way but to air spray a 2-acre field, then that is the way it must be done. In the Delta District, ¼ of all our airplane spraying time is actual spraying, 1/3 is ferrying, and 5/12 is turning.

Now just a couple of other items and I shall sit down before you can embarrass me. (Laughter) The equipment for which we contract is a 450 horsepower Stearman biplane with National high-lift wings. Those wings are cut-off on the ends and have a somewhat different shape which give excellent lifting and maneuvering qualities—otherwise our equipment is quite comparable to that of the Kern MAD.

It costs us $45 an hour to get the job done. That time does not include loading time, cleaning up the airplane, maintaining the airplane, or any such thing. It is strictly from the time the pilot cranks up his motor to go down the runway until the time he returns to the runway. Other times which must be considered if the District owns the airplane is the time the Manager has to stew around on one thing or another. Once the District gets a competent aircraft company to work with it, the manager's time is free to dream of other items, such as Harold Gray or Dick Peters brought up this morning. So grief and complexities are at a minimum if the District can get a good contractor.

I believe that just about covers the points of our District.

Milton H. Buehler: Milt Buehler.

Did I understand you correctly that you pay $45 an hour for just the time the plane is in the air, you might say?

Dr. Murray: Taxiing down the runway is included.

Mr. Buehler: But you pay only for the time the plane is in motion?

Dr. Murray: Correct.

Mr. Buehler: What about loading it, clean-up, and that sort of thing, is that carried by the contractor?

Dr. Murray: The contractor takes care of that; we aren't charged for that time.

Mr. Buehler: Do you supervise the loading?

Dr. Murray: We don't have to. We use Parathion and all it takes is a small bottle to dump in the airplane. It is very simple. Incidentally, we have this closely coordinated with our airport: we have duplicate maps showing all the fields which are routinely sprayed. At the close of a day our field operators report to one man who is in charge of the airplane spray work. This man then calls the airport on the phone and inside of 5 minutes or less he has relayed the information relative to the fields that need to be sprayed that evening or the next morning.

Mr. Gordon Smith: What is the average size of the fields that you spray, Don?

Dr. Murray: Our times spent on various sized fields are as follows: Less than 10 acres, 2%; between 10 and 30 acres, 64% (almost 2/3rds of our fields actually run around 20 acres); and 30 to 50 acres, 28%.

I might mention one other thing. We use Parathion at the rate of .1 pound per acre for larviciding. We do not get a 100% kill if we have late fourth stage larvae or pupae, so in that case we prefer to wait until they are adults. Then, if conditions are right, we may get a 100% kill of adults.

A Voice: With the same dosage?

Dr. Murray: Yes, the same rates.

Mr. Orland Carrick: Carrick, again, from Orange County. What is your total budget, and what percentage of that does the private owner of the land that you spray pay?

Dr. Murray: Our total budget for airplane spraying is about $9,500. We make the decision on where the spray goes without contacting the owner of the property, and we do not charge the owner. At the end of the year we send him a notice of how much we spent of public moneys on his property, for his information. That is as far as it goes. We do practically no treatment on public property.

Mr. L. L. Hall: Leon Hall, San Joaquin Mosquito Abatement District.

I have a question here: How or what percentage of your plane-spraying that you do is ineffective because the plane is not available or because of wind or other adverse conditions affecting your control percentage?

Dr. Murray: You should live down in the lower part of the San Joaquin Valley, it is really nice down there. (Laughter)

We have practically no wind problem. In fact, we have practically no weather problem; and, further, as I have said, in case there thould be an unusual condition when we couldn't hit them as fourth stage larvae or earlier, we hit them as adults the next day.

Mr. Hall: Isn't that a serious factor in using any plane? We find it here definitely, not being able to use the plane when we would like to because there are commitments to agriculture in many ways.

Dr. Murray: Well, I mentioned that if you can't get a contractor to stick with you, you are in an awkward position and your No. 1 job is to get the job done.

Mr. Hall: You are finding that true, though?

Mr. Murray: We have never had any trouble with our contractor. Perhaps we are lucky.

Mr. Hall: Yes, you are.

Mr. Robert Peters: Bob Peters, from Lodi.

I would like to know what your basis for negotiations is when the next day people are still complaining about mosquitoes after the airplane has sprayed? (Laughter)

Dr. Murray: If you refer to year 1955, I can speak with a smile, since we had no significant troubles, but any previous year—well, actually we have had very few occasions when we put out the airplane on the basis of complaints. The airplane is put out almost exclusively by us on the basis of our operator's report that field needs to be treated, that he couldn't get to it by ground equipment, and that the airplane was necessary.

Mr. Peters: Part of my question was, do you assume the responsibility for a miss, or does the contractor, or just how does it work out? What kind of a relationship do you have?

Dr. Murray: We assume the responsibility. There are occasions when we have a miss and don't know why, whether the pilot went to the wrong field or whether the wind might have come up and carried the spray away. There are times when we have no answer. So, if we miss and have to repeat, we pay for it (unless we can determine positively that the pilot made an error).

Mr. S. J. Kirkwood: When you larvicide or when you adulticide do you use the same method of application, same nozzles, same pressure and everything?

Dr. Murray: Identically the same. There is no change made on the basis of whether we are larviciding or adulticiding.

Mr. Washburn: Thank you. Thanks a lot, Don. I see Mr. Portman has just come into the room. Are you ready to participate on this panel right on the spur of the moment?

Mr. Portman: This is the first I know of it.

(Laughter)

Mr. Washburn: Well then, I think the Turlock Mosquito Abatement District, which I represent, is the only District in the State that happens to own their own aircraft and still goes further with contract. That is one reason, I guess, that Art put me on the panel. I don't know of any other real good reason.

G. Edwin Washburn, *Manager*
Turlock Mosquito Abatement District

For several years we have owned a ship. Actually, we purchased our craft from the Merced District when they moved into a little larger type of craft. We have likewise contracted on the outside for aircraft service for some several years.

The point was brought up in the last discussion as to the immediate availability of the contract aircraft, in relation to your own aircraft. As far as our District has been concerned, we would much prefer to own our ship. It is available at any time and one is not involved with the contract commercial operator's interest in agricultural application at the same time of day that you need him for your District work. We have run into that particular problem in the past years with contract ships, and of course, we do not run into that situation with our own aircraft.

The point was brought up concerning the loss of District owned aircraft. This wasn't mentioned earlier but, naturally, if you own your own ship and it is lost due to an accident of one type or another, the District is in a very awkward situation until the craft can be replaced. In the meantime, you must of course, rely on contract craft unless you are fortunate enough to have several ships. We find our own aircraft is much handier when assigned to individual spots and fields than the larger aircraft.

Perhaps I should have mentioned, that our own ship is a Piper Cub, 90 horsepower engine, being converted now to a higher horsepower of 120. Our contract craft is a Stearman with a 450 engine, so the two ships are quite different as to size, speed, rate of delivery, and so on.

We have used Parathion consistently for the last several years—in all of our aircraft larvicide applications, and have attempted to come as near one-tenth (0.10) of a pound per acre with both types of craft as is possible. Actually, in our computation of application we find we have not quite reached the one-tenth pound per acre figure. Occasionally there is probably an overlap of swath width and this results in a little higher rate of dosage than should normally occur.

I would like to give you some cost figures and our interpretation of them as they have affected our operations for the last two seasons (1954 and 1955). First I will give the cost involved with the contract aircraft only for 1954.

We do not have figures available for 1955 since we did not use contract aircraft in 1955. We have been under contract for several years with an operator near us on the same basis as the Delta District. On a flight-hour basis our costs have not been as great. We have been paying $32 per flight-hour to the contractor. The pilot takes care of the loading. We don't pay for the loading time or the ferry time from his field to our field, or anything like that. The average cost of insecticide only, by the contract aircraft, was 29.9 cents per acre treated. The total cost was .499 cents per acre, nearly 50 cents an acre with an average of 177 acres per flight-hour for the entire season's operations and in that season he flew 60 hours for us under contract.

Now we come to our own aircraft. In 1954 we flew 428 hours with our own ship. An average cost of material only, that is insecticide, was 27.7 cents per acre total overall cost of operations, was 38.6 cents per acre. And, curiously enough, our own craft flew the same number of acres per flight-hour, 177.

This past season (1955), we flew 430 hours and some odd minutes at an average cost of insecticide only, of 28 cents per acre. The total cost of operation of our own aircraft, overhead, insecticide, pilots, insurance, and so on was 40 cents per acre with an average coverage of 122 acres per flight-hour. Our total acreage sprayed by aircraft in 1955 was not as great as that of the previous years. I think the Source Reduction program has contributed materially to the reduction of the necessity of aircraft-spraying in some of our large acreage areas. I know they have as far as our District is concerned.

I was just checking our cost here of aircraft compared to ground equipment as Mr. Stivers did. Curiously enough, it comes out to the very same figure, $5.00. Our costs in general are very, very similar. We who own our own aircraft, however, think we have a little advantage. We can spot our ships where we want them; we can spot our air strips—we can do that with commercial likewise; but there is a flexibility about the use of your own ships that you don't have with the use of commercial craft.

I wonder if there are further questions from the audience to any members of the panel?

Mr. Robert Peters: Bob Peters, representing Lodi again.

I would like to ask whether or not there has been any need for flagmen or ground assistance in very much of this airplane work?

Mr. Washburn: We have not used flagmen except in the case of pilot training.

What about you, John? Do you use flagmen?

Mr. Stivers: As you do, for training purposes only. Gordon?

Mr. Gordon Smith: About the only time we ever use them is when we are putting on a test we want to control very closely on insecticide or something. Our pilots have found that they can go by the distance between power poles. You will usually have those on a certain distance or they know the width of the checks, or something like that, but it isver y rarely that we have call for any flagging.

Mr. Howard R. Greenfield: Howard Greenfield, Salinas Valley.

I would like to mention, in view of the fact that we also own a plane, we utilize ours in three other ways than just the actual spray-application work. For our engineering we use—

Mr. Washburn: Will you come up here?

(Whereupon Mr. Greenfield approached the podium.)

Mr. Howard R. Greenfield: I just wanted to point up the other uses of the aircraft that our District owns. First of all, we have embarked on an engineering program and we use our plane to conduct engineering surveys of a particular problem or project that we contemplate moving into.

Secondly, we use it in our planning of our zone operations. We find that the use of a plane will reveal many aspects of a zone that can't be discovered or learned about from the ground.

Thirdly, we use our aircraft to ferry each zone operator over his zone on monthly intervals. Every zone operator makes one trip a month on the average to look his own area over to be sure that he hasn't missed something. And frequently, since the Salinas Valley is not a flat valley, we have quite a few hills which can conceal a great deal of information from the zone operator, and I think those three points are probably used by all of these other Districts, but they didn't mention them and I think they are important to bring up.

Mr. Washburn: Thanks, Howard. I am sure that you who have been on the panel this morning have used aircraft for the same purposes. I know we have in Turlock, and we have taken individuals over their zones and supervisory personnel over the District, and it pays off. I know Merced does and I am sure Bakersfield does.

Mr. Carrick: Carrick again, from Orange County.

If you gentlemen would enforce the Mosquito Abatement Act requiring the private property owners to take care of their own mosquito abatement problems, couldn't you scrap the airplane programs and enjoy life more?

Mr. Washburn: I am not sure.

In regard to that question, phrased the way it was, I think I can supply one District's experience with that. Last year we had a group of owners in visiting with the Board and it was agreed that if the problem was so aggravated that it required airplane-spraying for this past season they would pay the cost of the airplane work. Now, the total cost of the labor and material for this area that I am speaking of was cut in half this past year over the year before. A slight amount of airplane work was required and, of course, the owners did pay for that, but it was amazing that there was, in round figures, a 50 percent reduction in the necessary spraying of those problem areas. It came only from that, including, if you want to call it that, their knowing that the private owner would have to pay for airplane work that was deemed necessary.

Now, this is a very aggravated area that represents as severe a problem as will be found in any part of the Valley.

Mr. Washburn: I would like to answer that question maybe further, to this extent; in my discussion and in several of the others', the source-reduction personnel in all the Districts in the Central Valley are working toward that end. We haven't gotten that far yet; but many of us have reduced by thousands of acres the area which we formerly treated, and each year we see less and less acreage involved. On the other hand, there is no method of mosquito larviciding cheaper than airplane spraying.

Mr. Harold Gray: Harold Gray.

I would like to remark, for the benefit of the Trustee from Orange County, if you adopt an arbitrary policy of strict law-enforcement, in two years there will be no Mosquito Abatement Act in California.

Mr. T. G. Raley: Ted Raley.

We have had amazing success in using the Act judiciously. Now, we have found that our most severe problems will be corrected by education or persuasion and cooperation and there is that certain percentage we feel only can be approached through the law which, in turn, is an approach that will hit them in the pocketbook if they don't correct their ways. With your progressive farmer, who will respond to your source-reduction plan, it has been our experience that they are going to come along; but with that fraction of a percent that will not respond, I can only see that one course is open, in my mind, and that is to approach them through the Act as it is now written. Judicious patience would be my only qualification in using the Act, but don't overlook it. And I would also like to point out too, that we are another District who has had the experience of owning an airplane and contracting. Our costs are so nearly similar that I question whether you could tell the difference. But by owning your plane we feel that there are so many intangibles that you cannot put down on paper that there is a cost factor there that is perhaps being overlooked in these figures. I think some one remarked that the secretarial help was not charged on there. I wonder if, in any of these figures, the manager's time is charged, and things like that?

Mr. Washburn: It is in our case.

Mr. Raley: Things like that are intangibles and we felt when we were operating our own plane, that they added quite a pressure of burden to those personnel who should be free to think.

Mr. Washburn: Ted, for your information, the figures I gave regarding the Turlock Mosquito Abatement District include all administrative costs on a prorata basis.

Mr. Gordon Smith: I may be wrong on this, but one way or the other, contract or otherwise, the same records are to be kept. I think the secretarial help on our part would be the same. As far as the manager's, whatever you have had to do with contract work, you would have a lot more of the manager's time spent on that than you would on your own plane.

Dr. A. W. Lindquist: Art Lindquist.

This has been a very informative and a very interesting discussion on costs and acres sprayed. I would like to ask: Are there any estimates available on the number of mosquito larvae destroyed and perhaps on the basis of cost per larva? Are there any?

(Laughter.)

Mr. Washburn: I know of none, as far as I am concerned, but do any of you have such figures? It is something for us to think about.

Mr. Gordon Smith: I think Marvin Kramer has some figures on that.

Mr. Marvin Kramer: We got together some figures on a number of mosquito larvae we had killed as a result of some operation but not as a unit cost of so many killed. That is a pretty good publicity note, on a unit. We haven't figured out a unit cost per larva in our operation. The information that we did release was picked up by some of the national news outlets; and in fact, they built it up to beyond the point where we had introduced it and said that we were wiping out a race. And that—well, you can imagine what they could do with something like that.

Mr. Washburn: Any further questions?

Mr. L. L. Hall: Leon Hall.

I was wondering, Ed, if you didn't have some information on the use of granules in your plane, particularly application of granules in your program as of now. I know you did some work, and could you say if it is being used effectively, or if you are using Malathion or Parathion, or what you are using in that line?

Mr. Washburn: Unfortunately, we were in the same position Kern has been in. We have not been able to find commercial aircraft suitably equipped to dispense granules, so we have not used the granular material at all, from aircraft.

I would like to ask Bob Portman about that, or perhaps Gus Augustson. Let's start with Bob. He has used aircraft in that manner.

Mr. Robert F. Portman: We didn't use any granules to speak of this last year. Prior to that, although we didn't use much granules, we used them for special instances, for instance on a windy day or to get the insecticide down through vegetative coverage and such as that. Looking back now, and reviewing it, I feel that the granules have a specific case for certain types of applications necessary; but I don't feel that they are feasible from a physical standpoint because of the cost involved. And if I remember correctly, we felt that we had to apply somewhere in the neighborhood of seven to ten pounds per acre to get a good distribution. And that ran the cost up more than the spraying with emulsion or oil.

Mr. Washburn: In answering that question, Leon, in order for an aircraft operator to equip his ship suitably, he would have to have a guarantee of probably at least 200 hours of flying time in order to do it. It takes special equipment, seeding equipment, to do that type of work.

Dr. A. D. Hess: Archie Hess.

I am wondering—I assume you all have treated some fields with livestock in them, so this question is addressed to all of you—have you had any indication that these dosages used are of any injury to livestock?

Mr. Washburn: I will answer first and then call on others.

We have had none, as far as our District is concerned.

Chairman Murray: It gives me an opportunity to make an announcement. On January the—this is answering the question, incidentally—on January 24, Tuesday afternoon, at Davis, from about 2 to 4 or later, there is going to be a symposium by Dr. Radeleff, Allan Lemmon and myself similar to ones which we had in the Valley last spring on the effects of chlorinated hydrocarbons and phosphates on livestock. Anybody is welcome. That is a veterinarian's conference at Davis that is called every year and anybody is welcome to come to it, in case you missed the ones going through the Valley or in case you would like to come again, and there probably will be new information.

The inference which I have from contacts with Dr. Radeleff and our panel is that it is impossible, using Parathion at the rate we do—and in case there is no accident in dosage application—it is impossible to harm our major livestock.

Mr. John Stivers: Have you had any occasion to?

Mr. Murray: None whatsoever. We avoid spraying directly on livestock wherever possible, but as you know, often it is not possible. A pilot that is used to working in pastures often can turn into quite a cowboy. I have seen them herd cattle from one side to the other while they sprayed the other side.

Mr. Gordon Smith: We did some work, not on Parathion, but still in answer to the question, when we were working on EPN—and I think this may partially answer your question—in the development of that material we had one pasture that we sprayed regularly and in that pasture the cattle were always left in by agreement with the farmer. We watched the cattle very closely and, Lew, you took samples after every spraying, about every two weeks, didn't you?

Mr. Lew Isaak: Six sprayings.

Mr. Gordon Smith: We sent that grass to Riverside for analysis for EPN. We never found what happened. They couldn't recover the EPN from the grass and when they added the EPN to the grass they lost it, too, in their analytical procedure; so we can't tell whether the stuff was destroyed by the grass or the procedure was no good. But we sprayed directly over the cattle. We wouldn't attempt to remove them from the field unless the farmer wants it done, and we haven't had any difficulty.

Dr. A. D. Hess: Did you run cholinesterase levels on cattle in the treated field?

Mr. Gordon Smith: Not at that time. There was so little known about cholinesterase it didn't seem worthwhile doing, Archie.

Mr. Thomas D. Mulhern: Will you advise them about that new bulletin on the subject? It is a very good new bulletin.

Mr. Washburn: I haven't seen it except your individual copy that I saw in Fresno.

Archie, in answer to your question, in our individual case in Turlock we make no effort to try to drive the cattle out of the pasture and we have had no difficulty whatsoever with the cattle, sheep or whatever it might be, and that has been the same procedure year on end. There is too much area to be covered.

Are there any further questions?

If not, then I would like particularly to thank the members of the panel and the audience for their participation. I hope it has been worthwhile to you. I know it has been to us on the panel, and any of you who may want further information or have further questions can ask any of us on the panel or there are others also involved in the audience who own and operate aircraft likewise.

Now, before we stop for recess, Tom, would you make your announcement about the bulletin you just referred to?

Mr. Thomas D. Mulhern: Evidently Ed doesn't remember nor do I the full title of the new bulletin that has just been gotten out by Dr. Radeleff and the group of USDA people who have been doing a great deal of work with the effects of all our common insecticides on livestock. However, that new bulletin is available and we do have a copy or two at the Bureau of Vector Control and a subsequent number of Vector bulletins will carry reference to it, together with to whom you may write. That is a real service.

Oh, here it is. The title of the bulletin is, "The Acute Toxicity of Chlorinated Hydrocarbon and Organic Phosphorous Insecticides to Livestock," and the impressive authors' list is R. D. Radeleff, George T. Woodard, W. J. Nickerson and R. C. Bushland, and it is Technical Bulletin 1122, United States Department of Agriculture.

Mr. Washburn: Thanks, Tommy. Let's break for recess for about ten minutes and be back at about 20 minutes after.

(Whereupon a short recess was taken.)

Chairman Murray: The next item on our program is one which is certainly intriguing. We have already had some debate, and I don't know that any one is convinced. I think we need some more information.

Jack Kimball, Manager of the Orange County Mosquito Abatement District, Santa Ana, will give us some more information on the legal approach to Mosquito Control as practiced in Orange County.

Jack?

Mr. Jack Kimball: Thanks, Don, and members of the Association and guests: Before reading this little gem here, I wanted to do my duty, as we always try to do in these conferences, as a member of the Orange County Chamber of Commerce, and bring you up to date—especially those who are fairly new or visitors to the Association—about where Orange County is. It is a little green area with orange trees, snug along the Coast south of Los Angeles, and has a peculiarity of the county lands in that somehow it automatically stops the LA smog and, as the mosquito workers up here in the San Joaquin Valley and northwards describe it, it is a Mosquito Abatement District without any mosquitoes and without any problems, so we will leave it go at that.

We have our country club, which used to rate No. 1 on your list; but, when you get a chance to visit our adjoining District's Southeast Abatement District and see their new headquarters, you will put us on the No. 2 list. So we have got competition in our own area and we do have a different story than what has gone on here this morning. We know and we realize that we are different in Orange County from the rest of California and we have possibly been working on our problems, our different problems, in a little different manner than the other Districts in the State.

However, we believe it will be interesting for you to listen to this detailed success story of Orange County.

LEGAL APPROACH TO MOSQUITO CONTROL IN ORANGE COUNTY

By

JACK H. KIMBALL, *Manager*
Orange County Mosquito Abatement District

The legal procedure for the abatement of a mosquito breeding nuisance was placed last on the list of methods for mosquito control in Orange County when the District commenced operations in January of 1948. During the following eight years, the Board of Trustees gradually and consistently formulated its policies on the respective responsibility of the property owner, the District and other public agencies. In July of 1955 the Board formally presented these policies on mosquito control to the general public by means of a four page brochure entitled "Some Facts You Should Know Regarding Mosquito Control." Quoting from this brochure the policies were presented as follows:

Objectives of Our Control Program: The objectives of the District are to abate existing mosquito breeding sources and to prevent new ones in order to permit full use and enjoyment of our backyards and our many recreational facilities, to permit mosquito-free agricultural and industrial working conditions and to protect public health and comfort.

Responsibility of the Property Owner: The owner of the property on which a breeding source is located is responsible for the abatement of the nuisance and for the prevention of its recurrence. The District informs the property owner of the mosquito breeding and assists him in working out a satisfactory correction. In extreme cases where the owner does not accept his responsibility to the public, the District may abate the nuisance and file a lien against the property as provided by the California State Health and Safety Code.

Breeding Sources Controlled by District: Chronic breeding sources created by standing water in street catch basins, subdivision drains, roadside ditches, flood channels, ravines and similar places on public right of ways are controlled by the District by routine larviciding operations throughout the year as necessary. The District works with City, County, State and Federal Agencies toward permanent correction of these sources.

District operations during 1955 conformed with these policies. Routine larviciding was not carried out on private property as was done in previous years. Larviciding on private property was done, however, under the following conditions:

1. To assist a property owner who had accepted his responsibility and was in the process of eliminating the nuisance or obtaining equipment to prevent future mosquito breeding.
2. At the request of the property owner, who paid for the actual cost of labor, material and equipment rental.
3. At times of adult mosquito emergence, (mostly *Aedes*

nigromaculis) to prevent a public nuisance resulting from the failure of a property owner to carry out adequate mosquito control measures. Actual costs of larviciding and/or adulticiding were billed to the property owner.

Since consistency in the administration of a policy of this type is the essence of its success, the Board of Trustees recognized the need for a specific legal procedure which the District could use against the exceptional property owner who refused to accept his responsibility to the public.

During the past years, persons responsible for the larger mosquito breeding sources have been contacted many times by members of the District Staff. Letters and printed forms requesting them to abate the breeding nuisance were sent at the direction of the Board of Trustees. Several were invited to attend meetings of the Board and to discuss their problem and the improvements requested by the District. Several cases were turned over to the County District Attorney for more positive persuasion. These informal actions, actions not based on specific legal procedures, have been very successful. Out of fifty such actions, all but one of the persons accepted the responsibility of mosquito control by instigating either physical improvements, routine larviciding operations, improved water management practices, maintenance of irrigation and water storage facilities, and/or paying for the cost of emergency larviciding or adulticiding operations performed by the District on their property.

Because of the one exception which was encountered during the 1955 season, the Board of Trustees decided that some specific legal procedure must be worked out. After consultation with the County Counsel and consideration of the abatement procedure provided in the Criminal Code, the court injunction, and special local ordinances that could be sponsored, the Board decided that the procedure provided in the Mosquito Abatement Act offered the most direct and positive action and should be followed in all its formality.

Consequently, on September 26, 1955, following an outbreak of *Aedes nigromaculis* mosquitoes which invaded the community of Westminster and especially the grounds of a nearby elementary school, legal proceedings were initiated for the first time since the District was created. Notices were served on the occupant of the property and on the owners, who resided elsewhere in California, directing them to abate the nuisance within ten days, and notifying them that they may appear and be heard by the Board of Trustees at a meeting to be held on October 21, 1955. At the conclusion of the hearing, the Board determined that no work had been performed by the owners to abate the public nuisance or to prevent the recurrence of mosquito breeding on this property; ordered that the requirements of the original notice must be complied with, and directed the District Manager to perform such abatement work on this property as may be necessary at the next occurrence of a public nuisance. In accordance with Section 2283 and 2284 of the Mosquito Act, the cost of abatement shall be repaid to the District by the owner and all sums expended by the District are a lien upon the property.

As mentioned in the opening paragraph of this presentation, the legal procedure for the abatement of a mosquito breeding nuisance was placed at the bottom of the list of methods for obtaining mosquito control in Orange County. The crystallization by the Board of Trustees of basic policy on the abatement of mosquito breeding problems peculiar to Orange County, and the determination of the need for a formal legal procedure was based on facts, figures and experience accumulated each year by the District Staff.

The accumulation of reliable facts and figures; the development of trust and respect for all District employees by the persons creating mosquito breeding sources, and the awareness of the general public and other public agencies as well of the policies and objectives of the District, are factors as important to the long term abatement program as the factors of mosquito ecology and toxicology are to the massive aerial larviciding programs so necessary in the "primitive" areas of California.

Facts and figures on all mosquito breeding sources within the District have been consistently recorded and accumulated over the eight years this District has been in operation. The record system is based on the "Section Survey Concept" as originally recommended to this District by the State Bureau of Vector Control, and as "championed" by Dick Peters these many years. All mapping and recording is done by the five permanent operators, who have a specific zone assigned to them. All breeding sources on each specific property are indicated on quarter section maps and the property given a permanent source number. Section maps are supplemented by county road maps of subdivided areas and incorporated cities. These map books are kept by the operator in his vehicle and corrected as frequently as time permits. During the winter season area maps covering from 12 to 16 sections are brought up to date by each operator. These area maps remain at the District Office and are invaluable for coordinating the control and abatement operations, as well as for presenting the overall community area problems to the Board of Trustees.

The Zone operator also maintains a yearly record on each mosquito breeding source number showing every inspection, treatment and personal contact with the owner or occupant. These annual Inspection-Treatment Record sheets are filed by Township-Section and Source Number and form the basis of our "Case History" files. Any additional contacts that may be required by the Entomologist or Manager are recorded in this "Case History" file along with copies of letters and information on property ownership and description. Photographs are also kept in this file to llustrate the breeding problem as it exists from year to year.

The second factor required for a long term abatement program is the development of trust and respect for all District employees by the persons creating the mosquito breeding sources. The Zone operator was selected because of his personal qualifications and employed on a permanent year round basis to permit the continuity required. Four of our five operators started with the District eight years ago and the fifth is just completing his fourth year. In addition to being responsible for all mapping, inspection, and larviciding in his Zone of some 100 sq. miles, each operator must develop the trust and respect of the public on whose property he must enter. He must continually explain the District's program and patiently inform the responsible person on the why and how of mosquito breeding and prevention. His objective is mosquito abatement by direct education of and cooperation with the property owner. He never acts as a policeman, but furnishes the facts and figures for informal action by the

Manager and if need be, for formal action by the Board of Trustees.

Awareness by the general public of District policies and objectives is an equally important factor to the success of the long term abatement program. We believe the development of good public relations is being maintained in Orange County by the continual attention to small details at the opportune moment. Response to all service requests within a maximum of 24 hours has always been a "must." The inspector's findings, whether positive or negative, are always explained to the requestor in person, or a written note is left. The person annoyed by the mosquitoes, or other insects as it may be, is always appreciative of this courtesy and is always cooperative if he is told that we can't find the source as yet or that it may be some time before the annoyance can be alleviated. This personal contact permits questions to be answered and the presentation of our informative leaflet "Some Facts You Should Know Regarding Mosquito Control." Information to the general public is presented each year by the District's exhibit at the Orange County Fair.

Invitations to present talks on the District's program are always accepted from Service Clubs and other organizations. Classroom study material in the form of mosquito eggs, larvae, etc., as well as the sound film "The Mosquito" is furnished to schools, especially the 5th grade level, to illustrate the phenomenon of metamorphosis. No effort is made to prepare press releases throughout the mosquito season, but information and pictures have always been furnished to reporters preparing a feature story.

The determination by the Board of Trustees of this District to establish a sound policy and then to enforce this policy by legal means, is the "priceless ingredient" in the Orange County formula for its long term abatement program. Although the Board's determination is based on the facts and figures prepared and presented by the District staff, the assimilation of this data and the development of the policy was possible because of the many years of continuous service, and the remarkable record of attendance by the members of the Board of Trustees. Five of the original twelve members are still active on the Board after eight and one-half years of service. Of the 107 meetings held by this Board there has never been a meeting postponed for lack of a quorum. During the past calendar year of 1955 an average attendance of 85% was maintained at the monthly meetings.

Since 1953 two outside cities have annexed District areas and three new cities have been incorporated, increasing the member of representatives on the Board to seventeen. The continuity of the abatement program from year to year and the orientation of new members is made possible by a documentary record of all actions taken by the Board. Each year specific actions on policy and abatement procedures are excerpted from these minutes and listed chronologically. A copy of this condensed version of the minutes is made available to new members of the Board, as it presents a fairly readable record of the District program.

In reviewing the abatement program which has proved applicable to Orange County, it is apparent that this program is not a legal approach to mosquito control as implied in the title. This program is, however, based on the specific policy of property owner responsibility. The use of the legal procedure reviewed herein was necessary to carry out this policy in a democratic manner.

Chairman Don Murray: Thank you, Jack.

We are running short of time or we would get into quite a discussion on this particular phase.

Next we have Les Brumbaugh, Manager of the San Joaquin Mosquito Abatement District, Stockton, and our host, who will present some information on this new, relatively speaking, mosquito district, the San Joaquin MAD.

Les!

ORGANIZING THE SAN JOAQUIN M.A.D.

L. R. Brumbaugh, *Manager*
San Joaquin Mosquito Abatement District

Thank you, President Don Murray, ladies, and gentlemen. I would like to correct President Don in saying "host." It should have been "co-host" with Bob Peters.

After sitting all afternoon or, perhaps, we should have said sitting all morning and all afternoon, these chairs can certainly get hard! Perhaps Mr. Peters and I can correct this condition by getting cushions. We will try to solve this problem tomorrow. As for now, the only adjustment that can be made is to throw away my notes and shorten your period of sitting.

In the starting of any organization, large or small, there are certain business principles to be followed in order to build a sound organization. Without these basic principles or definite plans it is like building a home without a set of blue prints. Some of the essential principles are: (1) adequate financing; (2) competent personnel; (3) good production or service; and (4) establishing good District policies.

Undoubtedly, many of you can name many more basic principles. However, since time will not permit, and since we have thrown away my notes, we will review a few of these basic principles. Number 1—Finances. Immediately you are thinking, "Well, here is a political subdivision that should have no financial troubles, an organization which is on the public tax rolls." The San Joaquin M.A.D. started operating on March 1, 1955, with no anticipated income until January 1, 1956. In order to start operations, it was necessary for the District to borrow from the Board of Supervisors, realizing that we would have a 16 months operation period instead of the usual 12 months.

Again, realizing that the District owned nothing, not even a pencil or a fly swatter, we would have to make a huge Capital Outlay budget to start operations. Thanks to our Board of Supervisors, it was quite simple for us to borrow money interest-free. And, again, thanks to the Board of Trustees for their time and effort, we finally arranged our budget so that we could live within our means. We realized that we would be somewhat limited in our operations for the last season and also for the next season until June 30, 1956. The public was informed through the mediums of radio and newspapers of the District's limited operations during the summer of 1955.

Now, our next step in organizing was establishing a sound personnel policy. The Board of Trustees felt this was very important. Mimeographed copies of District personnel policies were presented to each employee showing working hours; sick benefits; holiday schedule, etc., so that there would be no misunderstanding between employee and employer.

Further, in handling personnel problems, certain job descriptions and classifications were made of each position. However, difficulty in classification was encountered for many reasons: At first we did not know how to classify our employees. We found in visiting other mosquito abatement districts there are many different titles assigned to personnel. Some districts were classifying employees "inspectors" or "operators," while other districts were classifying their employees as "supervisors," etc. In trying to keep in line with other mosquito abatement districts, you can see we were somewhat confused, and the only possible solution was to use our own imagination. After deciding on the job classifications that would best fit the District's needs, it was then possible to set up a salary range in fitting with the employees' classifications. We then knew what we wanted. We knew what we could pay. We then started interviewing men whom we felt to be the best qualified for the classifications so established. At the present time we have 17 employees.

Our next step in organizing was to establish a training program because we knew that over 95% of our employees were going to have no experience in mosquito abatement district work or in the methods of killing mosquitoes.

With the help of the Bureau of Vector Control and other mosquito abatement districts, a training program was established. Training was conducted in the class room and in the field for all employees. At the present time we are still utilizing this training program for the advancement of our organization. We believe that a more thoroughly trained employee will do a more thorough job of controlling mosquitoes.

Our next point to consider in building a new organization might be classed "production" or "service." To have good production or service, you must have good machinery. We attempted to secure only those machines which were highly recommended to be very efficient in mosquito control work. By checking with other mosquito abatement districts, manufactures, and using our own ideas, it was decided to use Jeeps, equipped with power sprayers which were built by the District. We think that we have the best—(and we know that other districts feel the same about their own!)—mosquito control equipment. In the interest of time we will not discuss further our present equipment. However, all of you are invited to visit the S.J.M.A.D. and look over any power equipment that might interest you.

Ladies and gentlemen, we are still in the process of trying to improve our present equipment. We are borrowing ideas from other districts, the agricultural engineers, and pest control operators, and will continue to do so to improve our efficiency of operation.

I know, gentlemen, that with your help and with the help of the people in this area, that the District's service will be satisfactory for good mosquito control.

For the past ten months we have secured adequate financing, established personnel policies; hired capable personnel; prefabricated spraying equipment; and purchased necessary vehicles. We feel reasonably sure that we gave satisfactory mosquito control this past season.

It has been our pleasure to be here today and we hope that we can attend many more meetings for the purpose of learning. We are still in the process of learning.

Thank you.

Chairman Don Murray: Thank you very much, Les. For a relative newcomer to Mosquito Control you are certainly fitting into the group very well. We are proud of you.

That concludes the formal part of the program as listed. Now our District still has this movie. I don't think that it will take very long, in case anybody has to go.

So, if it is all right, let's set up the movie projector and while that is being done let me explain what we have here, because I believe it is an educational device which others can use.

The reason behind the taking of this movie is public education. Where we have mostly agricultural area and relatively small urban area, we are faced with a difficult situation in trying to bring any legal pressure on agriculture. Therefore we must devise other ways. We find ourselves in a comparable position to the Agricultural Extension Service, in that our biggest problems are among the poor farmers, those who do the poorest job, but we don't find it of much value to go to them first. Rather, we find that we have to go to the best farmers first. We may be trying to further the law of the Survival of the Fittest because if we can get the better farmers better, then the poorer farmers may drag farther behind and perhaps we can get rid of them because they won't be able to survive in competition.

Certainly, in any case, it is going to take a long time and much public education and understanding. Therefore we have developed this movie to show to many different groups. We will show it to all the service clubs which can receive it, to farmers' groups, to schools, and, if possible, we will develop new movies every year or two and repeat the process. The current film is on the subject "The Pasture Mosquito." Filming was done during the past year, the shots being taken by George Whitten and by me. Subsequently, the scenes have been very carefully and excellently edited by Tommy Mulhern, of the Bureau of Vector Control. There are still some rough spots in it, but the film itself will probably have to go as is.

Our projector is equipped with a magnetic sound recorder, this being available on a Bell and Howell at extra cost. This is not live sound. We narrated onto the sound stripe, added music for effect, and, to show you how fast this thing works, you are going to be guinea pigs. This film was received from Rochester, New York, on Friday afternoon and George and I worked quite a bit of Saturday to put on what sound is here. We weren't prepared, except that we had a few phonograph records we could use, and the narration for the first part was written. Some of the last part was also written but needs to be edited, and in the middle I have ad libbed somewhat facetiously, as you will see, but you can see the possibility of this system. All we have to do when we return home is to erase this as simply as one erases a tape recorder and replace it with a well prepared script.

I am sorry that this isn't completed but I think it will be interesting for you to see the developmental stage.

(Applause.)

(Whereupon the above-mentioned movie was shown to the Conference.)

Chairman Don Murray: I have an announcement that we have a Resolutions Committee appointed at each Conference on the first day to bring in some resolutions for the second. We usually take some one who knows the situation, usually some one rather local.

Bob Peters, I wonder if you would act as chairman on this, and Ted Raley can assist you. Thank you very much.

We will stand adjourned until 9 o'clock tomorrow.

(Whereupon, at the hour of 4:30 o'clock p.m. the Conference was adjourned until Tuesday, January 17, 1956, at 9:00 o'clock a.m.)

TUESDAY, JANUARY 17, 1956—9:25 A.M.
CMCA BUSINESS MEETING

President T. M. Sperbeck: We are late now, fellows, so I think we had better get started with our meeting.

This is the business meeting of the California Mosquito Control Association and as the first order of business I think we should have a roll call of the delegates present, if the Secretary will read off the roll.

(Whereupon Mr. Washburn took a roll call.)

President Sperbeck: We are all legal then. We have a quorum officially.

Now, fellows, I would just like to say how sorry I am that things turned out the way they did and we couldn't have our conference as planned in Marysville; but of course, as most of you know by this time, we have been hit by the flood situation up there and it was impossible to hold it there. This was not only because it was coming too soon upon such a disaster as we had, but also due to the fact that the outside people coming in to help, the Red Cross, Telephone, P.G.&E., and US Engineers and everyone, have taken every available room in that vicinity. The fact is, many of them have to commute as far as 35 miles from Nevada City and Grass Valley to find a place to stay, and I certainly appreciate that Stockton agreed to take it over on such short notice, to give us such wonderful accommodations, and take care of it the way they have.

I couldn't make it for yesterday's meeting myself because we had a second emergency coming right on top of our recent disaster and I didn't feel like leaving with the conditions the way they were up there, but as soon as it eased off yesterday afternoon I came down.

In regard to our events during the past year, there has not been anything spectacular happen, as far as the Association is concerned. I guess we haven't lost any ground and I don't know as we have gained any either, but we are still holding our own, which is better than going backward. And most of the activities, instead of me trying to cover them and taking the time, will be reported upon as the various committees report so that you will have a pretty good idea of what has happened as far as committee action during the past year.

Now, to get right into the matter of business, I think we will start with the Secretary-Treasurer's report on our financial condition. That is always one of the important items.

Secretary-Treasurer Washburn: Mr. Chairman, gentlemen. This is strictly a financial report this year. I have not written any other material as I have done in past years, probably, for one reason, that it seems that most of the material that I have written in the past has not been acted upon by the Board of Directors, so it seems a little foolish to go ahead and make recommendations. And so I have not made them.

FINANCIAL STATEMENT
CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC.

January 1, 1955-December 31, 1955

Income and Receipts		
Balance on hand January 1, 1955		$4,555.57
Income:		
Contractual Dues	$2,970.00	
Associate Member Dues	44.50	
Sustaining Member Dues	200.00	
Publication Sales (Proceedings)	64.62	
Decal Sales	25.80	
23rd Conference Rebate	1,101.10	
Total Income		4,406.02
Total Receipts		$8,961.59

EXPENDITURES

Printing 23rd Proceedings (1700)	$2186.86
Postage	151.76
Stenographic Service	6.00
Brochures for 1954 State Fair	163.00
Brochures for 1955 State Fair	85.00
Material for 1955 State Fair Booth	119.04
Hotel Statler Costs (President's Suite)	125.00
Telephone Costs (Leg. Comm. & Secty-treas.)	77.05
Receipt Book	2.53
Gummed Labels for 23rd Conference	8.74
Gummed Labels (AMCA Membership List)	19.67
Honorary Membership Certificates	20.80
Statements (500)	12.26
Letterhead (1500)	32.70
Mosquito News Ad ½ Page	108.00
Herms Award	35.00
Imprints for 23rd programs	33.32
Sustaining Membership Contribution to 23rd Conference	300.00
Recording Tapes	20.70
Onion Skin (2 reams)	6.86
Envelopes	3.95
Total Expenditures	$3518.74
BALANCE, January 1, 1956	$5442.85

The count of the inventory as was recorded in the 23rd Proceedings has been made. I don't need to go into details of that except that the same materials are on hand plus a few more that have been added. These were used in the 1950 Fair Booth in Sacramento. Also, there are some 359 copies of the 23rd Proceedings recently published that are still on hand. And of course, some of those will go out during the year.

One move that was made by the Board of Directors during the past year which may be of interest to you, you were notified of it, and that is that there will no longer be any cost involved in the decals. The CMCA decals that are used for our equipment no longer have any cost applied to them. They are free to you when you make such a request to the Secretary's office and they will be sent to you.

That is it, Mr. Chairman.

President Sperbeck: Thank you, Ed. How does that compare, Ed, with our last year's balance?

Secretary-Treasurer Washburn: About $900 more.

President Sperbeck: We have about $900 better standing than we did last year, which is good news.

I think it is in order to have a motion approving the Secretary-Treasurer's report.

Mr. Chester Robinson: Mr. President, I will so move.

President Sperbeck: All those in favor signify by saying "Aye." Contrary? So approved.

The next committee will be the report of the Auditing Committee, Mr. Kramer, Chairman.

Mr. Roy L. Holmes: Would you put that off for about ten minutes? He is still eating breakfast.

President Sperbeck: All right. Next will be the Duck Clubs Committee, Arthur Geib, Chairman.

Mr. Arthur Geib: I think perhaps it might be in order to mention that this committee was formed during the past year with the hopes that the committee could work with the Department of Fish and Game and local duck club owners and operators towards answering or alleviating some of the mosquito problems that result in the flooding of ponds to attract and shoot ducks.

In some regions of the State the problems in Mosquito Control resulting from the flooding of ponds for this purpose posed a serious problem to the agencies attempting to control mosquitoes in their respective areas. In others the problem is not so severe.

The committee was chosen with the thought of Regional representation over the State in those areas in which duck hunting and the resultant mosquito problems were encountered. Your committee, with the cooperation of the Bureau of Vector Control, Dick Peters and others of his staff, met with the Division of Fish and Game and attended two hearings of the Fish and Wild Life Commission of the State of California. We brought to their attention the problems that we had, the extent of mosquito activity in California, and asked if they couldn't be of some help in first and foremost attempting to have the duck-hunting season set back as late in the fall as would be commensurate with good hunting practices, thinking that the later in the season the fewer the mosquitoes we would have as a consequence of the flooding problem.

