PROCEEDINGS AND PAPERS

OF THE

TWENTY-FIRST ANNUAL CONFERENCE

OF THE

California Mosquito Control Association

AT

SACRAMENTO AND AT THE UNIVERSITY OF CALIFORNIA

AT DAVIS, CALIFORNIA

FEBRUARY 11, 12, AND 13, 1953

Edited by

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PROCEEDINGS AND PAPERS OF THE TWENTY FIRST ANNUAL CONFERENCE

OF THE

California Mosquito Control Association

FIRST SESSION, WEDNESDAY, FEBRUARY 11, 1953, 9:40 A.M.

ODD FELLOWS HALL, SACRAMENTO

The meeting was called to order at 9:40 a.m., by Vice-President Robert H. Peters, Manager of the Northern San Joaquin County Mosquito Abatement District.

Vice-President Peters: Gentlemen, our 21st Annual Conference has begun. It is not very often that the Vice-President has the occasion to open a meeting of this type. It is unfortunate this year that our President, Rolland Henderson, is unable to make this meeting. I received a special delivery letter two nights ago, herewith, "It is almost the last second and I find that it is impossible for me to be in Sacramento. I am extremely sorry that I will be unable to be there both from a personal standpoint and from the standpoint of the Association. Not that they can't get along without me but I would have liked to finish out my responsibility. Regrets. Rolland Henderson."

Before we get under way with the program I call to the attention of the group as a whole that we have a very interesting program, educational and social, arranged. We would like to have complete registration during the day. We have a registration booth set up outside in the lobby. The social activities that we have planned are, tonight, a Hospitality Hour, which will be held in the Silver Room in the basement of this building. We have also arranged a dinner dance which will be held in the Elks Temple and there, I believe, the Mirror Room is the location. We are selling dinner tickets for $3.00 per person and I'm sure you will never receive again as much value in the way of entertainment as you will receive on this particular occasion. I will now call on George Umberger, Manager of the Sacramento-Yolo County Mosquito Abatement District, and Chairman of our Local Arrangements Committee, to introduce the first speaker.

Mr. Umberger: Thank you, Mr. Chairman. We have with us this morning a man that has worked with the county Government at Sacramento for over forty years; he is eminently qualified in the field and he understands the problems of the people in the rural areas. A grand man, our county executive, Mr. Deterding.

Mr. Deterding: Mr. Chairman and members of the mosquito abatement districts of California. It is a real privilege for me this morning to welcome you to Sacramento and to express to you our appreciation for your visit to our city. Sacramento has always been happy to welcome those who come this way, but this morning we are particularly happy to have you of the mosquito districts meeting here to discuss your problems. We in Sacramento are vitally interested in them and like to see you meet here and discuss them and probably come up with some answers that we can use.

From the very inception of California, as you know, the central valley has been plagued with mosquitoes. The early miners complained vigorously and commented on the mosquitoes and down through the years it has been a problem. With the increased population and with more irrigation, the problems of drainage, and getting rid of breeding areas of mosquitoes is important, and it is important likewise that our people can enjoy the long fine summer evenings in the outdoor atmosphere, which all of us like to do so much. The techniques and methods of eradicating mosquitoes are becoming more involved and complicated and what is good today may be obsolete tomorrow. The spraying materials that you have been using do not react as continuously, or the mosquitoes may become immune to certain applications. So it is vitally important to you and to the State that you meet here and discuss in detail, technically and informatively, those methods and procedures, so that as you return to your respective communities you may be better able to carry out your responsibilities in your particular area.

Here in Sacramento we have approached this problem through the leadership of George Umberger with vigor and determination. We have been fortunate in that we have a local government that can be coordinated; we have tied together the health department, the sanitation department, the engineering department and the mosquito department so that these people work on a plan. Whatever is done, drainage work, whether it is roadside, whether it is in the field, or in some of the major drains of the country, it is done to effect an eventual result in an ultimate plan of drainage. That tends to develop efficiency and more complete eradication of the mosquito problem. So we will be interested and we will watch with enthusiasm to get what information we can from you so we can do a better job here in Sacramento. For that reason we are particularly happy to have you with us this morning. We hope that your deliberations will not only be profitable to you but will in addition be enjoyable and that your convention heer will be a success in every way.

Mr. Umberger: Our next speaker was to be Mr. Cavanaugh, but due to illness we won't have him here this morning. In his place is Sacramento city's representative Trustee to our Mosquito Abatement District, a man greatly respected in our community. In the last election he became a member of the legislature, in which capacity he is now serving. I take pleasure in introducing Mr. Roy Neilson, Assemblyman from Sacramento.

Mr. Neilson: I am sorry that our City Manager, Mr. Cavanaugh, was unable to be here this morning to welcome you to our city. You have a program which is going to be more beneficial to you and to this District and to

the people than any extended remarks that I might make. Our County executive, Mr. Deterding, covered the subject matter as far as the City and County of Sacramento are concerned. We have provided exceptionally nice weather for you during your stay here, which is usual for our City. I know that your exchange of ideas is going to be very helpful to all of us. Corperation and exchange of thoughts is beneficial not only to the District which I represent but to all of the Districts.