The hearings attended were at San Francisco and Los Angeles. Dick Peters on both occasions presented the problem very well. The official hearing in San Francisco was not too well received. As a matter of fact, it took people there rather by surprise when the Mosquito people descended upon the Fish and Game hearing. In Los Angeles they were more receptive and consented to consider it and they invited us later to sit down with them and their officials in the office in Sacramento, the administrative group, and discuss this whole problem. As a consequence, they have recommended that a committee meet with them sometime this spring and attempt to develop a set of guides or guide of recommendations toward water management and flooding of duck ponds and they will incorporate in it something regarding good water-fowl management practices. This set of recommendations or guides would then be issued jointly by the Division of Fish and Game, the California Mosquito Control Association, and the Bureau of Vector Control.

It is hoped that we can have this meeting this spring and that in time we may come up with something that will help at least minimize or alleviate some of the problems we have in some regions of the State.

President Sperbeck: Thank you, Art. The one suggestion I would make to the new incoming president is that this is one committee that should be carried on, and especially the chairman, Mr. Geib, because he has done a lot of work on it and made some wonderful contacts with the officials of the Fish and Game Commission. And so, in order to bring this to a conclusion, it would be a good thing to consider carrying this same committee on for that purpose.

May we have a motion approving the report of the Duck Clubs Committee?

Mr. O. W. Carrick: Carrick, of Orange County. I move that we approve the report.

Mr. John Brawley: Brawley, of Kings. I second that.

President Sperbeck: It has been moved and seconded to approve the report of the Chairman of the Duck Clubs Committee. All those in favor say "Aye." Contrary?

So approved.

President Sperbeck: The next report will be from Mr. Shanafelt, Chairman of the Culicidology Committee.

Is Mr. Shanafelt here?

(No response)

President Sperbeck: We will pass that up and have a report from Mr. John Stivers on the Education, Public Relations and Publicity Committee.

Mr. John Stivers: This committee's principal activity this year was concerned with setting up and operating an educational booth at the Sacramento State Fair. A detailed report on that activity has already been submitted. However, I would like again to remind all of you people that we built the exhibit this year with the idea of reusing it in the future. It is now stored in Merced County District Depot and if any District wants to use it, with a very few minor modifications it can be fitted to any project. We built it flexibly so it can cover pretty nearly any size exhibition space and we would like you folks to get some use out of it. So if you have county fairs or anything of that variety, contact us and arrange to use any or all of it. By so doing, you can save yourselves some work, and make the Association investment worthwhile.

We also have been annoying the speakers here the last few days taking photographs, which will be made available for you and also will be forwarded to the subjects for use in local press releases.

The Committee would like particularly to thank those individuals who helped us on that State Fair Committee by giving up your time to man the booth. I think the use of District personnel in the booth rather than hiring somebody makes for a more effective exhibit, better informed people there, and at the same time, of course saving the Association considerable money.

We would also like to thank particularly Leon Hall and Jerry Lant who, while not on the committee, worked with us very closely and contributed a great deal to it.

President Sperbeck: I think this Committee deserves a special thanks for the work that they did in taking over the job of having an exhibit at the Fair. And it was very good.

Secretary-Treasurer Washburn: Mr. Chairman, I move the acceptance of the Committee's report by John Stivers.

Dr. W. Donald Murray: I will second that motion.

President Sperbeck: It has been moved and seconded to accept the report of the Education, Public Relations and Publicity Committee. All those in favor signify by saying "Aye." Contrary? So approved.

We will have Mr. Kramer give us the report on the Auditing Committee.

Mr. Marvin Kramer: The California Mosquito Control Association, gentlemen: The Auditing Committee made the recommendation to the Board of Directors of the Association at the conference in Los Angeles last year that the auditing be made by a qualified person, such as a certified public accountant. The Board of Directors made no reply, so the Auditing Committee was without commission and without direction. There has been no audit of the Association's books this year.

The Auditing Committee urgently recommends that the Association shall determine whether it feels a legal and moral responsibility for an audit, and in the event that it does, whether that audit shall be made by a certified public accountant or by a member of the Association.

The Committee also recommends that in the event that an audit is desired, a standard procedure shall be established for making the books available at a given time and place.

Respectfully submitted, Marvin Kramer.

President Sperbeck: Thank you, Mr. Kramer. I was wondering at this time if we ought to take some action on that and see what we are going to do in the future. I think we have an honest secretary, but it is still good practice to audit books once in a while.

Would anyone care to open a discussion pro and con upon the advisability of engaging a certified public accountant to do this work or whether we would carry it on as we have in the past, by an auditing committee? Mr. Geib?

Mr. A. F. Geib: Well, I won't attempt to make a motion at this time, but I believe it would be most advisable that we have a certified public accountant go over the books, check them as soon as conveniently possible, then establish a system or method of keeping the books from that period on, and then have an annual audit by such an individual.

Gardiner C. McFarland: I would like to ask, please, what would be the cost of an auditor of this type?

President Sperbeck: Can any one answer that?

Secretary-Treasurer Washburn: Mac, I would estimate presumably around $60. It would depend on how deep we might want that individual to delve into the financial background of the Association. If he only audited for the last fiscal year it wouldn't be over probably a $50 or $60 charge. However, if we wanted him to go back for several years it would be a matter of digging up past records and then the charge could go up to $500 or more. I wouldn't think over a hundred dollars as a maximum.

I wish to state, as the secretary-treasurer, that I would welcome such an audit to see if I am on the right track. My books do balance, but it is nice to make sure we are using the proper procedure.

Mr. Gardiner C. McFarland: I would like to move that the recommendation of the Auditing Committee, at a cost not to exceed $100, be undertaking for the fiscal year 1956, starting in 1956.

President Sperbeck: You have heard the motion that we carry out the report of the Auditing Committee that the certified public accountant be engaged to audit the books of the District, the cost not to exceed $100.

Do we have a second?

Mr. Robert F. Portman: Mr. Chairman, I would like to add to that motion that the fiscal affairs of the California Mosquito Control Association for the calendar year of 1955 be audited by a certified public accountant.

Mr. C. Donald Grant: C. D. Grant. And I will second the amendment.

President Sperbeck: It has been moved and seconded that the services of a certified public accountant to audit the fiscal affairs of the Association—

Mr. A. F. Geib: Question: How does that affect the previous motion made by Mr. McFarland?

President Sperbeck: It hasn't been seconded yet. Is it all right with you on the second one? It is practically the same thing, isn't it?

Mr. O. W. Carrick: Mr. Chairman, how does the hundred dollar allotment stand? Does that still stand or does the amendment remove that?

President Sperbeck: Does the hundred dollar-limit still stand in your amendment, Bob?

Mr. Robert Portman: No, my motion was that the fiscal records, affairs of the CMCA for the calendar year 1955, be audited by a certified public accountant.

Mr. T. J. Raley: Before there is a vote on that, perhaps we should have a better understanding of the word "fiscal" assets.

We do have in our possession as an Association some equipment, as I understand it. Is that true, or is that in the name of the various Districts?

Secretary-Treasurer Washburn: Ted, the only equipment that the Association owns, actually owns itself, is a tape recorder and some tapes, a five-drawer file cabinet, some miscellaneous materials that have been used in various Fair booths and, of course, past copies of proceedings. The equipment which has been used in operations and investigations legally belongs to the individual Districts. At least we have a legal interpretation concerning that from several County counsels. It is not the property of this Association; strictly the property of the individual Districts through whom it was purchased.

Mr. T. J. Raley: I raise that question more to be sure we don't have a high priced accountant travel great distances to make a proper inventory of our assets.

Secretary-Treasurer Washburn: All of the property of the Association, except the materials that John Stivers mentioned, are in my office at Turlock.

President Sperbeck: Does that answer your question, Ted?

Mr. T. J. Raley: Yes.

President Sperbeck: . . What is the feeling on this amount? Do you think that that should be included under the question while we are still discussing it?

Mr. John Stivers: Question: I question not so much the amount, but Mr. McFarland mentioned 1956, Bob said 1955. Was that your intention to just make that two years rather than change it?

Mr. Robert Portman: No, my motion was limited only to the year 1955, which has not been audited.

Mr. John Stivers: I think that is Bob's intent, to let the motion stand but make it also for 1955 as well as 1956.

Mr. Robert Portman: No. My intention was for the fiscal year just closed. The report stated there had not been an audit and I made a motion that an audit for that year, the calendar year, be made.

Mr. John Stivers: I think we have two separate motions here, Bob's 1955, and the 1956.

President Sperbeck: Now we already have a motion before the house now and it has been seconded. Now I guess it would be possible if some one, with Bob's permission, would want to amend his motion—

Mr. Gardiner C. McFarland: With your permission, I would like to amend this as a continuing deal. This is something that shouldn't take the time of the Association each year. It should be a standard policy starting with 1955 and continuing on into the future.

President Sperbeck: Bob, will you accept that amendment?

Mr. Robert Portman: Yes.

President Sperbeck: The motion as it now stands is that we engage the services of a certified public accountant to audit the books each year for the Association—

Mr. Chester Robinson: Annual or fiscal? Is our fiscal account on the calendar year? Let's find that out first.

President Sperbeck: Our secretary says it will be more convenient on the calendar year. Is that right, Ed?

Secretary-Treasurer Washburn: Yes. Although your dues as Districts and individuals are on a fiscal year basis, July 1 to June 30, the records of the Association are kept on a calendar year basis, January 1 to December 31, primarily for convenience at conference time. They can be kept at any time, as far as that goes, but that has been the setup for a good many years.

President Sperbeck: I think if we engage the certified public accountant that he will set up a system that will be to the best advantage of the Association and make recommendations as to whether it should be on the fiscal or calendar year, and also set up a system of books meeting their approval.

Now, our motion before the house by Mr. Portman is that we engage the services of a certified public accountant to audit the Association's books beginning with the year 1955 and making it a yearly audit.

Am I correct, Bob?

Mr. Robert Portman: Yes.

President Sperbeck: That has been seconded and we are ready for the question.

Mr. Harold F. Gray: Mr. Chairman, was a hundred dollar limitation placed on that?

President Sperbeck: It hasn't been put back in.

The motion has been made and seconded. You have heard the question. All those in favor signifiy by saying "Aye." Contrary? None, and so ordered.

Can we have a motion now accepting the Chairman's report for the Auditing Committee?

O. W. Carrick: Carrick, Orange County.

I will move the report be accepted with the gratitude of the members of the Association.

President Sperbeck: May we have a second to that motion?

Mr. Robert Portman: I will second it.

Mr. Harold F. Gray: Mr. Chairman, again a point of information. I admit that I have no vote in the Association any more, but I don't think I must be quiet. I would like to ask, is the Secretary-Treasurer of this organization bonded?

President Sperbeck: I don't believe he is.

Secretary-Treasurer Washburn: No, sir.

Mr. Harold F. Gray: I am not mistrusting the present secretary or any future secretary you might have, but you are beginning to have an appreciable amount of money and I make a suggestion that you consider as to whether it would be worthwhile to take a little insurance out to protect that money. Years ago we didn't have very much and it didn't make any difference, but we are getting wealthy.

President Sperbeck: Well, I think you have a good point there, Harold. I was just wondering if that would be considered in the auditing report, if they would make certain suggestions as they usually do in that line, and whether we should wait for them or whether we should find out the feeling of the members now on such a move.

Mr. Gardiner C. McFarland: Wasn't that passed as a motion at the last business meeting, that not only the secretary-treasurer be bonded but in case there was a financial chairman of the program, that the financial chairman carry bond too? I believe that was regularly passed, wasn't it?

A Voice: It was passed that the secretary be bonded.

Mr. Gardiner C. McFarland: It has been passed, so I feel that that already is in the business and has been forgotten. I think the secretary should be insured.

President Sperbeck: Can we be brought up to date on that, Ed?

Secretary-Treasurer Washburn: Essentially Mac is quite correct. It has been suggested at several previous conferences. However, no board of directors has yet given any authorization to go ahead and have me bonded or have the officers bonded, either the secretary-treasurer or the financial chairman.

Mr. Robert Portman: Mr. President, it was brought to my attention by Dick Peters that Article VIII, Financial Responsibility, says:

> "Section 1. The Board of Directors shall require a bond covering financial responsibility of the Secretary-Treasurer, and may require similar bonds of other officers or employees of the Association. The Board of Directors may also provide for suitable general liability insurance. The premiums on such bonds or insurance shall be paid by the Association."

In other words, it is necessary that the Board of Directors require the Secretary-Treasurer be bonded and pay such premiums.

President Sperbeck: That was a motion that was passed you are reading there?

Mr. Robert Portman: This is the Constitution, the By-Laws.

President Sperbeck: It is in the Constitution?

Mr. Robert Portman: So they must do that or be derelict in their duties.

President Sperbeck: I think this matter should be referred to the Board of Directors and that the body here suggest or order the Board of Directors to take appropriate action upon this matter in the immediate future.

Secretary-Treasurer Washburn: Mr. Chairman, I call for the question.

President Sperbeck: We still need the approval of Mr. Kramer's report. It has been moved and seconded. Question? All those in favor signify by saying "Aye." Contrary?

So ordered.

The next committee will be Forms, Records and Statistics, by Don Murray.

Dr. W. Donald Murray: Mr. Chairman and CMCA members, I wish to thank all of you who so tediously answered the questionnaire which came to you. I realize that they are exasperating and sometimes they are not comprehensible, but the goal is good. We intend them to help you. So for your help, we thank you. The replies have been unusually good. A few Districts do not come through for various reasons—no criticism, but we would like as many of you as possible to continue.

Our Forms, Records and Statistics Committee will continue in business. We have many requests for information such as has been turned out in the past. Some of this information that was obtained was the salary and general working conditions schedule. That questionnaire came out fairly early last year and the results were made available to all Districts before the budget time.

The Year Book we started even before the last conference and finally got out the finished product just last month. I have had many comments that this Year Book must continue. I agree. We would appreciate comments from all of you. What do you like in it? Are there things in it you believe to be unnecessary? So come forth, please.

A final activity by our committee has been an attempt to develop a new monthly operational report form. The concept of a new form has been to increase accuracy, increase flexibility, decrease complexity, accentuate the positive and increase the readability to Board members and to other recipients. The form has been fairly well finalized. It needs final approval by our Committee but it is very possible you will see the results in another month or so.

Thank you.

President Sperbeck: Thank you, Don. I think that Committee has done a fine piece of work, as all of you who have received the Year Book will certify to.

May we have a motion approving the report of the Forms, Records and Statistics Committee?

Mr. T. J. Raley: Ted Raley. And I will move the acceptance of this Committee's report.

President Sperbeck: May we have a second?

Mr. Roy L. Holmes: Roy Holmes. I will second the motion.

President Sperbeck: Are you ready for the question? All those in favor say "Aye." Contrary? So ordered.

Mr. T. J. Raley: Mr. President, this Year Book I felt was quite a credit to the Committee of course, directly, and to the Association, and in that I was appointed to gather together as many sustaining members as possible for this particular conference, the thought came to mind that perhaps that Year Book should be considered with a little more credit and dignity than we might have thought before. I wonder if perhaps it wouldn't be wise to limit the distribution of this Year Book to the commercial groups, to only sustaining members, or perhaps at a reasonable fee. There is a tremendous amount of work that has gone into that. It contains a lot of valuable information and I do feel that those sustaining members who will receive it will appreciate the information. And to keep faith with them, shouldn't we perhaps limit its distribution and see that it maintains its position as a qualified publication of the Association?

President Sperbeck: I think you are right, Ted, as to the value of it. It certainly would be worthwhile. Do you want to put that to a vote of this Association, or refer it to the Board of Directors?

Mr. T. J. Raley: I would like to hear first how others feel about it and that would guide the Directors in their determination.

President Sperbeck: Would any one else care to discuss this?

(No response)

President Sperbeck: If not, why we will suggest that to the Board of Directors for their consideration.

The next committee is the Legislative Committee, Chet Robinson, Chairman.

REPORT OF THE LEGISLATIVE COMMITTEE OF THE CALIFORNIA MOSQUITO CONTROL ASSOCIATION

The State Department of Public Health in their budget for 1955-56 included $725,000 for State subvention plus 10% of this amount for studies and investigations. All but $400,000 subvention was deleted in the Governor's budget. Your Legislative Committee, through Assemblymen Ralph Brown and Ernest Geddes, presented AB 1649 to replace the $325,000 in the State Department of Public Health's budget. The hearing before the Assembly Public Health Committee on AB 1649 was defeated because many members felt local participation should be greater by many mosquito abatement district. However, your Committee secured a re-hearing, and the bill was passed by the Public Health and Safety Committee. This was in the closing days of the Legislative session and the bill died a natural death by there not being sufficient time to be heard by the other legislative committee. That is a favorite way of eliminating some of these bills.

In the final days of the legislature many hearings and conferences were held on the $400,000 subvention in the State Department of Public Health budget. At one time the special committee of the Senate Finance Committee said, "Not one cent for subvention": after a second hearing, "Well, O.K. You need something; maybe we will give you $100,000." The next thing we heard was, "Whatever you get will be for districts with 15¢ or over tax rate." Finally, $375,000 State subvention was granted to mosquito abatement agencies, on the basis of last year's pattern of allocation, and $25,000 for investigations and studies. Some of you will remember that $25,000 has been taken out of subvention funds for a number of years. They placed it directly into the operations investigation program.

Assemblymen Brown and Geddes secured the passage of AB 1647, continuing the exemption of mosquito abatement districts being formed under the District Investigation Act until the adjournment of the 1957 regular session of the Legislature.

Assemblymen Brown and Geddes presented AB 1648 which was to form a Council of Mosquito Abatement Agencies. This bill was withdrawn at the request of the California Mosquito Control Association after a poll of the membership signified a desire for more time to study its provisions.

Respectfully submitted,
By the Legislative Committee
E. C. ROBINSON, Chairman
HAROLD F. GRAY
ROBERT H. PETERS
ARTHUR F. GEIB
C. DONALD GRANT

President Sperbeck: I thank you, Chet. I know that Chet Robinson did a lot of work on this committee. He was back and forth a lot and in Sacramento they began to ask him if he had a lobbyist's card he was around the Capitol Building there so much.

May we have a motion approving the Legislative Committee's report?

Mr. Howard R. Greenfield: I move we approve the report. Howard Greenfield.

President Sperbeck: May we have a second?

Mr. Edward E. Davis: I will second it; Davis of Fresno.

President Sperbeck: It has been moved and seconded the report be approved. All those in favor—

Mr. Gardiner C. McFarland: Question. McFarland. I would like to ask the Legislative Committee if they have any report on that new law that was passed regarding the withdrawal of territory from Districts?

Mr. E. Chester Robinson: Dick Peters will answer that. He is right up to the last minute on that.

Mr. Richard F. Peters: My answer will be very feeble. I am not up to the last minute. I am extremely vague. What Gardiner McFarland refers to is a provision of a number of codes governing District operations; and apparently unawares to us in Mosquito Control, passage of which was accomplished last year in the Legislature, of a bill permitting a city council to withdraw annexed territory from identity with a Mosquito Abatement District if it had previously been in a Mosquito Abatement District. That is essentially correct.

Mr. Gardiner C. McFarland: That is correct.

Mr. Richard F. Peters: Now, the implications of that new statute are probably more ominous than that particular portion of it, and I am certain that it represents something worthy of consideration by Mosquito Control because, theoretically, situations could arise by which entire cities or portions of cities might by resolution of the City Council declare themselves no longer a part of a Mosquito Abatement District, and where would Ed Davis be if that happened?

(Laughter)

Mr. Edward D. Davis: I would be all right, but where would Ted Raley be? Remember, that the bulk of that belongs to Fresno now. Half of his District is in the City of Fresno. He would be out of business, Dick.

(Laughter)

Mr. Richard F. Peters: The question that was posed by Mr. McFarland was, who and how should the implications of this thing be determined by? I think that everybody agrees the Attorney General's office is the only competent authority, and I have discussed this matter with our people and they would prefer that the specific situation at issue be made the object—the example, that is, of an Attorney General's ruling. The Attorney General doesn't usually make sweeping rulings on matters of this kind because often there are many complicating local issues in such a matter that have to be brought into the judgment, and therefore it would be preferred if the County Council of the locality concerned initiated the request in behalf of that particular locality, which then, in turn, would cast its implications more generally.

Mr. Harold F. Gray: Mr. Chairman, this particular bill, as I understand it, does not refer directly to Mosquito Abatement Districts. It is the law governing all Districts.

Mr. Richard F. Peters: But it also includes Mosquito Abatement Districts.

Mr. Harold F. Gray: Presumably it includes. I think there is something in the Constitution that *ex post facto* laws are not possible under our American system of Government, and it would certainly be a decided question as to whether a law passed now could affect Districts organized under previous laws without this provision.

Secondly, there is also this general provision and law that where a specific method of dissolution of a District is provided, that another method put in later may not have validity.

I think that in all probability, if you want to settle the hash, would be to get some small city in a large District, to make the attempt and then get your ruling on that basis. I think you would be surprised to see what the result would be. I think probably you would be sustained, but it is a point of danger and you ought to do something about it.

President Sperbeck: Thank you, Harold.

Any further questions?

We have the motion made and seconded approving the Legislative report.

Mr. O. W. Carrick: Mr. Chairman, Carrick of Orange County.

I should like to know what action the Legislative Committee took in regard to attempting to get this new bill defeated. Is it possible that the Legislative Committee could advise the various Districts on pending legislation that should—that could result in some effective lobbying that would cause the legislation to die in committee or the like? Because this can, as I see it, have some detrimental effects upon the proper function of a Mosquito Abatement District. And it seems to me that the Legislative Committee can function in a manner that we can get together and if we can't get legislation favorable to the District through the Committee, we can probably stop legislation that is unfavorable in the committees.

President Sperbeck: That is right. That is a very good suggestion. I think this particular bill sneaked through us, didn't it, Chet?

Mr. E. Chester Robinson: None of us knew about it until we got the letter from Gordon through the Public Health Department. It was one of those things we didn't catch.

President Sperbeck: There are so many thousands of bills up there, that when we are working on our own bills it is hard to cover them all.

Mr. Gardiner C. McFarland: I might like to comment on this bill, that it is in the Public Health Code. I forget the section but I remember in this particular District deal there were many organizational changes, as Mr. Peters mentioned, but this particular one referring to mosquito abatement districts is very specific and it is in the Health and Safety Code and it deals with acquisition and formation of districts, so it definitely covers mosquito abatement districts. However, in the total bill it was not identified.

President Sperbeck: Yes. I think that was the idea that Harold Gray was mentioning, that it wasn't specifically a mosquito abatement bill, but yet it included it.

Mr. Richard Peters: I have it here, if you want to hear it.

President Sperbeck: It might be a good idea to enlighten the members on it.

Mr. Richard Peters: Well, I think I can make myself heard from here.

This originated through the Public Resources Code and it also applied to the Government Code and the Health and Safety Code, and the Highway Code. So it did have a broad bearing. It says expressly now in the Health and Safety Code, under Section IV:

> "Article 6.5, entitled 'Withdrawal,' is added to Chapter 5 of Division 3 of the Health and Safety Code.
>
> "Article 6.5 Withdrawal
>
> "2350. Whenever any portion of a District is included within a city by reason of incorporation, annexation, or otherwise, such portion may be withdrawn from the district.
>
> " '2351. Such withdrawal shall be effective upon the filing with the State Board of Equalization, the governing body of the district, and the county assessor, of copies of a resolution of the legislative body of the city, describing the included portion and declaring such portion withdrawn.' "

President Sperbeck: Very specific and very broad, as you say.

Mr. Norman A. McGillivray: Mr. Chairman, I think it should be emphasized there are changes in the Government Code that affect many districts and shouldn't be overlooked in regard to study with Mosquito Abatement Districts.

President Sperbeck: Thank you.

Any further questions on the motion to approve the Legislative report? If not, all those in favor signify by saying "Aye." Contrary?

So ordered.

The next will be the report of the Membership Committee by the interim chairman, Mr. Greenfield. Mr. Greenfield will also include in this report his report on Water Resources. We will just combine the two.

Mr. Howard Greenfield: As our President indicated, I am the interim chairman of the Membership Committee, though I don't have a great deal to report other than you will be receiving notice of dues payable within the next week or two. I can't even at this time give you the number of associate members that this organization has.

That concludes my Membership Report—oh, may I make one recommendation, however. In view of the discussion we have just had on the fiscal year versus the calendar year, in our audits, I would like to make one recommendation, that the membership be placed on a calendar year also. It would facilitate somewhat, I think, the billing and the reporting of the moneys received.

If I may now I will go into the Water Resources Committee Report.

WATER RESOURCES AND IRRIGATION COMMITTEE REPORT

The report of the Water Resources and Irrigation Committee is very brief.

Our organizational meeting was held July 22, 1955, at the Northern Salinas Valley Mosquito Abatement District's headquarters in Salinas. We briefly reviewed the objectives and past accomplishments of previous committees, and from these, we were able to determine the program under which we would work for the rest of the year. It was obvious to committee members that, in order to accomplish the work planned, monthly meetings would be held.

The Committee's accomplishments may be listed in the following order: (a) A Symposium on Source Reduction Methods was held in Stockton on November 3rd, 1955. (b) A questionnaire on Source Reduction was sent to all mosquito abatement districts (the results of that questionnaire are appended to this report). (c) A Memorandum to Member Agencies outlining a proposal whereby the Bureau of Vector Control would review those publications available to them on Water Usage and Water Development. The information obtained would then be released to those agencies most likely to be affected. Other projects are still in various stages of developmnt.

It is this Committee's recommendation that the incoming committee give consideration to the following: First, that meetings be arranged with representatives of the Bureau of Vector Control for the purpose of reviewing the information being received by the Bureau pertaining to the current and future water development and water usage in the State of California. The information obtained could then be released to Member Agencies most likely to be affected. Second, that consideration be given to the development of an Index to Source Reduction Information scattered throughout the Proceedings of the California Mosquito Control Asosciation. Upon completion of the Index to Source Reduction Information, all Member Agencies should be sent a copy for their information files. Third, that the development of the Division of Water Resources, State of California, be closely followed and matters pertaining to Mosquito Abatement Districts Control Programs be reported to Member Agencies.

The present Committee further recommends for consideration and approval by the Board of Directors of this Association the following: that, inasmuch as water usage and water disposal (drainage) problems have been consistently viewed by workers in the field of mosquito control as the primary method of controlling mosquitoes, and inasmuch as water management and development problems are, in themselves, extremely complex and their solution equally as complex, and inasmuch as the literature being published each year is becoming more voluminous requiring much time and labor to review, it is the Committee's opinion that future committees, in order to keep abreast of new developments that may affect mosquito abatement programs in this State, must develop continuity of thought and purpose from committee to committee.

Therefore, this Committee proposes that the Board of Directors develop a procedure whereby the majority of Committee Members may be retained for more than a one year period. It is believed that only be retaining a majority of the Committee Members, that those programs, requiring two and possibly three years of research to develop, can be brought to completion.

Respectfully submitted,

HOWARD R. GREENFIELD, *Chairman*
RICHARD DeWITT
T. D. MULHERN
L. S. HAILE
EARL ARNETT
JOE WILLIS

SUMMARY: WATER RESOURCES AND IRRIGATION COMMITTEE SOURCE REDUCTION QUESTIONAIRE

The information in this report was compiled from answers received in the Source Reduction Questionaire sent to all districts last August. This report is intended to furnish material for discussion among those of the Mosquito Abatement Districts actively engaged in a Source Reduction Program. It may also bring forth questions from those who are just beginning or are contemplating a program.

A number of districts have been engaged in source reduction for the past few years, and the people involved have, no doubt, learned much by way of experience and continue to learn something new each day.

To make it possible for all of us to compare notes or pool our experiences and information, the answers to the Source Reduction Questionaire have been compiled.

Forty-five questionaires were sent out, and as of October 19, 1955, twenty of these have been returned. The percentages mentiond in this report are based on those twenty questionaires returned. We will assume that the remaining twenty-five districts are not too active in a source reduction program.

It is interesting to learn that all twenty of the districts are using some personnel on source reduction, with 40% having full-time personnel with part-time personnel assisting. All districts, of course, have the assistance of the field operators in one way or another.

The types of sources generally recognized to be problems for source reduction personnel have been separated into six different groups. Percentages are given to compare the districts involved.

It was noted that in the districts reporting, only 30% have a salt marsh problem, industrial waste problems are experienced by about 32%, and 78% have a definite agricultural problem. Since many of the districts are situated inland, it is not surprising that 80% of the districts have natural sources such as creeks, sloughs, swamps, etc. All have home municipal problems and all districts have drainage ditch problems.

Forty percent of the districts own and operate heavy equipment for source reduction, with about 25% doing contract work. Below are listed the types of equipment and costs as compiled, as pertains to those districts involved in source reduction work.

Track layer with dozer blade—$4.00 to$5.00 per hour (practically all districts have this type of equipment)

Carry-alls—$4.00 to $5.00 per hour	(2 districts)
Draglines—$7.00 to $8.00 per hour	(4 districts)
Motor graders—$3.00 per hour	(1 district)
Backhoe—$7.00 per hour	(1 district)
Tow graders—$4.00 to $7.00 per hour	(2 districts)

Legal agreements are used by most of the districts. Legal counsel apparently was available and was utilized in the development of the agreement forms used by each district. (See forms attached)

Ninety percent of the districts reported a routine method of channeling information for source reduction needs. With those districts having a full-time source reduction man, information is usually channeled through to him for further investigation, planning, etc. There are many and varied methods used by those districts where almost all source reduction activities are limited to work by part-time personnel. Apparently most districts have devised a method of reporting source reduction problems according to their own particular situation and need.

A high percent of the districts, approximately 90%, do receive cooperation from governmental agencies. The following is a list of such agencies: County Health Department, County Public Works, County Flood Control, County Farm Advisor, County Agricultural Extension Service, County Planning Commission, Irrigation Districts, Local Soil Conservatiton Districts, State Highway Department, County Road Department, U. S. Conservation Service, and Municipal Sanitation Districts.

The question pertaining to weed control uncovered a rather surprising trend in current mosquito abatement activities. It would seem that most of the districts are confronted with serious weed problems, and all are working toward a solution of their respective problems. The equipment used runs the gamut, from a mower through the weed oils, plant hormones, soil sterilants, to the use of liquid propane gas burners. It was very apparent that weed control will play an increasingly important part of each district's source reduction program.

All districts report definite budget accounts being set aside for source reduction work. The least amount recorded was 2% of the total budget, and the most spent by any one district was reported as 50%. On the average it may be stated that about 25% of the total operational budget is being set aside for source reduction work.

President Sperbeck: Thank you, Howard.

May we have a motion approving Mr. Greenfield's report as interim chairman for the Membership Committee?

Secretary-Treasurer Washburn: Mr. Chairman, I so move.

Mr. O. W. Carrick: Carrick. And I second the motion.

President Sperbeck: It has been moved and seconded to approve the report of the Membership chairman. All those in favor signify by saying "Aye." Contrary?

So carried.

Now may we have a motion approving Mr. Greenfield's report for the Water Resources Committee and also approving the recommendations that Mr. Greenfield suggested?

Mr. Robert Peters: Bob Peters. I will so move.

Mr. O. W. Carrick: Carrick. And I will second the motion.

President Sperbeck: It has been moved and seconded to approve the report of the Water Resources Committee chairman. All those in favor signify by saying "Aye." Contrary?

So ordered.

Now we will hear from Mr. Shanafelt, Chairman of the Culicidology Committee.

CULICIDOLOGY COMMITTEE

Mr. President and CMCA members: It has been called to my attention that some of our Districts didn't receive our report. We were apparently short on copies at the time they were mailed so I have brought a stack of them here for those who didn't receive them.

We decided that we would recommend the 1956 Committee review our survey of the committee on the adult mosquito population measurements. We also wish to recommend that a survey of the immature *Culex tarsalis* be started in 1956 and that would require a standard collection form for each of the Districts. The Bureau of Vector Control has already begun such a survey on 43 species of mosquitoes here.

We also recommend that Section IV-E in our survey be given a little more consideration. It seems that there is a desire for a more standardized identification key.

Also we wish to recommend that four of our committee members be retained for a one-year period and four new members added for a two-year period, which would give us a little better continuity between changes. The older ones would continue their trend of thought and the newer ones could pick it up and, for our old members, we wish Gordon Smith, Shanafelt, Arnold, and Herms, and the others to be appointed, so that we would have two members from each area in the State.

Respectfully submitted,
JOHN SHANAFELT, *Chairman*

President Sperbeck: Thank you, Mr. Shanafelt. I guess it would be in order to include Mr. Shanafelt's recommendations along with the approval of the Association. While we don't want to tie the hands of the new president in naming his committees, I think it is a good suggestion and one that the new president can take under consideration. It is just a recommendation anyway.

Mr. O. W. Carrick: What is the name of that committee?

President Sperbeck: That was the Culicidology Committee.

May we have a motion approving Mr. Shanafelt's report for the Culicidology Committee, including his recommendations?

Mr. C. Donald Grant: Don Grant. I will move for its acceptance.

Mr. O. W. Carrick: How many does the by-laws state should be on the committee? There are only seven here now.

A Voice: It is the option of the President.

President Sperbeck: Now, is there a second to Don Grant's motion to approve the report?

Mr. Edward D. Davis: Ed Davis. I will second it.

President Sperbeck: It has been moved and seconded that the report of Mr. Shanafelt be approved. All those in favor signify by saying "Aye." Contrary?

I was wondering if either of the members that were appointed to the Advisory Committee representing the Association on the State Health Advisory Committee would care to make a short report, if they are prepared for it. Either Art Geib or Don Grant.

Mr. A. F. Geib: Chet Robinson that would be.

President Sperbeck: Are you on that? Is there any report to be made on that?

Mr. Chester Robinson: Dick might. He is always there. He might have something to say. Do you have anything to say, Dick?

Mr. Richard F. Peters: I haven't anything to say, except the names you have just read are the appointees of the CMCA for the 1956 committee. Arthur F. Geib and Don Grant will represent your Association.

President Sperbeck: Oh, they are the new ones. No wonder you can't make a report.

The next committee will be Ways and Means, Ed Smith, Chairman.

Mr. Dean H. Ecke: We have an alternate for Santa Clara. I have no report. I just would like to say that Ed said this morning that the Committee had not had a meeting and there was no report.

President Sperbeck: All right. The next will be the William B. Herms Award, Richard Peters, Chairman.

WILLIAM B. HERMS AWARD

Mr. Richard F. Peters: Mr. President, and Members of the Association: Through funds in the amount of $35 furnished by the California Mosquito Control Association, Larry Wachtler and Roy Buckingham, of the Mt. Diablo Council of the Boy Scouts of America, Berkeley, were enabled to attend summer camp in the name of the late Professor W. B. Herms.

The Committee recommends that this monetary assistance in the same manner and amount be continued in the year 1956.

This is signed by C. Donald Grant, my co-member of this Committee.

President Sperbeck: Is there a motion approving the report of this committee?

Mr. T. G. Raley: I move it be approved.

Mr. Roy L. Holmes: I will second that.

President Sperbeck: It has been moved and seconded that the William B. Herms Award Report be approved with the recommendation of it being carried on. All those in favor signify by saying—

Secretary-Treasurer Washburn: Mr. Chairman, one point in question. Was there not, among the recommendations, a statement that it be in the same manner and amount?

Mr. Richard F. Peters: Yes.

Secretary-Treasurer Washburn: I would like to recommend that the amount be stricken out because it varies from year to year. It would depend upon circumstances, as I understand from the Mt. Diablo Council of the Boy Scouts of America, whether it would be $35 or $40 or $50, and it has not been the same amount. It has never exceeded $50, but it does vary from year to year.

Mr. Richard F. Peters: I would say in the same approximate amount, then.

President Sperbeck: It seems to me we set a limit in the first place of $50. I think that is true—didn't we?

Secretary-Treasurer Washburn: Yes.

President Sperbeck: It has been moved and seconded. All those in favor signify by saying "Aye." Contrary?

So ordered.

RESOLUTIONS COMMITTEE

Resolutions Committee, Bob Peters, Chairman.

Mr. Robert H. Peters: Mr. President, Members of the Association: Since this committee was brought into existence very suddenly at the end of last night's meeting, this committee recommends, first of all, that the Secretary be authorized to add the "Whereases" and the "Wherefores" involving three resolutions:

One, and most important, that the actions through the conference year of 1955 of the Board of Directors be approved by the general membership;

No. 2, that the Secretary send those letters of appreciation to those who contributed to the success of this Conference;

Resolution No. 3, a resolution recognizing the untimely passing of W. H. W. Komp, of the United States Public Health Service, who passed away on December 7 of 1955.

President Sperbeck: Thank you, Bob.

Mr. T. G. Raley: Mr. President, I think the membership should know that part of this committee worked until 2 o'clock this morning on these resolutions.

(Laughter.)

President Sperbeck: You are to be congratulated for such good work under those circumstances.

Mr. Robert H. Peters: I would like to add, Mr. President, that obviously Mr. Raley was the other member of this committee.

(Laughter.)

President Sperbeck: May we have a motion approving the Chairman's report of the Resolutions Committee?

Mr. W. Donald Murray: I will so move.

Mr. C. Donald Grant: I will second it.

President Sperbeck: It has been moved and seconded that the report and recommendations of the chairman of the Resolutions Committee be approved. All those in favor signify by saying "Aye." Contrary?

So ordered.

Could we have a report from you, Mr. Geib, on the Insecticide Committee? Do you have something to say on that special committee?

INSECTICIDE COMMITTEE

Mr. A. F. Geib: Gentlemen, I will start this out in a rather indirect way. To me it is most gratifying to see the progress of the activities of the CMCA. Among us there are a lot, a considerable number, of what we might call new-comers to the fold of Mosquito Control in California, but on the other hand, there are a considerable number of so-called old-timers that go back for a number of years and the work of Don Murray and his committee in putting out the Year Book, I think, exemplifies this growth that the Association is experiencing in the field of Mosquito Control here in California.

For ten years now we have been using the so-called newer insecticides in our Mosquito Control activity beginning with DDT, chlorinated hydrocarbons, and subsequently going through a series of chlorinated hydrocarbons related to DDT, perhaps a little heptachlor, benzene hexachloride and the gamma isomer of BHC.

I think that brings me down now to the point where, as you all know, we have experienced this resistance. We have gone into the other families of insecticides, the phosphate group, we have used EPN, Malathion and Parathion. Who knows where we will go from here. We have gone far enough now that it might—at least it seems time to me and a number of other fellows who have had an opportunity to discuss this field of insecticide use—that it would be in order that we prepare a brochure, a guide and recommendations covering the use of insecticide for Mosquito Control in California. Now, at the present time we have no single source of reference to which we may turn to get information relative to the use of insecticides in our work, what is the dosage rate that we want to use, what type of material do we want to use, how are we going to apply it, what procedures should we follow in handling the material.

Now, whether we like it or not we are confronted with a very serious problem in using these materials of a hazardous nature and most of you will agree that, on private property, we are exposing the operators, the public, and the livestock to these materials. In light of that, it seems that it might be well worthwhile that the Association sponsor a so-called guide and recommendations, the contents of which will be a brief history, a historical review of the use of insecticides for Mosquito Control in California and also, data related to the common usage, toxicology, dosage rates, procedures, handling, and general housekeeping. I think that such a bulletin would tend to do two things primarily: one would be to give us a single source where we find reference to data on the usage of insecticides for pest control; and the other would tend to show our Agricultural Commissioners, the public in general, veterinarians and others, that the California Mosquito Control Association is cognizant of toxicological hazards involved and is trying to do the best job possible in handling and using these more toxic insecticides.

I would like to see a committee appointed, or some other method pursued, whereby the Association would sponsor such a bulletin. It should then be taken to Al Lemmon's office at the Department of Agriculture and submitted for his sanction. If we could obtain his approval, as well as that of the Bureau of Adult Health, I am sure that the bulletin would be of considerable value to the Association and to us individually.

President Sperbeck: Thank you, Art. I think that Art has a very good suggestion there.

Mr. Portman?

Mr. Robert F. Portman: Mr. Chairman, I would like to make the motion, in correlation with Mr. Geib's report, in effect that this committee be placed in existence and carry out the functions as outlined.

Mr. J. D. Willis: Joe Willis. I will second the motion.

President Sperbeck: It has been moved and seconded that Mr. Geib's report be accepted and his recommendations approved. All those in favor signify by saying "Aye." Contrary?

So ordered.

Secretary-Treasurer Washburn: I haven't asked Art whether I may make this remark regarding that committee or not. Several of us have been working on this particular problem and, for your information, the ground work has already been laid and we have in our hands, the several members of us, an outline and many of us have completed our portions of that brochure. We trust that it will be in your hands before the control season starts so you will have this for this next season.

President Sperbeck: Thank you, Ed. I suggest now—we have an hour to go yet—that we may take a ten-minute break; but don't forget to be back in ten minutes, fellows, because we have a couple of very important items to come up yet.

(Whereupon a short recess was taken.)

President Sperbeck: Well, we are ready for business again.

There are a couple of committees that we have overlooked here. There is the Operational Investigations report by Chairman Ted Raley.

Mr. T. G. Raley: I will make no report as such now, but this afternoon the first item on the program will cover a report on the Committee's—not the Committee's activities directly but the activities of the personnel working on the Operational Investigations program. That is at 1:30 promptly.

President Sperbeck: And the Publications Committee, Chairman Don Grant.

Mr. C. Donald Grant: Ed Washburn is the chairman.

Secretary-Treasurer Washburn: You put Don Grant down because he is the editor of the Proceedings, the only publication that has been considered the past year by the Publications Committee strictly. We underwrote or approved the publication of the Year Book by the Forms, Records and Statistics Committee; but our function, of course, has to do with the Annual Proceedings, the Proceedings of the 23rd Conference held last year in Los Angeles, and, of course, they are out and should be in all of your hands. If you have not received your individual copy, or your District's copies, or should your District desire additional copies for your library and so on, please contact the Secretary's office so you may be supplied with those.

President Sperbeck: Thank you, Ed.

May we have a motion approving the report of thc Publications Committee?

Mr. Chester Robinson: I will so move.

Mr. O. W. Carrick: I will second it.

President Sperbeck: It has been moved and seconded. All those in favor signify by saying "Aye." Contrary?

So ordered.

That just about covers the old business and the committees, excepting the Nominating Committee, which we will have a report of in just a few minutes. There are a couple of items that I think should be discussed here that are of great interest to all of us. I know I personally am not too familiar with the details of it and didn't realize the significance of it until some discussion we had with some of the members that were familiar with it, and that is regarding some Federal legislation that has been presented. I am going to ask Mr. Geib, who is a member of the Legislative Committee of the American Mosquito Association, to give you a run-down on this bill, and also he will tell you what he thinks we should do here as a body today to add our thoughts on that legislation that has been presented.

Mr. Geib!

Mr. A. F. Geib: Thank you, Dick.

As Mr. Sperbeck pointed out, I am a member of the Legislative Committee of the AMCA. This past November I received from the Chairman of that Committee proposed legislation which I had previously known nothing about. I think perhaps I should also mention that on this Committee the other members are George Thompson, from Texas, Otto McFeeley, from Lyons, Illinois, Lester Smith, from New Jersey, and I believe there may be one other whom I can't recall at the moment.

This past season in Florida, the East Coast and along the Gulf States, they experienced terrific seasons from infiltrations of salt water *Aedes* mosquitoes. So much so, that the Districts in operation were in for considerable complaint and criticisms by the public wanting to know why they couldn't do something about the severe mosquito problem they had. That, perhaps, to some degree, initiated action, particularly in Florida, with the thought of trying to develop a concerted program aimed at basic research and demonstrations, with the hope that something could be done ultimately towards answering the problems they were confronted with.

I hope that many or all of you received copies of this proposed legislation. I believe the Secretary sent this to you sometime in December. I think it is pertinent that the American Public Health Association approved a resolution or passed a resolution approving the proposed legislation. The Territorial Health Officer's group or association—I don't recall which they name themselves—also passed such a resolution. The Florida Anti-Mosquito Control Association passed such a resolution also. This matter will come up for consideration at the coming American Mosquito Control Association meeting in Texas the 1st of February.

It seems most pertinent that this matter be discussed as fully as possible here, and some type action be taken by this group.

I think perhaps I ought to try to limit myself to an initial discussion of this thing in reviewing the Act as it is to be submitted to the Congress. At least that is the present consideration.

Mr. Mulrennan, Chairman of the Legislative Committee for the State Board of Health of Florida, has carried the ball on all of this work. He has gone so far as to have the bill drawn up and Senator Spessard Holland, State of Florida, has agreed to introduce it into the Senate, and Mr. Sikes will introduce this legislative matter in the House of Representatives. And the bill, as it reads, is this:

"To provide for research and technical assistance relating to the control of salt-marsh and other pest mosquitoes of public health importance and mosquito vectors of human disease.

"That (a) in order to promote the public health and the general welfare, and to alleviate the present injurious effect on agricultural activities, the development of recreational facilities, and community development in general occasioned by the existence of salt-marsh and other pest mosquitoes and mosquito vectors of human disease (hereinafter referred to merely as 'mosquitoes'), the Congress, while recognizing that the extermination and control of mosquitoes is, and should be, primarily the duty and responsibility of the State and local governments concerned, hereby establishes a policy and program of (1) aiding and supporting technical study and research carried on for the purpose of devising methods for the extermination and control of mosquitoes, and (2) providing Federal technical facilities and services to aid States in the formulation and execution of State and local mosquito research and control programs.

"(b) It shall be the duty of the Surgeon General, acting under the supervision and control of the Secretary of Health, Education and Welfare, to carry out the purposes of this Act.

"Sec. 2. The Surgeon General shall (1) establish a program to promote and encourage cooperative activities by State and local governments in the extermination and control thereof; (2) collect and disseminate information relating to mosquitoes and the extermination and control thereof; (3) conduct, within the Public Health Service, technical research and demonstrations for the purpose of developing methods for the extermination and control of mosquitoes, and aid and support State and local governments, other public agencies, and private agencies and institutions in the conduct of such research and demonstrations; and (4) make available to State and local governments, other public agencies, and interested private agencies and institutions the results of any surveys, studies, investigations, or demonstrations which may be carried out by the Surgeon General and which relate to mosquitoes and the extermination and control thereof.

"Sec. 3. The Surgeon General is authorized, upon the request of any State, to conduct investigations, studies, demonstrations, and research and to make surveys with a view to discovering a solution to any specific mosquito control problem with which such State (or any local government thereof) may be confronted.

"Sec. 4. The Surgeon General shall, from time to time and to the extent he considers to be desirable, prepare and publish reports of such surveys, studies, investigations, research, and demonstrations carried out under this Act, together with appropriate recommendations with regard to the extermination and control of mosquitoes.

"Sec. 5. (a) Nothing contained in this Act shall be construed to authorize the Surgeon General to deal directly with a local government of any State without first securing the explicit consent of the State concerned.

"(b) The term 'State' as used in this Act includes Alaska, Hawaii, the District of Columbia, Puerto Rico, and the Virgin Islands and refers to the State organ or agency charged with the duty of carrying out State laws relating to, or providing technical assistance in connection with the extermination and control of mosquitoes.

"(c) Nothing contained in this Act shall be construed to limit the authority of any department, agency, or instrumentality of the United States to conduct research and experiments relating to the extermination and control of mosquitoes under the authority of any other provision of law.

"Sec. 6. For the purposes of carrying out the foregoing sections of this Act there is hereby authorized to be appropriated to the Department of Health, Education and Welfare a sum not to exceed $2,000,000 per annum beginning with the fiscal year which commences July 1, 1956.

"Sec. 7. There is hereby authorized to be appropriated to the Department of Agriculture, for the purpose of carrying on investigations of the effects produced on livestock by mosquitoes, a sum not to exceed $200,000 per annum beginning with the fiscal year commencing July 1, 1956."

There is a great deal more data also, covering the justification for this Act, the need for it, the agreements by the legislators to introduce this proposed legislation, but I don't think time permits us to go into those in detail. I just hope that you had the opportunity to review this thing when it was sent to you approximately one month ago.

(*Editor's Note:* Mr. Geib then quoted from a letter sent to Mr. Mulrennan which reflected the opinions of Mr. Geib and the Trustees of the Kern Mosquito Abatement District. A lengthy discussion of the proposed legislation ensued which for practical reasons has been deleted. The culmination of the discussion concerning the advisibility of the California Mosquito Control Association's endorsement of the proposed legislation lay with a roll call vote upon the motion by Mr. Carrick that the assembled members render a personal endorsement of the Holland Bill for forwarding to the American Mosquito Control Association. The vote was taken and resulted as follows:)

Secretary Washburn: Three "Yes," nine "No," nineteen "Abstain."

President Sperbeck: I think it would be in order if we would make a motion now, or the Chair would be receptive to a motion, that we take a ballot vote by districts and get it back in as soon as possible.

Mr. John H. Brawley: Brawley, Kings. I so move.

Mr. Gardiner C. McFarland: I will second it.

President Sperbeck: It has been moved and seconded that a mail ballot be taken on this issue. All those in favor signify by saying "Aye." Contrary- (Carried)

So ordered.

Now, why don't we have that mailed out. The Secretary will mail out the form and you can mail it back to the Secretary. Have you all received a copy of this bill? We are going to miss our lunch hour if we don't move along here. It is really late now.

Art, I want to thank you.

Is that all?—Before I forget about it, I would like to mention that the regional members get together and preferably during the lunch hour, if you can. I suggest that the presiding member take it upon himself to get the rest of the group together and appoint your representative to the Board of Directors for the coming year and report that to the Chair.

Now, there was one more thing, and I don't know if it is going to take much time, but I will just give a short word on it. If it is going to involve a lot of time we will have to discontinue it before we have our Nominating Committee Report, and that is a resolution from this body to Dr. Merrill, the Director of the State Department of Public Health, asking that he intercede with the Governor for some emergency aid to Mosquito Abatement Districts damaged by the recent flood.

Now, you might think that is for me only, but I understand there are other districts affected, and, believe me, I am going to have to have help because we are in desperate circumstances. There are emergency funds available for practically all phases of the disaster, and there is no doubt that we will be considered, but I believe that a resolution or a support of this body to Dr. Merrill will give him something to go on when he appears before the Governor.

Would anyone care to make this in the form of a motion?

Mr. Robert Peters: From Northern San Joaquin as the District which has had the second most amount of flood damage, to my knowledge, I wish to make such a motion.

Mr. Chester Robinson: I will second it.

President Sperbeck: It has been moved and seconded.

Mr. Jack H. Kimball: The question is, will that be damage to District vehicles and equipment?

President Sperbeck: For emergency use, not confining it strictly to vehicle damage as such, but to help meet this terrific emergency of flooded grounds and rivers that we are going to have right upon us. There is going to be no relief in miles and miles of the river bottom, and thousands of acres of counties that are going to be flooded. Sutter County will be a third flooded problem along well until June. It can't get out until it reaches the summer levels.

Now, that is a terrific problem. It is on a much larger scale. It is the same thing developing right now that we had in 1952 where we are going to have a tremendous early crop of *tarsalis* mosquitoes. Our assessed evaluation, conservative estimate, is going to be shot a third for next year, so I think if there is a possibility of getting some of the disaster funds, that we should get it in the districts that are damaged and they should be entitled to it.

It has been moved and seconded that such a resolution be forwarded to Dr. Merrill. Are you ready for the question?

All those in favor signify by saying "Aye." Contrary?

Thank you. So ordered.

Now, last but not least, the report of the Nominating Committee, Mr. Bob Peters, Chairman.

NOMINATING COMMITTEE

Mr. Robert Peters: As the past president of this California Mosquito Control Association I am quite certain I am speaking for the officers when I say that I am giving the most important single report of the day.

The following candidates were unanimously arrived at for the officers of the coming year:

For President, Don Murray.

For Vice-President, Howard Greenfield.

For Secretary-Treasurer, Ed Washburn.

For Trustee Representative, Roy Holmes.

Respectfully submitted, Robert H. Peters, Chairman, Joe Willis and Pete Pangburn.

President Sperbeck: Thank you, Bob.

Have there been any names submitted, Mr. Secretary, in accordance with the by-laws?

Secretary Washburn: None.

President Sperbeck: Well, then, I will entertain a motion that the Secretary cast a unanimous ballot for the representatives named by your Nominating Committee.

Mr. Robert Peters: Mr. Chairman, I so move.

Mr. C. Donald Grant: I will second that.

President Sperbeck: Ready for the question? All those in favor signify by saying "Aye." Contrary?

We have a new President. So ordered.

(Applause)

President Sperbeck: I would like to thank all of the members of the Committee for the wonderful work they have done and hope that the new President will get the same cooperation.

The members of the Sacramento Valley group will meet in the lobby in front of the fireplace immediately after being dismissed here. Will you take it upon yourselves, as I say, the presiding members, to get your groups together.

The San Joaquin boys will meet right here.

If there is not further business nor announcements, the meeting is declared adjourned.

(Whereupon, at the hour of 12:35 o'clock p.m. a recess was taken until 1:30 o'clock p.m.)

AFTERNOON SESSION — 2:00 O'CLOCK

President Murray: Let us proceed so we do not get too late. May I ask, for information, has the Northern California group or the Southern California group elected their regional representative?

Secretary Washburn: The Southern California region has. Regional Representative, Gardiner McFarland.

President Murray: Let us proceed with our program. This afternoon we will hear from the Cooperative Investigations Unit, State Department of Public Health, Bureau of Vector Control, and the California Mosquito Control Association with the Operational Investigations Committee with Chairman Ted Raley.

Mr. T. G. Raley: The Operational Investigations Unit is now more directly under the supervision of the Bureau of Vector Control but, of course, still of direct interest to all mosquito districts. We perhaps will serve more particularly now as an advisory group to the Operational Investigations, and yet I do hope that none of you will ever allow this to become a secondary or a routine part of our Mosquito Control activity.

We had quite a discussion this morning on research through federal aid. We have quite a research program going within our own structure of Mosquito Control in California and I sincerely implore that you do not let this become an old shoe, but that every day you will be conscious of it. Harold, in his opening address yesterday, remarked about our need for a brain trust and I will now introduce our brain trust and they will present to you an informal picture of the work that they are dedicated to and the work that they are accomplishing.

The more formal matters will all be presented in the proceedings and Ed Washburn has assured me that under the present pattern of gathering the information he will have the proceedings ready in early April of this year.

(Laughter)

Mr. Chester Robinson: Is that the joke?

Secretary Washburn: That is it.

(Laughter)

Mr. T. G. Raley: Well, let's do hope, then, that the proceedings are out by April the 15th then.

Our first member of the Brain Trust, the panel today on Operational Investigations, Basil G. Markos, of the Bureau of Vector Control, Fresno, California, and Basil will give his observations on mosquito production in selected cotton fields.

Basil!

A STUDY OF THE MOSQUITOES IN AN IRRIGATED COTTON FIELD ENVIRONMENT OF FRESNO COUNTY, CALIFORNIA

Basil G. Markos[1] and Allan G. O'Berg[2]

California's cotton acreage in 1955 was estimated at 745,000 acres, the smallest since 1950. In 1952 there were 1,818,000 acres under cultivation. The reduced acreage in recent years is in keeping with the Federal acreage allotment program. Cotton accounted for 36 per cent of the total value of California field crops grown in 1954, and, in terms of value, still outranked all other crops in the State by a wide margin, retaining its lead established in 1947.

The irrigated cotton field environment has been known to produce stubstantial numbers of *Aedes* and *Culex* mosquitoes. Of these, the encephalitis vector, *Culex tarsalis* Coquillett, is believed to be the most significant.

Cotton plants use varying amounts of water in different localities and under different conditions. The heaviest ir-

[1], [2] California State Department of Public Health, Bureau of Vector Control.

rigation is needed at the time when the temperatures are highest and the plants are at the peak of flowering and boll development. This water use coincides with the peak of mosquito production.

During the summer of 1951, Augustson (1952) made a survey of irrigated cotton fields in Madera County. Cotton acreage had been greatly increased in this locality, in most cases replacing alfalfa and permanent pasture. He observed that pre-irrigation early in the spring resulted in hatches of *Aedes nigromaculis* (Ludlow) as early as April, before the first irrigation, particularly in those fields known to have been a source for this species with the previous crop. Significantly, however, during the pre-irrigation period in these barren fields maturation of mosquitoes was apparently incomplete.

Augustson did not find mosquito larvae of any species in planted fields until June 19, when larvae were collected from furrows near the tail ends or in low spots. Early samples yielded *A. nigromaculis* and *Aedes dorsalis* Meigen. As the season progressed, *A. dorsalis* declined. *A. nigromaculis,* however, persisted for some time.

In poorly leveled fields water would stand in low spots, and if not too large such areas were frequently abandoned to weeds. Larvae of *C. tarsalis* and *A. nigromaculis* were taken in these habitats during the early part of July.

Augustson observed that during the early and midsummer cotton growing period, tractor cultivation was carried on regularly and irrigation was seldom excessive. After the first week of August most cotton fields were no longer cultivated by machine, and from this time on flooding was virtually continuous. This method of irrigation is generally advocated by technical advisors for good cotton production. Thus, after the first week of August, *A. nigromaculis* was replaced by *C. tarsalis,* as the predominant species. During September, the last month of heavy irrigation, *C. tarsalis* could still be found in significant numbers.

Husbands and Rosay (1953) found in studies on irrigated pastures in Fresno and Madera Counties that from July through October *C. tarsalis* larvae reached the fourth instar by the sixth or seventh day. At this rate emergence could normally be anticipated by the ninth or tenth day following irrigation. Husbands and Rosay report further that "if pupae can survive on damp soil and produce successful adults, as in the case with *Aedes nigromaculis,* then standing water that remains upon a field for six or seven days will probably produce *Culex tarsalis.*"

The shortest aquatic cycle for *A. nigromaculis* observed in Madera County (Husbands and Rosay, 1952) was 6½ days, with a mean air temperature of 77.2° F.

Thurman et al., (1951) observed in irrigated pastures in Stanislaus County a short cycle for *A. nigromaculis* in July of 4.75 days. The cycle consisted of the following stadium periods: first, 24 hours; second, 12 hours (at night); third, 24 hours (some fourths developed during the last 12 hours); fourth, 36 hours; and pupae, 24 hours.

While exact experimental evidence is wanting, the developmental period for *A. dorsalis* is believed to be similar to that of *A. nigromaculis.*

Similarly, on the basis of casual observations the aquatic cycle for *Anopheles freeborni* Aitken is believed to require 10 to 12 days.

Cotton Irrigation Practices

Pre-Irrigation: According to Hoover and Booher (1952), in most of the state's cotton areas the winter rainfall is not sufficient to wet the soil to the depth needed to start the season. An adequate pre-irrigation will permit the seedling to establish a root system to full depth during its early growth period. A reserve of soil moisture also is obtained for use later during the period of high water requirement.

All of the fields under study received pre-irrigation water except one. The Franchini cotton field was in rice during the previous year, so the rancher felt that the soil was sufficiently moist. Tables 1 and 2 and Figure 1 show the number of irrigations in the cotton fields under observation during the 1955 season. The greatest number of irrigations were during June, July and August. All growers preferred to irrigate in furrows which were spaced for cotton planting. For the most part siphons were used to convey water from the irrigation lateral to the cotton fields.

Spring Irrigations: Although timing is important with all irrigations, it is particularly so with the first one after planting. Tests made in Arizona showed that plants which made rapid and extensive growth prior to heavy flowering outyielded plants which received insufficient water during the early stages of growth. Early irrigation encourages early fruiting, with a higher percentage of the total crop being harvested at the first picking (Hoover and Booher, 1952).

Summer Irrigations: As the cotton plants come into the flowering period, growers continue to time irrigations very carefully. The rate of water use is then at a maximum during this period. By this time the plant has developed a full root system which enables more complete utilization of the available soil moisture. The importance of a sustained supply of soil moisture has been demonstrated in irrigation tests conducted over a period of four years at Shafter (Hoover and Booher, 1952).

Influence of Soils: The type of soil is an important consideration in determining irrigation practices. The three main soil types found in cotton growing areas in California are sandy soils, loam and clay.

The sandy soils usually take water rapidly, but retain very little. They therefore require frequent irrigations. The Gentry "B" cotton field, under observation during this study, received a pre-irrigation plus ten additional irrigations during the season.

Clay soils are generally productive, but they require careful management to produce a crop. Water penetration is usually slow but the water-holding capacity of clay is higher than that of sandy soil or loam. Because clays hold more water, they do not need to be irrigated as frequently as the other two types.

Methods

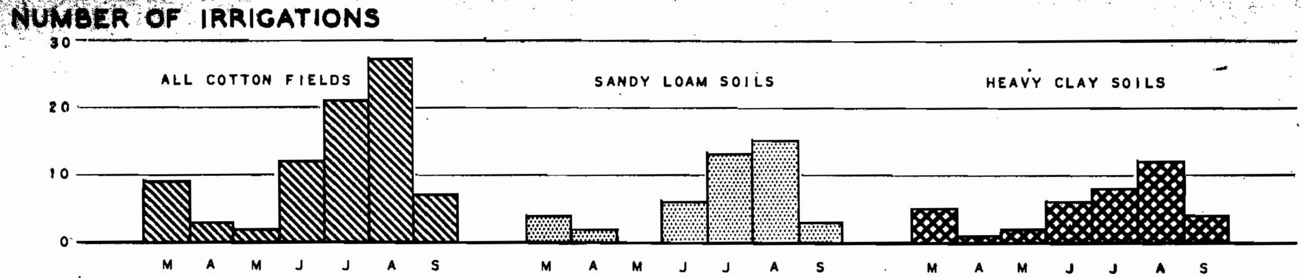
The cotton fields selected for study were located in West Fresno County, which has no organized mosquito control. The principal crop in addition to cotton in the vicinity of the study areas was rice. The furrow method of irrigation is used by cotton growers in this area and water is supplied by deep wells.

Five of the cotton fields consisted of sandy loam soil, seven of Temple clay loam or Merced clay loam.

Of the sandy loam fields the Lidfors, Heims A, Heims B, and Gentry A cotton fields were in cotton in 1954, while Gentry B was in alfalfa.

Of the heavy clay fields the Orlando and Groppetti fields were in barley in 1954, while the Franchini field was in rice, the Braun and Sulavan fields were in cotton, the Jones field was fallow, and the Marchini field was newly cultivated land.

FIGURE 1



MOSQUITO LARVAE AND PUPAE PER DIP

FIGURE 2

JONES COTTON FIELD DRAINAGE AREA

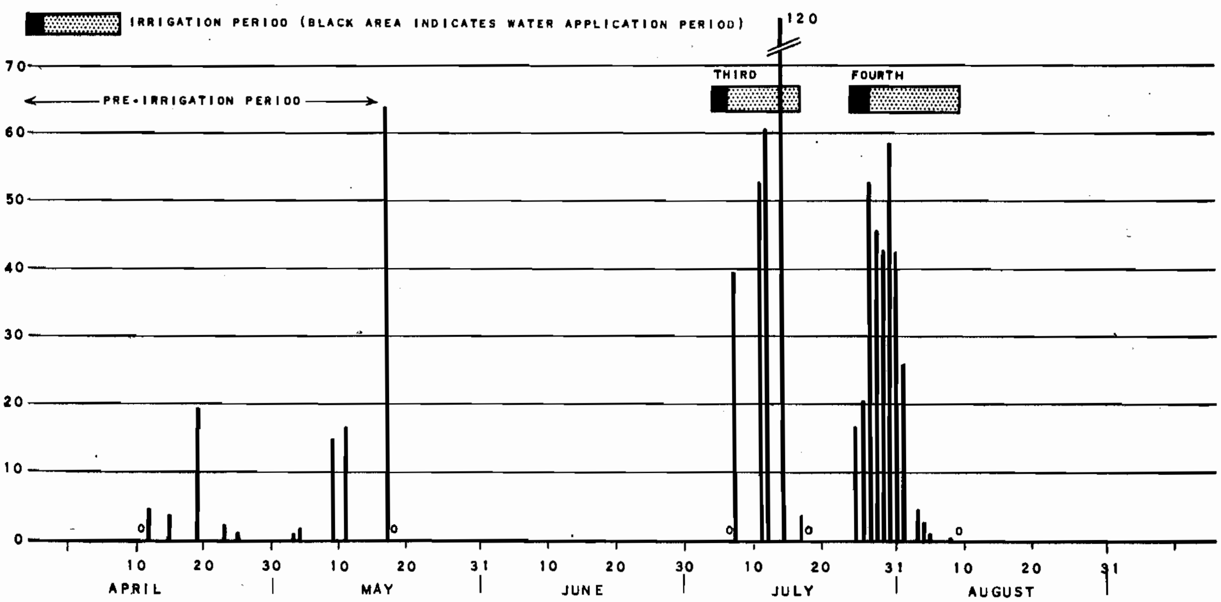


FIGURE 3

GROPPETTI COTTON FIELD DRAINAGE AREA

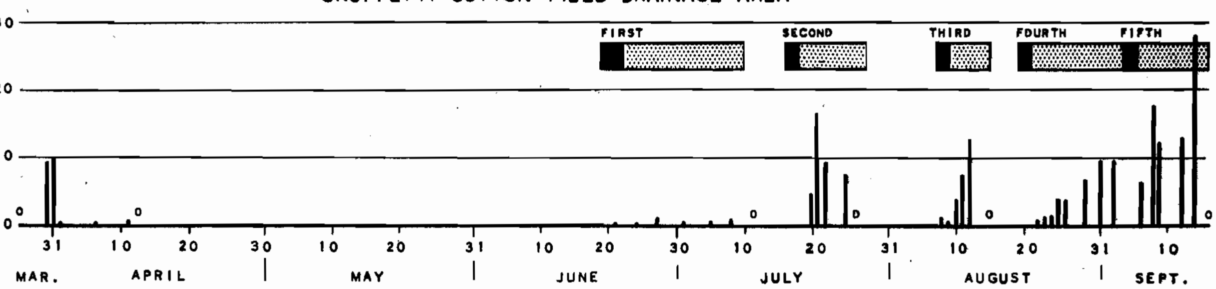


FIGURE 4

SULLAVAN COTTON FIELD IRRIGATION LATERAL

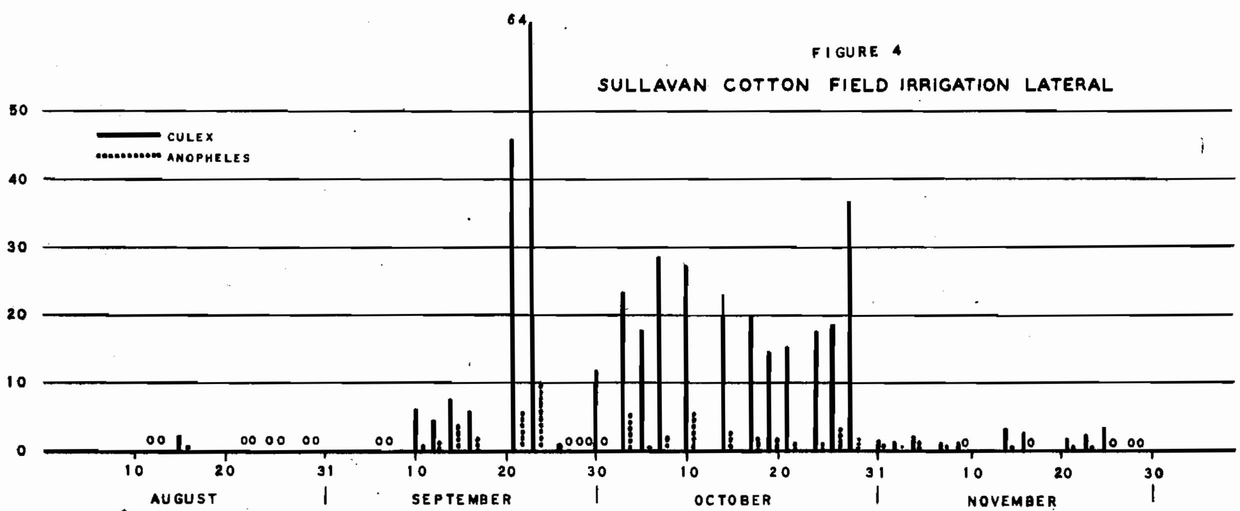


TABLE 1. IRRIGATIONS IN COTTON FIELDS, MARCH — SEPTEMBER, 1955

	SANDY LOAM SOIL					HEAVY CLAY SOIL						
Irrigation Period	*Gentry Field A*	*Lidfors Field*	*Heims Field A*	*Heims Field B*	*Gentry Field B*	*Orlando Field*	*Jones Field*	*Groppetti Field*	*Braun Field*	*Marchini Field*	*Sullavan Field*	*Franchini Field*
Pre-Irrigation	Late March	Late March	April 2-3	March 28-29	March 28	Late March	March 28-29	March 25-26	March 28	March 25	April 1	None
First Irrigation	June 9-13	June 16-19	June 14-16	April 4	June 14-17	May 18-19	May* 18-19	June 18-20	June 16-19	June 23-25	June 30-July 2	July 9-11
Second Irrigation	June 22-24	July 6-7	July 6-7	June 21-24	July 2-4	June 24-26	June 6-8	July 16-17	July 9-10	July 23-28	Aug. 18-20	Aug. 2-4
Third Irrigation	July 7-9	July 21-22	July 22-25	July 14-15	July 12-14	July 17-20	July 5-6	Aug. 7-8	July 25-26	Aug. 10-11	Sept. 1-2	Sept. 5-6
Fourth Irrigation	July 25-27	Aug. 10-11	July 30-31	July 29-31	July 20-21	Aug. 6-8	July 24-26	Aug. 19-20	Aug. 9-10	Aug. 29-31		
Fifth Irrigation	Aug. 8-11	Aug. 23	Aug. 9-10	Aug. 9-10	July 29-31	Aug. 22-24	Aug. 8-9	Sept. 4-5	Aug. 24-26			
Sixth Irrigation	Aug. 18-19	Aug. 31	Aug. 17-18	Aug. 20-21	Aug. 8-10	Sept. 7	Aug. 25-26					
Seventh Irrigation	Aug. 25-27		Aug. 25-27	Sept. 1-2	Aug. 15-18							
Eighth Irrigation	Aug. 30-31				Aug. 25-27							
Ninth Irrigation					Sept. 7							
Tenth Irrigation					Sept.* 13							
TOTAL Irrigations	9	7	8	8	11	7	7	6	6	5	4	3

*Partial Irrigations

TABLE 2. TOTAL NUMBER OF IRRIGATIONS IN COTTON FIELDS

MARCH - SEPTEMBER, 1955

		TOTAL NUMBER OF IRRIGATIONS						
Type of Soil	*Total Number of Cotton Fields*	*Mar.*	*April*	*May*	*June*	*July*	*Aug.*	*Sept.*
Sandy Loam	5	4	2	0	6	13	15	3
Heavy Clay	7	5	1	2	6	8	12	4
Totals	12	9	3	2	12	21	27	7

The cotton acreage of the fields selected for study in the sandy loam soil ranged from 19 acres (Heims A) to 100 acres (Gentry B). In the heavy clay soils the fields ranged fro m20 (Franchini) to 80 (Orlando) acres.

In order to observe the mosquito production problem systematically, the habitat areas were designated as follows: (1) pot-holes, (2) drainage areas, (3) tail-end water, (4) irrigation laterals, and (5) cotton fields.

The so-called pot-hole area was the plowed up area around the field and was later generally used as the service road. Drainage areas consisted of all low weedy, uncultivated areas along the sides of the field, usually adjacent to a railroad or highway embankment. The irrigation laterals consisted of the small irrigation ditches which conveyed water to the cotton field. The cotton field area was designated as the area between the rows of cotton. Tail-end water comprised the area wher water accumulated after its run through the rows of cotton.

A total of twenty dips were taken in each sub-section of the above mentioned areas. Every attempt was made to dip at regular intervals so that the flooded areas were uniformly sampled. For example, in the drainage areas and irrigation laterals, dips were taken at 12-15 foot intervals. As the size of the flooded area decreased, the number of dipping stations was also decreased. In one instance where there were heavy concentrations of *Aedes* larvae and pupae, the peak of mosquito production was somewhat exaggerated due to concentration of larvae and pupae in pools of water (Figure 2, third irrigation period).

Collections of larvae were taken frequently for identification purposes. Pupae were also taken, from which emerged adults were identified.

TABLE 3. MOSQUITO LARVAE AND PUPAE IN SULLAVAN COTTON IRRIGATION LATERAL, JULY - NOVEMBER, 1955

Date of Inspection	Irrigation Period	Total Number of Dips	NUMBER OF LARVAE AND PUPAE: Culex tarsalis	An. freeborni	Total Larvae and Pupae
7-14-55		20	0	0	0
7-18-55		20	0	0	0
7-19-55	First	Dry			
8- 5-55	Irrigation	20	0	0	0
8- 8-55		20	0	0	0
8-12-55		20	0	0	0
8-15-55		7	15	1	16
8-22-55	Second	20	0	0	0
8-25-55	Irrigation	20	0	0	0
8-29-55		Dry			
9- 6-55		20	0	0	0
9-10-55		20	123	10	133
9-12-55		20	84	28	112
9-14-55		12	95	31	126
9-16-55	Third	12	70	18	88
9-21-55	Irrigation	12	546	53	599
9-23-55		12	762	121	883
9-24-55		Sprayed with weedicide			
9-26-55		12	2	1	3
9-28-55		20	0	0	0
9-30-55		20	235	0	235
10- 3-55		20	464	8	472
10- 5-55		20	349	6	355
10-7-55		20	576	31	607
10-10-55		20	542	85	627
10-14-55		20	464	40	504
10-17-55		20	401	31	432
10-19-55		20	299	23	322
10-21-55		20	306	19	325
10-24-55	No	10	178	9	187
10-26-55	Irrigation	10	183	24	207
10-28-55	During	6	221	7	228
10-31-55	This	20	32	1	33
11- 2-55	Period	20	31	1	32
11- 4-55		20	42	3	45
11- 7-55		20	14	2	16
11- 9-55		20	31	0	31
11-14-55		20	63	1	64
11-16-55		20	50	0	50
11-21-55		20	35	1	36
11-23-55		20	41	0	41
11-25-55		10	33	0	33
11-28-55		Dry			

TABLE 4. TOTAL MOSQUITO LARVAE AND PUPAE IN GROPPETTI COTTON FIELD DRAINAGE AREA, MARCH - SEPTEMBER, 1955

Date of Inspection	Irrigation Period	Total Number of Dips	NUMBER OF LARVAE AND PUPAE: Aedes dorsalis	Culex tarsalis	Total Larvae and Pupae
3-25-55		20			0
3-29-55		20	185		185
3-31-55	Pre-	20	202		202
4- 1-55	Irrigation	20	14		14
4- 6-55		20	12	2	14
4-11-55		20	8	23	31
4-12-55		Dry			
6-21-55		20	4	1	5
6-24-55		20	21	1	25[1]
6-27-55	First	20	1	35	36
7- 1-55	Irrigation	20	2	15	17
7- 5-55		20		17	17
7- 8-55		10	1	18	19
7-11-55		Dry			
7-20-55		20	89		89
7-21-55		20	32	205	327
7-22-55	Second	20	38	182	220
7-25 55	Irrigation	10	151	72	223
7-26-55		Dry			
8- 8-55		20	25		25
8- 9-55		20	13		13
8-10-55		20	75		75
8-11-55		20	12	134	146
8-12-55		16	8	199	207
8-15-55	Third	Dry			
8-22-55	Irrigation	20	13		14[2]
8-23-55		20	10	16	26
8-24-55		20	16	16	32
8-25-55		20	5	67	72
8-26-55		20	5	67	72
8-29-55		20		125	125
8-31-55		20		192	192
9- 2-55		20		193	193
9-6-55		20		124	124
9- 8-55		20		353	353
9- 9-55	Fourth	20		240	240
9-12-55	Irrigation	17		221	221
9-14-55		11		306	306
9-16-55		Dry			

[1] Includes 3 *Aedes nigromaculis*
[2] Includes 1 *Anopheles freeborni*

TABLE 5. MOSQUITO LARVAE AND PUPAE IN JONES COTTON FIELD DRAINAGE AREA, APRIL - AUGUST, 1955

			NUMBER OF LARVAE AND PUPAE			
Date of Irrigation	*Irrigation Period*	*Total No. of Dips*	*Aedes dorsalis*	*Culex tarsalis*	*Culiseta inornata*	*Total Larvae and Pupae*
4-11-55		20	0	0	0	0
4-12-55		20	86	1		87
4-15-55		20	40	2		42
4-19-55		20	323	45	13	381
4-23-55	Pre	20	26	14		40
4-25-55	Irrigation	20	17	2		19
5- 3-55		20	12	1	6	20[1]
5- 4-55		20	12	12	14	38
5- 9-55		20	39	98	156	294[2]
5-11-55		20		268	68	336
5-17-55		6		348	34	382
5-18-55		Dry				
7- 6-55		Dry				
7- 7-55	Third	20	786			787[3]
7-11-55	Irrigation	10	460	66		526
7-12-55		10	450	158		608
7-14-55		10	955	244		1199
7-17-55		10	6	33		39
7-18-55		Dry				
7-25-55		20	332			332
7-26-55		20	408			408
7-27-55		20	1055			1055
7-28-55		20	904			904
7-29-55	Fourth	20	834	21		855
7-30-55	Irrigation	10	560	24		584
7-31-55		10	419	5		424
8- 1-55		10	235	29		264
8- 2-55		10	33	12		45
8- 4-55		10	0	27		27
8- 5-55		10	0	12		12
8- 8-55	Fifth	5	0	2		2
8- 9-55	Irrigation	Dry				

[1] Includes one *Aedes nigromaculis*
[2] Includes one *Anopheles freeborni*
[3] Includes one *Aedes nigromaculis*

Observations

A. *Pot-hole areas*

Only one of these areas (Groppetti field) contained water long enough to produce mosquitoes. This situation was caused by seepage of water from a furrow in the cotton field. The seepage was such that the water finally washed out and flowed over the pot-hole area into the Groppetti drainage area.

Pre-irrigation Period (March 25-26)

March 25—20 dips—no mosquitoes
March 29—15 dips—551 *A. dorsalis* (4th)
March 31—10 dips—400 pupae *A. dorsalis*
April 1—No standing water—soil moist

A large number of *A. dorsalis* adults were produced from this small area.

B. *Overflow Areas*

These were the areas where water flowed from the cotton field onto a dirt road along the edge of the field. Only one of these habitats (Jones) contained water long enough for mosquitoes to develop.

Sixth Irrigation Period (August 25-26)

August 29—20 dips—no mosquitoes
August 31—20 dips—62 larvae
C. tarsalis 61
1st instars 42
2nd instars 19
(One 2nd *A. Freeborni*)
September 2—20 dips—81 larvae
C. tarsalis 81
1st instars 35
2nd instars 25
3rd instars 21
September 5—no water

C. *Irrigation Laterals*

These areas all consisted of ditches which conveyed water from the main irrigation canal to the cotton fields. Of the fields under observation, only five were found to hold water sufficiently long to contain mosquitoes.

The Jones irrigation lateral was observed to contain water during the following periods: 1st irrigation (7 days), 3rd irrigation (10 days), 4th irrigation (8 days), 5th irrigation (7 days), and 6th irrigation (11 days). Mosquito production was observed only on two occasions, namely, following the third irrigation period (July 5-6) when *C. tarsalis* averaged 1.1/dip and *A. freeborni* averaged 0.05/dip. During the sixth irrigation period (August 25-26), *A. freeborni* averaged 0.20/dip.

The Groppetti irrigation lateral was observed to contain water during the following periods: pre-irrigation (26 days), 1st irrigation (10 days), 2nd irrigation (14 days), 3rd irrigation (9 days), 4th irrigation (11 days), and 5th irrigation (23 days). No mosquito larvae or pupae were observed following each of the above irrigation periods. The irrigation lateral was practically devoid of vegetation. There was some short, scattered vegetation on the upper portion of the ditch bank, but none was observed growing within the water or at water level.

The Orlando irrigation lateral contained water during the following periods: 2nd irrigation (7 days), 3rd irrigation (10 days), 4th irrigation (10 days), 5th irrigation (8 days), and 6th irrigation (15 days). No mosquito larvae or pupae were observed following each of the above irrigation periods. During most of the season, the lateral was devoid of vegetation. By the latter part of August, however, it contained light and scattered vegetation. (See discussion under cotton field.)

The Marchini irrigation lateral was observed to contain water during the following periods: 1st irrigation

(14 days), and 3rd irrigation (14 days). Mosquito production was observed shortly after the third irrigation (August 10-11) when *C. tarsalis* was found to average 1/dip.

The Sullavan irrigation lateral became flooded on July 14 and contained water for the remainder of the season. Flooding of the lateral was due to a faulty shut-off valve at the head gate, which allowed water to trickle from the main irrigation canal into the irrigation lateral. This lateral contained a good growth of vegetation. Routine observations indicated that this irrigation lateral was highly productive of *C. tarsalis* and *A. freeborni* (Table 3 and Figure 4).

The Sullavan irrigation lateral was sprayed on September 24 by personnel of the Tranquillity Irrigation District. A General Petroleum product, Kem-Kill "W" Aromatic Weed Oil, was applied by means of a portable Bean sprayer. The spray mixture was prepared by mixing 75 gallons of concentrate mix to 225 gallons of water. Apparently only the upper two-thirds of the irrigation lateral was sprayed. A pronounced reduction of mosquitoes was observed as a result of the herbicidal application.

D. *Tail-End Water*

Only two such habitats contained water long enough to harbor mosquitoes.

Sullavan Field: Following the second irrigation period (August 18-20), *C. tarsalis* averaged 3.2/dip and *A. freeborni* averaged 0.05/dip. Standing water persisted for a period of seven days.

Marchini Field: Following the first irrigation (June 23-25), *A. dorsalis* averaged 0.15/dip and *C. tarsalis* 0.25/dip. After the third irrigation (August 10-11), *A. dorsalis* averaged 0.05/dip. Following the fourth irrigation (August 29-31), *C. tarsalis* averaged 2.8/dip and *A. freeborni* 0.45/dip. The area contained water for six days (1st irrigation), six days (3rd irrigation) and nine days (4th irrigation).

E. *Drainage Areas*

These areas were observed to be the most productive mosquito sources in the cotton field environment during the 1955 season.

The Groppetti drain (Table 4 and Figure 3) was productive of mosquitoes during the following intervals: pre-irrigation, 1st, 2nd, 3rd, 4th and 5th irrigation periods. The dominant species were *A. dorsalis* and *C. tarsalis*. During the latter part of August (3rd irrigation) and first half of September (4th irrigation) only *C. tarsalis* was present. On March 31, 67.3 per cent of the specimens taken were *A. dorsalis* pupae. On July 25, 67.7 per cent were *A. dorsalis* pupae. On August 12, 96.1 per cent were first and second instar *C. tarsalis*. Since there was no water in the drainage area on August 15, only a small number of adults emerged during this (third) irrigation period. A large emergence of *C. tarsalis* started on August 26 and continued for approximately three weeks. On September 14, the day before the water disappeared from the drain, the samples consisted of 23.5 per cent fourth instar and 11.4 per cent pupae of *C. tarsalis*.

The predominant flora in the drain were *Juncus mexicanus, Eleocharis palustris, Scirpus spp.* and *Elymus triticoides,* in the order of abundance.

The accumulation of water was a result of seepage through the levee which in turn caused a break-through of water over the pot-hole area into the drainage area.

The Jones drain (Table 5 and Figure 2) was very productive of mosquitoes during the pre-irrigation and the third and fourth irrigation periods. The principal species were *A. dorsalis, Culiseta inornata* (Williston) and *C. tarsalis*. On April 19, 78.2 per cent of the specimens collected were pupae of *A. dorsalis* and *C. inornata*. On May 17, 42.1 per cent were pupae of *C. tarsalis* and *C. inornata*. There was no standing water in the drainage area on May 18. The July 14 samples showed 69.8 per cent pupae of *A. dorsalis* and 4.7 per cent of *C. tarsalis*. A very heavy emergence of both species resulted. On July 18 there was no water in the drainage area. On July 30 and 31 and August 1 the samples showed respectively 5.99 per cent, 95.0 per cent and 88.2 per cent *A. dorsalis* pupae. A moderately heavy emergence of this species resulted. There was also a small emergence of *C. tarsalis*. On August 9 there was no standing water remaining in the drainage area.

The vegetation in this area was similar to that found in the Groppetti drain.

This accumulation of water, approximately 25 feet from the edge of the cotton field, was quite unusual. Apparently the water flowed through a gopher hole from the end of the irrigation lateral.

F. *Cotton Fields*

Groppetti Field: This field contained water within the cotton rows for five days after each of the following irrigation periods: 2nd irrigation (July 16-17), 3rd irrigation (August 7-8), and 4th irrigation (August 19-20). No larvae were found during these intervals. However, after the fifth irrigation period (September 4-5) larvae were found in the residual water between cotton rows. On September 7 first instar *C. tarsalis* averaged 2.2/dip. By September 10 the population had increased to 13.2/dip and consisted of 36.7 per cent third instar, 32.9 per cent second instar, and 20.40 per cent first instar. On September 12 *C. tarsalis* averaged 33.5/dip and consisted of 11.9 per cent fourth instar, 17.6 per cent third instar, 54.0 per cent second instar, and 16.5 per cent first instar. One *A. freeborni* was taken. By September 14 water had disappeared between the cotton rows. The mosquito producing area in this cotton field was small and only a few mosquitoes emerged.

Sullavan Field: This field contained water within the cotton row for six days following the second irrigation period (August 18-20). On August 22 *C. tarsalis* larvae averaged 10.9/dip and consisted of 3.6 per cent first instar and 96.3 per cent second instar. A single *A. freeborni* larvae was taken. By August 24 the water had disappeared. No production of mosquitoes occurred in this field following the second irrigation.

Following the third (final) irrigation residual water remained on this field for eight days. On September 7 *C. tarsalis* averaged 11.8/dip and consisted of 35.5 per cent first instar, 55.9 per cent second instar, and 8.6 per cent third instar. *A. freeborni* larvae averaged 3.9/dip and consisted of 29.1 per cent first instar, 69.6 per cent second instar, and 1.3 per cent third instar. By September 9 all standing water had disappeared. In view of the small area involved and the short period of standing water, very few mosquitoes emerged from this field following the third irrigation.

Jones Field: This field contained water between cotton rows for seven days following both the fourth irrigation (July 24-26) and the fifth irrigation (August 8-9). No larvae were found during either of these periods. The field contained water for eight days following the sixth irrigation (August 25-26). On August 29 *C. tarsalis* averaged 0.80/dip, all first instar. *A. dorsalis* averaged 0.10/dip and consisted of second and third instar larvae. The water had receded and disappeared to such an extent that on August 31 five dips revealed only a single third instar larva of *C. tarsalis.*

Orlando Field: This field contained water in sump-holes gouged out by water flowing through the irrigation siphon tubes. Water remained in these holes for fifteen days following the sixth and final irrigation (September 7). On September 9 *C. tarsalis* averaged 0.95/dip. On September 10 the average was 3.5/dip and on September 16, 5.0/dip. One *A. freeborni* larva was taken during each of these inspections. Mosquito production in this field was low because of the small source area. On September 22 the water had disappeared from all of the sump-holes. These sump-holes were adjacent to the irrigation lateral which held water for long periods but contained no mosquito larvae.

Franchini Field: This field contained water for seven days following the third and final irrigation (September 5-6). No mosquito larvae were found during this interval. No standing water remained on the field after September 12.

Gentry (Yuba) Field: This was the only field on sandy soil that was found to contain mosquitoes. The field held water for three days following the ninth irrigation (September 7). On September 8 *A. nigromaculis* averaged 0.25/dip. On September 10 the water had disappeared from the field. This field received the greatest number of irrigations (pre-irrigation plus ten regular irrigations) and was the only field found to contain *A. nigromaculis.*

G. *Adult Mosquitoes in Cotton Fields*

In August, after the cotton plants had begun to branch out and fill in the rows, several artificial resting stations in the form of red cubic-foot boxes (Goodwin, 1942) were located in the field in order to determine if adult mosquitoes utilized this area as a resting place.

Collections from the boxes were made almost every day, and whenever possible during th morning hours. The adults were chloroformed within the box and placed in pill boxes. This was accomplished by placing a cover over the open end of the box and injecting chloroform through a small opening onto a layer of cotton attached to the inside surface.

During August, the largest number of adult mosquitoes taken per box per night was 41, consisting of *C. tarsalis* (3 males, 17 females), *A. freeborni* (4 males, 17 females), and 1 female *Anopheles franciscanus* McCracken. This collection was made on August 5 in the Jones Field. During the same period a station located in another part of the cotton field contained 44 adults. This collection consisted of *C. tarsalis* (8 males, 18 females), *A. freeborni* (1 male, 16 females), and 1 female *A. franciscanus.*

Another box was placed within a concrete road culvert a few feet away from the edge of the Jones cotton field. Adults taken here during the same period totaled 88, consisting of 10 male and 78 female *A. freeborni.* The largest number of mosquitoes collected per night during August for the box in the culvert was 424, consisting of *C. tarsalis* (16 males, 8 females) and *A. freeborni* (120 males, 280 females). This collection was made on August 15.

During September, the largest number of adult mosquitoes taken per box per night was 19. This collection consisted of *C. tarsalis* (7 males, 7 females) and *A. freeborni* (3 males, 2 females). This box was located within the Sullavan field and the collection was made on September 1.

In contrast, the largest collection for September from the box in the culvert was 296 adults, consisting of *C. tarsalis* (2 males, 6 females) and *A. freeborni* (66 males, 139 females). This collection was made on September 7.

During October, the largest number of adult mosquitoes taken per box per night in a cotton field was 2 adults of *C. tarsalis* (1 male, 1 female). This collection was made on October 31 in the Franchini field. This field contained cotton plants, some of which were nearly five feet tall.

The largest number of mosquitoes taken per box per night during October for the box in the culvert was 47, consisting of *A. freeborni* (7 males, 39 females and 1 female *A. franciscanus.*

Summary

The cotton fields selected for study were furrow irrigated fields located in West Fresno County. No organized mosquito control is provided in this area. Five fields were on sandy loam soil and seven were on heavy clay loam.

The greatest number of irrigations during the 1955 season were in June, July and August. The demand for water was greatest when temperatures were high and plants were near their peak of flowering and boll development. This water use coincides with the period of maximum mosquito production. The largest number of irrigations observed occurred in a field with sandy soil which received a pre-irrigation plus ten regular irrigations. The smallest number of irrigations occurred in a field located on heavy clay soil which received only three irrigations during the 1955 season.

The irrigated cotton field environment associated with sandy soils was not found to be as productive of mosquitoes as the cotton field environment associated with heavy clay soils.

Study areas were grouped in the following categories: pot-holes, drainage areas, tail-end water, irrigation laterals, and the cotton field. The areas observed to be major mosquito sources in this study were drainage areas, irrigation laterals, and pot-hole areas.

Cotton fields contain their highest mosquito production potential during the latter part of the season; however, the observations recorded in this study indicated that, in the fields under observation during 1955, the water did not remain long enough to allow mosquitoes to complete their development.

Small numbers of adults of *C. tarsalis, A. freeborni* and *A. franciscanus* were taken in artificial resting stations within the various fields.

ACKNOWLEDGEMENTS

The authors wish to express appreciation for the generous assistance of Mr. L.K. Stromberg, Associate Agriculturist, University of California, and Miss Bettina Rosay and Messrs. James H. Bray, Stanley G. Hanks, John R. Walker and Richard F. Peters of the Bureau of Vector Control.

LITERATURE CITED

Anonymous, 1956. California field crops—Annual summary for 1955, California Crop and Livestock Reporting Service, U.S.D.A., Agric. Marketing Service, and Calif. Dept. of Agric., Bureau of Agric. Statistics, Sacramento, January 12, 1956.

Augustson, G. F., 1952. Some observations on mosquitoes from irrigated cotton fields in Madera County. Proc. & Papers, 20th Ann. Conf. Calif. Mosquito Control Ass'n, Feb. 1952, pp. 89-90.

Goodwin, M. H., Jr., 1942. Studies on artificial resting places of *Anopheles quadrimaculatus* (Say). J. Natl. Mal. Soc., 1:93-99.

Hoover, Marvin, and Booher, L. L., 1952. Guides in cotton irrigation. Univ. of Calif., Agric. Ext. Serv.

Husbands, R. C., and Rosay, Bettina, 1953. Irrigated pasture mosquito ecology studies—1952. Proc. & Papers 21st Ann. Conf. Calif. Mosquito Control Ass'n, Feb., 1953, pp. 33-37.

Husbands, R. C., and Rosay, Bettina, 1952. A cooperative ecological study of mosquitoes of irrigated pastures. Proc. & Papers 20th Ann. Conf. Calif. Mosquito Control Ass'n, Feb., 1952, pp. 17-26.

Thurman, D. C., Jr., Husbands, R. C., Mortenson, E. W., Rosay, Bettina, and Arnold, J. R., 1951. Review of the 1950 studies of mosquitoes in irrigated pastures. Proc. & Papers 19th Ann. Conf. Calif. Mosquito Control Ass'n, March, 1951, pp. 72-79.

Mr. T. G. Raley: That is really food for thought. I am only sorry I cannot take the time for questions. We may be able to do so at the end of the panel presentation.

Our second speaker, Richard W. Gerhardt, will give additional limnologic studies relating to mosquito production in rice fields.

PRESENT KNOWLEDGE CONCERNING THE RELATIONSHIP OF BLUE-GREEN ALGAE AND MOSQUITOES IN CALIFORNIA RICE FIELDS

Richard W. Gerhardt*

The first person to work on the possible mosquito deterrent properties of the *Myxophyceae* was Dr. William C. Purdy. His work was completed during 1919 and 1920 while Dr. Purdy was employed by the United States Public Health Service.

As a matter of historical interest, the summary of Dr. Purdy's paper is reproduced here:

Aside from the several findings which are stated in pages 5 to 8, the two years' biological investigation in California presents one or two outstanding items of more interest than is usually accorded to routine results. The interest in the matter attaches partly (1) because the information referred to is unexpected and out of the ordinary, and partly (2) because of the human interest involved—the possible public health effects.

The first item is the practical absence of mosquito breeding on the Nelson rice field. This fact was established by persistent and continuous collections during the entire rice-growing seasons of 1919 and 1920. Meantime nearby puddles and ditches showed breeding and, during the second season, when three additional rice fields and four additional ditches were included, all these showed breeding. The Nelson rice field alone stands out from all the other fields and related waters by reason of the radical difference it exhibits in that it practically fails to breed mosquitoes. This failure suggests the presence of some natural agency which operates to inhibit breeding. Such a natural agency would, it is needless to say, be a thing greatly to be desired.

The second item is the apparent result of the search, during the second season, for the probable reason for lack of breeding in the Nelson field, an inquiry as to just what this natural inhibitive agency might be. To this end a careful comparison of the Nelson field with all the other fields and puddles seems to indicate no considerable or essential difference in—

(1) Number of larval enemies;
(2) Relative amount of food supply;
(3) Temperature;
(4) Alkalinity of water;
(5) Free CO_2;
(6) Dissolved oxygen; or
(7) Relative stability.
(See table 22 and chart 9).

Study of the alga growths, however, does reveal a difference which appears to be as fundamental and as well marked as in the contrast in breeding. The Nelson field contains a very heavy growth of a blue-green alga which is not found, except in rare instances and in very minute quantities, in any of the other fields or waters examined. Other algae appear on the Nelson field in very small amount only. Moreover, this same blue-green (*Tolypothrix*) was similarly prevalent on the Nelson field in 1919. Further testimony concerning the apparently larvicidal effects in water containing this alga is furnished by the field tests (recorded on pages 28 to 31), and these effects seem potent not only for very young larvae but also for vigorous, half-grown ones; and, finally, the water in the feed canal (before coming in contact with this alga) is found to be favorable for larval development. Meantime no explanation is yet available as to the manner in which the larvicidal agency acts.

While definite conclusions may not safely be drawn from the field tests, which were carried out during one season only, yet it is permissible to say, pending further research, that there exists a possibility, and even a probability, that the lack of mosquito breeding on the Nelson rice field—in which matter it differs fundamentally from all the other waters examined—may be related in no small degree to the other outstanding difference with this same field exhibits, in that it contains a heavy growth of blue-green alga, *Tolypothrix*. (Purdy, W. C., 1925, Pub. Health Bull. No. 145.)

Examination of the experimental evidence of Purdy's report suggests the following:

Incoming water of the Nelson rice field was not harmful to mosquito larvae.

Half-grown larvae (probably 2nd or 3rd instar) placed in the field water under varying circumstances died within a few days.

Adult female mosquitoes confined in a large cage over the surface of the Nelson rice field oviposited normally. The resulting eggs hatched normally but the larvae failed to survive.

It should be pointed out in connection with the latter test that the adults had no choice in selection of oviposition sites since there was no alternative water present.

The general incompatibility of the *Myxophyceae* and mosquitoes has been observed by other workers, notably Bradley (1932).

*Assistant Vector Control Specialist, State of California, Department of Public Health, Bureau of Vector Control.

With the foregoing factors in mind the writer undertook to investigate this interesting problem for the first time during 1952 (Gerhardt, 1953).

The essence of the work completed during that year is as follows:

The Nelson, California area was visited and it was found that rice fields of the area still exhibited dominant growths of blue-green algae with a corresponding lack of mosquito larvae. However, a dominant growth of *Tolypothrix* was nowhere to be found. Rather, the fields were usually dominated by growths of various species of *Anabaena* or by *Aulosira implexa* Born and Flab. Diligent examination of these fields during the late season of 1952 failed to demonstrate mosquito larvae.

During the seasons of 1952 and 1953 an extensive field survey was undertaken in order to determine the distribution of blue-green algal species in rice fields, and to correlate with this distribution the abundance of mosquito larvae. Of 55 rice fields examined for dominant algal types and for the number of mosquito larvae at the time of the examination, 46 fields were found to support a dominant growth of blue-green algae. Without exception, mosquito larvae were virtually absent in these fields. Fields in the same area, but which were not dominated by blue-green growths, were found to produce many mosquitoes.

In an attempt to establish the mode of action involved in this relationship, specimens of *Myxophyceae* collected from rice fields of the Nelson area (*Anabaena unispora* Gardn.) were cultured in the laboratory. Mosquito larvae were subjected to filtrates of the cultures under varying conditions and with suitable controls. These tests seemed to indicate that the alga in question was producing some water soluble metabolite which was toxic to mosquito larvae.

With this encouragement, the task of identifying and confirming the existence of such a substance was assumed by Dr. Daniel I. Arnon and Dr. Mary B. Allen of the Department of Plant Nutrition, University of California at Berkeley. Their work, in cooperation with the writer, has met with problems. It has been found difficult to consistently repeat the experiment described above. The experiment has been repeated with success at times only to have the next trial prove to be a complete failure. Obviously, until it is possible to repeat the experiment at will and thereby be assured of the presence of the supposed toxin, the substance cannot be identified or proved to exist.

In many cases, field demonstrations are as valuable as laboratory analyses. During 1952 attempts were made to transplant blue-green algae from the Nelson area to rice fields in Placer County which were known not to support abundant blue-green growths. Of the several methods tried one was successful. The method consisted of harvesting rice stubble from a rice field known to have supported abundant growth of *Anabaena* the previous season and utilizing this stubble as an inoculum in the new area.

This method was retested on an expanded scale during 1954. Of five trials, four were successful and the fields inoculated showed reduced mosquito populations after July 15. The coincident decline in the mosquito population in all fields indicated that the principle involved does not become effective until mid-July. Further field observations on this subject have since confirmed this hypothesis.

With the background of the work previously done concerning the relationship of blue-green algae and rice field mosquitoes, the investigational work completed during the rice growing season of 1955 is presented.

The survey of rice fields conducted during 1952 and 1953 which was designed to correlate the occurrence of dominant growths of blue-green algae with mosquito prevalence was, in one sense, incomplete. Each of the 55 fields examined was examined only once during the season. Inspections of fields not dominated by growths of blue-green algae revealed that mosquito larvae were prevalent in the areas studied; at the same time fields dominated by blue-greens showed a marked absence of larvae only at the time of examination. In view of the number of fields examined, this source of error seems to be slight. Nevertheless, work was completed this season which should eliminate this possible fault.

Ten rice fields were chosen which contained dominant growths of *Anabaena* sp. or *Aulosira* sp. These algae were generically determined by microscopic examination in the field by the writer. All fields were inspected for the presence of mosquito larvae by dipping at two-week intervals beginning July 1, 1955 and continuing until the fields were drained (Sept. 1 to 15). All fields were examined a total of 5 times during this period. Inspections consisted of dipping throughout several "checks" and no less than 50 dips were taken at each inspection.

The fields were located as indicated in the following list and the dominant genus of algal growth associated with each field is named:

Yuba County:					
(1)	T16N	R4E	S20	ss3	*Anabaena*
(2)	T16N	R4E	S5	ss3	*Aulosira*
(3)	T16N	R4E	S5	ss4	*Aulosira*
Butte County:					
(4)	T19N	R2E	S18	ss4	*Anabaena*
(5)	T19N	R1E	S13	ss3	*Anabaena*
(6)	T19N	R1E	S15	ss1	*Anabaena*
(7)	T19N	R1E	S10	ss1	*Anabaena*
(8)	T19N	R1E	S3	ss1	*Anabaena*
(9)	T19N	R2E	S35	ss2	*Aulosira*
(10)	T20N	R1E	S27	ss4	*Aulosira*

In all cases these fields contained a few larvae of *Culex tarsalis* Coq. during the first few days of July. After July 15 no larvae could be found in these fields despite very intensive dipping. Fields used as a comparison which supported abundant growths of various green algae were located nearby. Six of the fields described above were utilized as study plots for the experimental work reported below and the charts presented illustrate larval occurrence in the fields during the 1955 season.

The question of water quality associated with blue-green dominance has been considered. During 1952 extensive analyses were completed by the Sanitation Laboratory of the California State Department of Public Health. These included chemical and spectrographic tests for the presenee of the following substances: Chlorides, Nitrates, Nitrites, Boron, Arsenic, Aluminum, Phosphates, Selenium, Calcium, Ferric and Ferrous Iron, Magnesium, Manganese, Potassium, Copper, Silicon, Zinc, Lead, Antimony, Barium, Bismuth, Cobalt, Lithium, Mercury, Molybdenum, Strontium, Tin. Except for minute quantities of Chlorides, Nitrates and Nitrites, Phosphates, Calcium, Magnesium, Silicon and Lead, the tests were negative. It has been demonstrated by the writer and other workers that there is little direct effect likely from the presence of these substances (Gerhardt, 1952; Senior-White, 1926, 1928; Beattie, 1932; Buxton, 1934).

The question of organic pollution associated with the presence of blue-greens has been considered. Considerable work has been done on the occurrence of various species of mosquitoes in waters containing varying degrees of organic materials. In considering the problem the question soon arises: What criteria can be used to measure the degree of organic pollution. After considering the work done by Senior-White, Beattie, Buxton, Williamson (1928), and others, it is the opinion of the writer that the concentration of organic nitrogenous materials dissolved in the water of the habitat is, perhaps, the most significant factor. Data were collected this year from six rice fields representing various possible conditions of organic pollution.

A brief description of the fields and the conditions pertaining to them follows:

(1) Riceton No. 1 rice field. Location: Butte County, T 19 N, R 2 E, Sect. 35, ss1. Dominant algal growth: various green algae, esp. *Spirogyra, Hydrodictyon.* Water from Western Canal (source, Feather River). Fertilizer applied: ammonium sulfate at 150 lbs. per acre, broadcast from aircraft after seeding and flooding.

(2) Riceton No. 2 rice field. Location: Butte County, T 19 N, R 2 E, Sect. 35, ss3. Dominant algal growth: *Aulosira* sp. (blue-green). Water from wells. Fertilizer applied: ammonium sulfate at 150 lbs. per acre, broadcast from aircraft after seeding and flooding.

(3) Butte Creek No. 3 rice field. Location: Butte County, T 20 N, R 1 E, Sect. 27, ss4. Dominant algal growth: *Anabaena* sp. (blue-green). Water from well and from Western Canal. Fertilizer applied: ammonium sulfate at 150 lbs. per acre, broadcast by aircraft after seeding and flooding.

(4) Butte Creek No. 2 rice field. Location: Butte County, T 20 N, R 1 E, Sect. 26, ss3. Dominant algal growth: various green algae esp. *Spirogyra, Ulothrix.* Water from Butte Creek. Fertilizer applied: ammonium sulfate at 200 lbs. per acre broadcast from aircraft after seeding and flooding.

(5) Biggs rice field. Location: Butte County, T 18 N, R 2 E, Sect. 9, ss4. Dominant algal growth: *Nostoc* (a blue-green which is considered by the writer to be harmless to mosquito larvae.) Fertilizer: Vetch cover crop disked before planting.

(6) Smith rice field. Location: Butte County, T 20 N, R 2 E, Sect. 32, ss4. Water from Western Canal. Dominant algal growth: various greens esp. *Hydrodictyon, Spirogyra.* It should be noted that this rice field has been studied for 4 consecutive seasons. During 1952 and 1953 it supported dominant growths of *Anabaena unispora.* During 1954 the field was out of rice production and was sowed to a cover crop of vetch. During 1955 the field was put back in rice and the algal flora changed. Fertilizer: none, other than the vetch which was disked under before planting and flooding.

Water samples were taken from each of these fields on a weekly basis and the amount of organic nitrogen and ammonia was determined by the Sanitation Laboratory of the State Department of Public Health.

Larval populations were determined by dipping on a tri-weekly basis.

Results of the seasons studies are presented in tabular form below:

	Riceton No. 1			Riceton No. 2		
Date	R-NH_2Mg/1	NH_3	Ave. larvae /dip	R-NH_2	NH_3	Ave. larvae /dip
7-19-55	0.48	0.04	0.90	0.56	0.06	0.00
7-26-55	0.44	0.06	0.53	0.44	0.00	0.01
8- 2-55	0.52	0.00	0.40	0.48	0.01	0.00
8- 9-55	0.50	0.10	0.40	0.40	0.00	0.00
8-15-55	0.32	0.00	0.23	0.48	0.00	0.00
8-23-55	0.60	0.00	0.10	0.40	0.00	0.00
8-30-55	0.32	0.00	0.06	0.32	0.01	0.00
9- 6-55	Drained			0.56	0.00	0.00
9-13-55				0.72	0.02	0.00
Average	0.454	0.028	0.374	0.484	0.01	0.001

	Butte Creek No. 1			Butte Creek No. 2		
Date	R-NH_2	NH_3	Ave. larvae /dip	R-NH_2	NH_3	Ave. larvae /dip
7-19-55				0.32	0.06	0.30
7-26-55	0.40	0.00	0.00	0.36	0.08	0.60
8- 2-55	0.48	0.00	0.00	0.64	0.00	0.20
8- 9-55	0.60	0.10	0.00	0.40	0.00	1.36
8-15-55	0.40	0.01	0.00	0.32	0.00	2.26
8-23-55	0.50	0.00	0.00	0.50	0.00	0.60
8-30-55	0.32	0.00	0.00	0.36	0.02	0.40
9- 6-55	0.72	0.16	0.00	0.80	0.16	0.16
9-13-55	Drained			0.64	0.02	
Average	0.488	0.038	0.00	0.482	0.037	0.735

Date	Smith			Biggs		
7-19-55	0.96	0.04	0.30	0.56	0.04	0.00
7-26-55	0.80	0.04	0.20	0.56	0.02	0.20
8- 2-55	0.72	0.01	0.30	0.80	0.02	1.63
8- 9-55	0.60	0.00	1.56	0.80	0.00	4.33
8-15-55	0.40	0.00	3.33	0.40	0.02	3.63
8-23-55	0.40	0.00	7.93	0.50	0.00	3.00
8-30-55	0.32	0.00	0.86	0.40	0.00	1.40
9- 6-55	0.72	0.16	1.06	0.72	0.08	0.55
9-13-55	0.72	0.01				
Average	0.626	0.029	1.94	0.592	0.22	1.84

As can be seen by an examination of the charts presented, there is no significant difference in the amount of organic nitrogenous material dissolved in the water of fields supporting dominant growths of blue-green algae (Rice No. 2 and Butte Creek No. 1), and those supporting various green species (Riceton No. 1 and Butte Creek No. 2). However, some difference can be noted between fields having been fertilized with ammonium sulfate and those which supported a leguminous cover crop the previous winter which then serves as the nitrogen source for rice culture. Biggs rice field and the Smith rice field both had vetch cover crops which were disked under the soil before planting. Both of these fields show a relatively higher concentration of nitrogenous material than do the others studied and both produced the most mosquitoes throughout the season. It would seem that the higher amount of nitrogenous material favors the general productivity of the habitat.

Of particular interest is the Smith rice field. This field has been observed for 4 rice seasons. During 1952 and 1953 the field supported dominant growths of *Anabaena* and mosquitoes were notably absent from it. During 1954 the field was allowed to lie fallow with a cover crop of vetch. During 1955 the field was highly productive of mosquitoes and its algal flora changed to include a variety of green forms. Since, obviously, nothing was changed in the field other than the form of nitrogen supplied, it would seem that the lack of available nitrogen in the water of the rice field favors the domination of the environment by blue-green algae. This hypothesis fits with what is already known concerning the physiology of many blue-greens. Many species of the *Myxophyceae,* especially some species of *Anabaena,* possess the ability to fix atmospheric nitrogen and thus satisfy their own growth requirements. The greens, on the other hand, must have nitrogen available to them in other forms.

Discussion of the Present Evidence Concerning the Relationship of Blue-green Algae and Rice Field Mosquitoes.

In review, the following statements are supported by experimental and observational evidence:

(1) Blue-green algae occur commonly in California rice fields as dominants.

(2) When dominant certain species are associated with an absence of mosquito larvae in the environment.

(3) Considerable indirect evidence indicates that there is a cause-effect relationship between the presence of blue-greens and the absence of mosquitoes.

(4) Some experimental evidence exists which seems to indicate that a metabolite may be produced by the blue-greens studied which is toxic to mosquito larvae.

(5) The presence of such a toxic metabolite remains to be positively demonstrated.

(6) The mode of action of the blue-green algae in rendering a field free of mosquitoes may be that of a repellent factor rather than/or as well as a toxicant.

(7) Blue-green algae are not indicative of a foul water condition in rice fields.

(8) Blue-green algae may tend to occur more frequently in rice fields poorly supplied with nitrogen.

With these factors in mind it is the writer's opinion that there are three possible explanations for the observed phenomena:

(1) Blue-green algae of certain species may produce toxic metabolities which are toxic to mosquito larvae.

(2) Blue-green algae may produce substances or are indicative of substances which adult female mosquitoes find to be repellent.

(3) Blue-green algae may be associated with a condition of general low biological productivity probably due to the lack of available nitrogen.

It should be pointed out that any combination of these separate factors would, of course, achieve the same result.

BIBLIOGRAPHY

Beattie, M. V. F., 1932, Chemical factors affecting the breeding of *Anopheles* in Trinidid. Bull. Ent. Res. *23* (4): 477-496.

Buxton, P. A., 1934, Chemical factors affecting the breeding of *Anopheles* in Trinidad. Bull. Ent. Res. *25*(4):491-494.

Gerhardt, R. W., and Sherman, E. J., 1953, Preliminary limnological investigations on four California rice fields. Proc. and Papers of the 21st Annual Conf. of the Calif. Mosq. Control Assoc. (1953) p. 40-42.

Gerhardt, R. W., 1953, Blue-green algae—a possible anti-mosquito measure for rice fields. Proc. and Papers of the 22nd Annual Conf. of the Calif. Mosq. Control Assoc. (1953). p. 50-53.

Gerhardt, R. W., 1954, Further studies on blue-green algae—a possible anti-mosquito measure for rice fields. Proc. and Papers of the 23rd Annual Conf. of the Calif. Mosq. Control Assoc. In press.

Purdy, W. C., 1924, Biological investigations of California rice fields and attendant waters with reference to mosquito breeding. U.S.P.H.S. Pub. Health Bull. No. 145.

Senior-White, R., 1926, Physical factors in mosquito ecology. Bull. Ent. Res. *16*(3):187-248.

Senior-White, R., 1928, Physical factors in mosquito ecology. Pt. II. Ind. Jnl. of Med. Res. *16*:1.

Williamson, K. B., 1928, Mosquito breeding and malaria in relation to the nitrogen cycle. Bull. Ent. Res. *18*(4):433-439.

Bradley, G. H., 1932, Some factors associated with the breeding of *Anopheles* mosquitoes. Jour. of Ag. Res. *44*(5):381-399.

OBSERVATIONS ON ASSOCIATION OF BLUE-GREEN ALGAE WITH ANOPHELINES

B. P. Neogy and P. Kachroo*

In a previous note (Kachroo, 1955) a few observations on anti-larval action of blue green algae were recorded. The present note deals with effects of *Oscillatoria* and *Anabaena* on the rate of emergence under laboratory conditions; their association with various anophelines under natural conditions, as determined by stray catches at various localities; and the dependence of larvae on blue-green algal food as indicated by their gut contents.

1) Rate of emergence: A few common algae were collected from the local ponds and grown in tap water in large glass jars. Equal numbers of eggs or first stage larvae were later transferred into each jar and the latter covered with a mosquito net. Time of hatching of 1st-4th stage larvae, pupae and the emergence of adults was recorded; as also the presence of larvae etc. (Table I).

*Malaria Research Laboratory, Damodar Valley Corporation, Burdwan, India.

TABLE 1. RATE OF EMERGENCE OF SOME ANOPHELINES IN BLUE GREEN ALGAE UNDER LABORATORY CONDITIONS (AUG. - OCT., 1955)

Sps. of anoph-eline	*Duration of experi-ment*	*Algae used*	*Presence of larvae*	*EMERGENCE* In blue green algae	*EMERGENCE* In other algae*
1. *annu-laris*	Aug. 4-11	*Anabaena flosaque* (Lyngbya) Breb	Positive for 2 days, doubtful later, all dead within 7 days.	0%	30%
2. *sub-pictus*	Aug. 8-11	Same	Positive for 2 days, doubtful later, all dead within 8 days.	0%	20-60%
3. *sub-pictus*	Sept. 2-16	*Oscillatoria princeps* Vauch	Positive for 6 days, 1st emergence after 10 days.	6%	11-25%
4. *philip-pinensis*	Sept. 22-Oct. 11 (-24)	*Anabaena flosaque*	Up to 30 days still eggs.	0%	40-50%
5. *palli-dus*	Oct. 10-30	*Oscillatoria princeps*	Positive for 2 days, none reached maturity.	0%	Not noted

*Other algae used were: *Spirogyra, Cladophora, Chara,* mixed algae & *Pithophora.*

TABLE II. ASSOCIATION OF SOME ANOPHELINES WITH BLUE GREEN ALGAE DOMINATED VEGETATION IN NATURE DURING SEPT. - OCT., 1955

Date of observation	*Breeding pool (locality*)*	*Nature of water*	*Vegetation*	*Anopheline sps. and number*	*Anophelines from a corner without blue green algae*
Sept. 27	Pond 1 (Nandipur)	Clear	*Oscillatoria amphibia, Anabaena* sps., grass	*hyrcanus*—5 *barbirostris*—4 *varuna*—1	Not noted
Oct. 12	Pond 1 (Maheswarpur)	"	*Anabaena sphaerica, Pistia stratioites*	*hyrcanus*—5	*hyrcanus*—22
Oct. 18	Baganpukur (Krishanpur)	"	*Oscillatoria splendida, Pistia*	*hyrcanus*—15	Not noted
	Telipukur (Krishanpur)	"	*Anabaena sphaerica, Pistia, Neptunia oleracea*	*hyrcanus*—8	*hyrcanus*—8
Oct. 19	Talpukur (Babla)	"	*Oscillatoria princeps, Pistia*	*hyrcanus*—3	*hyrcanus*—7
	Munshipukur (Galsi)	"	*Phormedium* sps., *Limnanthemum indicum*	*hyrcanus*—6	Not noted

*All localities occur within district Burdwan of West Bengal, India.

It will be seen from the above table that *Anabaena flosaque* appears to be more inhibitory than *Oscillatoria princeps.* It may be mentioned here that pH and temperature were nearly the same in all the experiments and that changes in pH below 6 and above 8 were equally inhibitory, even though the food provided was *Spirogyra,* usually a preferred diet.

2) It was possible to determine the anopheline populations in a few ponds with dominant blue-green algal flora, rather uniformly associated with *Pistia stratioites.* Stray catches were taken in such ponds (each catch being a total of 25 standard dips with a frying pan, 8 inches in diameter and about 2 inches deep) once a month. The most predominating anopheline-associate was *A. hyr-*

TABLE III. GUT CONTENTS OF ANOPHELINE LARVAE FROM BLUE GREEN ALGAE DOMINATED POOLS (c.f. Table II)

(a) FROM BANGANPUKUR, KRISHANPUR

*Species and size of larvae**	*FOOD: Number of individuals* *Blue green algae*	*Other algae*
A. hyrcanus:		
1. 6.1 x 0.3 mms.	0	325

*The first measurement gives length of larva, the second the breadth of head.

2. 5.2 x 0.29 mms.	155	300
3. 4.5 x 0.29 mms.	195	278
4. 5 x 0.31 mms.	0	683

(b) FROM TALPUKUR, BABLA

A. hyrcanus:		
1. 7.1 x 0.42 mms.	250	306
2. 4.7 x 0.37 mms.	257	502

(c) FROM POND 1, NANDIPUR

A. hyrcanus:	150	263
A. barbirostris:	105	428
A. varuna: (4.1 x 0.31 mms.)	10	23

TABLE IV. GUT CONTENTS OF ANOPHELINE LARVAE FROM POOLS WITH INSIGNIFICANT BLUE GREEN ALGAL FLORA

(a) FROM POND MENE, CHOTKAND

Species and size of larvae	*BLUE GREEN ALGAE* *From Gut*	*Incidence in nature*	*OTHER ALGAE* *From Gut*	*Incidence in nature*
1. 7 x 0.51 mms.	133	..	293	..
A. hyrcanus:				
2. 6 x 0.5 mms.	107	rare	333	very common

(b) FROM POND "PHILIPPINENSIS," CHOTKAND

A. philippinensis:				
1. 4.9 x 0.39 mms.	70	..	85	..
2. 4.8 x 0.45 mms.	160	..	96	..
3. 3.8 x 0.35 mms.	90	..	22	..
4. 4.6 x 0.5 mms.	10	..	70	..
5. 5.1 x 0.45 mms.	30	..	43	..
6. 5.3 x 0.38 mms.	50	..	15	..
7. 4 x 0.45 mms.	150	not common	39	very common

canus. Table II gives a detailed record of these observations.

3) In considering the amount of algae found in the various species of larvae dissected it was possible to determine the value that blue-green algal food has as nutrition for larvae. In places where these were dominant a good number of them were no doubt ingested, since the choice was limited; and even though the only other algae available were unicellular, e.g., desmids, diatoms, spores, etc., and limited in number they constituted the main food supply (Table III a-c).

It might, thus, appear that blue-green algae are avoided as far as possible, yet it would be a hasty judgment to presume that these are uniformly discarded. A glace at Table IV a-b) reveals that even when they are present in very meager quantity in a breeding pool, they *do* form an ingredient of larval food—though in this case it is only the non-sheathed species that find an easy access to the gut. It is observed that blue-green algae are assimilated in nearly the same way as other algae.

Thanks are due to Dr. Sribas Das for his cooperation and to Mr. K. Biswas for assistance.

LITERATURE CITED:

Kachroo, P., 1955. Myxophyceae as possible anti-larval agents. Proc. and Papers Calif. Mosq. Cont. Assoc. (In press).

MYXOPHYCEAE AS POSSIBLE ANTILARVAL AGENTS

P. KACHROO*

In his interesting report on rice fields of California, Gerhardt (1954) gives a brief review of the previous works on the subject, notably those of Purdy (1925) and Bradley (1932). The present preliminary investigations show a considerable agreement with those of Gerhardt and it is thought worthwhile to publish the same for mutual benefit and information.

Paddy fields, fallow lands (lands previously cultivated for paddy) and ground pools formed a part of investigations under the Laboratory for determination of the incidence and breeding of the probable vector species of malaria in the region included within the irrigated area of the Damodar Valley Corporation projects. Normal fields were selected for evaluation of anopheline larvae, and various conditions pertaining to paddy plants, water and vegetation were recorded. Nudipur Village, about 19 miles east of Burdwan City, provided a typical paddy field where *Myxophyceae* were dominant and nearly similar conditions prevailed in a nearby fallow land. In the paddy field, for the most part, could be observed huge masses of *Myxophyceae*, at places forming a close association with *Utricularia*. The relative incidence of larvae in these fields is figured for the period August-December 1954, (Fig 1). The paddy field dried up during November, but later, due to opening of the irrigated canal, was again flooded; the larvae even then kept their low incidence. However, the sudden rise in the figure on November 2 is explained due to the fact that it had rained heavily during the preceding days and the algae accumulated towards certain corners, and in case of the fallow land were washed off. Actually on inquiry it was reported that larvae were collected fram places having no algae. In the fallow land this explains the slightly better state of affairs in the later part of the investigations. A striking contrast was provided by another paddy field about ¼ mile away and with absence of blue-green algae. Here on average a catch fetched no less than 12 larvae per 25 dips.

A study of the gut contents of the various anopheline species from this region shows that the larvae do not show

*Malaria Research Laboratory, Damodar Valley Corporation, Burdwan, India.

Figure 1.

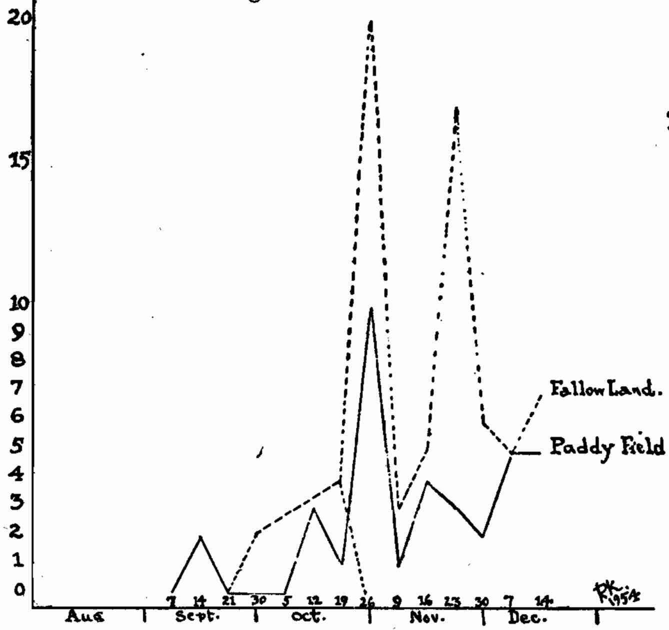
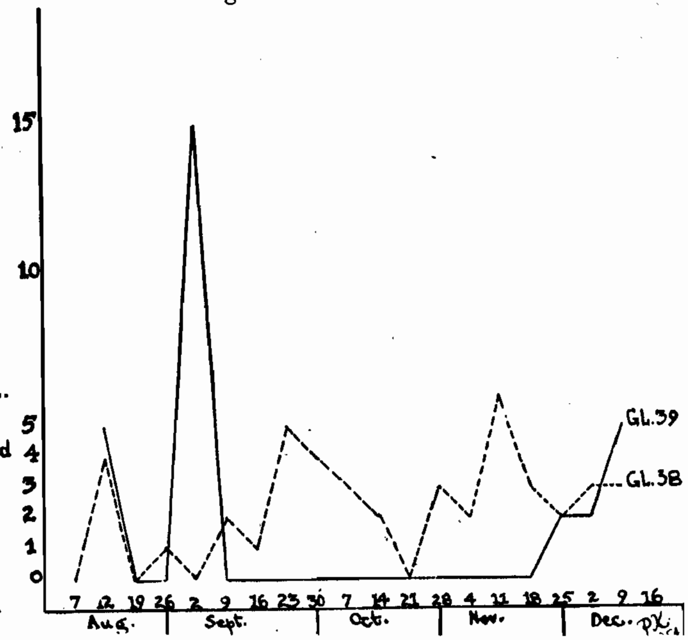


Figure 2.



a preference for Myxophycean food if other algae are available. But in the situations where other algae are absent or not available to the larvae, the choice being limited, they are forced to devour whatever comes their way. The following table gives the gut contents of the larvae collected from paddy fields at Nudipur.

Table I. Gut contents of larvae from paddy fields at Nudipur (August-December, 1954)

Anopheline species	*Plant species detected*
philippinensis#	*Cosmarium, Desmedium, Xanthidium, Pennularia, Frustulia*
pallidus#	*Chlorella, Cosmarium, Xanthidium, Euastrum, Synedra, Radiococcus, Grammatophora, Bacilleria,* spores of algae and fungi
annularis#	*Melosira, Cosmarium, Cyclotella, Pinnularia*
hyrcanus†	*Microcystis, Chroococcus, Gloeotrichia, Oscillatoria, Chlorococcum, Spirogyra, Closterium, Cosmarium, Pinnularia, Cyclotella, Frustulia*
*barbirostris**	*Oscillatoria* (a few cells), *Pinnularia, Navicula, Ghomphronema*

\# from fields lacking *Myxophyceae*
† from mixed fields
* from fields with same

This probable antilarval action of *Myxophyceae* is further evident from observations on Tank No. GL39 at Purusha Village, about 19 miles west of Burdwan City, and an unirrigated area. This tank shows hardly any emergent or floating vegetation, save a few *Cryptocoryne* plants and a few grasses, but on the other hand harbors an abundance of *Myxophyceae*. During the period under review just 29 larvae were collected from this tank. An adjoining tank, GL38, with sparse floating vegetatiton but nearly with the same extent of *Myxophyceae* shows a comparatively better incidence of larvae, because the usual practice is to collect larvae about or around the vegetation. Even then this can be of hardly any note as is evident from Fig. 2.

I am indebted to Dr. B. P. Neogi for research facilities and encouragement to Dr. A. K. Adhikari and my colleagues for cooperation and to Mr. K. Biswas for assistance.

LITERATURE CITED:

Bradley, G. H., 1932. Some factors associated with breeding of *Anopheles* mosquitoes. J. Agri. Res. 44(5):381-399.

Gerhardt, R. W., 1954. Rice field study report, Blue-green algae—a possible anti-mosquito measure for rice fields. Proc. and Papers, 22nd Ann. Conf. Calif. Mosquito Cont. Assoc. 1954.

Purdy, W. D., 1925. Biological investigations of California rice fields and attendant waters with reference to mosquito breeding. Pub. Health Bull. No. 145, December 1924.

Figure 1. Number of larvae collected from Nudipur paddy fields and fallow land with dominant *Myxophyceae* for Aug.-Dec., 1954.

Figure 2. Number of larvae collected from GL38 (*Myxophyceae* tank) and GL39 (Partial *Myxophyceae* tank) at Purusha for Aug.-Dec., 1954.

FURTHER STUDIES ON THE EFFECT OF INSECTICIDE TREATMENT ON SOME NATURAL PREDATORS IN CALIFORNIA RICE FIELDS

R. W. Gerhardt[1]

During 1954 a study on the effect of a single insecticide treatment on the natural invertebrate mosquito predator populations in rice fields was completed by the author (Gerhardt, 1954). The objective of the study was to detect the effect of a total removal of predator pressure on the larval mosquito population in rice fields. The data of the study indicated that a single massive insecticide treat-

[1]Assistant Vector Control Specialist, California State Department of Public Health, Bureau of Vector Control.

ment resulted in the depletion of both the predator and mosquito populations. Following the treatment both populations recovered but the numbers of mosquito larvae in the test plot exceeded those of an untreated control plot.

As was stated in the 1954 report, "Ecological experiments of this type need to be repeated in such a manner as to yield information on the effects of insecticides as they are normally applied in abatement work."

Larviciding operations are not considered to be economical in rice fields by most mosquito abatement agencies. However, larviciding is undertaken in certain circumstances. Frequently, DDT wettable powder is applied with the seed rice at the time of sowing (Sperbeck, 1949; Portman, 1952). Some larviciding with liquid sprays or granular formulations is done near the close of the rice growing season to reduce the late brood of *Anopheles freeborni* Aitken which emerges from California rice fields.

The present study falls into two phases:

1. Observations of the effects of seed-dust treatments designed to control early larvae and/or tadpole shrimp.
2. Evaluation of the effect of insecticide treatment applied by hand using concentrations of insecticides and techniques commonly considered to be standard practice with mosquito control operators.

Unfortunately, it was not possible to observe the effects of an aerial application of spray material done by an abatement district this year.

PHASE ONE: *Observations on the effect of seed-dust treatment.*

During June, 1955, two rice fields located in Yuba County, Township 15 N, Range 4E, Section 6, were treated with wettable DDT dust applied with rice seed by aircraft. One of these fields received the dust on only half of its area. Another adjacent rice field which received no treatment was chosen as a comparative example. Observations on the relative abundance of predator species (*Notonectidae, Dytiscidae,* and naiads of *Odonata*) and mosquito larvae were made at weekly intervals after the treatments. The number found in the treated half of the rice field which received DDT over half of its area were compared with the numbers found in the untreated area of the same field. Likewise, the predator and mosquito populations of the field which was completely covered with the DDT dust-seed treatment was compared with an adjacent field which received no insecticide.

Results and discussion: At the time of DDT application, few aquatic mosquito predators or mosquito larvae could be found in any of the study plots. Within two weeks after the treatments notonectids were numerous in all study plots and mosquito larvae (*Culex tarsalis* Coq.) were easily found. No significant differences in the relative numbers of mosquito larvae or aquatic predator species could be detected in the treated or untreated areas.

PHASE TWO: *Observations on spray treatments.*

Methods: Study plots were established in a rice field near Davis, California (Yolo County, Township 9 N, Range 2 E, Section 28). Three study plots were located within portions of the field. These plots represented three different predator-mosquito relationships.

Plot #1 was characterized by a moderate population of both mosquito larvae and predators *Dytiscidae, Notonectidae* and naiads of *Odonata.* This plot received the insecticidal treatments.

Plot #2 was characterized by moderate populations of predators and mosquitoes. The seasonal average for the predators used as an index was about 1.2 per sweep (Gerhardt, 1954), while mosquito larvae averaged about 1.4 per dip.

Plot #3 was characterized by a high predator population and correspondingly low mosquito population. Predators averaged about 2.8 per sweep seasonally and mosquito larvae averaged about 0.4 per dip.

Plots #2 and #3 were not treated with insecticides during the study.

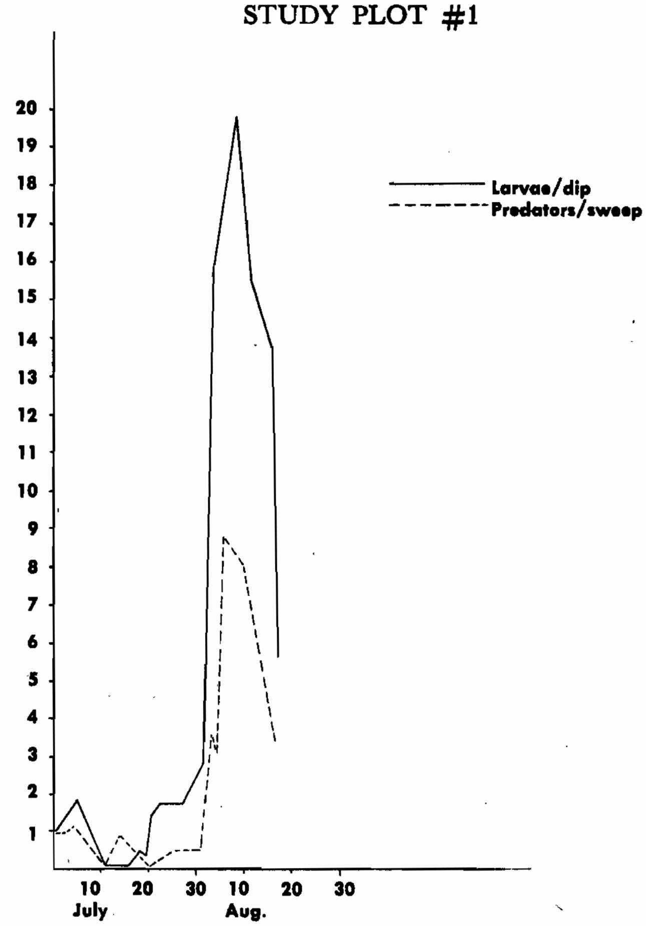
All plots were approximately ¼ acre in size.

On July 1, 1955, Plot #1, was treated with a 0.5% DDT water emulsion spray applied by hand with a 3-gallon pressure spray can. The application rate was approximately ¼ lb./acre. This treatment was entirely unsuccessful, killing neither the mosquito larvae (mostly 4th instars) nor the invertebrate predators.

Ten days elapsed before treatment was again attempted. During this ten-day period the mosquito population increased from 1 per dip to 1.8 per dip.

Gerhardt — Insecticides - Predators

STUDY PLOT #1



On July 11, 1955, plot #1 was again treated using a 1% water emulsion spray of DDT. The application rate was approximately ½ lb. per acre. Distribution of the spray was aided by a light wind and appeared to be satisfactory.

Results: The DDT applicatiton using a 1% water emulsion spray resulted in virtually complete depletion of both the mosquito larval population and the populations of the invertebrate predator species being used as an index to predator pressure.

Within three days (July 13) first instar larvae were again found in study plot #1.

Notonectids were reestablished in the habitat after one week.

Between 15 and 20 days after the treatment both the larval and predator populations increased sharply. However, the larval increase in population by far exceeded the increase in the numbers of predators. Following emergence of the bulk of the mosquitoes, both populations declined.

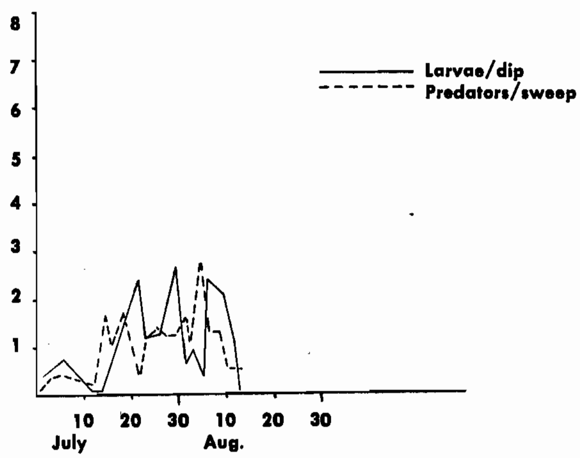
The graphs presented below best represent the predator-larval population relationships.

Discussion:

Examination of the populations graphs reveals three separate mosquito-predator relationships.

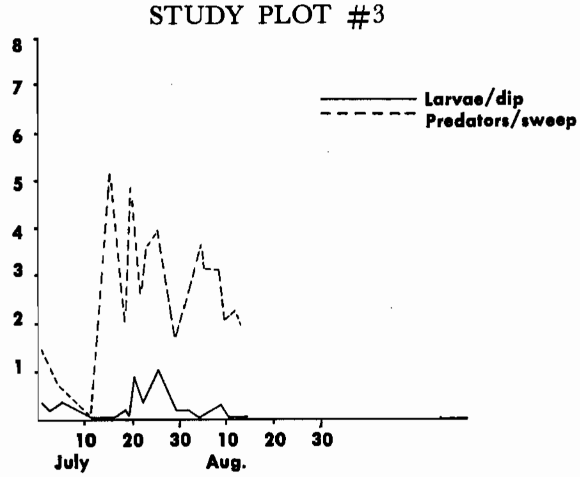
Study plot #2 illustrates an approximate balance between numbers of mosquito larvae and numbers of predators.

STUDY PLOT #2



Study plot #3 illustrates the effect of a high predator population which results in a lowered mosquito population.

STUDY PLOT #3



Study plot #1 illustrates the effect of temporary removal of predators from the environment which results in a temporary increase in the mosquito population. The predator population quickly reestablished itself but a balance was not regained before large numbers of mosquitoes emerged.

LITERATURE CITED

Gerhardt, R. W., 1954. The effects of an insecticide treatment on some natural investebrate predators in rice fields. Proc. and Papers of the 23rd Annual Conference of the California Mosquito Control Association. In press.

Hinman, E. Harold, 1934. Predators of the *Culicidae* (Mosquitoes). I. The Predators of Larvae and Pupae, exclusive of Fish. Jour. Trop. Med. & Hyg. 37(9):129-134.

II. Predators of Adult Mosquitoes. Jour. Trop. Med. & Hyg. 37(10): 145-150.

Portman, Robert F. and A. H. Williams, 1952. Control of Mosquito Larvae and other pests in Rice Fields by DDT. Jour. Econ. Ent. 45(4):712-716.

Sperbeck, Thomas M., 1949. Recent Improvements and Experience in the Use of Aircraft in Mosquito Control. Proceedings and Papers of the 17th Ann. Conf. of the California Mosquito Control Assoc. Feb. 1949—pp 82-83.

Mr. T. G. Raley: They are, of course, all only able to give you the highlights of their work and, as I remarked earlier, the full reports will be published in the proceedings and they will be out, Ed indicates, around April 15.

Our next speaker, Richard C. Husbands, Bureau of Vector Control, Fresno. "Significant Developments from Studies Relating to Mosquito Production in Irrigated Pastures."

Dick Husbands!

SIGNIFICANT DEVELOPMENTS FROM STUDIES RELATING TO MOSQUITO PRODUCTION IN IRRIGATED PASTURES

RICHARD C. HUSBANDS[1]

Significant developments from studies pertaining to mosquito production in irrigated pastures can be related to all phases of operational mosquito control. In order to discuss these relationships the subject matter has been divided into the following important elements: program planning, chemical control, source reduction, mosquito surveillance, and new approaches to control.

Program Planning

Ecological information has the potential of contributing significantly to operational program planning. For example, programs should consider species control. The life histories of each species of mosquito is influenced by a multitude of favorable and unfavorable elements in its environment. In irrigated pastures, for example, development rates of both pest and vector mosquitoes are influenced by temperature. To produce adult mosquitoes successfully, water must remain standing for specific minimum periods of time determined by temperature. Therefore, with proper water application records, temperatures can be used to determine the time when control should be initiated in the spring for each individual pasture, how frequently each pasture must be treated, and when a specific pasture is no longer a source of adult mosquitoes (2). Based upon operational experiences, irrigation records and species growth, temperature relationships can

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

be successfully used as a basis for efficient "program planning and modification."

It has been pointed out that pasture deterioration will lead to increased mosquito problems. As pastures deteriorate the relative proportions of species change. This change results in an increase in vector species. Based upon this knowledge, program planning can then include the increasing or changing problem based upon the age and conditions of mosquito-producing pastures in each area. Future needs can be projected and planned for, and the urgency for remedial methods, such as source reduction, can be brought to the attention of boards of trustees, agricultural interests, and the general public. The processes needed to achieve this end are, therefore, dependent upon technical measurements, biological data, and the skilled use of specialists trained in mosquito-agricultural ecology.

Chemical Control

Important developments from studies relating to mosquito production in irrigated pastures that have contributed to the efficiency of chemical control can be cited. Timing of mosquito control in individual fields can be determined by the rate of aquatic development. The relationship between *Aedes* and *Culex* species development should be taken into consideration for adequate control of both species. The length of time water remains ponded in individual fields should be considered (as well as field temperature) in order to determine if field treatment for *Culex* species is necessary. The biological data need to determine these factors have been contributed by the irrigated pasture studies.

An additional and recent contribution has been the determination of larval migration during irrigation. Deduction would indicate that larvae are transferred from one end of a border strip check to another by water movement. Larvae hatching during the first hour of water application would, therefore, end up to some degree, in the tail water. In Merced during the 1955 study this has not been the case. Very few larvae were transferred by water movement during the period when water was advancing and flowing the length of the border strip. The greatest migration occurred during the period of recession when ponds were formed and the larvae moved into ponding areas. Therefore, under many conditions the rate of water applications and the length of the border strip will determine the age of larvae within each part of the irrigated strip. Dipping larvae only at the tail end of the field will not always show the stage of development or the potential of adult mosquito emergence in different parts of the field or border strip. It has been shown in the 1955 Merced study that adult production in the upper half of the field was increased during a period of extended water application, and the greatest number of adults produced by the border strip was from the upper half of the field. Chemical treatment, therefore, should be applied to take into consideration the less obvious ponding areas within the field.

This suggests that chemical control should be tailored for the larval distribution pattern. For example, drip barrel treatment of the upper half or third of the field could possibly become an economical operation in those pastures where water application rates or length of run warrants such treatment.

Future work on the control of mosquito ova by chemical means is also influenced by this information. An evaluation of individual pastures will show the presence or absence of larval transportation or migration. In the absence of larval movement the reduction of ova by chemical treatment only in the areas of potential adult production would lead to complete field control. This would reduce cost and could result in an economical ovicidal operation.

Source Reduction

Significant contributions to source reduction planning have resulted from recent exploration work. The cooperative study with A.R.S., U.S.D.A., in Merced County has demonstrated the relationship between irrigation efficiency and mosquito production. Surface water from irrigations that produce mosquitoes can generally be attributed to inefficient irrigation methods, poor land preparation, and improper cattle management. Much of the excess surface water that is present on fields and remains standing long enough to produce mosquitoes could be avoided by increasing the efficiency of water management. On fields where irrigation efficiencies are extremely low a partial improvement in efficiency may result in an increase in *Aedes* production and a reduction in *Culex* species. As efficiencies are further improved *Aedes* production will be reduced until all mosquitoes are eventually eliminated. The interrelationship between soil factors, climatic factors, and water management practices must be taken into consideration at all times. These factors have been examined critically by the irrigated pasture mosquito ecology unit and have been discussed in detail in several papers, one of which is published in the Proceedings (1). Future progress in source reduction through water management will be facilitated by a broad acceptance and application of these principles.

Mosquito Surveillance

Recent studies having a bearing on mosquito population measurement and surveillance have been limited to aquatic forms. The importance of the survival of pupae in pastures due to stranding has been pointed out. Adult emergence can occur in areas where water remains long enough to produce pupae. During the summer the last 24 to 48 or more hours of the aquatic cycle can be spent in the pupal stage. This reduces the time water must remain standing in order to produce adults. Measurements of larval densities to determine adult production must take these factors into consideration.

The relative proportion of aquatic stages taken during sampling is theoretically related to the potential of a field to produce adult mosquitoes. To the measurement program this hypothesis can be used as a guide in evaluating adult production in the field by larval dipping. During the summer of 1955, work was conducted upon the problems of larval sampling. Preliminary results indicated that each separate ecological situation must be taken into consideration in order to obtain an adequate or representative sample from border strips. Much more work is needed on this problem before its true significance can be exploited.

Larval distribution in pasture border strips were also examined during 1955. In the areas studied no significant larval migration or transportation was found. In other cases the movement of larvae by the flow of water has been recorded. Each pasture, therefore, represents a specific condition. This is significant to the measurement of aquatic stages since no general rule can be cited based upon the influence of water flow, field topography, and climate until more work has been done on this subject.

It has also been pointed out that there is a great potential value in sampling larvae in fields where adult production does not take place. Such fields represent a measure of the influence or degree of adult mosquito control in surrounding areas. Carefully arranged samples, primarily for densities of early instars, should, over a period of years, indicate the degree of control practiced in surrounding areas. Reseeding of these non-producing fields by migrating adults would be the basis and reason for such a comparison.

An additional study, the results of which have been useful to the measurement program, is the supplementary evaluation of methods of using nontechnical personnel with the guidance of field entomologists to sort and evaluate mosquito collections taken from light traps. This work was carried on during 1950 under the direction of Mr. Deed C. Thurman and has been reported in mimeographed form (4) to the agencies involved in mosquito control programs in California. The significance of this contribution is attested by its present application by many districts.

New Approaches

Treating mosquito eggs by chemicals or subjecting them to induced environmental changes represent potential methods of mosquito control. These have been investigated as new or undeveloped control techniques. So little is known about the processes that influence or protect eggs in nature, it can be surmised that the study of these factors may provide clues to new control methods.

The principal developments in this field are those related to advances in the study of factors influencing eggs conditioning and hatching. This study has progressed beyond the stage of trial and error methods. By means of carefully planned laboratory measurements, individual factors are being examined and interesting results have been obtained. *Aedes nigromaculis* (Ludlow) eggs have received first attention.

Significant results in this study have been related to moisture and temperature factors and periods during which these factors operate (3). By the manipulation of these factors, within genetic limitations, various degrees of response can be produced. As our understanding of these phenomena becomes more complete, their application to natural or artificial control techniques can be elucidated.

Conditions which result in quiescent or dormant mature eggs which will not hatch when flooded may provide eggs for overwintering, eggs that survive in uncultivated unflooded fields, and eggs which accumulate to produce major increases in *Aedes* populations in late summer periods. The factors that recondititon these eggs to hatch or influence their survival in the laboratory are, therefore, equally important in determining how many will hatch or survive in nature.

Eggs that will hatch immediately when flooded are equally interesting. The understanding of conditions in nature that will determine how many eggs will enter this state is dependent upon laboratory findings of conditions which produce this reaction. If conditions could be developed in the field that would cause hatching without producing adults, we would have an avenue for control by reducing egg densities. This could be initiated in the spring or during periods of controlled low water application.

Eggs have been produced by laboratory conditioning which block the entrance of chemicals or, by further conditioning, will allow materials other than water to enter. The development of ovicides may be dependent upon an understanding of this phenomenon.

In general the results obtained from the study of mosquito eggs have been very promising and should eventually lead to the successful application of this knowledge to mosquito control procedures. Much remains to be done, however.

Conclusion

The program devoted to the study of mosquitoes and their environment in irrigated pastures has endeavored to cover a wide field of application. At the same time this program has not ignored the need for basic knowledge upon which to build correct interpretations. Future work will support and demonstrate the value of these interpretations and should result in practical operational knowledge which can be applied in the control of mosquitoes.

LITERATURE CITED

Davis, Sterling and Husbands, Richard C., 1955. An indication of the relationship between irrigation practices and mosquito production. Proc. and Papers 23rd Ann. Conf. Calif. Mosquito Control Assoc. and 11th Ann. Conf. Amer. Mosquito Control Assoc., pp. 117-119.

Husbands, Richard C., 1955. Irrigated Pasture Study—A review of factors influencing mosquito production—weather, ponding and irrigation, and soil moisture. Proc. and Papers 23rd Ann. Conf. Calif. Mosquito Assoc. and 11th Ann. Conf. Amer. Mosquito Cont. Assoc., pp. 112-117.

Rosay, Bettina, 1955. Some observations on*Aedes nigromaculis* eggs. Proc. and Papers 23rd Ann. Conf. Calif. Mosquito Control Assoc. and 11th Ann. Conf. Amer. Mosquito Control Assoc., pp. 119-120.

Thurman, Deed C., Jr., 1950. A discussion of the operation of mosquito light traps as an entomological tool with suggestions concerning light trap operation as an activity of a mosquito abatement district. Mimeographed paper distributed by California State Department of Public Health, Bureau of Vector Control.

Mr. T. G .Raley: Thank you, Dick. I sincerely hope that at our next conference we can have a full session for presenting this type of work.

Our next speaker, Norman A. MacGillivray, Agricultural Research Service, U.S. Department of Agriculture, Merced, California, "Water Management and its Relationship to Mosquito Production in Irrigated Pastures." Norman!

WATER MANAGEMENT AND ITS RELATIONSHIP TO MOSQUITO PRODUCTION IN IRRIGATED PASTURES[1]

N. A. MacGillivray[2] and R. C. Husbands[3]

A comparative study established in 1954 between the Agricultural Research Service, USDA, and the Bureau of Vector Control, California State Department of Public Health designed to investigate the relationship between irrigation practices and mosquito production was continued during the 1955 irrigation season. It has been

[1]For presentation at the California Mosquito Control Conference, January 16, 17, and 18, 1956, Stockton.

[2]Project Leader, Irrigation, Western Soil & Water Management Section, SWC, ARS, USDA.

[3]Project Leader, Mosquito Ecology, Bureau of Vector Control, California State Department of Public Health.

found that mosquito production could be correlated with irrigation application efficiency on those irrigated pastures having low intake rate soils (Davis and Husbands, 1954). The work in 1955 was directed toward further examination of this relationship and also to the investigation of the various inter-relationships between the factors which contributed to irrigation application efficiency and also influenced mosquito production.

Irrigation practices were evaluated on two irrigated pastures located near the City of Merced in California's San Joaquin Valley. Fields were selected to represent conditions that reflected better pasture management. Areas selected for study were typical border strips on a single soil type. These soils were: (1) Kellogg pasture, a Wyman Clay Loam over Yokohl Hardpan (this is a heavy soil of relatively low infiltration rate); and, (2) Moyle pasture, a Honcutt Loam (this is a deep alluvial soil characterized by good texture and a low intake rate). Most soils of the Honcutt series are devoted to orchards and other deep rooted crops. It was selected to demonstrate the relationship between irrigation practices and mosquito production under what would be considered nearly ideal soil conditions in this area.

Field slopes on Kellogg's pasture varied from 0.5 foot per 100 feet in the first 200 feet to nearly level through the center and 0.3 for the last 75 feet. Surface drainage for the lower end of the field was good. The slope on Moyle's pasture was fairly uniform, averaging about 0.15 percent. The soil surface was characterized by shallow depressions, a majority of which averaged 2-3 inches in depth. They ranged from hoofprints to areas several square feet in size. Many of these depressions were interconnected and drained well from one to another; some were isolated and provided areas in which ponding did occur.

The method used to evaluate irrigation practices is described by Criddle and Davis, 1951 (1). Soil moisture deficits were determined by soil sampling before and after each irrigation. The amount of water applied, rate and time of application, and surface runoff were all measured. Observations were made of the advance and recession of the water applied as it moved into and out of the border strips. Irrigation application efficiency and mosquito production were determined only in the border strips studied.

Application efficiency was calculated for each individual irrigation as well as the over-all seasonal average. Water application efficiency is defined as the percentage of the water applied that is stored in the root zone and ultimately consumed by the crop. The degree of application efficiency attained is indicative of the irrigation practices followed. High efficiency indicates good water management practices while low efficiencies reflect poor practices. To evaluate its influence on mosquito production, water was applied for an extended period of time on two occasions.

Refinements in standard mosquito sampling procedures were devised based upon last year's work. Larval samples were taken each day following irrigation or until water disappeared from the surface. Samples were taken at stations located at one hundred foot intervals in selected border strip checks. Each station was divided into three sampling areas approximately 33 feet long. When possible, the first area was sampled on one side of the check, the second area from the center of the check, and the third area from the opposite side of the border strip check. This diagonal sampling method provided for the measurement of species and instars as influenced by check margins, ponds, and the movement of water. Larval samples were measured for densities and collected for laboratory identification of species. Adult emergence areas were determined by visual inspection.

Maps were prepared daily to relate aquatic sampling with standing water conditions. Reference is made to the preliminary method of mosquito sampling suggested by Husbands (Davis and Husbands, 1954) to compute "Sample Opportunity Index," in relation to mosquito producing areas.

Measurements were made during eleven irrigation periods extending from May through September. Overall application efficiencies for the season agree quite well with previous work (Davis and Husbands, 1954). Kellogg's pasture border strip had an over-all application efficiency of 64 percent and did not produce mosquitoes. Moyle's border strip had an efficiency of 52 percent and had conditions suitable for mosquito production during two irrigations. The study conducted in 1954 found that a field with an efficiency of 66 percent produced no mosquitoes, a field with an efficiency of 35 percent produced a moderate number of adult mosquitoes, and a field with 25 percent efficiency produced many mosquitoes. Efficiencies on the Kellogg and Moyle pastures were intermediate between 35 and 66 percent and mosquito production was of corresponding magnitude between moderate and none.

Tables 1 and 2 show the results of larval sampling in both study areas. *Aedes nigromaculis* (Ludlow) is the dominant species of mosquito; *Aedes melanimon* (Dyar) constitutes approximately 3 percent of the species taken. *Culex tarsalis* (Coquillett) was very low in proportion to other species and occurred only in Moyle's border strip. The relative proportion of aquatic stages and instars taken during all irrigations is also shown in Tables 1 and 2. Moyle's border strip produced a higher proportion of fourth instar larvae than Kellogg's. This supports the theory that an increase in opportunity to sample late instars and pupae is indicative of increased opportunity (emergence area) for adult mosquito production.

On Moyle's pasture it appears that, although the over-all season efficiency and resulting production of mosquitoes substantiate the findings of Davis and Husbands (1954), individual irrigations are exceptions. Referring to Table 3, it can be noted that although no mosquitoes were produced during periods of high efficiencies, certain irrigations of low efficiencies also produced no mosquitoes. Mosquitoes were produced only during irrigations (7) and (9) which had low efficiencies but also had extended periods of water application. On this field with a low intake rate, the factor that seemed necessary for mosquito production was an extended period of water application, which increased the time that water remained ponded in the border strip.

Conclusion

In general, seasonal irrigation efficiencies are indicative of the degree of mosquito production on soils of moderate to low intake rate. However, particularly on those soils of moderate intake rate, irrigation efficiency as a measure of mosquito production should be applied with caution since it appears that the factor that contributes to the production of mosquitoes is the water management practices that are followed. It can be demonstrated that on moderate intake rate soils, low efficiencies can be obtained without mosquito production. It appears that a reduction in mosquito populations can be achieved

Table 1 Species composition and distribution of larval instars as influenced by irrigations and standing water following irrigations for the period May through September, 1955, in Kellogg's border strip check.

	Larval Instar						
Species	1	2	3	4	Pupae	Total	Percent
Aedes sp.	2022	1570			2	3594	66.17
A. melanimon			122	53		175	3.22
A. nigromaculis			1408	254		1662	30.60
Culex sp.			None				
Total	2022	1570	1530	307	2	5431	
Percent	37.23	28.90	28.17	5.65	0.02		

Table 2 Species composition and distribution of larval instars as influenced by irrigations and standing water following irrigations for the period May through September, 1955, in Moyle's border strip check.

	Larval Instar						
Species	1	2	3	4	Pupae	Total	Percent
Aedes sp.	4927	3832			28	8787	65.42
A. melanimon			275	57		332	2.47
A. nigromaculis			2638	1634		4272	31.80
Culex sp.	17	20				37	0.27
A. vexans			2			2	0.00
Anopheles sp.	1					1	0.00
Total	4945	3852	2915	1691	28	13431	
Percent	36.81	28.67	21.70	12.59	0.19		

Table 3 Irrigation dates, water application, irrigation efficiency, and mosquito production in Moyle's border strip, May through September, 1955.

Irrigation		*Water Application*			*Application Efficiency*	*Mosquito Production*
No.	*Date*	*Avg. Rate cfs*	*Time Hours*	*Depth Acre in/Acre*		
1	May 15	.08	35.5	2.58	High	None
2	May 27	.....Incomplete Data.....				
3	June 13	.17	25	4.18	Low	None
4	June 24	.26	18	4.46	....	None
5	July 8	.20	24	4.58	Low	None
6	July 20	.18	23	3.93	High	None
7	Aug. 1	.06	96	5.63	Low	Few
8	Aug. 16	.11	22	2.33	High	None
9	Aug. 29	.07	79	5.32	Low	Few
10	Sept. 11	.10	28	2.86	High	None
11	Sept. 29	.14	19	2.52	High	None

through practices that result in high application efficiencies. The process of striving for higher efficiencies will tend to eliminate or reduce those practices that are conducive to mosquito production.

ACKNOWLEDGMENTS

Many persons assisted this project. The Merced County Mosquito Abatement District, John O. Stivers, Manager, provided office facilities and assisted in the selection of study areas. The California Mosquito Control Association, Operational Investigations Committee, Theodore G. Raley, Chairman, aided greatly in the development of the program. Field assistance was rendered by George Payne and Daniel Stephanian, Bureau of Vector Control. Entomological identifications were made by Bettina Rosay, Bureau of Vector Control.

REFERENCES

1. Criddle, Wayne D. and Davis, Sterling. A method for evaluating border irrigation layouts (Provisional). U. S. Dept. of Agri., Soil Conserv. Serv. Research, March, 1951.
2. Davis, Sterling and Husbands, Richard C. An indication of the relationship between irrigation practices and mosquito production. Proc. and Papers, California Mosquito Control Association, and American Mosquito Control Association, Conference, January 27, 1955.

Mr. T. G. Raley: Thank you, Norman, and I am sure all of us in California honestly subscribe to the first line of this page, "Cooperative Investigations." We feel that only by cooperating with all interested parties will we arrive at that end result we are so anxious to find.

The last number on the list, but, indeed, not the last in importance in interest to particularly those people concerned with the immediate killing of mosquitoes, Lewis M. Isaak, now with the Bureau of Vector Control, but reporting on work that was done while he was in the employ of the Kern Mosquito Abatement District, and he will report on "Results of Screening of Newer Insecticides for Mosquito Control" and "What Has Happened to Resistance of *Culex tarsalis* to DDT?"

THE RESULTS OF FIELD TESTING SOME NEW MOSQUITO LARVICIDES

LEWIS W. ISAAK
Associate Vector Control Specialist

Although field testing of potential new larvicides was continued this past season, activity was curtailed considerably as most of the time was spent with studies on the flight range of *Aedes nigromaculis* in Kern County.

Briefly though I will list those which have been tested in the field and comment as to their possible potentialities as mosquito larvicides.

1. *Allethrin* at .25 and .5 lb./acre looked very good. The .5 lb./acre plots revealed 100% kill within 15 minutes. Conditions were ideal, however; no scum, light vegetation, water 6 inches deep. Larvae were fourth stage *A. nigromaculis*. Production on allethrin is limited, however, and cost is approximately $32/lb. Prognosis: no immediate future as a larvicide.

Despite a difference of opinion, clorthion could be used effectively by some districts at .2 to .25 lbs./acre. Manufacturing difficulties have limited its production, however, and its future in mosquito control at least appears rather dismal.

Dipterex in the new powder formation looks good beginning at .5 lb./acre. If production is increased and price decreased, it may find a place in our control program.

Diazinon appears better than malathion in laboratory testing but is less effective in the field. At least in Kern County it would have to be used at .75 lb./acre which would cost roughly $6.00.

Although American Cyanimids 4124 has proved to be quite effective on flies, it is not quite as good as malathion on *Aedes nigromaculis* larvae. It will be checked further next season.

Chemagro's 17147 is one of the best larvicides we have ever tested in the field. Somewhat like malathion, it appears only mediocre in lab testing but surpasses expectations in the field. Eight plots at .075 lb./acre gave 100% control within 12 hours as did two plots at .05 lbs./acre. An exact price is not available but evidence indicates that it will be rather expensive.

The last material worthy of mention is one formulation of synergized pyrethrum. The sample arrived too late for field trials but in laboratory testing it is excellent, almost as good pound for pound as parathion. One very unfavorable aspect, however: Cost for material application alone may run in the neighborhood of $15-$20 acre.

In conclusion, I would like to say that the search for a better all-around larvicide will continue in a more intense manner this next season. We hope to find one which is less toxic to warm bloods than parathion and less expensive than malathion.

WHAT HAS HAPPENED TO RESISTANCE OF *CULEX TARSALIS* TO DDT IN KERN COUNTY

Lewis W. Isaak
Associate Vector Control Specialist

Relative to the subject of DDT resistance, one of the questions that has been in the minds of many people for a long time and one that is asked quite often is this: "How long will it be before we can use DDT again as effectively as we used to?" No one can answer this question positively, but in an attempt to shed some light on the subject, a series of tests were completed last October in Kern District to evaluate, by laboratory technique, the degree of resistance that remains four years after DDT was discontinued as a larvicide. All larvae checked were *Culex tarsalis* and were collected from widely separated areas in the district. Results obtained were interesting but somewhat discouraging.

For a base line of comparison, our first series was completed with a strain from an uncontrolled area where larvae were non-resistant, we thought. The last check of these larvae was made in 1951, and although there is no control of any type within 10-12 miles of the area, larvae from that area are capable of tolerating approximately 5 times as much DDT, on an LD-50 basis now as then. This fact would indicate a greater movement by the *tarsalis* adults than is generally believed. All other collections, however, were from within the controlled area. Unfortunately, there was only one location in which larvae were available for collecting both years. Results of this place are given below on an LD-50.

DDT	1951	1955
1.ppm	78%	32%
.5	74%	31%
.3	. .	22%
.2	68%	13%
.1	59%	6%
.04	45%	. .
.03	27%	. .
.02	5%	. .

All other collection areas also indicated a high degree of resistance but larvae collected from the Wheeler Ridge area several miles beyond district control proved to be the most highly resistant of any tested. Although this area has never been sprayed for mosquito larvae as such, it is located in a highly productive agricultural region where insect control practices in general are extremely intensive and no doubt both adults and larvae are exposed to a variety of insecticides quite regularly.

Transferring on a weight for weight basis, our laboratory results to 4½ acre inches of water, 20 pounds of actual DDT would be required to successfully control 4th instar *Culex tarsalis* from these areas. In passing, it might be added that although this amount may control *tarsalis* larvae, further measures might be necessary to control alfalfa growers if their crops are condemned under the new ruling of the Miller Pesticide Act, because of excessive residue from spraying by a local Mosquito Abatement District.

Taking all aspects into consideration then, it appears quite likely that DDT in itself is pretty much a thing of the past for those of us now involved in controlling resistant mosquito larvae.

Mr. T. G. Raley: Thank you, Lew, and I think this group should add a resolution to those presented by the committee thanking the Kern Mosquito Abatement District for supporting the work that they have supported in the insecticide study for, I believe, the past five years.

I must compliment the speakers for getting us through within the exact hour, and yet I feel this is too important to break off with just this resumé of what has been done to date. Although it does not appear on the program, I have asked Dick Peters to give us a brief summary of the future seasons' operational investigations in California.

Dick!

Mr. Richard Peters: I will be exceedingly brief, which is not characteristic of myself. I think there is a great future in it. Looking into the present fiscal year I note that the budget submitted, since this is an inter-legislative year, the budget will conform appreciably to that which the Legislature approved for our current year, that is the one coming up in July 1. There has been, however, an increase sought in the amount of that salary necessary to continue the last speaker beyond the $25,000, so that much is being sought as the proportion of the $400,000 for operational investigations.

From the standpoint of emphasis, I subscribe to and have long been of the conviction that what Harold Gray outlined is the only way to do research in this field, first things first; because on a foundation of such limnologic and ecologic studies, which activities eventually prove to be correct, will point to the course that mosquito control can count upon. So, to the extent that I am able to administratively spur this program, I fully intend to underscore that approach, and I do trust that in the long run it will demonstrate itself to have been the wise decision.

Thank you, Ted.

Mr. T. G. Raley: Thank you, Dick.

(Applause.)

Mr. T. G. Raley: In closing, $25,000 is not enough money to carry on the type of research that we need, so as you do discuss the need for federally supported research with your Board of Trustees, I do sincerely hope that every manager will fully inform his Board on the need for expanded research in California under the State Department of Public Health.

President Murray: Thank you, Ted, and panel.

Next, we continue with some of the investigational work as done by C. M. Gjullin, of the U.S.D.A. Field Station, Corvallis, Oregon, who will present the activities of that field station as occurring in California.

Mr. Gjullin!

NOTES ON MOSQUITO RESISTANCE TO DDT IN CALIFORNIA[1] [2]

C. M. Gjullin

Entomology Research Branch, Agr. Res. Serv., U.S.D.A.

An investigation of the resistance of mosquito larvae to chlorinated hydrocarbon insecticides was made in the San Joaquin Valley in 1951. A recheck of this area was begun during the 1955 season to determine if any changes in resistance had taken place. These tests were made in the Merced County Mosquito Abatement District from August 8 to 21 and in the Delta Mosquito Abatement District in Visalia from August 26 to October 7.

The laboratory tests were made in the same way as in 1951. Four or five concentrations of the insecticide were tested against larvae from each location in tap water at 80° F., mortality counts being made after 24 hours. Tests were made with DDT in the Merced District and with DDT and malathion in the Visalia District.

Irrigation water was turned off in the Merced District before samples of larvae from a sufficient number of areas could be tested; so the results represent only a partial survey. Larvae of *Aedes nigromaculis* (Lud.) from two of the areas in this district (table 1) had a higher LD-50 than those tested in 1951 and larvae from two other areas had a lower LD-50. In larvae taken from an untreated area 3 miles outside the district resistance was approximately five times as great as in 1951.

Culex tarsalis Coq. from two areas in the Merced District gave an LD-50 of 0.21 p.p.m. No tests were made on *tarsalis* in 1951, but tests in the Consolidated Mosquito Abatement District in that year gave an LD-50 of 0.0641 p.p.m.

Five acreas in the Delta District showed a higher LD-50 for *nigromaculis* larvae in 1955 than the average for six areas in 1951. A single test from an untreated area about 4 miles outside of the district showed increased resistance over 1951. Larvae of *tarsalis* also showed increased resistance over 1951 in both treated and untreated areas. Malathion was equally effective against *nigromaculis* larvae collected in the Delta District this season and larvae taken in the Kern Mosquito Abatement District in 1951. The LD-50 was 0.025 p.p.m. in 1951 and 0.023 in 1955.

[1]Accepted for publication

[2]An investigation undertaken cooperatively by the U.S. Department of Agriculture, Agricultural Research Service, and the California State Department of Public Health, Bureau of Vector Control. Grafton Campbell assisted in the project.

Table 1. Relative susceptibility to DDT of mosquito larvae from different areas in 1955 (LD-50's for 1951 given for comparison).

District and number of areas	*Percent mortality at indicated parts per million*								*LD-50 (p.p.m.)*	
	1.2	0.8	0.5	0.3	0.2	0.1	0.06	0.03	1955	1951
				Aedes nigromaculis						
Merced:										
2 treated	..	..	93	82	36	11	3	2	0.21	..
2 treated	..	..	..	..	..	95	70	8	.056	.09
2 untreated	..	..	95	87	..	71	36	21	.072	.015
Delta:										
5 treated	..	..	87	..	77	58	39	18	.094	.059
1 untreated	..	..	..	..	..	90	85	20	.043	.0014
				Culex tarsalis						
Merced:										
2 treated	...	87	68	..	47	34	43	..	.21	.064
Delta:										
1 treated	87	67	74	..	65	42	..	..	.13	.08333
1 untreated	86	..	71	..	59	31	14	..	.21	.0333

Some DDT has been applied by spray truck each season in the Merced District, but in the past two years organic phosphorus insecticides have been applied by airplane to cover the major portion of the area. In the Delta District phosphorus insecticides have been used exclusively for the past four years, except for some DDT against adults and on dairy drains this season.

The increased resistance in the Delta District and nearby untreated areas where little or no chlorinated hydrocarbon insecticides have been used for mosquito control suggests that these insecticides have been used for crops in this area.

LITERATURE CITED

Gjullin, C. M., and Richard F. Peters. 1952. Recent studies of mosquito resistance to insecticides in California. Mosquito News 12(1):1-7.

President Murray: Well, it sounds encouraging. Thank you.

Now, the menu calls for a brief recess.

THE MILLER BILL AND MOSQUITO CONTROL

ALLEN B. LEMMON, *Chief,* AND
ROBERT Z. ROLLINS, *Assistant Chief*
Bureau of Chemistry, State Department of Agriculture

Public Law 518, otherwise known as the Miller Bill or the Miller Amendment to the Federal Food, Drug, and Cosmetic Act, provides a procedure to facilitate establishment of tolerances for pesticide chemicals in or on raw agricultural produce such as fruits, vegetables, nuts, grain, hay, forage, milk, meat, and eggs. Specific tolerances have been established during the past year for about fifty pesticide chemicals on a number of crops, and some chemicals have been exempted from the requirement of a tolerance. Additional tolerances are being announced every week or so. Petitions for other tolerances are currently under consideration and application of the law to these specific uses has been postponed until next spring. It will probably be a year before all the old uses of pesticides are fully covered.

There is a general misunderstanding that the Miller Amendment and the announced tolerances have increased the restrictions on pesticides and have made their use more difficult. This is not wholly true. Mr. W. B. Rankin, Assistant to the Commissioner of the Food and Drug Administration, in a paper presented to the Entomological Society of America at Cincinnati, Ohio, on November 30, 1955, said:

"Many people are under the impression that this new law sets up some new requirement about pesticides in foods and that it will render crops in interstate commerce more likely to be seized by the Federal Government. As a matter of fact, the new law does not change the basic requirement of the Federal Food, Drug, and Cosmetic Act that foods in interstate commerce shall be free of dangerous quantities of spray residues. This requirement has been a part of the basic statute since it was enacted in 1938. What the new law does is to set up a more convenient method of determining what is a safe residue and announcing this safe level or tolerance level to the public."

The basic federal law, which has been in effect since 1938, states that food or feed shall not contain any deleterious substance. Then it provides that certain tolerances may be established for substances such as pesticides and that a residue below such an announced tolerance will not be considered in violation. Announcement of a tolerance is therefore an easing up rather than a tightening down. In other words before a tolerance is announced for a chemical, any detectable amount renders the food in violation of law. After a tolerance is announced the tolerated amount may legally be present. For example, a year ago and earlier, lettuce containing DDT up to 7 ppm was in violation of law. Today it is not. Up until last month, olives could not be marketed if they contained any detectable parathion residue, but by establishment of a tolerance in December the Federal Food and Drug Administration has announced that it will take no action against such residues unless they exceed 1 ppm.

On the other hand, with the adoption of specific tolerances, it is expected that the federal law will be more effectively enforced than it has been for the past ten years. The present federal law was enacted in 1938. Consideration of tolerances was suspended during the war. After the war, the tremendous developments in organic pesticides so complicated the problem that official action was paralyzed. Now the matter is clearing up and enforcement will be resumed. So the user of pesticides is like the little boy whose mother has replaced the club she used to threaten him with, with a switch that she really intends to use.

There are many aspects of pesticides that interest you in your official work. You know that when they are misused or mishandled, they can hurt people, they can hurt livestock, they can hurt honeybees, and they can hurt wildlife. At the moment, we are not considering any of these dangers but only the hazards that arise when the chemicals you use leave residues in or on raw agricultural commodities.

You may point out that you are not using rare chemicals with unusual characteristics but that you are only using some of the same pesticides that farmers themselves are commonly applying to food and feed crops in greater amounts than you are. That is very true, but in some ways it serves to complicate your problem. If a farmer's produce is found to contain excessive amounts of pesticide when it is marketed and both you and he had applied that same pesticide to the growing crop, who is to say who's application caused the trouble?

A number of firms and agencies are now compiling data on the magnitude of residues deposited on produce by various agricultural pest control applications and on the persistence of the residues on the marketed portion. This information will provide farmers with a basis for arranging a pest control program, a schedule of dosage and timing, that will not leave excessive residues at harvest time. He will know, for example, that he can apply one pound of a certain pesticide ingredient per acre on his crop up to 30 days before harvest and the residue will weather off and drop within the tolerated amount by the time the crop is harvested. Now suppose he cuts the waiting period critically short, and during that time you apply a little more of the same chemical or a similar chemical in your work. Then suppose his crop is found to contain excessive residue and is seized. He will claim that *his* residue was not in violation of law but *yours* was. What will you have to say?

You need data, and you need it soon, to tell you what you can and cannot do in applying pesticides near food or feed crops and to prove your innocence when your innocence is questioned. You should have dependable measurements of the amount of residues left on food and feed crops by your pesticide applications and some determination of how long the residues remain.

One of the biggest problems you are going to face this year is the hazard of chlorinated hydrocarbon residues on pasture, forage, and feed crops. Data developed in past years have proven that the health of livestock themselves is not apt to be endangered by the customary usage of pesticides on or around their feed. But data also show that when animals eat very small amounts of DDT or other chlorinated hydrocarbons, the chemical is stored in their body fat and excreted in their milk. Furthermore, the contamination may last for a long time after the animals cease eating the chemical.

The Federal Food and Drug Administration is currently considering tolerances for pesticides in meat but it has announced that it will permit no residues whatever in milk. Now, if no detectable amount of residue is to be permitted in milk, it looks as though no DDT, DDD, toxaphene, dieldrin, heptachlor or other chlorinated hydrocarbon can be allowed to reach pasture, forage or feed that might be fed to dairy animals. It is possible that light applications of heptachlor and dieldrin might be used if ample time is allowed for residues to weather off before feeding but the available data are not conclusive. Parathion and malathion are not excreted in milk and do not seem to present this particular hazard.

In addition to the problem of pesticide residues, certain chemicals are known to cause off-flavors in food crops and this must be guarded against in your work. The outstanding material that has caused off-flavors, of course, has been benzene hexachloride and in some cases lindane. The California Olive Association has just brought to attention the serious situation that can occur if any benzene hexachloride or lindane is used around olives. It has been found that almost infinitesimal amounts of these chemicals can be absorbed through the trees, or through the roots in case of contaminated soil, and be carried into the olives. The off-flavor then shows up later in the processed olives. Furthermore, raw olives from various growers are mixed during processing and one bad lot can spoil a much larger batch of packed olives. The Committee for Protection Against Pesticide Residues of the California Olive Association has asked that the attention of all of you be called to this serious problem and requests your cooperation. We have been told that in one case an olive orchard was treated with a fogging machine using benzene hexachloride and such operation can definitely ruin the crop.

Fortunately, BHC and lindane are about the only pesticides you use that present this flavor problem. Most of your interests will concern residues as such and the special problems concerning meat and milk animals. These are serious questions and the questions must be met. If you and a farmer are both applying pesticides on a food or feed crop, then you and the farmer are vitally interested in the amount of residue at harvest time. Before you apply a pesticide over an area, you need to know, (1) what crops are in the area, (2) the amount of residue your application leaves on the crops, (3) the tolerance established for that pesticide on those crops, (4) the farmer's pest control program for those crops, and (5) the proposed harvest dates. Don't believe the old adage that what you don't know won't hurt you. On the contrary, the less information you have, the more trouble you can expect.

President Murray: Mr. Rollins, just a minute. We may be pressed for time but your topic is so critical to us, it is one of our main occupations, the use of insecticide. Could we have about five minutes for questions?

Mr. Robert Rollins: I didn't mean to run out on you. If you have questions now, go ahead.

President Murray: Does any one have a question he would like to pose to Mr. Rollins?

Mr. Homer W. Kirkman: Mr. Kirkman, Turlock.

Does the State have any pamphlets in regard to tolerances now?

Mr. Robert Rollins: You may have seen a loose-leaf notebook of pink sheets that we have prepared for the Agricultural Commission, inasmuch as the Agricultural Commissioners are in this with us in enforcement. There is nothing secret about the document. It is just that the costs of printing and mimeographing are such that we cannot distribute it generally. We have nothing in this particular list that is not easily available from other sources. I should think each of you would want to write to the Federal Government and get on the mailing list to receive this information as it comes out. You write to the Federal Food and Drug Administration, Editorial Branch, Washington 25, D.C.

I will repeat that, you write to the Federal Food and Drug Administration, Editorial Branch, Washington 25, D.C. and you ask for two things: You ask for the information that they have issued up to the present time on pesticide tolerances on food stuffs, and secondly, don't forget to ask to have your name placed on this mailing list to receive future publications as they are issued. To find out what they would send to an ordinary taxpayer as contrasted to a law enforcement agency, I sent my home address in on a postal card, as any one might do. First of all I received a compilation about three-quarters of an inch thick, with all the information published so far, and since then I have been receiving mimeographed sheets every few days keeping me up to date.

Incidentally, tolerances have been issued on approximately 50 chemicals on perhaps 150 crops. Other tolerances are presently under consideration and they are acting upon them week by week. As a matter of fact, the application of the law to a number of pesticides has been specifically postponed until next spring so that really it is going to be a full year before all the classical usages of pesticides on all food crops are completely covered. And from then on the law will act mainly on new pesticides as they are developed.

Mr. Gardiner C. MacFarland: Is there any routine testing of milk, as an example, on inter-state shipping at the present time?

Mr. Robert Rollins: We know of no routine testing of milk in California. California does have a spray residue law which is written in an entirely different manner from the Federal law. The Federal law says the produce shall contain no chemical, and then it says we won't pay any attention to these small amounts.

The California law says that produce, meaning fresh and dried fruits and vegetables and hay and forage, shall contain no more than certain stated amounts of pesticide residue. It does not include milk. At present there are State tolerances only for lead, arsenic, fluorine and DDT, nothing else. If vegetables were on the market with a high amount of strychnine, for example, it would be none of our official business. It would be very definitely the business of the Food and Drug office of our State Department of Public Health.

Mr. Dean H. Ecke: Ecke, Santa Clara.

What insecticides have been cleared by the State for us in and around dairy establishments?

Mr. Robert Rollins: When you say "cleared" you bring up a problem. It is easier to say "none." You see, ours is a regulatory agency. The Bureau of Chemistry doesn't recommend anything. Manufacturers make products and label them and they submit them for registration and sale. It is our job to look at the proposed labeling and see if it is all right. If it is all right, we register it. Registering it doesn't constitute a recommendation. We have registered 12,000 products in California and I wouldn't waste my money on 2,000 of those.

Mr. Dean H. Ecke: We frequently get the question from the farmer, what can he use around his dairy barn, and the only thing we have been able to get from the Agricultural Commissioner is that they have recommended toxachlor. Of course, you know how much effect that might have.

Some of the dealers have told us that malathion and some of the other—

Mr. Robert Rollins: Yes, malathion as well as methoxychlor and lindane have been registered for use in dairy establishments. Labels include caution that they not be used in the milking room where milk is open.

Mr. Dean H. Ecke: There is no law against it, is that right?

Mr. Robert Rollins: That is right. The label, indicates you can use malathion on dairy barns but not where the milk is exposed. Methoxychlor was accepted on the basis of findings that it did not appear in the milk, but we have seen some data in the past six months indicating methoxychlor applied to the livestock did come through in the milk. So there you have a situation where certain products have been registered for use both Federally and by the State, and are offered for sale today, and yet today we learn of some hazard we didn't know before. And at the present time no action has been taken to revoke this usage.

President Murray: One more question, Lee?

A Voice: I was recently asked to give a little advice on spiders in a milking barn, and on the basis of what I could find out I recommended Lindane. Does that mean we are not to use Lindane any more in the milking barn for spiders?

Mr. Robert Rollins: I don't know. It certainly would be questionable with what we know now about lindane's very definite vapor pressure. It depends on the barn. I know that sounds like splitting a hair. It depends on the circumstances and the barn. In one barn, you might be able to use it over here because the cows are milked over there by machine and the milk is never open. But in another case, a fellow may be milking when you spray it around and it gets in the milk.

I don't want to complicate matters too much, but to say that a zero tolerance must be followed ,and to say that no pesticide should be present in food stuffs, is a rather vague thing. It is not as clear as you would think. Perhaps the chemist with the method he has today cannot detect an amount that is in violation of law. There may be a case where lindane could not be detected in milk by a method we have today, and by tomorrow some ingenious and bright chemist will find he can detect it, so that a procedure or a use of a pesticide which was suitable last year may not be suitable now. A use acceptable today might not be acceptable next year. We would much prefer that there would be no zero tolerances, that they would all have a magnitude. We don't care where you set it. It would be all right if it were not more than a thousandth of a part per million of mercury, for example. That is workable. We can get a method whereby we can determine a thousandth part per million. If a thousandth part is not there, it is all right. But when the law says "none" that means not detectable by any present or future analytical method.

Mr. Embree E. Mezger: "Detectable amounts of milk." Now, does that detectable mean no insecticide at all in the milk? I mean, "no?"

Mr. Robert Rollins: Well, our methods vary on every commodity. I would hesitate to give you a figure without speaking to the chemist at the last minute, but I think we can determine a hundreth of a part per million without trouble because on some of these liquids it is possible to take a large sample and concentrate the residue.

Incidentally, there are thousands of dollars worth of silage at the present time tied up down in the southern part of the State because it contains excessive amounts of DDT. We just received a letter in this morning's mail from down there asking for a suggestion about what to do with the forage. We haven't the slightest idea what to tell them. Field corn, which may be dusted only once with DDT is all right, but sweet corn is treated many, many times with DDT. When the sweet corn ears start maturing and the silk is out, the farmers may go through every day or every other day with a hand duster and give each one of those bundles of silk a shot of DDT so that when the corn is harvested, they are full of DDT. It doesn't bother the corn because when it is analyzed the edible part of the corn contains no DDT. But in this case the green corn plant repeatedly treated with DDT last year was chopped up and made into silage, and it can't be fed. One fellow alone has $16,000 worth of silage. It contains somewhere between 50 and 80 parts per million of DDT and from the best information we have available, holding that for several months won't do him a bit of good. One year from now he might be down only 10 or 20 per cent of the original load. What can he do with it? He can't feed it to dairy animals.

He asked, "Can I feed a little bit one day a week?" That is simply like asking the dog if he would like his tail cut off an inch at a time. He asked if he can feed it in fattening yards. No, it is going to get into the fat of animals. I don't know what he can do with it except take it back and plow it in, $16,000 worth of mulch.

President Murray: Thank you, Mr. Rollins, very much.

We must move on. There are a few standing in the rear who might hear better and see better if they come forward. And we have several announcements.

Dick Peters wishes to announce something.

Mr. Richard Peters: There are a couple of things I would like to say to you. One of them is in the scope of the Bureau of Vector Control program review. I think most of you know that the Bureau of Vector Control has been for some time awaiting the assignment of both a technical team from the Public Health Service and a fiscal management, that is, a management appraisal person from the Department of Finance. Both have been supplied as of yesterday and, inasmuch as this would be an opportunity for you to identify the individuals, I would like to ask Dale Henner, from the Department of Finance Management Analysis Section, to stand, if he would, please.

All of you I want to know Dale Henner because Dale Henner is going to be looking objectively at the Bureau of Vector Control's program. I want you to tell the truth, and I don't want you to pull any punches. And I know Dale in turn will be asking you many questions.

I am sure you will find the same cordiality when you go around observing Mosquito Districts, Mr. Henner, as you have here in the Conference.

Next I would like to have Dr. Milt Goodwin stand, please. And is Jack Henderson here?

In any case, all of you had the opportunity to see Jack Henderson when he stood up here before you discussing the legislative bill earlier today. Dr. Goodwin and Mr. Henderson will constitute the technical team who will be appraising the technical aspects of the program, both Mosquito Control and the other things that we are doing in the Bureau of Vector Control.

President Murray: Thank you, Dick.

While we are in the process of introductions, I think the group as a whole should get better acquainted with some of our sustaining members. We, I believe, still have some who are here. I would appreciate your standing up and introducing yourselves.

Any sustaining members, chemical companies, etc.?

(No response)

Are there some here? There is Wilbrand with Speekman Chemical Company, and Ernie Luck, from Chipman, as is also George Meyer from Chipman.

Thank you.

Any others?

Mr. W. J. Cherry: My name is Cherry, recently transferred here from Colorado and Texas to Sacramento, California, Rohm and Haas Company.

President Murray: Well, there is Don Denning back there, with Velsicol, who was apparently embarrassed to stand up. Don't let the apparent paucity of these persons confuse you. They do play a tremendous part in making these conferences a pleasure and a success.

Now let's see, is Archie Hess here?

Let's move on to our next program, which is a symposium moderated by Gordon Smith, Entomologist, Kern Mosquito Abatement District, on "What do we Know About Naturalistic Control of Mosquitoes?"

Mr. Gordon Smith: First, I think we should hear from Mr. Bill Bollerud, who is the Executive Officer of the Durham Mosquito Abatement District.

Now, Bill, will you come up here?

SYMPOSIUM ON NATURALISTIC CONTROL OF MOSQUITOES

Mr. William Bollerud: Before we go into the meat of this thing, let me tell you a little story, which I s'pose you've all heard.

A lady in a nice, sociable and chatty way, said to her associate, "Whenever I'm down in the dumps I get me another hat." Her associate in a nice, sociable and catty way replied, "I wondered where you got them."

I thought about that when I learned I was on the program. "Where does the Program Committee get its talent?"

My portion of this program deals with the use of predators, or rather the natural or biological control of mosquitoes by the use of predators. We simply mean that we —thank you. How soon will I be able to get a copy of that picture? The only reason I took a place on the program was in the hope of getting my picture in the paper.

As I was saying before we were interrupted by the flash camera, that the use of predators is simply pitting one organism against another. It is as simple as all that. When we think of predators for mosquitoes, we think about fish, at least I think about fish, more particularly about *Gambusia affinis.*

There no doubt have been many scores of scientific tests to prove that *Gambusia affinis* destroy mosquito larvae. I have my own proof. It is simple. It is short, and not too scientific. I put some larvae in a jar with the fish, after a while the larvae are gone and the fish remain. Prima facie evidence I call it. In no case have I know the fish to disappear and the larvae remain. This is not due entirely to the disparity in size. The little newly spawned *Gambusia* are no match for a big 4th instar wiggler. It's just that the larvae are vegetarians.

There are other species of fish who will eat mosquito larvae—I think chubs, shiners, gold fish, whales perhaps; but for a guided program of mass mosquito destruction we have chosen the *Gambusia affinis*—a minnow 1½ or two inches long. He is chosen for these reasons:

1. He does not feed upon game fish so as to get us in trouble with organized fishermen.
2. He has no other bad personal habits which make him a pest.
3. He is easy to rear. By that I mean that he does not require very exacting conditions—reasonably warm and reasonably clear water is all.
4. He multiplies rapidly.
5. He is adaptable to all latitudes in the U. S.
6. He is easy to transport.

None of those items require any explanation.

Against the advantages of using these fish we must measure the disadvantages.

Chief among these is that he has numerous enemies.

First among these is himself. He's cannibalistic. He'd as soon eat his wife as sleep with her—which in my opinion is some kind of perversion. With equal greed he'll eat his children or grand-children.

Secondly, among his enemies are most any kind of fish larger than he is. Further among his enemies are snakes, frogs, pelicans, cranes, cormorants, and gooney birds.

In my district, to be sure of a supply of fish, we try to rear them in an irrigation reservoir about 200 feet square. It's a good fish pond and we raise a lot of fish. The chief disadvantage is that they are exposed to all the creatures that prey upon them.

In some districts—I noted one, particularly, in Kern County, the tank is very small, perhaps 12 x 24 and is located on their headquarters property. This has several advantages.

1. They can be protected against their natural enemies.
2. The water may be heated a few degrees and they'll start breeding earlier in the spring.
3. The task of gathering them is reduced to almost nothing.

Where do we use these fish to the best advantage?

1. Rock gardens.
2. Watering troughs.
3. Semi-permanent pools.
4. Rice fields.

We'll begin with the rock gardens.

I can go back a long ways and think of one of the first pestiferous places we used them and that was in rock gardens. The rock garden is passé now, I think, but at one time it was one of the pillars of modern landscaping structure, fairy castles, if you please. In everybody's backyard—almost everybody's, because at first it was a mark of social distinction and culture to have a rock garden and no rock garden could be fully self-respecting without a fish pond in it populated with ornamental fish, of course. In due time everybody caught up with the Joneses and the rock garden lost its glamour, and instead of being a mark of the elite, it was as corny as all get out. And I say that with apologies to any of you who may still have a rock garden.

But they soon became the victims of neglect and the fairy castles crumbled and the gold fish died and the little fish pond became a mosquito breeder ne plus ultra; that was where the high energy mosquito staff came in, and that is where the solemn-faced little *Gambusia* entered the picture and we peddled *Gambusia* in every backyard in the community for awhile. In due course, rock gardens began to peter out, bottoms cracked and leaked, sometimes with the help of a sledge hammer, but you can see that while the rock garden was in its glory the *Gambusia* was very effective in taking care of the specific problem.

Another problem we used the *Gambusia* for was the watering troughs—not necessarily the big water tank out in the pasture that served a herd of cattle, but it was on the little subsistence place, acre, acre and a half, two acres, where there was one milk cow or the kid had a pony, or the 4H boy had a calf he was raising to take to some junior livestock show, or somebody was raising up a steer for his own meat. You should see some of those watering troughs; anything that would hold a few gallons of water and didn't cost anything, an old wash tub or a half of a 50-gallon drum, old bathtub—you remember that kind with the eagle's claws for feet—and usually they were befouled with sediment and bird droppings, tree leaves, and dead grasshoppers.

Now, those vessels wouldn't necessarily breed the mosquitoes if they were kept clean and the water changed occasionally, and the owners promised me, so help me, to empty them and scrub them out regularly, but they never do. I or my staff could clean them out, but it was beneath us. So it became a double-distilled breeding place for mosquitoes, and we do not dare do anything so crude as putting poisonous insecticides in the water. You must remember these items of personal livestock are pets and are members of the family, and you don't go squirting DDT or oil in that watering trough, so we peddle fish every spring to the water troughs. We go by from time to time to see that they are still there and see how they are thriving.

Next to that we had bodies of water of a semi-permanent character. They are here a few weeks or maybe all summer, here this summer, gone next summer. They are the result of a man's year to year changes in his operation. They usually are one acre, two acres, three acres, and may be seepage from a new reservoir and may be seepage from a ditch built on top of the ground, and may be seepage from a porous dyke in a rice field, and may be just plain old sloppy poor water management.

You can't anticipate these and you don't know about them until you stumble upon them, and you don't usually find them until the irrigation season is on the way and they are already full of larvae. A good heavy planting of fish there will do the trick, but it is usually necessary to larvacide it first—I mean with insecticides—then to get those larvae which are already there.

Now about rice fields. One doesn't like to give pat answers about *Gambusia* in a rice field because of the many factors and side issues which bear upon the problem. It is difficult to credit or charge the *Gambusia* with this or that development. There is one general statement that can be made, though, that where the best agricultural practices are followed, the *Gambusia* are the most effective.

Now, I want to divide rice fields into two classifications. I hope I don't get any back talk from Sperbeck on this. He is the rice tycoon up in our country.

First you have the larger holdings, the thousand acres and upwards; places that have been operated for some years, where the land is level, water depths are uniform, dykes, dams and structures are in order, drains are neat ditches that hold and carry the water without shallow sprawling slough-like areas. A coordinated network of canals and ditches all connected. On such a spread there are sumps or ponds and canals in which the fish may winter over. In spring as soon as the water in this system starts moving, the fish are carried to all parts of it at once and the *Gambusia* have an even start with the larvae, and in such places I find the *Gambusia* very effective.

Then there is the other type of rice field represented by an isolated plot 60, 70, 80 acres, a hundred acres, and generally operated by a Johnny Come Lately. An opportunist who jumped on the gravy train; and why not, with rice at $4.50 a bag? He often hasn't the necessary backing, the necessary equipment, the necessary know-how. His dykes are inadequate, his drainage isn't organized, he resorts to shortcuts and temporary measures. His toe ditches and seepage drains are not continuous. He leaks and spills water haphazardly. There are no fish wintered over on the premises. On places like this we have to plant the fish. Planting quantities of fish early in the season, say April, is difficult and discouraging. In the cool weather they stay on the bottom, probably half-buried in the mud, and are hard to catch. Therefore, if and when we do plant them, they get a late start and don't develop in enough numbers to be very effective.

In fields of this latter type I can dip larvae any time, any place, all summer. In fields of the former type, production of mosquitoes is comparatively low until perhaps the latter part of the season.

I have described these two rice fields. They represent extremes and there are all the graduations in between.

Before I quit, before I fold this book, I want to talk one-half minutes on tadpoles and snails.

In bodies of water populated by tadpoles I seldom see any mosquito larvae, and in pools of water inhabited by snails I very seldom find any mosquito larvae. That brings us into the cause and effect: If not, why not? Is it the same reason you don't find mosquito larvae fraternizing with *Gambusia;* simply that the fish eat the larvae?

That is evidently not the case because tadpoles and snails are vegetarians. There is another thing in this connection that I want to mention. I have tried to discuss this strange situation with other gentlemen in the profession, Mosquito District Managers, entomologists, vector control specialists. They just won't talk. They give me a sort of disapproving look as though I had said something improper.

There are exceptions to this, of course. Harold Gray discussed it with me and suggested the possibility that our polliwogs and our snails have eaten up all the available food. I talked to Mortenson about it and he said possibly that polliwogs and snails exuded a substance which is repugnant or toxic to the mosquito larvae. I hope someone will come up with an answer to that.

Thank you.

Mr. Gordon Smith: Thanks, Bill, and I think you have gotten off to a good start. I think you will find from the rest of the panel that we don't have very much definite information. We are not going to draw charts on the blackboard. We are reporting observations, things we noticed that may point a way or may not, trying to develop a little thought along a line which may have been seriously neglected in our rush to use insecticides or to find new insecticides to take the place of ones that are no longer usable.

NATURALISTIC CONTROL OF RICE FIELD MOSQUITOES IN KERN M.A.D.

GORDON F. SMITH, *Entomologist*
Kern Mosquito Abatement District

In looking for crops to replace acreage cutback by cotton and other production controls, Palm Farms, in the Buttonwillow area, planted a large experimental acreage in rice in 1953. Their success with this planting, with considerable cotton cutbacks scheduled for 1954, made it rather certain that the Kern Mosquito Abatement District could expect a considerable acreage of rice to be planted within its boundaries.

Since this district had had no experience with rice field problems, it was necessary to plan an operational procedure. In the planning stage, two things were noted. One, that to obtain full control in the rice fields would, by the use of chemicals, be a very costly procedure and, secondly, little had been done in the way of actual field attempt to obtain naturalistic control in rice fields—especially under conditions of climate and agricultural practices found in the Southern San Joaquin Valley. It was felt that chemical control would not only be costly, but that if the rice stands became dense, kill would probably be impaired.

It was decided that before initiating a routine chemical spray program, an attempt at broad-scale naturalistic control would be made. It was hoped that a sufficiently satisfactory level of control could be obtained with mosquito fish and other natural enemies and that the need for costly spray operations would be eliminated. This plan was based on the possibility that if fish were introduced into the paddies immediately upon flooding, their increase in numbers would tend to keep pace with the mosquito breeding potential as the season progressed, and that other natural enemies, such as the dragon fly and water beetle larvae, would aid in destroying the larvae.

At the time that the ponds were flooded the operators planting the fish noticed that dragon flies were very active over the ponds. Although routine entomological observations were not made, the ponds were watched closely and checked frequently by the operators and foremen and occasionally by the author.

As the season progressed, it became apparent that in those ponds where fish had been planted, only occasional larvae could be found, even by intensive dipping, and pupae were virtually absent. In the ponds where fish were not introduced at the time of flooding, very heavy populations of *Culex* larvae developed as the spring progressed. This population declined as predatory insects and insect larvae became more numerous. Mosquitoes present in these ponds were almost entirely *Culex* species.

In the ponds where fish were introduced later in the season, virtual absence of 4th instar larvae and pupae were noted after a few weeks.

Although the results in the rice fields were highly satisfactory, a number of questions were raised during this period, especially concerning the place of predators other than fish in the biological control. It was, therefore, decided to run a study on a duck club which could be watched closely. For this purpose, the B and B Duck Club was selected.

B and B Duck Club

This club consists of four ponds, each roughly square in shape and about five acres in size. The bottoms of the ponds are leveled and the levees are high, sharp sided, straight, and broad enough on top to drive on. The bottoms of the ponds were free of vegetation at the time of flooding, having been disked and rolled with a road packer in an attempt to reduce water penetration. The vegetation on the sides of the levees was mowed prior to flooding.

Two of these ponds were selected for study purposes. In one pond a light population of fish was introduced with the irrigation stream running from the reservoir. In the second pond additional fish were introduced in moderate numbers, but no attempt was made to stock it heavily.

The ponds were flown for *Aedes* immediately after flooding with parathion at 0.1 lbs. per acre. At this rate no kill of fish was observed. After the introduction of the fish, these ponds were checked carefully at least twice a week. Large numbers of dragon flies were observed depositing eggs in the ponds immediately after flooding.

Culex larvae were found in the grassy margins of the ponds a few days after flooding, and early in the trial a heavy larval population developed. Since the centers of these ponds were open, *Culex* development was confined almost entirely to the grassy margins. In order not to upset the natural development of predators, these margins were sprayed only when numbers of pupae were present. The margins were sprayed three times by a Jeep power spray using oil. Although this killed the water bettles, both adult and larval, it had no apparent effect on the aquatic stages of the dragon and damsel flies.

An equilibrium was reached in about one month, after which only an occasional pupa could be found, indicating that few if any adults were emerging. At this time the mosquito fish in the ponds had developed in considerable numbers, and also there was a heavy population of dragonfly naiads or larvae in the water.

Los Angeles Athletic Club

At the time of flooding of the Los Angeles Athletic Club, a rice field nearby was being dried up, and great numbers of fish were easily available. Mosquito fish from this rice field were taken literally by the gallons, and a number of the ponds in this club were stocked very heavily. Observations on these ponds were not made with the frequency or regularity as those on the B and B Club, but sufficiently so that certain things may be noted.

These ponds are triangular in shape and $2\frac{1}{2}$ acres in size. The bottoms are roughly level but have definite high and low spots. Vegetation in the ponds consists principally of tules and wire tules with other emergent plants. The ponds were mowed and partially burned. The mowed but unburned vegetation produced rather heavy surface floatage in some places. The levees are of moderate height and not maintained. There are often shallow margins and numerous cracks which contain seepage water.

The fish were introduced in numbers sufficient that it was hoped no mosquito production, especially *Culex,* could take place. Since the fish present were sufficient to very nearly eliminate the production of *Aedes,* no general spraying was done for this species. Some mop up was done using oil in cans and ground power spray.

Shortly after flooding-in two ponds first flooded and selected for observation- *Culex* larvae appeared and developed in heavy numbers, much in the same fashion as on the B and B Club. Since floatage and vegetation allowed breeding throughout the pond, they were sprayed once with 6 gallons of oil per acre by air. The larval kill obtained ranged from 75% to 90%.

Except for the *Aedes* mosquitoes, these ponds followed roughly the same cycle as those in the B and B Club and reached an equilibrium in about a month, at which time it was felt that mosquito production was almost eliminated.

In one of the ponds some of the fish were killed near the point of entrance of the water. This water was from a new well and may have contained some toxic material.

Westminster Duck Club

An attempt was made to set up a study on this club since it had ponds of irregular size and shape and very heavy grassy type vegetation. However, the water fluctuation in these ponds was so great that, for the most part, it became impossible to attempt interpretation. In one pond, however, the water level was kept relatively stable. The vegetation consisted of wire tules and heavy clumps of emergent bermuda grass.

After spraying for *Aedes* at 0.1 lbs. of parathion per acre, fish were introduced in large numbers. Development of *Culex* in this pond followed essentially the same pattern as in the B and B and L.A. Athletic Clubs. However, since it was felt that the vegetation was so heavy as to make spraying with oil by air virtually useless and, since the pond was planted to millet which the oil would burn, no spraying was done.

In 1955, mosquito fish were planted in all rice fields immediately after flooding. It is felt that very little production occurred in these fields and possibly less than would have occurred had limited chemical control been attempted within economic reason. Mr. Ernest Meyers, of the Bureau of Vector Control, made routine studies on several of these fields during 1955 and will report on his observations in this panel.

General Interpretation

1. No attempt was made to assess such factors as algae lethal to mosquito larvae in these ponds. However, Mr. Richard Gerhardt, of the Bureau of Vector Control, found no blue green algae of the type which appears to have such an effect in the Sacramento Valley. The fact that on occasion larvae of all instars could be found, indicates that such a condition does not exist.

2. It appears that in the past fish have been given much more credit than they may deserve for controlling mosquito larvae. It appears that they may be a part of a complex with other predators, and that the entire complex may be necessary for control. These predators would probably feed primarily on mosquito larvae as they are not as fast and are captured more easily. However, they can sustain themselves by feeding off each other when no other food is present.

3. In all cases numerous dragon flies were observed depositing eggs in freshly flooded areas. This may or may not be the normal case and awaits further observation. At any rate, it is felt that the dragon fly naiads or larvae, play a major part in this complex.

In order to get some idea of the ability of dragon fly larvae to consume food, five large specimens were brought into the laboratory and placed in a pan. Over a period of 18 hours, these larvae consumed 35 pupae and one of their own members. When a mixture of larvae and pupae were put in the pan, the pupae were taken but few if any of the larvae were consumed. In the field, the relative scarcity or absence of pupae as compared with the numbers of 4th instar larvae indicate that some preference is given to pupae as food.

4. Since minute free-swimming crustaceans are present in large numbers in many ponds, random field-collected material was offered both to fish and dragonfly larvae. Both appeared to refuse this material as food.

5. Although floatage and vegetation may have some effect on fish, it did not appear to disturb the effectiveness of the complex as a whole.

6. Insofar as *Culex* mosquitoes are concerned, the advantage of the introduction of a very heavy fish population over the introduction of moderate numbers is questionable. In fact it may do more harm than good, as the excessive number of fish may delay reaching a balance by feeding too heavily off the very young forms of the other predators.

7. In places where an attempt is being made to use predators, it is preferable to use no spray at all, though some mosquitoes may emerge. If spraying is absolutely necessary, it is essential that only oil be used, as organic insecticides may destroy a large part of the predator complex. The use of chlorinated hydrocarbons may eliminate the use of this method for a year or more.

8. This method is of very doubtful value in duck clubs. At the time of flooding of these ponds, the mosquito season is at its height, and normally the mosquito season would be over by the time an equilibrium is reached. Also, the time and effort involved in getting fish places a great demand on the operator's time at this busy period.

9. In assessing the results of this type of control only pupal counts are of any value, and considering the apparent preference for pupae as food, interpretation of these counts is difficult.

Conclusion

On the basis of two years' experience, it appears that in the Kern County area, good control of *Culex* mosquitoes can be obtained in rice paddies by introducing fish immediately after flooding, and then letting nature take her course.

Now, following this I would like Ernie to come up here and give us what he has in continuation of our 1955 operations.

As Gordon has mentioned, there was work done in rice fields in the Kern County area. I worked on two particular rice fields over in Jerry Slough, which is the main area where the Encephalitis Laboratory does most of its field work. We had hopes, at the same time that I was trying to get some other data, to find whether predators were of value in controlling mosquito larvae; also to get material on the immature stage of mosquitoes in the Jerry Slough area for the simple reason that most of the work done by the Encephalitis Laboratory concerned adult insects, and any local information on immature stages of mosquito larvae would, of course, be of value.

Two rice fields in the area were chosen. One of the fields was planted by a mechanical seeder on the ground; the other field was sown from the air. Consequently, on that second field rice plants were growing across the dykes and the levees that separated the various checks, whereas, on the first field the checks were clean at the beginning of the season, having no rice plants occurring there. During the latter part of the season these checks had some of the highest water grass that I have seen. It was actually over my head.

Within the field that was mechanically planted or seeded there were two checks that were of primary interest. The first check was apparently too close to the source of the main ingress of water. Along the border or along the dykes of that particular check there was quite a clear area where no rice plants could be found; whereas, in the second check rice plants came directly up to the check banks themselves. As I have mentioned, the second field was sown by air, and consequently, the rice plants were growing directly from check to check and across the checks as well.

For the purpose of dipping each of these fields, each of the three checks was divided into two sections. One hundred dips were made along the levee of the check; dips were made from along the levee out to a distance of six feet. The other section was dipped by going directly across the rice check itself from one check or from one dyke to the other. The distance between the two banks averaged about 25 feet. An average of 50 dips was made on this cross-water check. Larvae of mosquitoes were comparatively uncommon throughout the whole year. The larvae that were picked up were found, for the most part, in the first field along the dykes. In the second field (the one that was sown by air), the larvae were found primarily in the center of the check with very few mosquitoes occurring close to the dykes. I have not been able to explain this.

Mosquito fish, which we are quite interested in—we rather thought that maybe a great deal of credit had been given to them that they don't deserve—were rather uncommon in the center of any of the fields. They were found primarily in the cleared areas and in the boxes where the water was dumped from one rice check to the other. They seemed to be aggregated where there was a slight but noticable current.

Other possible predators were the adults and larvae of dytiscid and hydrophilid beetles. The dytiscid beetles would go after the mosquito larvae and pupae rather voraciously. We took some of them to the lab in containers of water and dropped in mosquito pupae; the pupae no sooner hit the water than they were in the jaws of the dytiscid beetles. The hydrophilids apparently were of little importance, being primarily scavengers.

There were a few *Anopheles* showing up in the latter part of the season as the algae growth accumulated. The *Anopheles* larvae were found primarily in the algal mats around the edges of the rice checks or around the edges of the open water. In those same checks the beetle larvae were to be found quite commonly and were, therefore, apparently ineffective in eliminating the *Anopheles*. It was very seldom, as Gordon has mentioned, that mosquito larvae were able to mature to the pupal stage. There was very little adult production apparent from those checks that I actually looked into. We had a large adult mosquito population in the Jerry Slough area; I would say off-hand that those adults did not emerge from a rice field or at least not from those rice checks that I was actually looking into.

Besides the mosquito fish and the beetle larvae, there was quite a considerable number of dragon fly and damselfly naiads. As Gordon said, we came into pretty good contact with some of these rather short-lived, or short-cycled, damselfly and dragon fly nymphs. In fact, it was about eight weeks from the time that the rice fields were flooded until the time that the naiads were crawling up on the plants, leaving the water, and emerging as adults. For some reason or other, the majority of the large dragonfly naiads were found in the mud and in the silt at the bottom of the rice fields. It was very seldom that they came to the water surface. For this reason I feel, at this time, that they did not play an important role in the control of mosquito larvae. I may very definitely modify this thought next year with further observations.

Bill Bollerud has mentioned the tadpoles. There was a fair number of tadpoles to be found in the rice fields; also there was a fair number of very young adult toads that were to be found all over the rice growing area. They may not have gone too much for the immature stages of the mosquitoes, though they played a rather important part in the control of small flying gnats that were in that particular area. All I can say is that right now I have got a base line from which to do future work and in that same general area I certainly would like to have the opportunity next year or this year to carry it on and get some more observations. There were too few mosquito larvae and there were too few potential predators this year. I don't know how to explain it. As Gordon has said before, "This was just not the year." I cannot say that predators played a definite part in the control of mosquito larvae—there were just insufficient numbers.

Thank you.

(Applause.)

Mr. Gordon Smith: You can see we don't necessarily agree with anything you hear. Before we go on here, Archie, was there something you had to say?

Dr. A. D. Hess: We have been in contact with most of you about the Good Neighbor Club of the American Mosquito Control Association. Those of you who don't know, this Good Neighbor Club of AMCA is a club organized to help take Mosquito News to foreign workers, mosquito control workers, who are unable or find it very difficult to obtain it.

Now, that seems sort of funny in our country where $5 is not too hard to come by even for us Mosquito Control people, but in many of those countries, individuals, say a doctor, has a full salary of maybe less than a thousand dollars a year and it is not worth any more than it would be here. Five dollars to some of them is like $150 would be to us, and they get practically no literature at all. So this little Mosquito News, with advertisements even, they eat those up; and the equipment, that little literature abstract, is a wonderful help. I have seen a lot of the people who get it and know how important it is to them. So the American Mosquito Control Association has worked to try and adopt Good Neighbors. We have individuals and commercial concerns in Mosquito Abatement Districts. We have a number of adoptions by Mosquito Abatement Districts.

Now, we will be turning in a final report on it this year at Beaumont. We have had very good response. I am unhappy to say, however, that California's response hasn't been as good for some areas even though it is the leader of all the States in Mosquito Control. So I just want to make a little appeal, that any individuals who might want to adopt a Good Neighbor, or if you know a commercial concern, most of it is direct personal contacts, and if you know an individual with a commercial concern it is darned good advertising for $5, and they can adopt a Mosquito Control worker. There is a big market in most of these foreign countries, even greater than in our own country, and so, where I have known individuals in a commercial concern they respond very favorably to it, and one outfit, Hudson Spray Chemical, adopted eleven Good Neighbors.

Now, we have been pretty fortunate. We have got about three times what we had last year and it is going to be a big help to the Association. Mosquito News now is going to Good Neighbors in thirty-two foreign countries, so I would like very much, if any of you have been sort of waiting and haven't taken final action, say, in your Mosquito Abatement District, or if any of you individuals know some one who would like to pay for a subscription or to let us adopt one for you, I would like very much if we could have that within the next couple of weeks so it will go in on our report at Beaumont the first part of February.

Mr. George A. Meyer: I was wondering, do you have a list of names to whom these subscriptions can be sent?

Dr. A. D. Hess: Yes, we have a list of what we call Good Neighbor Candidates selected by Mosquito people of the countries who know the needs of the individuals and we can give you these. Some Mosquito Abatement Districts have said, "Well, send me names of five candidates and we will pick three or four out of that." To one of the Illinois Mosquito Abatement Districts, I sent five names and they adopted three of the five; so we can send you names if you want them, but I can't send the same names everywhere because we will get two adoptions for the same person. So if you want half a dozen or a dozen, I have at least a hundred candidates on file now, deserving Mosquito Control workers, that I can give you the names of. In fact, I have some here. I might give them to Ted Raley before I leave. I have got to leave right after this meeting, but I could get some names tomorrow that could be used. You can contact Ted then to get some names right away.

How about that, Ted? If I leave you a group of candidate names in case any one wants to get a name in short order he could get it through you?

Mr. T. G. Raley: Yes, and on the other side, Archie, if any worker would care to select his own we would be very happy to have him do that.

Dr. A. D. Hess: We have had cases where a person has known a worker personally, maybe they visited here or visited them, and they would like to adopt a particular individual, and, of course, that is fine. We will appreciate any support we can get on the Good Neighbor Club.

We are very happy with the response. I would like to see a little more from California.

Mr. Harold Gray: Stand up by the door, Archie, and when they go out at the conclusion, separate them from five bucks.

Mr. Gordon Smith: Ed Washburn has been letting Nature take its course on some of his rice fields, so let us see what he has to say.

Secretary Washburn: Mr. Chairman, in the essence of time, I am only going to say that our experience has been one season only with the use of *Gambusia* in the control of mosquitoes or the lessening of mosquito problems in the rice fields. It has been very satisfactory in our own particular instance, and that is as much as I will say at this time. I will turn the paper in later and now turn the meeting back to our Chairman.

OBSERVATIONS ON THE USE OF *GAMBUSIA* FOR MOSQUITO CONTROL IN RICE FIELDS IN TURLOCK M.A.D.—1955

G. Edwin Washburn, *Manager*

For the past several years personnel of this District have been seeking other methods than chemical treatment, to control or greatly lessen mosquito breeding occurring in rice fields found in the District. While chemical control has usually given satisfactory results, the cost is rather high and as each rice growing season advances, the chances of obtaining good chemical control lessens with the growth of the rice plants themselves. Quite naturally we have turned to the use of fish, mainly *Gambusia affinis,* as a possible means of obtaining the desired results.

Rice growing within the TMAD is not extensive. Plantings range each year from 1,000-2,000 acres; all located within easy flight range to heavily populated areas. This part, in 1952, created a very real problem and presents a potential infestation of these cities each year. Thus, it can be seen, the mosquitoes developing in the rice field areas were a very real problem and one we could not ignore.

After learning from other districts in California of their apparent success in the use of these fish we decided to give it a try in 1955. Accordingly early in April we surveyed the situation and found an abundant supply of *Gambusia affinis* occurring in a cut-off slough adjacent to the San Joaquin River.

Since the rice fields were being flooded preparatory to seeding by air, we proceeded to plant these rice fields with fish. A total of seven (7) fields, or about 1,000 acres were heavily planted with fish. Unfortunately, now, no estimate was made as to the number of fish planted per acre; we only know that large numbers were introduced. One field was not planted to fish as it was seeded to rice about two weeks later than the rest. These planting of fish were made during the period of April 10 to April 20.

Since several of the rice fields had been flooded for at least two weeks the population of *Culex tarsalis* larvae was high, in many instances averaging fifty (50) per dip. This same situation was present in some 25 sloughs and permanent fresh water ponds within the District. One week after planting all of these areas failed to produce more than 2-4 *Culex tarsalis* larvae per dip. No other method of treatment had been employed during the period or for the entire season. Repeated larval surveys were made throughout the summer of the fish planted rice fields and ponds. Only rarely were we able to find any mosquito larvae and then only one or two per dip. Populations of predator insects in the rice fields remained high all summer.

As the season advanced into August, dipping began to reveal a gradual build-up of the larval population of

Anopheles freeborni. This continued until the fields were drained in preparation for harvesting operations.

In contrast, the one field that was not planted to fish maintained a high larval count of *Culex tarsalis* all season; often with counts of 50-60 larvae per dip. In this field, dipping always produced pupae of this species which were never found in hundreds of dippings in the fish planted fields and ponds.

Although we realize other conditions than the fish present may have contributed to the lack of mosquito larvae in the treated fields it appears that they played a very dominant role in controlling the mosquito populations. As the season advanced fish were observed to be very abundant. In fact one could always pick up several fish in routine dipping from the levees. From the observations we made the use of mosquito fish as a mosquito control measure in the rice fields and permanent fresh water ponds was good enough for us to plan another year's trial of this method. During the 1956 season an attempt will be made to more accurately record and observe the use of these fish in this district. At least two factors appear most important in assuring success of this method: first, the fish must be planted in the rice fields as early as possible to allow time for several generations of fish to develop; secondly, from literature it appears that not less than 150 fish per acre must be planted to assure a fair degree of success.

LITERATURE CITED

Herms, W. B. Gray, H. F. "Mosquito Control" 1944.

Gerhardt, R. W., "Preliminary Observations and Literature Survey of Gambusia for Use in Rice Field Mosquito Control" Mimeograph Sheet; Calif. State Dept. Health, BVC, 94-55; 1955.

(Applause.)

Mr. Gordon Smith: I know that Mort wants to make it short.

Mr. Earl W. Mortenson: Well, the information I have to present here is perhaps more on the negative side than any of the other talks that have been presented.

MOSQUITO PREDATOR ACTIVITY IN THE DUCK CLUB AREAS OF MERCED COUNTY[1]

Earl W. Mortenson[2]

A study was made in the duck club areas of Merced County in 1955, beginning with the first fall flooding on September 15. The purpose of this study was to evaluate the extent of mosquito production and the ecological factors that influence mosquito populations in such an environment. One of these factors was the relationship of predators to mosquito larvae. This discussion will be limited to a brief account of this single consideration.

There are several fundamental points bearing on the effectiveness of predators that should be acknowledged before discussing our observations in the duck club areas. Hinman (1934) lists over a hundred references pertaining to animals that prey on mosquito larvae. Most of these reports have merely recorded the groups or species of organisms that were observed preying upon mosquitoes. Unfortunately, there is a conspicuous lack of information on the quantitative aspects of mosquito-predator relationships. The level that a predator population must attain before it exerts a measurable influence on mosquitoes has seldom been determined. In order to make such information meaningful, the environmental conditions that influence or limit predator populations must be understood. These environmental considerations should include temperature, food supply, shelter, and the complete range of biotic interrelationships.

Perhaps the most important single factor is temperature. With optimum temperature conditions most predators will multiply rapidly. The temperature factor becomes even more significant if the range needed for maximum development of the predator population approximates the requirements of the prey population. This principle was observed in operation in the duck club study when prevailing fall temperatures resulted in a faster rate of development for the mosquito larvae than for the predator populations of damsel-fly naiads and mosquito fish.

Another important environmental factor is the available food supply. Generally speaking, an abundant food supply will result in dense predator populations. The predator's natural food habits are also important. To illustrate this point, Smith (1904) observed that dragonfly naiads feed very well on mosquitoes when larvae are introduced into a laboratory aquarium; however, when observed in the field the naiads showed a preference for certain bottom living organisms.

Shelter is another environmental factor that must be considered in determining the effectiveness of a predator as a possible control factor. The predator must spend a substantial part of its time in the same micro-environment as its prey if it is to exert a controlling influence on the prey population. This is well illustrated by the problems that have faced the biological control workers in agriculture. Many of the potentially effective predators that have been introduced to prey upon agricultural pests have failed because under natural conditions the predator may spend only a small part of its life in the micro-environment of the insect to be controlled. On numerous occasions it has been observed that mosquito larvae will develop successfully in water covered with dense protective vegetation when a large population of mosquito fish are present only a few inches away.

The counter influence of other animals on predators may affect their efficiency in reducing mosquito populations. An example of this is the parasitism of mosquito fish by a parasitic copepod of the family Lernaeidae. This parasite penetrates the abdominal cavity of the mosquito fish, and if the infestation is heavy it will interfere with the fish's normal behavior, eventually causing death.

The evaluation of mosquito larvae predators in the duck club areas in Merced County showed that a correlation existed between the presence of mosquito fish and a decrease in the number of larvae in three of seven study plots. This occurred where a heavy population of fish and the *Culex tarsalis* larvae were found in relatively open water. Several species of *Notonecta* were present at one station averaging one specimen per dip; however, there was no reduction in *C. tarsalis* larvae. Nine of the stations showed a presence of damsel-fly naiads at .5 per dip, but there was no correlation between their presence and a reduction in mosquito larvae. Two stations revealed no

[1]The cooperation of the Merced County Mosquito Abatement District is gratefully acknowleged.

[2]Associate Vector Control Specialist, California State Department of Public Health, Bureau of Vector Control.

predator population and yet the *C. tarsalis* population steadily declined. This is perhaps indicative of one of the most characteristic features of natural animal populations —their tendency to fluctuate. Such fluctuations can occur in the absence of predators as well as when they are present.

Mosquito larvae predators can be effective when they are able to live and multiply in the same environment as the prey, and when food and shelter requirements, or preferences, are compatible and in favorable balance in a given habitat. In order to better understand the role that predators play in mosquito control more refined and reliable techniques must be developed to measure the changes that occur in predator populations. Before this can be accomplished it will be necessary to gain an appreciation of the total ecology of each predator under consideration that is comparable to the knowledge of the mosquito species to be controlled.

LITERATURE CITED

Hinman, E. H., 1934. Predators of the Culicidae, I: The Predators of the Larvae and Pupae, Exclusive of Fish. J. Trop. Med. Hyg., 37: 129-134.

Smith, I. B., 1904. Report of the New Jersey State Agricultural Experiment Station of Mosquitoes Occurring Within the State, Their Habits, Life History, Etc., Trenton, N. J. MacCrellish and Quigley.

Mr. Gordon Smith: We have some ideas of what to do now.

Now, Dick Gerhardt has been doing some control tests with mosquito fish in rice fields. So, Dick, will you come up and do it, and try to make it short and sweet? We are half an hour behind now.

Mr. Richard W. Gerhardt: Well, first of all, it won't be necessary to transcribe this.

NOTES ON THE VALUE OF *GAMBUSIA* TOP MINNOWS AS A MOSQUITO CONTROL MEASURE FOR CALIFORNIA RICE FIELDS

R. W. Gerhardt[1] and A. G. Gentile[2]

Considerable interest has been shown by mosquito control workers in California, who have rice field problems, in the use of *Gambusia* as an aid in reducing rice field mosquitoes.

While the amount of work that has been done with these fish in the past is great, little attention has been given to their effectiveness in rice fields. Horsfall (1942) completed the most recent and perhaps the most extensive investigation with *Gambusia* in rice fields. His paper indicates that *Gambusia* may be an aid in rice field mosquito control but they cannot be expected to completely free rice fields of mosquito larvae and pupae.

Geiger and Purdy (1919) conducted studies on the efficiency of *Gambusia* in rice fields. They reported reductions of larval abundance ranging from 35 to 70%. They further note that the fish tend to congregate along levee banks where the water is deeper and not shaded by rice plants.

These two papers and many others are listed in the excellent bibliography on *Gambusia* by Gerberich (1946).

[1]Assistant Vector Control Specialist, State of California, Department of Public Health, Bureau of Vector Control.

[2]California Mosquito Control Association, Inc.

A study of somewhat limited scope designed to evaluate *Gambusia* efficiency in rice fields was conducted by the authors during the rice growing season of 1955.

Methods

A suitable rice field was chosen near Davis, California. The field was characterized by a clay-adobe soil. Irrigation water was from wells. The vegetation of the experimental field for the duration of the study was mostly rice, water grass, green and small amounts of blue-green algae. Water on the fields was mostly turbid and very slow flowing.

Two cages consisting of screened wooden frames, open on top and bottom, were used as a means of confining the fish within a known area of the plot. The cages delimited an 8.73 sq. ft. area, roughly one square yard. The bottom frames of the cages were firmly fixed in the mud of the rice check to insure stability and prevent the fish from escaping. Two wooden bridges provided access to the cages.

One of the cages, identified as cage #1, delimited an area with slow flowing water, and for the entire duration of the study, by almost complete absence of vegetation. This cage was stocked with one mature *Gambusia.*

The other cage, identified as cage #2, delimited an area characterized by slow flowing water and abundant rice and water grass which, with green algae mat formations, covered most of the water surface. This second cage was stocked with two adult female *Gambusia.*

The immersed screen of the cages was brushed frequently in order to remove algae formations and prevent stagnation.

The commonly used dipping method was utilized in ascertaining the relative mosquito population within the study cages and the rate of mosquito breeding in the unstocked plot or rice check. A record of biweekly larval dippings was kept and is reported on a graph following the text. The larvae dipped from the cages were counted according to instars and replaced in loco by means of a dropping pipette. An average of five dips per survey were taken from each cage and ten random dips were taken from the unstocked rice check which constituted a comparative control.

Results

The attached records show initially a gradual constant decrease in the number of mosquito larvae in the vegetation free water of cage #1 containing one adult *Gambusia.* The mosquito larvae dipped from the cage during the initial period were mostly 1st and 2nd instars. After the appearance of the fish offspring a complete absence of mosquito larvae was noted for the remainder of the study period.

The dipping records of the surrounding unstocked plot indicated a normal mosquito population.

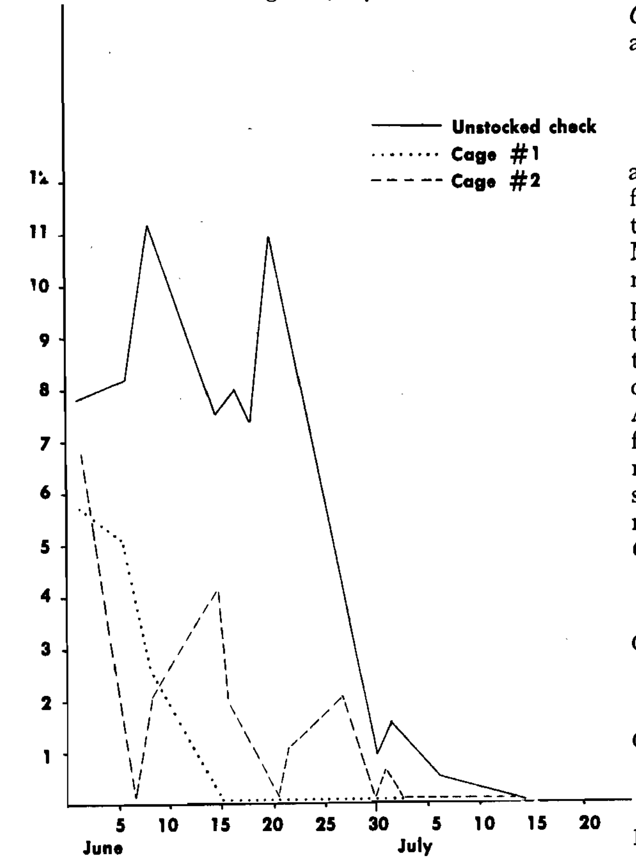
On June 22 the water of the cage #1 was treated with Rotenone and the fish population appeared to consist of:

1	mature female
1	immature adult
76	very small minnows
78	Total

The cage was then restocked with one fish.

The records and graph for cage #2 stocked with two minnows show an initial sharp decrease in number of

Larval occurrence in Cages and Rice Check
Showing No./dip



mosquito larvae ending with a complete absence of larvae. During this first period the vegetation in the cage was very limited. For the remainder of the study the area of the cage was characterized by abundant vegetation and presence of the offspring of the fish. During the middle period of the study several newly hatched mosquito larvae were dipped from the area of the cage. Following surveys showed only a very limited number of 4th instars and pupae confined to algae mats, hence out of reach of the fish.

The mosquito population in the surrounding unstocked area was the highest in the entire experimental plot.

On June 22 the area of the cage #2 was poisoned with Rotenone and the fish population appeared to be formed of:

2 adults
32 immature adults
24 very small minnows
—
58 Total

The cage was restocked with two fish.

Numerous observations during the study period seem to confirm the positive phototropism of *Gambusia* as stated by other researchers. Surveys at different times of the day showed that the minnows congregated in the lighter parts of the cages and where the water was clearer.

Aquarium observations showed a more accentuated predacious activity of the minnows on mosquito larvae in lighted conditions. Young minnows proved to be visibly more active than the mature adult minnows. Pupae, 4th and 3rd instars were highly preferred by the minnows. *Chironomidae, Cladocera,* and *Copepoda* appeared to be a good source of food for the minnows.

Discussion and Conclusion

The authors believe that *Gambusia* minnows can be an aid to the control of mosquitoes in California rice fields. That they are able to accomplish a reduction in the numbers of mosquitoes in these habitats seems obvious. No definite figure can be given in terms of the percent reduction which might be possible. From the evidence presented in this report and by previous workers it seems that *Gambusia* will tend to seek out clear water areas in the rice fields. Undoubtedly, the reduction of the numbers of mosquito larvae from these locations would be positive. After the rice plants are emerged it is doubtful if these fish will penetrate into the mid-field area in search of mosquito larvae. In view of this likelihood, inspectors should be cautioned not to regard an absence of larvae near the check banks as being typical of the entire field if *Gambusia* are active in it.

SELECTED REFERENCES

Geiger, J. C., and W. C. Purdy, 1919. Experimental mosquito control in rice fields. Jour. Am. Med. Assoc. *72*:774-779.

Gerberich, J. B., 1946. An annotated bibliography of papers relating to the control of mosquitoes by the use of fish. Am. Mid. Nat. *36*(1):87-131.

Horsfall, W. R., 1942. Biology and control of mosquitoes in the rice area. Univ. of Ark. Coll. of Ag. Expt. Sta. Bull. #427, Fayetteville, Ark.

Mr. Gordon Smith: Well, I haven't much more to contribute. We have had, I hope, some information, possibly some misinformation, and a few ideas. It seems to me that we may be missing the boat here. Maybe it will seem to some of you that we are doing the same. I do hope that we can give it some thought and maybe some of the rest of you try a little experimenting or messing around, or whatever you want to call it, and try to find out if there is anything, because the way insecticides are going now, we want every boat we can lay our hands on.

President Murray: Thank you, Gordie, very much for your information from this panel, and I think we were very fortunate in having William Bollerud Gobel as one of your members.

Mr. Harold Gray: Mr. President, could I make one suggestion? Perhaps we would elicit a great deal more information and all if we rephrase the question, "What don't we Know about Naturalistic Control of Mosquitoes?"

President Murray: Are there any announcements?

(No response)

President Murray: We are late. We will stand adjourned.

(Whereupon, at the hour of 5:15 p.m. the Conference adjourned until Wednesday, January 18, 1956, at 9:00 o'clock a.m.

WEDNESDAY, JANUARY 18, 1956 — 9:15 A.M.

President Murray: Well, let's proceed with the final session.

There is one announcement I would like to make. Mr. Milton Buehler, from Eugene, Oregon, just left a pile of Lake County Mosquito Control Program, Third Annual Report, booklets. It is a very nicely printed publication and so long as they last, one to a District, you may take it home with you.

He also requested that if you have a monthly report or an annual report that you send out, that he would appreciate receiving a copy.

I had a similar request from Oscar Lopp, at the South Cook County Mosquito Abatement District, Illinois. These other districts appreciate receiving monthly reports or annual reports. It ties us all together so you districts keep that in mind.

We will proceed with the Weed Control Symposium, Howard R. Greenfield, Moderator, who is also the vice-president and the person who will take over today.

Mr. Howard R. Greenfield: Thank you, Don. Right at the moment I am really at a loss. Mr. Harvey was—I hope he will show up soon—to be the backbone of our panel this morning. I just hope that Mr. Harvey will show up because he had a full thirty minutes here to talk, and I know he is a well-known weed specialist and had a lot of information that he could give us.

As Don said, we will get on with the panel because time today is very important.

I might introduce this Weed Control Symposium today by saying that essentially it is an outgrowth, I believe, of our Source Reduction Programs that many of the Districts are embarking upon. Source Reduction was the first step.

Now, it is a logical outgrowth of such programs in that after you have done, for instance, some drainage work, you must use follow-up methods in the form of weed control; otherwise the Source Reduction program quickly falls by the wayside.

WEED CONTROL SYMPOSIUM

Mr. Greenfield: Then may I introduce Mr. Harvey, who is the Extension Weed Specialist from the University of California at Davis.

Mr. Harvey!

(Applause)

Mr. William Harvey: In the field of weed control there are three types of problems that you folks have that maybe we can give you some help on. At least we have some information on three specific sorts of problems that apply to you folks in the mosquito control business. I will list and describe them and then we will talk about control measures for the three problems that I think bother you folks, judging from the inquiries that come in to us at Davis.

First are the submerged aquatics, the weeds that grow beneath the water. They interfere with water flow, damming up the streams into pools and holdings where you have trouble. There are a whole array of these submerged weeds, pondweeds, elodea, parrots feather—you can name them as well as I can.

The second type of weed problem that you folks have is that of emergent aquatics that grow in the water and stick out and interfere with the flow and again do a lot of damming up. The worst in this group are the cattails and the tules, although there are lots of other sedges and aquatic types of vegetation that do cause you trouble.

The third group would be the various types of ditch bank vegetation that interfere in several ways. There are some grasses, such as Johnson grass, that often interfere with water flow along the edges of streams and may interfere with your access to the streams to get at the mosquitoes.

Along with Johnson grass is a weed that we call knot grass or ditch grass. It grows with a long runner sort of thing that can stretch out into the stream. I have seen them 20 feet or more in length, rooted on the side, but with these long stems dragging out into the stream. Also, in this group of ditch bank vegetation I think we should include woody plants, because we get a number of calls on what to do with willows and cottonwoods that interfere with access to the streams or the banks and that interfere with the job you are trying to do.

Let's look at controls for these problems and we will go back first to submerged aquatics, the weeds that are growing underneath the water. There are several control methods that I think you probably know and that certainly your irrigation districts are familiar with.

One method common in years past has been a large tractor on either side of the ditch dragging a large chain or cable, sometimes with plates fastened on it, to try to tear out these aquatics from the bottom of the stream so that you can get satisfactory water flow.

Some of the irrigation districts have big drums with cleats welded on them and some of them actually use gang disks that they haul under the water.

All of these methods roil up to water a lot and are only partially successful. You have to keep doing it time after time and you get in trouble with structures. You have to pull the chain or the disk or whatever you are using out of the stream to get around structures and it causes quite a bit of trouble. Yet many of the districts do use mechanical methods.

The chemical methods, I think, would perhaps be of more interest to you. And there are two chemical methods for submerged aquatics that seem to be quite useful. For ponds or reservoirs or lakes or bodies of still water I think probably the cheapest method of control of the submerged aquatics is with sodium arsenite. This chemical has been used for a long, long time for control of weeds under the surface of the water, and it has several advantages: it is not difficult to apply, and it is cheap. Probably the greatest disadvantage is the fact that the sodium arsenite itself, the concentrate, is quite toxic. But at the concentration we are using it in the water we can save the fish, which is a big advantage in your work.

With sodium arsenite we generally use four to six parts per million in still water, although we may go as high as ten parts, as only a portion of a pond or reservoir is treated at one time.

Now, in terms of amount of arsenite, four parts per million takes a gallon of a four-pound material per 16,000 cubic feet of water. If you are going to treat with arsenite, you do need to make some estimate of the volume of water you are treating in order to get pretty close to the parts per million you are shooting at. It is cheap because arsenite is not an expensive material and in these low concentrations only small quantities of chemical are needed.

As I have mentioned also, at these concentrations the sodium arsenite does not kill fish, and after about three days you can normally use the same body of water for swimming or for irrigation or whatever you want. I wouldn't use it immediately, although there probably is no trouble with these low concentrations even immediately after application.

The easiest method of application would be a power sprayer of some sort in a boat and zigzag back and forth across the area to be treated. I would suggest going over it twice if you possibly can in order to be sure of getting the concentration equalized over the body of water.

The other method of chemical control for the submerged aquatics in the running streams and ditches is the use of aromatic solvents. We have used various materials over a period of time. The first in its field was a material called Benoclor, a trichlor benzene. More recently we have had some lighter oil-like naphthas. The Bureau of Reclamation has done a great deal of work on these aromatic solvents for irrigation districts.

An average rate of application here would be six gallons of one of these aromatic solvents per second foot of flow. If you have a big ditch it is desirable to cut down the flow of water during the period of treatment so you can reduce the amount of chemical used and also so you can concentrate the aquatic weeds in the smaller volume of water. Sometimes you do get a channeling if you have too much water and the solvent tends to go where the water is going and not get back in the heavy beds of aquatic weeds where the waterflow is very slow.

Use a minimum of six gallons per second foot of flow and apply it over a period of 20 to 30 minutes, spraying it beneath the water's surface with a power rig in order to get an emulsion. If you do it right, you come out with a nice milky substance flowing down the stream from the point of application.

Again, it is possible to put it in at a structure where you are getting some roiling or turbulence to help mix it. Then the usual thing to do is to put in about half that dosage, a half-mile further down the ditch. We think of it in terms of a blanket of chemical moving down, about a 20 to 30-minute blanket, if we can call it a blanket in terms of time, and as it goes down and the weeds take out the chemical the water gets a blue look and the emulsion begins to fade. So usually, about a half-mile down, you stick in about a half dose to reinforce this.

You may have to do this about a half-mile down the ditch, but after you have had experience with it you can follow the blanket down and decide when you need to reinforce it a bit, and when it is beginning to gêt too thin. As I mentioned, you need a power sprayer to apply the material because you want to make a pretty good emulsion with the water in the ditches.

These aromatic solvents are rather hard on rubber. Some of the outfits that have used it have used copper tubing and copper pipe to connect the pump to the boom through which they are sprayed. It is desirable, if this is an irrigation ditch, to close the cut-outs as this blanket goes by; that is, not to run it deliberately out in the field, for two reasons: One, is that you are losing material if you are running it out on the farmer's field and you will have to reinforce it faster; Two, is you could hurt some crops with it. However, the toxicity to growing crops is rather low. There has been work on this in furrow irrigation, where you don't contact the crops with the water and used this way it doesn't harm row crops. If you do dump it out on a pasture, you can get a little leaf burn on some of the plants. However, we recommend, and so do the manufacturers, to close the cut-outs as you go down with the blanket and then dump it into the drain where you get some further dilution.

This material has the disadvantage that it does kill fish. It is quite toxic to fish and frogs and various sorts of animals. I don't think you have to worry about livestock because the water treated with this solvent smells so bad the livestock won't drink it and it is in the ditch at one particular spot for only 20 or 30 minutes so that it isn't a serious factor as far as livestock is concerned.

The second type of problem, that of emergent aquatics, such as cattails and tules, again has two answers that I think you can use.

The cheapest for the last several years for cattails and tules has been 2,4-D where you could use it. There are many areas in California where cattails and tules are growing where 2,4-D in the summertime is prohibited because of the danger to surrounding crop plants. Nevertheless, 2,4-D is probably the cheapest material we can use, where we can use it. The mixture that we have been successful with and the one that has been quite widely used is one and a half to two pounds of a low-volatile ester of 2,4-D. That would be a quart and a half to two quarts, since most of the low-volatile esters of 2,4-D are four-pound materials. So we would use a quart and a half to two quarts of a low-volatile ester of 2,4-D, plus one gallon of Diesel oil per hundred gallons of water. With this mixture we would spray to wet the cattails and tules rather thoroughly and at the time they had considerable growth but before the heads are showing. You don't want to wait until too late in the summer, until they get old and tough. On the other hand, you don't want to spray them so early in the spring that there is not enough leaf surface to get spray absorption and movement down in the roots.

We have had good luck with this mixture. Usually you do not get eradication with one application of it, but you should get a fairly high percentage kill with the first spray. Sometimes you can make a follow-up spray the same season. More often we hit it next spring to follow up on any we missed or didn't get a good job on the previous year.

Again, you need a power sprayer. You can probably use your insecticide sprayers. There is a problem in getting adequate wetting, and we have used as much as four or five hundred gallons per acre in the heavy stands. Don't be frugal with the total volume if you really want to get a kill with this method.

As I mentioned, you do have a hazard with surrounding crops. You need to spray when there is a minimum of wind and you need to keep the droplets large so they do not drift. You don't want to fog it on. And if you can get on both sides of the ditch and spray from both sides, you will probably get a better kill than if you try to do it all from one side of the ditch.

Another material that is looking promising—and we don't have a great deal of information on it yet, but it is one I think you folks will be interested in—is Amino Triazole. It is a new chemical we have worked with for the last two years and it has some rather specific uses. I will mention another one later, but it looks very good on cattails and tules. The drift hazard is nowhere near as great as it is with 2,4-D, although with any of these weed killers you have to be careful to keep them off crops because they are vegetation killers, and if you get them directly on crops you will get damage.

The mixture we are using now—and I am not sure this is the best because we haven't had as much experience as we have with the other—but the mixture is two pounds actual Amino Triazole per hundred gallons of water.

One of the products that was offered for sale on a limited basis this year is a 50 per cent powder that is water-soluble. We have added wetting agents to it in most of our work and I am not sure how necessary that is. I think if you are doing some spraying on your own, it would be well to see what sort of wetting you are getting. If the droplets are balling up and not flattening out, I would add some wetting agent to it because it is not going to give a good kill if it is not wetting.

Again, I would use a power sprayer with this material in order to get good coverage of the cattails and tules, and again I would spray to wet. There is some indication we could use somewhat smaller volumes with the Amino Triazole than we can with the 2,4-D. Last year was the first year any extensive tests were made and we have a lot more to do to find out what is the cheapest way to do it. It looks to us like Amino Triazole has a very definite place in much of our Sacramento-San Joaquin Valley area where 2,4-D causes too much trouble.

One more caution in spraying cattails in very deep water you are apt to get poor effect, so if you can cut down the water depth so there is no more than six inches or a foot of water, you will do better than with three or four feet of water. Apparently it is a problem of translocation of the chemical. If you are only wetting the top two or three feet of the leaves and there are two or three feet of leaves below the water to translocate through before the chemical gets to the roots, apparently the chemical gets lost somewhere in getting down there and it does not get in the roots in sufficient quantities to kill them. So wherever possible, I would reduce the water level.

We also have had poor results on the edges of streams where the cattails were up on the dry part of the bank and I think this has been more true with 2,4-D than with the Amino Triazole. Sometimes we get a fringe on each side which was just out of the water at the time we sprayed, so we would like some water over the roots but not too deep.

Now, for ditch-bank vegetation there are various things we can do. For grasses and normal weed growth along the ditch bank the commonest thing that we have used in the past has been a mixture of dinitro and diesel oil, or one of the specific weed oils. Most of the oil companies put out an oil that is high in toxicity. It works very nicely on something like Johnson grass used straight. If you are after a mixture of grasses and broad leaves, you can make an emulsion of it in water with 40 or 50 gallons of oil and 60 or 70 of water, and do a wetting job. We use a mixture like that quite commonly.

The dinitro material is a help in getting a kill of some of the broad leaf plants that are somewhat oil resistant. It is also a help in making an emulsion of the oil and water.

Now, within the last few years we have been testing a new material that was on the market this past year and probably will be more readily available this year as a grass killer, called Dalapon. It looks very good to us. I think it is going to take over part of the work that we have done with oil.

Dalapon at about 20 pounds per acre can be used in 150 gallons of water if the grasses are tall. Again, we have to do a wetting job if we are going to kill these plants. Here again I would add a wetting agent. I think in most cases you will want to check the effect of the spray when you start out and see if it is doing a good job of wetting. If it is not, and the Johnson or Bermuda is tough or are getting mature, I am sure you will have to add some wetting agent.

To get best results with Dalapon, the grasses should be making good lush growth. I would say Johnson grass ought to be somewhere from 12 to 18 inches tall and the knot grass, or ditch grass, probably with 12 to 18 inches of new growth. Old beat-up growth following disking or following burning or if it is dried out a bit has not responded as well to Dalapon. Actually Dalapon is a translocated spray. It enters the leaves, goes down to the roots, and we need healthy leaves to pick it up and absorb enough of it to do a job. Now, Dalapon is not a miracle chemical at all. You will not get eradication of Johnson or Bermuda with one shot of Dalapon. We have had good control and a high percentage of kill with two applications in a season.

I think you will find the Dalapon is probably cheaper than our oil sprays and it certainly does more, as far as killing out roots and rhizome. If you have a ditch area with Bermuda grass on the banks and want to retain part of the Bermuda for ditch bank stabilization, I think you can use Dalapon at this rate or a somewhat lower rate and just keep beating it back so it doesn't seed and cause too much trouble but is not completely killed out.

I think Dalapon is going to have a big place in our ditch bank and roadside work because it is quite convenient to handle, quite readily water-soluble, and at these rates, you can stick a drum or two on the truck and work all day; whereas with oil. you have to come back to get the oil. Some workers don't like to handle the weed oils because they will blister if you don't get them off soon. Dalapon is nicer to handle. It is going to be cheaper. It definitely gives some rhizome kill, which oil did not.

The woody vegetation could be a whole talk in itself. We have one person in Davis who is working full time on brush and woody vegetation control. However, we still do not have all the answers. There are three types of treatments on woody plants and I think it might be well to distinguish between these.

One is a foliage spray where we wait until the plants are all leafed out, trying to wet the leaves thoroughly. Usually here we will use a water base spray since we don't want to burn them; we just want to get the chemical in and kill them.

The second is a basal spray that can be applied in winter time, although it can be used any time. In this method we try to get the chemical into the bark and the very base of the woody plant stems. Here we put the chemical in diesel oil because the water doesn't penetrate bark very well.

The next is a cut-surface method which would be used on trees from three or four inches in diameter on up. Make a frill around the base of the tree and put the chemical in the frill. Actually this is the surest of the three methods. We can almost guarantee a kill if you do it this way.

Now, to go back over these: For a foliage spray we would use either 2,4-D, 2,4,5-T, or a combination of the two. If you had nothing but willows, we would use 2,4,5-T, or the brush killer, because the 2,4,5-T is much better than 2,4-D on blackberries. So the one to use depends somewhat on the vegetation.

If you are not always sure, you can compromise and use the brush killer, which is a combination of both. That is actually what is usually done.

For willows the spray will be about four pounds of a low-volatile ester of 2,4-D per hundred gallons of water, with maybe a gallon of diesel oil. You will note this is another place in which we add a little diesel oil to our spray in order to get somewhat better wetting and in order to cut through the waxy cuticle on plants. We don't want enough diesel to burn because we interfere with the movement of the chemical. We want just enough to increase the wetting and to penetrate outside of the leaves. You can use a light summer spray oil just as well, if you happen to have it available. The best time to spray is after the leaves are full size in the spring or early summer.

Now, in spite of what we have been led to believe over a period of years, willows are tough to kill. If you want to completely eradicate them, you have to spray several times. We sprayed willows and we did a good job but found one branch here or one portion of a branch there that would survive. I think some of you have seen willows along rice checks that have been sprayed for several years and that are beat back but are still surviving. In the early days we thought they were real easy because they did respond to 2,4-D.

With blackberries I would use about three pounds or three quarts of a low volatile ester of 2,4,5-T, or of brush killer, plus a gallon of diesel oil per 100 gallons of water. The brush killer, being a mixture, is a little cheaper than the "T", a little more expensive than the "D", which just reflects the price of the "D" and the "T". We have had best results in the spring when the new cane growth on the blackberry was three feet long and it was growing vigorously. And again, blackberries are tough. You aren't going to get complete eradication with one spray. It will be necessary to respray any regrowth if you want eradication. These are foliage sprays where we are using large volumes of water to get good coverage of all the leaf surface. The basal spray is a different thing entirely. We would use about four gallons of brush killer per hundred gallons of diesel oil, a much more concentrated mixture. This is about 16 pounds of chemical per hundred gallons of diesel, but we are only spraying the lower 18 inches of the plants. We are not trying to get it on the leaves at all, just around the basal 18 inches, with enough volume to get some run down or draining down the bark and around the crown a little bit.

This method will work on smooth bark trees. It is more suitable for these than on big old heavy barked trees. This doesn't work there because you can't get through the heavy, corky bark unless you first go around with an axe and cut some slashes.

The third method for use on trees is to make a frill or series of cuts around the tree as near to the base as you conveniently can. The higher up, the more apt we are to get sprouting. Make the cuts within a foot or 18 inches of the base and in these cuts put the pure, undiluted 2,4-D amine.

We use a squirt oil can to put it in, and with an axe or a hatchet, and with one squirt oil can one man can do a lot of trees in a day using a cut with the hatchet and then a squirt of the chemical. It is the cheapest method because the amine is cheaper per gallon. It doesn't require a lot of equipment. Although results are more rapid from early spring applications, we get results any time of the year.

Another woody plant that you may run into and that may cause some trouble is poison oak. We have used brush killer as a foliage spray at about three pounds of brush killer per hundred gallons of water. You will have to spray more than once because one shot one year doesn't kill it, and sometimes our regrowth next year looks like we didn't do anything at all. However, the second spray usually knocks off quite a bit of it.

The chemical I previously mentioned for cattails, Amino Triazole, looks very good for poison oak. We have had some one hundred per cent kills with it, using two pounds of Amino Triazole per hundred gallons of water and spraying to wet. The Amino Triazole is not as good on other woody vegetation.

There are a number of chemicals available as soil sterilants. The important requirements for any sterilants must be kept in mind in relation to your problem if you are to get good results from their use.

The first of these is the need to have the sterilant in the soil in the root zone of the plants you are going to kill. Now, that means that in areas of low rainfall you may have to get it on early in the fall and it may actually require some irrigation if you are going to get adequate results with sterilants, because on very low rainfall areas the rain itself may never leach the sterilant into the root zone. Secondly, the chemical must be in the root zone at the time that the plants are actually absorbing materials. We have had trouble in that respect with some of the very soluble materials in that they would reach it in the wintertime but not be there next summer when the plants start growth.

Thirdly, the chemical must be there in a sufficient concentration to do a job of killing, that is—if we get just a little of it in, we may damage the plants, knock the leaves off, turn them yellow but not completely kill them. And fourth, this concentration must stay for a long enough time so that the plants can absorb a lethal dosage.

Those are the four things we are up against with sterilants. We have to adjust both our rates and the chemicals we are using, depending on the rainfall, or the moisture situation. We also are faced with a moisture problem in sub-irrigated areas, or swampy areas, because the moisture moves up and keeps the chemical on top of the soil. Thus it is not carried down into the root zone where it can be absorbed.

There are many chemicals for soil sterilization. Rather than try to cover them all in the limited time we have here, let me suggest one of our new circulars that covers the whole subject of soil sterilization.

This is Circular 446 on "Weed Control by Soil Sterilization" put out by the University of California. You can get it from any of the farm advisory offices. You can write in to me for it if you want. It is reasonably new and pretty well up to date.

Another new one is Number 447 on "General-Contact

Weed Killers," which discusses oils and various oil mixtures for weed control. Again, that one is available from your Farm Advisor's office.

There is an older one on "Control of Aquatic and Ditch Bank Weeds." It is Circular No. 158, but is not as up to date as it might be. It covers some of the early work with the solvents and with the benochlor type materials, and has pictures of some of the aquatics. It might well be useful to you folks in your work. It needs revision and probably will be revised as soon as time permits.

Now, if you are interested in woody vegetation, there is a mimeographed circular you can get from some of the counties, or at least that you can see in some of the counties. I am not sure we have enough copies for complete distribution. This is "Chemical Brush Control Techniques of California Range Lands." Now, some of this won't apply to your problems along ditches and drains, but quite a little bit of it will. It discusses chemicals and the way to use them. Dr. Leonard wrote it and I know there are copies in all of the County offices, but whether there are enough for distribution or not, I am not sure. We have a bulletin on brush control in the mill somewhere that should be out this summer.

Just a final word as to sources of information for further problems that you may have, or some of the things that I may not have explained as clearly as you need. You can talk to the Farm Advisors in any of our County offices and they will be very glad to help you. If you want to write in to me, I will give you any help I can.

I again apologize for being late this morning.

President Murray: Question: You mentioned using weed killers like 2,4-D in a power sprayer. What is the hazard in using that for other purposes?

Mr. Harvey: The question is, what is the hazard of using a power sprayer for other purposes after you have used it for 2,4-D.

Let me approach it backhandedly. You cannot be sure you completely get the 2,4-D out of the sprayer. Now, if you were using the power sprayer for some of your insecticides in ditches, I don't think it would make any difference. If you were spraying crops afterwards with insecticides, I think it would make a difference. I would not use the same sprayer to spray crops that has had 2,4-D in it because it is extremely difficult to clean it out.

Mr. Smith: Can you kill the chemical with alkali, or by putting something in the sprayer?

Mr. Harvey: The question is, can you kill or neutralize the 2,4-D with an alkali or something in the sprayer.

Not completely. Actually what we do in cleaning is to use ammonia or something like that to try to neutralize the 2,4-D and get it all out. You can't be sure of completely doing it and there is no way to completely neutralize the 2,4-D, so you can only clean it all out and that is extremely difficult.

Mr. Marvin C. Kramer: Is it possible to mix the substituted ureas that are specific for annuals and those that are specific for perennials; and if it is possible, is it feasible on a cost basis?

Mr. Harvey: The question is, mixing substituted ureas, and you are thinking of CMU and that group?

Mr. Kramer: Yes.

Mr. Harvey: Yes. There are three different ones of those, as you folks know. CMU, or the Telvar W is the middle one, so to speak, and there is one less soluble than that, the DW that tends to persist longer. There is one more, FW, that tends to leach down and perhaps do a better job on deep rooted perennials where there is a shortage of moisture. They could all be mixed very readily. I am not sure what the best mixture of them would be. However, if you are shooting at deep-rooted perennials, certainly you need to get the chemical deep down in the soil, and it may be cheaper to make two applications; one early in the season; one late in the winter or early spring.

Now, it may be possible to use some of these as mixtures. I haven't seen enough on it to know if it would work or not.

Mr. M. H. Buehler: On this Amino Triazole, is that very toxic to livestock?

Mr. Harvey: The toxicity to livestock is very low. We seem to have had little or no hazards. We have, or seem to have, less drift hazard as well.

Mr. Greenfield: Thank you, Mr. Harvey.

If we may, for the rest of the panel, since there might be some questions that you would like to ask of them also, and if you would hold those until the end of this panel discussion has been completed, it might be better. We may have a couple of things that we can attempt to answer.

Our next speaker on the panel is Bob Peters, from the San Joaquin Mosquito Abatement District.

Mr. Robert H. Peters: If I may be allowed to make peace with Gordon Smith and his panel on "Naturalistic Control," I would like to, before I discuss weed control, very quickly make some comments which are pertinent perhaps.

I have found we have had as much experience as any one in the naturalistic approach, and I can only say, in 1953 that we could not afford to continue spraying rice fields, so I will quickly make three points following that:

In using mosquito fish we estimate the cost is considerably less as an approach, perhaps as low as one-third of the cost of spraying. The results being much better by comparison. This is also an unscientific report, based only on observation.

Another point that can be made is that we attempted to put at least 100 fish per acre, which gives some of you at least a basis for a starting point.

A third and final point is, what are we going to do this year? Believe me, we are going to use mosquito fish.

Now to get down to the subject of weed control.

I do believe that in each case where a weed control program is instigated in a mosquito abatement program that it is necessary to follow an approach suitable to the conditions that are present. I might say that in our case we have a specific type of problem which involves mainly organic type waste ponds which include cannery wastes, sewage, and grape product sumps.

Another point in relation to approach is that we must adjust to a type of program involving a fact that one of our trustees is the chairman of what I shall refer to as an anti-2,4-D society. So for that reason we have initiated a peculiar approach, perhaps, in that I believe we are the only ones that are using a mechanized weed control program to the extent that we operate a Ferguson tractor and mower, which we find to be extremely effective in dealing with this specific type of problem. It utilizes a seven-foot blade which is adjustable. It can be operated on the down position or the up position for the mowing of weeds of various types on the banks. The actual cost of operation is something which I do not have available information on. I can only say that part of the reason for instigating this approach has to do with our requirements for using the same piece of equipment along our river bottom areas for our maintenance and what you may call trail-clearing operations as well. So therefore we have a piece of equipment for year-around application.

Our approach to this has been a cooperative one similar to that which we operate in our source-reduction program, in that we do not desire to carry public service to the point of actually getting rid of a man's weeds. It has been pointed out by some people that it is somewhat debatable how far we should go in the actual spray end of the program, but we definitely try to draw the line when it gets beyond the actual control of mosquitoes themselves, and as such, we operate this particular piece of equipment for $3.50 per hour and you can do quite a bit of work in that period of time. Our cooperation in this respect has been very satisfactory.

The only other thing which I can report that we have done in addition is to recently acquire a very large tank. As a matter of fact, it came from the Alameda County District. We bought it, moved it out of their yard so they could build that fine new building they have down there. We did them a great favor. We find we also did ourselves a favor at the same time, and we expect to combine the use of an oil-type weed spray in conjunction with our mower during this coming year.

(Applause)

Mr. Greenfield: Thank you, Bob.

Whereas Bob has talked about the use of the weed mower along ditch banks, Gordon Smith will give us some of the work that he has done in the oil fields in the control of cattails and tules.

Gordon!

Mr. Gordon Smith: After Mr. Harvey got through I found that I haven't got too much to say, so I will keep it short and sweet.

WEED CONTROL PROBLEMS AND PROCEDURES IN THE KERN MOSQUITO ABATEMENT DISTRICT

GORDON F. SMITH, *Entomologist*

For operational purposes, the weed control problems in the Kern Mosquito Abatement District can be separated into two categories: Those that are normally taken care of by the operators as a part of their routine operation and which consist mainly of ditch bank weeds which interfere with larviciding procedures; and the cattail problems arising from oilfield operations, which are the subject of a special control program by the district.

The ditch bank problems are primarily due to grasses and other weeds found in dairy drains and roadside drainage ditches. Some problem is encountered in irrigation and field drainage ditches, but these locations are usually maintained by the farmers in their routine operations. Since it has not been deemed feasible to set up a special weed control program for this type of location, the usual procedure is for the operator to spray the weeds with oil as a combination weed control-larviciding operation when vegetation begins to interfere with normal spray application. The oil used is Richfield Larvacide Oil, which is also a good weed oil. In addition, attempts are made through the source reduction activities of the district to have dairy wastes introduced into an irrigation system where available, or put into a proper sump, rather than run into a ditch where control is difficult at best.

The control of cattails in oil field waters is a problem in this district, requiring special emphasis for several reasons.

Especially in the older, hillside fields north of Bakersfield, only a small part of the total liquid pumped by the wells is oil, and the greater part is water. The pumps discharge into tanks or a series of basins where the oil rises to the surface and is skimmed off, and the water is withdrawn from the bottom and wasted off in the most convenient manner. Usually this is done by turning it into the nearest gully, where it runs down hill, joining the flow from other gullies. At the bottom of the foothills and before it flows into the river, it enters another series of sumps where a final skimming operation is performed to prevent oil pollution of the river water.

This crude oil does not seem to be particularly toxic to cattails and tules or to mosquito larvae. Cattails grow luxuriantly with the bases of the plants coated with crude oil, and larvae may be found with their siphons penetrating a thin film of oil directly beside a floating blob of oil.

This problem is especially serious to the district, since this type of water is attractive to *Culex tarsalis*, the principal encephalitis vector in California, and Bakersfield is bounded on the north by foothill oil fields.

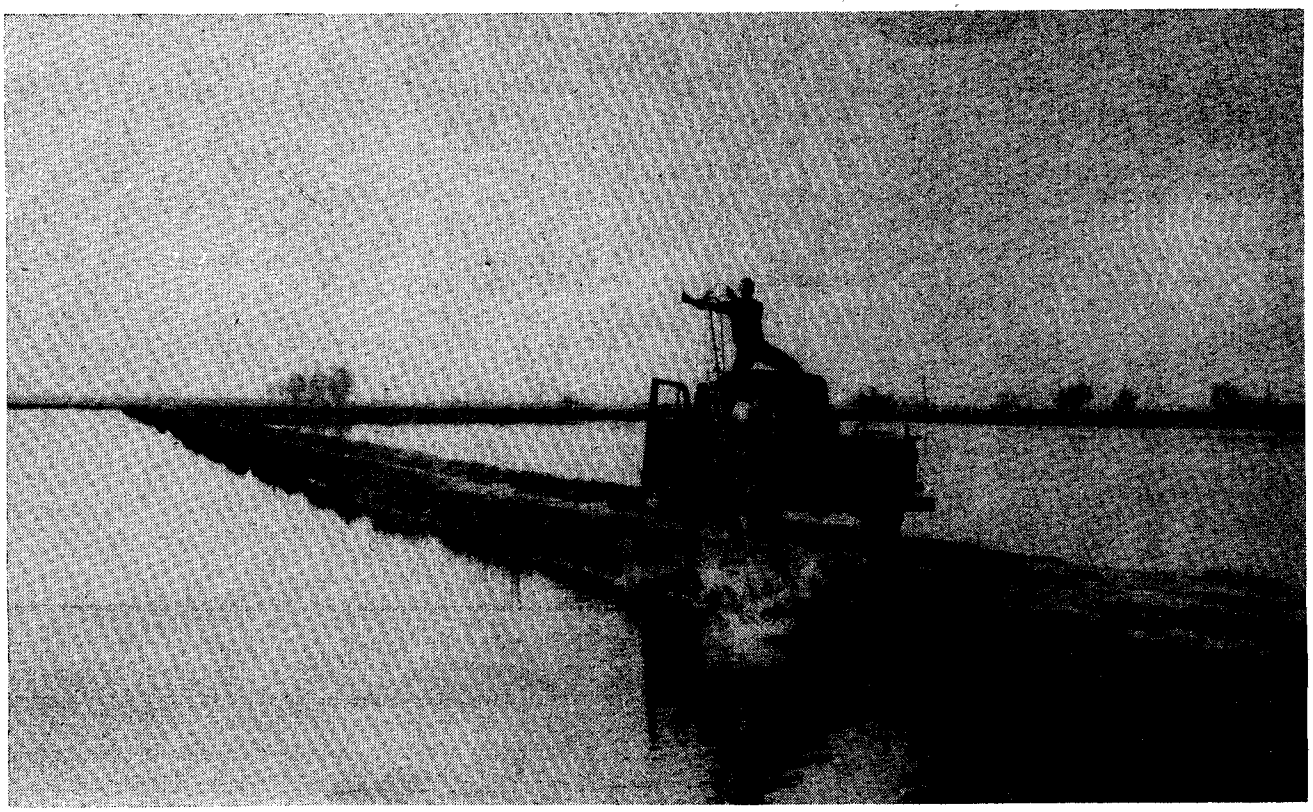
Mosquito control through the use of larvicides is extremely difficult, since most of the streams of water are in the bottom of steep-sided gullies and for the most part inaccessible to power equipment. There are many miles of these streams.

The saving factor in this whole situation is that the stream gradients are relatively steep, and if they can be kept in good condition, the water velocity is such that breeding cannot occur. One of the major problems involved in this stream maintenance has been the establishment of cattails, impeding the water flow and eventually, through sedimentation, resulting in delta-like flats, covered with slow moving water.

Hand-ditching, either through or around these beds of cattails, serves only as a temporary expedient, since the plants rapidly re-establish themselves in the new ditch. In the spring of 1950 a special program was initiated for chemical control of this cattail problem. Since there are no farms near the problem area, it is feasible to use 2-4D for this purpose. This material has been used in one form or the other till the present time. TCA was added experimentally but seemed to be of no value. The mixture used is 3 quarts of 59% tetrahydrofurfuryl ester of 2-4D (equivalent to 1 pound of parent acid per quart), 10 gallons of diesel oil and 90 gallons of water, applied to runoff. Two treatments are made each year.

This program has not produced any spectacular results but has, year by year, reduced the problem of cattails to a point where they are now very few, and one man can do the job in much less time than originally it took two men to do. All in all, we could have wished for a more effective material but have done well with 2-4D.

Some experimental work was done by Lewis Isaak during his time with the district, testing IPC, Methoxone, and others. The most promising of these materials was



This talk was based on illustrations, both kodachrome slides and movie, of weed control along the banks of reservoirs. Hykil weed oil is sprayed on the marginal weeds to obtain a kill of the tops. After about a week, the tops are sufficiently dead and dried to provide good fuel for burning. At this stage a propane weed burner mounted on a four-wheel-drive Jeep pickup is used to burn all vegetation to the ground.

W. D. MURRAY, *Delta MAD*

Dalapon. Single applications of forty and sixty pounds per acre gave good initial knockdown and apparently this material translocates to the roots. It is probable that better results would be obtained by making two applications in dense stands. Since the material was applied in 1955, the amount of regrowth is not yet known.

Sodium ethyl xanthate, at 5 pounds per 100 gallons of water, applied in July to dense stands of cattails and tules, gave very rapid contact top-kill, but as yet shows no effect on the tubers.

It is planned to put on some tests with amino-triazole next summer, using varying concentrations at various stages of growth. From some preliminary reports, this material is extremely toxic to cattails and may be a solution to this problem.

Mr. Greenfield: Thank you, Gordon.

Our next speaker on the program is Don Murray.

Don!

Mr. Donald Murray: Confucius say, "One picture worth 10,000 words." I won't do much talking but we will just look a bit. (See above.)

First let's look at some lantern slides.

(Whereupon various slides were shown on the screen while Mr. Murray gave the narrative.)

Mr. Greenfield: Don, I was very glad to see that burner in operation. Ted Raley has asked that he not be called upon because he could only give a little more on the weed work and he thought possibly his time could be used by questions and answers.

(Applause)

I guess the last on our program is Gerald Lant, from Northern Salinas Valley. Jerry will give you a little brief discussion on the Reclamation District setup in our area.

THE RECLAMATION DRAINAGE SYSTEM #1665

GERALD W. LANT, *Entomologist*
Northern Salinas Valley M.A.D.

The Reclamation Drainage System #1665 was originated to free hundreds of acres of swamp area for productive farming. This was the intent and it served nobly such an end for many years. However, all of this occurred more than thirty years ago and, during the intervening years, the system was subject to normal weathering, sedimental accumulation, and monumental neglect. No one person or body admitted responsibility for the complete maintenance of the ditch when sufficient funds to support the special district administering it were curtailed.

When finally the newly-formed Northern Salinas Valley Mosquito Abatement District was invited to a meeting called by the Salinas City Council to determine responsibility and administration of the system, the Mosquito Abatement District had suffered an outlay of many hundreds of dollars attempting control on what amounted to almost thirty miles of continuous mosquito sources.

When the meeting, which included representatives from the County Health Department, Salinas City Council, City Administrator's Office, County Board of Supervisors, and the Northern Salinas Valley Mosquito Abatement District's Board, convened, it was thought that since the Mosquito Abatement District had the greatest interest in good drainage for source reduction purposes, the District, logically, should take over the responsibility of the Reclamation Ditch.

Apprehension was originally felt, in that the District might be stepping out of the bounds of pure mosquito control; however, when the initial dragline cleaning had been completed, it was obvious that a tremendous reduction had taken place in the light trap collections, resting stations, and larval samplings count.

This first cleaning was time consuming, costly, and difficult. Because of vegetation blockage and sedimentation, the channel had flooded two hundred feet wide in some areas. The operation of drainage equipment in an area of such saturated peat and silt did prove extremely difficult even with mat usage.

On recleaning the following year, much of the area that had proven nearly inaccessible was now above water and draining nicely. It was at this point that weed control measures were inaugurated because of the multiple benefits possible. By reduction of vegetation, fewer cleanings would be required; hence, less dragline time with a possible saving of over seventy percent. Less obstruction to flow and therefore fewer larval sources to spray further effected a monetary saving. There was another side affect; the eventual elimination of the District's aerosol generator which had been an intrinsic part of the District's mosquito control program.

Over ten miles of channel have been mechanically cleaned and it is presently in the process of a systematic weed program. As a part of this program our Liquid Propane Weed Burner serves as the mainstay, with soil sterilants, plant hormones, and oil applications as necessary adjuncts.

It has been clearly demonstrated to us, in our tests, that intelligent weed control *is* source reduction.

Mr. Greenfield: Thank you.

Now, to quickly sum this up, I would like to say this: In our own particular case we were dumped into weed control. There is no way of putting it any differently. The County, the City, the rest of the agencies in our County, felt, as was discussed there, that we were the logical ones to take over this reclamation system because of our mosquito control activities. We were apprehensive about it but it has proven to be a very wise choice, or a wise acceptance of the problem.

Weed control, I mentioned earlier, does seem to be the logical movement following any source reduction program. I don't know how else we can escape such a problem.

Now I see that we did run over our time, but the program now calls for a recess, so we will take a ten-minute break at this time.

(Whereupon a short recess was taken.)

President Murray: The Board of Directors will meet in the dining room for a board meeting immediately after this program. We have as the Board of Directors:

President—Yours truly;
Vice-President, Howard Greenfield;
Secretary, Ed Washburn;
Board of Trustees Member, Roy Holmes;
Sacramento Valley Area is Bob Portman;
San Joaquin Valley Area is John Stivers;
Southern Area is Gardiner McFarland; and
The Bay Area is Hal Brydon.

About ten minutes after we adjourn I would like to see you down in the dining room and we will eat.

Mr. Greenfield: Next on our program here is Dr. Bohart, Associate Professor of Entomology, University of California at Davis, and he will tell us about the identification and distribution of *Aedes melanimon* vs. *Aedes dorsalis* in California.

Dr. Bohart!

IDENTIFICATION AND DISTRIBUTION OF *AEDES MELANIMON* AND *AEDES DORSALIS* IN CALIFORNIA

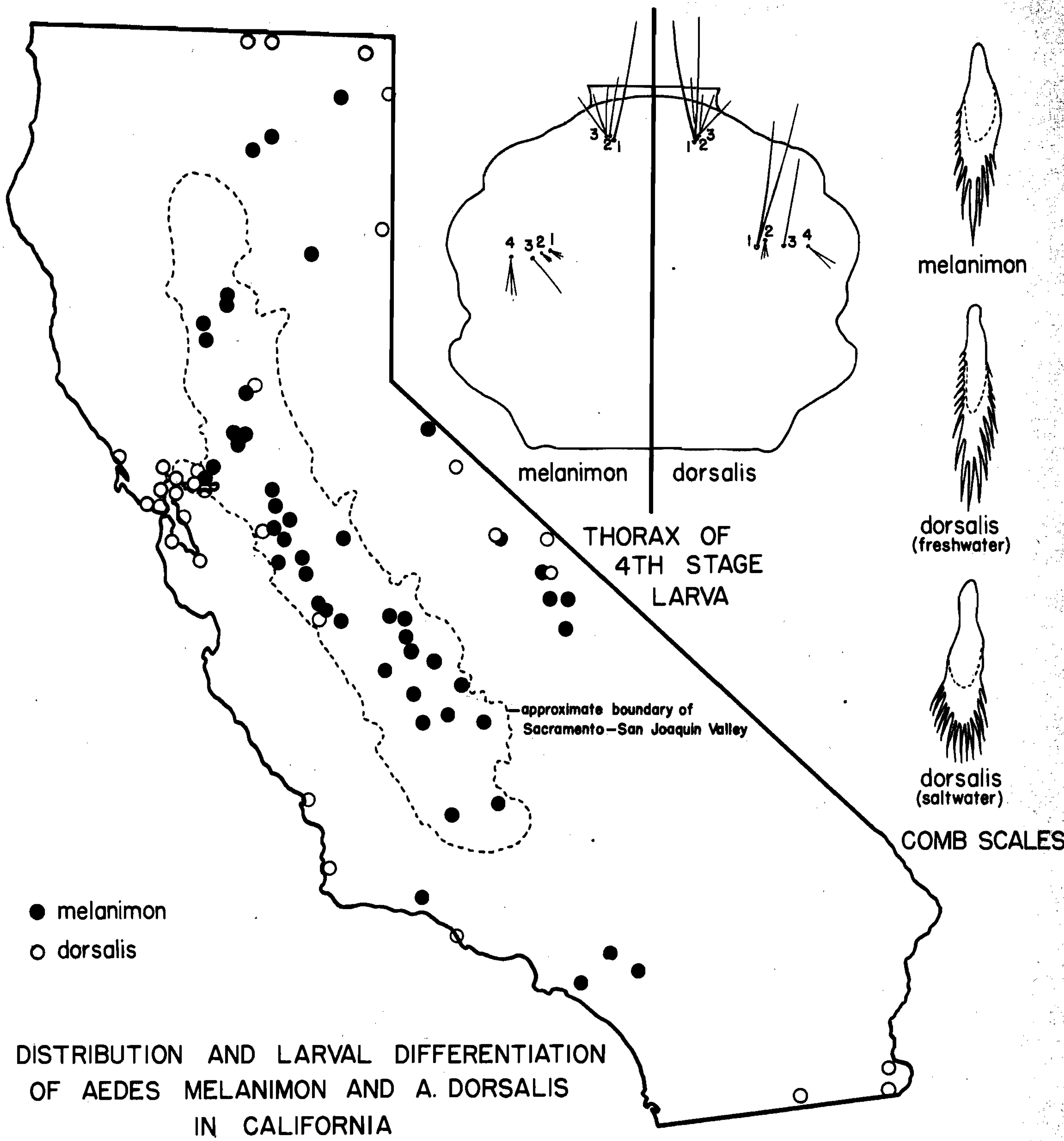
R. M. Bohart
Department of Entomology, University of California, Davis

Aedes melanimon Dyar has long been considered a synonym of *A. dorsalis* Meigen. Proof of the distinctness of the two species has been recently presented by S. J. Carpenter and A. Stone, recorded in Carpenter and LaCasse (1955), and by Barr (1955). In both cases the only reliable differences given were those of the male genitalia. In *melanimon* the claspette filament has a longer shank and the apical lobe of the basistyle is more pronounced. The latter characteristic is sufficiently obvious so that an experienced observer can distinguish males under a dissecting microscope without making slide mounts of the genitalia.

The discovery that two species are involved in the *dorsalis* complex immediately opens questions with respect to previously published records. For instance it appears rather certain that records of encephalitis infection and transmission by California "*dorsalis*" should actually be credited to *melanimon*. Furthermore, records of "*dorsalis*" by mosquito abatement districts in the Sacramento-San Joaquin Valley should have been *melanimon* in practically every case.

In order to get a broad, preliminary view of the distribution picture, I have examined available material and prepared the accompanying map. Records have come principally from the California Insect Survey at the University of California, Berkeley, through P. D. Hurd; from various abatement districts through E. C. Loomis of the Bureau of Vector Control; from J. N. Belkin of the University of California at Los Angeles; and from my own collection. Many of the critical Sacramento River Delta records were furnished by E. Mezger of the Solano County Mosquito Abatement District.

In order to take full advantage of available material it was necessary to find differences in females and larvae in addition to those in males. By a study of many reared specimens with associated larval skins it was discovered that larvae are readily separated by the large mesonotal hair 1 of *dorsalis* (see figure of thorax). In addition pronotal hair 1 of *dorsalis* is almost always double or triple instead of single as in most *melanimon*. The comb scales



DISTRIBUTION AND LARVAL DIFFERENTIATION OF AEDES MELANIMON AND A. DORSALIS IN CALIFORNIA are somewhat different, also. In the female the large percentage of pale scales on the wing of *dorsalis* has been commented upon by several authors. Unfortunately, this feature is subject to considerable variation. However, if attention is narrowed to the anal vein, it can be seen that practically all specimens of female *dorsalis* have this vein more pale than dark, with the reverse being true in *melanimon.*

The fact that the brackish-water, coastal *dorsalis* appears to differ from its inland cousin of the same species by its much broader comb scales may indicate speciation in progress. On the other hand, male genitalia of the two types appear to be identical. The typical freshwater *dorsalis* comb scale, as illustrated, is moderately slender and usually has 3 rather equal terminal spines flanked by several of decreasing size. This is intermediate between the scale of *melanimon* with its strong central spine and that of saltwater *dorsalis* which is usually stout and with 5 or 6 rather equal terminal spines flanked by some lesser ones.

In general, *melanimon* appears to prefer (or to be best adapted to) fresh water. However, larvae have been taken in the Delta region along with *dorsalis* in water containing amounts of salt up to 1.8 percent. Further studies of the salt tolerances are needed. Several times the concentration of sea water can be tolerated by *dorsalis* larvae which at the same time can be reared in nearly pure water. The competition between *nigromaculis* and *melanimon* (misnamed *dorsalis*) in the irrigated areas of the Great Valley has been remarked frequently. Now, in the light of the very few cases of true *dorsalis* in this area (Dos Palos, Merced Co.; Tracy, San Joaquin Co.; Rio Oso, Yuba Co.), we must consider the interaction of three competitors of which *dorsalis* is the least successful.

A generalization based on presently known distribution data would place *dorsalis* in this state as primarily coastal, southeastern, eastern, and northeastern. There appears to be some evidence that margins of lakes as well as bays are favored breeding places. Examples are Tule Lake, Goose Lake, Honey Lake, Guadalupe Lake, and Laguna Lake. In contrast, *melanimon* is essentially an inland, valley species associated with such river systems as the Sacramento, San Joaquin, Kern, Santa Ana, Santa Inez, Pit, and Feather.

Outside of California, *dorsalis* has been reported from many parts of North America and Eurasia. States from which *melanimon* are known are California, Nevada, Oregon, Montana, and Colorado. It appears to be uncommon except in California but the need for reliable records both here and elsewhere is apparent.

REFERENCES

Barr, A. R., 1955. The resurrection of *Aedes melanimon* Dyar. Mosquito News 15:170-172, 1 fig.

Carpenter, S. J. and W. J. LaCasse, 1955. Mosquitoes of North America, 360 pp., 127 pls. Univ. Calif. Press, Berkeley.

Mr. Greenfield: Thank you, Dr. Bohart.

Now we have "Mosquito Measurement—Its Present Strengths and Shortcomings." And before Dick Peters comes up here I would like to ask him about those questions he begged us for the other day.

MOSQUITO MEASUREMENT—ITS PRESENT STRENGTHS AND SHORTCOMINGS

Moderator: RICHARD F. PETERS, *Chief*
Bureau of Vector Control

Mr. Richard F. Peters: I have had considerable experience in begging and I find if I persist I eventually get results.

First of all, I would like to have the other two members of the panel come forward, if they will, please, Dr. Bellamy and Mr. Loomis. We have but one microphone here and I do want, as I promised you, to make this time allotted to mosquito measurement as informal as possible; hence we will have to rise and seat ourselves alternately in order to be able to answer questions and have the audience hear the replies.

The subject, "Mosquito Measurement," is probably as under-appreciated, I would say, as anything we are doing in mosquito control. I think we came to respect it to the maximum in 1952 when we had the big encephalitis experience and were obligated to recover from it and to decide since then how we were going to plan and avert another 1952. It isn't that we hadn't done mosquito measurement before 1952; it is just that we hadn't tested the validity of what we were doing before 1952. So, since that time, we have been obliged to objectively analyze what can we do to predict potential future emergencies and also to help size up the result of the year's operations.

We have also become clearly aware that there are really two objectives to mosquito measurement, one for public health purposes (if we can use the term loosely), the other for operational purposes (again sort of a loose use). For the purposes of this panel discussion we are going to try to consolidate them to the extent that such is possible while reviewing the strengths and weaknesses of mosquito measurement.

Without doubt the matter of mosquito measurement hinges upon the word "intelligence" in both of its connotations: "intelligence" meaning acumen or brain power, in that we have sense enough to use it; and "intelligence" in the military connotation, in that we utilize what measurement can give us by which to guide mosquito abatement operations and to document mosquito occurrence so that we and those who follow us will have something to base future work upon.

To begin with, we want to have the members of this panel provide a bit of background before we get into specific questions. So, I am going to call upon Dr. Bellamy first of all, because of his rich experience in mosquito measurement practices on a wide-spread basis ranging from Florida to California, including midway points. Dr. Bellamy will start out by appraising the different approaches to mosquito measurement so that we can be grounded from the standpoint of having a sort of base line.

Dr. Bellamy.

Dr. R. E. Bellamy: Don't be frightened by the volume of material here. I just scratched down some notes on the back of this during eggs and coffee this morning when we held a briefing session to determine what course our discussion should take. I was told by our chairman, Dick Peters, here, that he was going to ask me a question as soon as he had given an introduction. I think I was even told what the question was, but I wasn't quite sure at the time how the question should be interpreted, and now that I have heard it again, for the second time, I am still not certain.

The thing that crossed my mind was that he wanted a sort of brief outline as to what are the purposes (the reasons) for making mosquito measurements. After he said a few more things I gathered that this wasn't what he wanted; that he wanted, rather, a run-down, or appraisal, of the various different methods that have been used for making mosquito measurements.

Would you clarify this, Dick?

Mr. Richard Peters: I think you are proceeding admirably, Buck, just dive in.

Dr. Bellamy: Well, on the first assumption (which may be an erroneous one) there are certainly two very distinct approaches to the "why" of mosquito measurement. One is for the here and now, which is usually associated with active control procedures, as a guide, for making control efforts. The other is more a long-range type of reason; after three, five, or ten years of operations (mosquito control operations), have we made any progress or not? And it is easy to say "Go out and pour oil or DDT or other insecticides on all of your mosquito sources, on all of the actively producing areas, and don't worry about how many mosquitoes you kill and so on, as long as you get control."

This is fine, but inevitably this approach leaves the operator (I think) after a period of years—one, two, three, four, five, ten—wishing he had made some measurement or had some basis to show how many mosquitoes were out there when he began. His taxpayers are going to be interested in how much good he is doing *now* as compared to the problem that existed five or ten years ago. Some of his taxpayers *now* may not remember how bad the mosquito problem was when he started, and I think it is well to get a base level measurement (the best available, certainly, that is within the means) for such long-range comparisons.

The logical type of measurement related to the "here and the now" of a control operation is a more practical thing. It is very easy to sell the operators because they can see if there are mosquitoes in the water in the larval stages that this requires control, and they apply the insecticide or take the control measure, and they look again and see whether or not the control measures are effective.

It isn't necessary to support this philosophy, certainly, but I did want to emphasize the long-range aspect which is sometimes overlooked.

There is also the question of the value of mosquito measurements from the standpoint of being able to predict what may occur during a given season. I haven't had too much experience on this, and I don't want to claim that the possibilities here are too encouraging. However, we don't want to overlook the possibility that by making standardized measurements and in correlating these with the resulting populations of mosquitoes that follow from year to year, that after a time such measurements will become of value; and I am aware that a certain gentleman on the panel feels that this does not hold considerable promise.

Another reason for making measurements is in connection with the special studies that are carried on in the study of some specific diseases, such as the one we are studying at Bakersfield, arthropod-borne encephalitis. Here the measuring techniques are likely to be different because the purposes are different. We are trying to relate the activities of mosquitoes to various points in the life cycle (or the cycle, at least) of the virus, and we are actually working sometimes on things that are too detailed to be of interest in an over-all control program.

We are interested in the specific location of the mosquito as related for instance to the resting habits of certain birds. Does it bite in the tree tops, close to the ground, in the evening, late at night, and so on?

In order to determine these things, some special sampling methods (measuring methods) have to be devised.

Now, assuming the second question was asked (or second interpretation of the question) rather than the first, there are quite a few different methods that have been used to measure mosquitoes or their abundance. One of these is the well-known New Jersey mosquito light trap, or American mosquito light trap, as I believe it is preferred that it be called now, and I have stated in the past, before this group, or the Culicidology Committee of this group, that the light trap was certainly one of the most sharp-edged tools and of greatest value from the standpoint of your long-range comparisons. Years from now, when we come back and want to see what the populations of mosquitoes were today as compared to that time hence, perhaps the light trap will be the thing (the light trap catch will be the thing), that is sufficiently standard, that you will be able to make a fairly valid comparison. And for that reason I think light traps are extremely important.

Collections from natural shelters, resting stations, artificial resting units, or combinations of these, I think, are much more important for short-term comparisons—for telling you what the population of mosquitoes is now it changes in the course of a single season. Such measurements will not have too much application to regional comparisons (for interpreting whether or not the mosquito population at the southern end of the Valley is greater than that at the northern) because the individual stations from which collections are made are so variable. The local environment is different from place to place, and this influence any aggregation of mosquitoes in such resting stations.

Artificial units have been devised in an attempt to rule out some of the variability of the normal resting places, such as bridges, barns, and privies, or chicken houses, which are fairly good resting places for mosquitoes. The artificial mosquito resting unit does rule out some of the disadvantages as you provide a unit of uniform size and construction. But there still is variability in the actual placing of the unit. It may be placed near a favorable resting place that is already present and your population of mosquitoes is somewhat diluted, some of the mosquitoes going into the test unit and some of them going into the natural places. Another unit might be placed where there aren't so many good places for mosquitoes to sit down and this one would attract the larger proportion of the mosquito population in the immediate vicinity.

Somehow or other my name got associated with one unit which has been used in the State, the standard red box made of wood and of one cubic foot dimensions, with one side open, and I tried to correct this two years ago at the meeting in Berkeley. There was an "amateur carpenter" down in south Georgia who actually devised this unit, namely, Mel Goodwin. Dr. Goodwin is in the audience, as a matter of fact, and he can give you his personal experiences with this unit. The unit is definitely a Goodwin box.

Mr. Richard Peters: Is it a "goodone?"

Mr. Bellamy: I think it is a "goodone."

(Laughter)

Quite a number of other devices have been used for sampling mosquitoes, the pant leg count, the biting collection, and bait traps. We have done quite a bit on bait traps as Bakersfield. Bait traps can be baited with an artificial attractant, such as carbon dioxide, or with a bird, a mammal, or some other type of animal. Traps have been operated under special conditions through a full 24-hour period. In Africa, biting collections have been performed on a 24-hour cycle in order to determine the activity of the different species of mosquitoes through the day and night. We haven't quite reproduced the extensive type of sampling that the workers in Africa have performed.

There are some special things. One uses a radioactive material to mark mosquitoes for release and recapture to determine dispersal. And the same type of procedure can be used for an index such as the Lincoln Index, where a given, known (counted or estimated), number of mosquitoes under captivity are treated and released into the natural population and then collected. The marked individuals collected being a portion of those released gives you a fair basis for estimating the actual population from the unmarked sample collected. The Lincoln Index is probably the very best device we have at present as a tool for determining what our sample is in relation to the actual field population. However, this is a very special type of operation and I don't think one that wants to be established as a routine procedure.

I have very carefully avoided saying anything about the measurement of mosquitoes in the larval stages. Some work has been done on this. My own experience is certainly limited to *Anopheles. Anopheles quadrimaculatus* in the Southeastern United States was the species to be concerned with there, and is, I think, more subject to being measured by a standardized procedure than are the various culicine species that are of primary concern in California. And with what experience I have had, I certainly hesitate to express very much hope that a good standardized procedure for measuring larval populations of even *Anopheles quadrimaculatus* on a routine basis can be accomplished in any significant series of stations.

For localized conditions, where one or only a few breeding area unit sources are to be examined, some sort of quadrat system or standardized dipping pan procedure, or something of that kind, can be worked out; but because of the uneven distribution of larvae in the various habitats of a single pond, stream or ditch, I never felt there was much hope that a good standard procedure for sampling larvae, and relating the samples to the total production collectively, could be successfully worked out—in our time, anyway.

Thank you.

(Applause)

Mr. Richard Peters: Thank you, Buck.

Now we can seek to define the mosquito measurement undertaking which you mosquito workers are all participating in. Probably the first point to bring out is that of, are we seeking to accurately appraise the number of mosquitoes in each district, or just what is the real underlying objective of a measurement program such as has been established? What are some of the basic considerations in using any measurement system? Probably Ed Loomis is best prepared to embark on this subject because Ed has been charged in the Bureau of Vector Control with the responsibility for providing supervision and guidance to mosquito measurement and also criticizing it and otherwise acting in the relationship of a mechanic to overhaul the system as need to a point where it operates smoothly and properly.

So Ed Loomis will now define for the group the present program of the Bureau of Vector Control and give a little bit of basis for why it is as it is.

Mr. E. C. Loomis: Thank you, Dick.

I am sure that we are all aware of the program that we earmarked on in 1953, but I will quickly review for those who are not acquainted with our program the finer points.

Adult measurement is chiefiy done through the use of light traps. We have stated that one trap per town be located in each district and in each mosquito control area and not to exceed over ten light traps per area or per agency. As a result we have come up with approximately 200 light traps operating in California, 150 of which are located in the Central Valley.

An important point in this light trap program is the location of these traps. Without standardization in the location we fall right back to where we were in using resting places or resting shelters. We operate these traps on a 12-hour period every night of the week. We make collections based on the recommendation of at least twice a week. There are times when there is a leeway in this procedure since different areas find that the collection procedure varies according to the amount of humidity and the number of insects collected in each light trap.

Processing and identification is also an important standard procedure. After all, we go to a great length in collecting but the whole thing falls down if we don't process and identify these specimens correctly.

Finally, the reporting procedure. This reporting procedure is based on a weekly report by the Mosquito Control agencies to the Bureau of Vector Control.

Now, the strengths. Following the theme of our program here, the strengths of this light trap program lie in that all subvented agencies are contributing, plus the surprising contribution from non-subvented mosquito agencies. Over two-thirds of these latter agencies are contributing along with the subvented agencies.

The second strength is that the light trap program has showed us that we can obtain a good index of the *Culex tarsalis* population. Both in individual areas and from adjacent areas, this is true.

Thirdly, a second species which may be adequately plotted by light traps as far as population trends, are our old friends, *quinquefasciatus* and/or *pipiens*. There is a question of whether these light traps are valuable in plotting *Aedes* species. There is some indication that perhaps these can be used, these light traps can be used in that way, yet I am not ready to go out on a branch and say with great assurance that they can be.

There is also the possibility of plotting the *Anopheles* population trend in these areas where the *Anopheles* population is of sufficient magnitude to reach the light trap location.

Now, how about the shortcomings of the light trap program?

As I mentioned before, location is of high importance; collection is important; the killing agent that we use is important. How many times do we change? Do we keep a fresh supply of the presently used cyanide in the jar?

As I mentioned before, in processing the material we receive how many times do we identify a total collection? When we look at the pile of bugs do we shudder and take only a quarter of the sample forgetting the other three-quarters?

Reporting is another important shortcoming of this program, inasmuch as during the past two years we have had only approximately 50 per cent cooperation in receiving these reports on time, and that is important, particularly during the spring and early summer months, in our evaluation of the *tarsalis* population.

The second major point on our measurement program deals with the immature stages.

The larval surveys have been based on a subjective larval report by the mosquito control agencies. This report is submitted simultaneously with the adult report every week. This report on the immature stage of occurrence of mosquitoes varies greatly from permanent larval stations that are established in mosquito control agencies all the way down to random surveys of the area conducted by foot or by vehicle and merely based on observation with no dipping procedure or any other type of sampling.

Now, the strength of the larval survey measurement lies in the fact that we have everyone thinking about the immature stages and their occurrence. At least I hope we have got them thinking, because first things first—larvae before adults, that is the only thing I can say about the strength of these larval surveys.

The weaknesses are great. We have no standard for interpretation of this data based on the procedure that I have just outlined to you. The larval survey procedure needs to be analyzed correctly and we need to come up with something a little better in order to fill in on our objectives in estimating primarily the *tarsalis* population in relation to the occurrence of encephalitis in this State.

Now, the other point I want to make is the evaluation of the data. It is last, but it is not the least important. It is important since we evaluate the data received from the mosquito control agencies. We base the adult measurement data on the number per light trap. I believe we all realize the importance of that data since light traps are subject to failure and therefore we have to have some standard denominator. I wish we could judge or give an index.

The interpretation or evaluation of the larval data is another thing. So much so to a point that I have submitted to our Bureau of Vector Control a revised program for this part of the measurement program to start this year. I am not going to go into it, but it is something that will give us, I hope, a better index of the *tarsalis* population and it is based on the selection of cross-section surveys in the Valley here to serve as a guide for giving us this information.

I hope that this, in part, Dick, is what you wanted. We are open for questions.

Mr. Richard Peters: I think perhaps it deserves qualifying a bit now as to what those little numbers mean in the column opposite the individual agency participating in the light trap program. Could you tell me? I have heard some stories to the effect that those indicate the degree of efficiency of the program. Would you say that is true?

Mr. Loomis: Definitely not. That is not so. The numbers opposite the district on the report are the number of mosquitoes. In the case of *tarsalis* it is the number of female *tarsalis* per trap night and in no way reflects what degree of control there is, because I think sometimes we have seen the difference, particularly the difference in population occurrence of *tarsalis* in non-controlled areas and in controlled areas.

Mr. Richard Peters: Another point that I think might be reinforced is the need for standardized conditions surrounding any and every method irrespective of what is in use.

Dr. Bellamy, would you care to comment any more so in terms of that particular aspect?

Dr. Bellamy: I have already cast my vote as being in favor of the standardization of mosquito measurement for the purposes of long-term comparison of mosquito population changes, and, I have had a personal experience this winter that greatly supports this philosophy. By a quirk of fate it happened to me, instead of to somebody that I might have spoken to about this thing.

For the past four or five years we have managed to keep fairly extensive regular mosquito measurements going through the year—through all twelve months of the year—and we have been particularly concerned with the winter mosquito population because of some work on the over-wintering reservoir aspects of encephalitis virus. We were maintaining extensive collections through the three winters previous to this one, but press of other activities (this is not my parent body so I won't emphasize the lack of funds and personnel), having too much to do, and a backlog of several winter seasons more or less recapitulating each year what happened the year before, led us to slacken off a bit our emphasis on regular weekly collections of (particularly *C. tarsalis*) mosquitoes as a standard procedure.

This winter we placed our emphasis on some other things, but we did make a few pilot investigations of the mosquito population at our standard stations from time to time, sometimes spaced as much as two or more weeks apart, and what did we find? We found that this winter is not behaving according to the pattern of several previous winters.

Now, we wish we had the collections we did not make on those weeks that were left out. This was the winter we stopped making the standard collections for continued comparisons of what *tarsalis* might be doing in the wintertime. This *would* be the winter for *tarsalis* to behave differently from the way it has in the past three years (and probably, if we had them, records would show for many years more than that). And it is because such things can happen—this is an excellent illustration of it—that I emphasize maintaining continuity of mosquito measurements by some standard procedure that will leave you with data to which you can refer back, and compare one year's collection with another year's, or even make comparisons five or ten years back.

Mr. Richard Peters: Now, a couple of questions that

I am just sort of bringing out of the series I have received here.

There have been in the past allegations made that some districts may put cyanide in their killing jars, but the possibility also exists that sodium chloride might look like cyanide.

Ed, what do you have to say about the ingredient that is used and the frequency with which it is brought up to a point where it will kill mosquitoes in a light trap? And generally speaking, effecting one specific question, when is the State going to adopt a satisfactory killing compound for light traps?

Mr. Loomis: I know the gentleman that gave you that last question. We have frequent arguments on that in our discussions.

Well, we have turned to sodium cyanide or potassium cyanide, as the killing agent. We have recommended that the jar be frequently changed. Now, this may vary. We leave it on an honor system, that a jar may be changed from one-week intervals anywhere from a month to six-week intervals, but certainly from our experiences in the field with mosquito control agency personnel, there has been a laxity on this important phase of the program and if you can stick your nose in a jar and inhale very deeply and still walk away, something is wrong.

Mr. Richard Peters: We haven't lost a Vector Control specialist yet with that method either.

Mr. Loomis: On the other hand, when you come to a light trap for collecting in the morning and see the insects actually flying in the jar and they are usually out of the jar, that is another example. We have other killing agents: paradichlorobenzene has been used before, and successfully, and the use of chloroform has been tested; I know, definitely of an instance by one agency and it proved satisfactory. The use of chloroform provides a constant level of evaporation and dissipation in opposition to the non-standard preparation of the cyanide material, because what one person in one area believes is enough, the next person in an adjoining agency or area believes that three times that amount is enough. So you see the variations that can be added and therefore the number of changes that are needed during the season.

All I can say is, we will attempt to evaluate this killing agent quantitatively so that the jars can be standardized as much as possible this coming season.

Mr. Richard Peters: Dr. Bellamy, I will throw the context of this question your way: Knowing that the light trap program doesn't begin until the 1st of March, and knowing that the light trap is relatively ineffective for the first months due to a variety of reasons, can you suggest a practical way to measure the oncoming *Culex tarsalis* occurrence prior to the time the light trap begins to get effective?

Dr. Bellamy: No.

(Laughter)

(Applause)

Mr. Richard Peters: Thanks for your directness. That apparently represents an unsolved problem and remains one of the reasons why Ed Loomis and the CMCA Culicidology Committee are in existence.

Now we have several questions such as, do you plan a *Culex tarsalis* flight range study? I assume that means the Bureau of Vector Control. For the information of the questioner, Dr. Reeves some years ago conducted a *Culex tarsalis* flight pattern study which provided certain suggestive information. I would say that any study that we might conduct would probably be based upon such having a top priority and our having funds to conduct it. It might not come for years.

Mr. Loomis: All I can do is refer the mosquito control agencies and the members in each agency to the report by the Culicidology Committee, which brings out those two important parts of the answer of the question. The Culicidology Committee members made a survey of each agency and asked those specific questions of what time in man hours, was spent in collecting, and what time in man hours was spent in identification procedures. That included both types of surveys, on the adults on the larvae. There was a great range of hours spent. There was a medium, of course, that we could arrive at, but I think the only answer is that each agency is a separate problem and we all know the problems that may confront each agency so that no one recommendation of, say, ten hours a week for collecting, and three hours a week for identification, can be put forth to all agencies here in California, because we recognize the great variability in each agency's manpower, and particularly the budget.

Mr. Richard Peters: All right.

Now, there are several questions which hit upon the actual placing and locating of light traps and the density of light traps to the area and population served.

Dr. Bellamy, would you comment upon whether you feel a—I will take the extreme first of all—that a light trap which serves approximately a hundred square miles as part of a mosquito abatement district's participation and some districts, you know, are 2,000 miles in territory and they range in all directions up to that point—but what would be your opinion of the value of a light trap under such conditions? And would you go to the other extreme and say where you feel really effective measurement comes in terms of square miles per light trap?

Dr. Bellamy: I refuse to fall into the trap.
(Laughter)

I don't want to say how light traps should be placed in relation to square miles to sample adequately any species of mosquito, and I think it will vary certainly with different species as their flight habits would be different. I understand it may be (possibly not this year but some time in the future) that further testing of the flight range of *Culex tarsalis* to supplement the work that Dr. Reeves did, will be available as a basis to make such an estimate in regard to that species. We know already that *C. tarsalis* flies rather great distances in Kern County, and there are strong indications that very extreme distances are traversed by *Aedes nigromaculis.* Such wide dispersal by a species is naturally a limitation to the use of a light trap for pin-pointing mosquito production sources. If a mosquito moves freely throughout the whole area traps don't have to be spaced too closely, but if it tends to be localized, as *tarsalis* may tend to be (*tarsalis* may be of longer flight on the average than we expect—some data would indicate this), then, the light traps need not be so closely spaced, but should certainly be as comparably placed as possible for certainly the catches by identical light trap units at different stations, not necessarily far apart, will show wide variation.

Those who operate several light traps soon find this out, and I expect it is due both to the placing of the light trap in relation to the local environment, whether there are obstructions to the traps such as tree, vegetation, etc., as well as to differences in the density of the mosquitoes from spot to spot. While we seek ideals on how closely we should space light traps (or how closely other measuring devices should be spaced), to know what the total population of mosquitoes is, obviously we can't attain such ideals, and the best thing we can do within reason is use the number that we can keep up with, and standardize on this number, and keep it running through several years.

If circumstances change, and you have a windfall (your budget is increased or you obtain an additional entomologist), you can expand the old program, but don't throw the old program away; keep up your observations at a series of standard stations.

Mr. Richard Peters: Thank you.

This is the last question I am going to submit to you because we could go on for the rest of the day with the amount of material contained even inside the several questions that have been presented. I do want to close this discussion stressing that we must accept the measurement program primarily as an index which will suggest a trend over time. We must not look hopefully or expectantly upon the measurement program as it is being conducted today as providing a criterion of those districts that are operating without a threat of encephalitis or that they are otherwise attaining a degree of efficiency which is comparable on the basis of a numerical index against other agencies next door or elsewhere. We are in our infancy in this measurement program. We have a long way to go.

One last point that I would also like to make exceedingly emphatic is this: Any and all agencies engaged in the mosquito measurement program are not primarily serving the State by the participation entered into. You are really serving yourselves. We are merely coordinating and consolidating the information so that the value obtained over a period of time both inside a given year and from year to year will eventually become apparent. We are merely serving as your medium for making the information available following analysis, evaluation, and your ultimate use. Light traps and other measurement devices will serve only local programs in the direct sense. Such biological auditing is furthermore, good business.

Mr. Greenfield: Now we come to that portion of the program that is somewhat different in scope, Fly Control.

Ernie Campbell, of Contra Costa District, will give us a few remarks on what he has done in his area.

FLY CONTROL AS CARRIED ON BY A MOSQUITO ABATEMENT DISTRICT

Ernest Campbell, *Manager*
Contra Costa Mosquito Abatement District

Well, of course we haven't been in Fly Control long enough to have any conclusions in the matter. Anything that I might say would not necessarily apply to another Mosquito District where conditions obviously would be different.

Like many other areas in the State we are developing an urban-suburban type of living with populace areas coming into proximity with fly sources. The fly problem had been building up for some time. People wanted fly control to eradicate an annoyance which would involve intensive control, and at a cost over and above that which the Health Department might feel could be justified for health reasons only.

The problem came to a head when a citizens' group decided that they wanted fly control now in a certain limited area. After talking it over and getting more information, they found that control would not be successful in the limited area which they had in mind. With further consideration it became apparent to them that the already existing Mosquito District embraced a suitable geographic area for fly control and would be the logical agency to perform this function. The local County Health Department concurred in this conclusion.

The Citizens' Committee contacted improvement clubs, service clubs, and City Councils. Altogether twenty-four such organizations passed resolutions requesting that the Mosquito District do fly control in addition to mosquito control. An outstanding aspect of this was that no organization disapproved of the proposal. Money for the cost of the work was included in our District's 1955-56 budget.

Our fly sources are about what would be expected, namely garbage dumps, chicken ranches, horse stables, commercial rabbiteries, etc.; and, of course, the inevitable garbage can and other backyard sources.

Our first order of business was to make a complete inspection-survey of our District. We recorded all fly sources for future consideration and took up the matter of correcting the source with the owner or operator. We made source card records for about 4,500 souces.

We mailed out 45,000 brochures on flies, using a commercial mail list. This winter (55-56) we are covering about one-half of our school system, showing a movie on flies, together with a personal appearance of a Mosquito District representative.

Most of you are familiar with what Ed Smith is doing in Santa Clara County. We have about the same thing except that our total problem is smaller. We are perhaps in a better position money-wise as our tax rate would allow us to expend an amount of money which the need and desirability indicates.

So, to keep it brief for now, that is about it. As time goes on we, no doubt, will have some conclusions in which other Mosquito Districts may be interested.

Thank you.

Mr. Greenfield: Now we come to that which really is the last moment in this program or this year's program; and that is the last speaker on our list, Mr. Smith.

Ed is Chief of the Division of Vector Control in Santa Clara County and he will present his problems and program on Fly Control.

FLY CONTROL IN SANTA CLARA COUNTY

Edgar A. Smith, *Chief*
Division of Vector Control
Santa Clara County Health Department

The major fly problems in Santa Clara County include 10 garbage dumps, fruit waste from more than 20 canneries, vegetable waste from numerous packing plants and freeze plants, 200 dairy ranches, 1200 poultry ranches, 100 rabbit ranches, and about 40 hog ranches. In most cases the fly problem results from delay in the adequate disposal of the organic wastes involved. In many cases the problems are so severe that insecticidal treatment is useless since flies are produced so rapidly that it is impossible to keep up with them. These problems can only be solved through changes in management practices. This type of program requires cooperation among farmers, public health officials, law enforcement agencies, and the people themselves.

The Division of Vector Control was established within the Santa Clara County Health Department two years ago to begin working towards a solution to these problems. Primary emphasis of the program is placed on the progressive reduction and elimination of fly sources through education, persuasion, and cooperation. Particular attention is given to cooperation with individuals and organizations to develop better cultural and management practices in handling of waste materials which are potential fly media. Constant efforts are directed towards encouraging the assumption of responsibility for fly production by those individuals, organizations, and agencies involved.

During the first two years of operation of this program considerable progress has been made. In 1954 a county ordinance was passed governing refuse disposal operations. This ordinance made it mandatory that the garbage dumps change over from open-face operation to one of sanitary fill and cover methods. This reduced one of the principal fly problems of the county to relatively minor significance.

Fruit waste from the twenty canneries in the county created severe fly problems until the Cannery Association accepted full responsibility for any fly nuisance created from the improper disposal of fruit waste. A committee of Cannery Association members and Health Department representatives discussed the matter thoroughly and came up with a series of recommended practices governing fruit waste disposal operations. These were put into practice for the first time in the summer of 1954. Prior to that time most of the waste disposal sites were creating serious fly problems. However, in 1954 out of the many hundreds of cannery waste disposal operations there were only three cases where serious fly problems arose. All three of these resulted from failure to follow the recommendations made by the Cannery Association. These recommendations involved preparation of the field ahead of time, spreading of the fruit waste thinly on the ground, deep plowing of the ground within twenty-four hours, and disking within forty-eight hours. In all cases where these practices were followed, the fly production was negligible. In the summer of 1955 there was only one serious fly problem resulting from failure to follow these practices.

Poultrymen have taken an active part in drawing up recommendations for the reduction of flies on chicken ranches. This was accomplished through a committee of representatives from the County Farm Bureau, the Grange, the Poultrymen's Associations, the Farm Advisors Office, and the County Health Department. This committee developed a program for fly control on poultry ranches which when applied has been highly successful. In many cases where poultry ranches were creating a public health nuisance through the production of flies, changes in management practices have drastically reduced the fly problem so that complaints of neighbors have been withdrawn. This problem of fly control on poultry ranches was covered in California Vector Views, Vol. 1, No. 6, December, 1954.

The Health Department, together with the University of California Agricultural Extension Service, has sponsored a series of meetings with dairymen to develop a list of recommended practices on dairies which would lead to the reduction of flies. This problem too is being approached from the angle of developing better management practices, particularly in regard to the handling of manure.

The Division of Vector Control is also working with farmers on each of the other major agricultural fly problems, such as hog ranches, rabbit ranches, feed lots, etc.

Flies also are produced in residential backyards in piles of lawn clippings, compost heaps, faulty garbage cans, and in small animal droppings. These problems are approached through educational campaigns in the problem areas. These campaigns involve house-to-house inspections, talks to service clubs, improvement associations, women's clubs, etc., as well as newspaper articles and radio talks. The Vector Control educational program of the Santa Clara County Health Department is described in California Vector Views, Vol. 2, No. 10, October, 1955.

The Division of Vector Control of the Santa Clara County Health Department has been established for two years. In the fly control program, policies have been adopted stressing source reduction through education, persuasion, and cooperation. Working relationships have been established with the various segments of agriculture and industry involved in fly problems. Some major fly factories have been virtually eliminated as sources of annoyance. However, even more important is the fact that workable programs for fly control in the various agricultural industries have been developed by the farmers themselves.

Mr. Greenfield: Thank you very much, Ed.

Now, before we close this meeting I would like to ask if Don Murray has anything that he would like to say. Are there any further announcements that can be made or want to be made at this time?

The Board of Directors meeting is to follow. Please don't forget it. Don has requested that the Board members meet with him at the Joaquin Room down on the main floor.

Well, then, it is with a great deal of pleasure that I can for the first time in my life close or adjourn one of these meetings. If it meets with your pleasure then, the meeting does stand adjourned.

(Whereupon, at the hour of 12:15 o'clock p.m. January 18, 1956, the 24th Annual Conference of the California Mosquito Control Association, Inc., adjourned sine die.)