I feel that perhaps this mosquito control is becoming more of a State problem than just a local problem and that the State of California should interest itself more in control. By that I mean that I think the Districts throughout the State should receive a large subvention from the State. Again I welcome you to the City of Sacramento and extend the greetings of our City.

Vice-President Peters: I request that all who do participate in the program turn in their papers when presented, and will all speakers please stand in this position since we have our sensitive microphones in front of us here and we will thereby pick up a more uniform recording.

I believe that no meeting will be complete if we didn't receive an oficial welcome. In this case we are honored to have Dr. Stanley Bailey, who is the head of the Entomology Department of the University of California at Davis, and also officially is President of the Board of Trustees of the Sacramento-Yolo County Mosquito Abatement District.

Dr. Bailey: Mr. Chairman, ladies and gentlemen, fellow entomologists. I trust that the local representative of the Mosquito Abatement District has taken care of the hibernating *Anopheles* behind the molding above here. If not, on warm afternoons, when they come out of hibernation they will find something to feed on here. The Boards of Trustees usually try to accept their responsibility seriously, they try to protect the health and welfare of the public, to hire the best people they can get, and try to hold on to them, and to do the best job we know how. I'm sure this is characteristic of all of the Board of Trustees. The usual experiences will be exchanged here, as well as a few stories. I hope you will enjoy yourselves. The program and entertainment chairmen have made the necessary arrangements, in knowing what you want. I'd like to say also briefly that it would be a great pleasure I am sure if Professor Herms were here today to see how mosquito abatement has grown, how the professional level has been raised, and I am sure Mr. Gray fully appreciates this better than any one else in the room. We have to go ahead or backwards; we have come a long ways since the days when we didn't have anything but oil and Paris green. I am sure we are going ahead in spite of the present difficulties encountered with resistance and other complications, and that is the reason you are here.

Vice-President Peters: The next item on our program was to be a message from the Governor of California. We have hopes that Governor Warren will be here today and this message will be delayed with the assumption that the Governor or a representative from his office will be with us some time during the morning, and we will attempt to fit him in at the proper time. I now take pleasure in introducing the keynote speaker of our conference, Dr. Stanton J. Ware, who is the Chief of the Water Projects Section of the United States Public Health Service Communicable Disease Center. Dr. Ware is going to talk to us on the subject "Coordinated Effort and Conservation—The Permanent Way".

COORDINATED EFFORT AND CONSERVATION —THE PERMANENT WAY

Introduction

It is a real honor and indeed a privilege to occupy this position on the program of the 21st Annual Mosquito Control Association Conference. To keynote such a program upon which appear such august names in the field of mosquito control as Drs. Freeborn and Rees, to name but two, carries with it what I fully recognize to be a grave responsibility.

Perhaps first, then, it is best to define the meaning of the term "keynote talk." Webster defines this term as "an address that presents the essential issues of interest to the assembly." In earlier correspondence, your program chairman, Mr. Robert Peters, laid down the general theme for the conference by stating that emphasis would be placed upon the return to sound abatement methods with the obvious implications of water conservation and general mosquito source reduction.

The objective of this talk is to direct attention to these essential issues which will be so ably covered by the numerous speakers to follow. With that in mind, I chose as the title for my brief discussion "Coordinated Effort and Conservation—The Permanent Way." I believe that you will find ample evidence in the papers to follow that the path of continuing progress in mosquito control, in California or elsewhere, lies along the lines indicated by the title. The title, itself, is self-interpretative. By it, I intend to convey the thought that only by the widest sweep of coordinated effort, namely, coordination of all agencies, organizations, and individuals concerned, can we expect to achieve successful control, and that in this coordinated effort, we must keep in mind constantly a most important objective expressed by a word which is becoming more important to our country and to all of us with each passing day; that word is "conservation."

Although the program chairman has most generously allotted to me 30 minutes of your valuable time, I feel that it would be presumptuous to talk that long in the face of the important contributions to follow. Accordingly, I have taken the liberty to concentrate my remarks to the point that they can be made in approximately 15 minutes. I feel sure that the time thus saved will be used to good advantage in ensuing discussions.

The Basis for Coordination of Effort and for Water Conservation

The history of mosquito abatement in California prior to World War II is one of development of techniques and equipment for combatting mosquitoes. It must be emphasized that mosquitoes were a serious problem, largely because of man's agricultural activities, before the first Abatement Districts were organized. They became an even more serious problem during those formative years, despite all efforts at abatement, principally because of increased activities in the field of water resources development. Since the mosquito problem already existed when Abatement Districts came on the scene, officials of these organizations necessarily had to concentrate upon reducing, by the most expeditious means, the numbers of mosquitoes present in their respective areas. Obviously, thought must have been given to the means for more permanent control; and, indeed, statements were made by such outstanding persons as Professor Herms and Mr. Harold Gray to the effect that the solution to the mosquito problem lay not in the application of oil or chemicals

to collections of water already in existence, but rather in the prevention of such collections of water by proper irrigation practices, drainage, filling, and other methods of permanently removing breeding places. However, during and immediately following World War II, there was a wholesale acceptance of the newly developed organic insecticides, and it would appear that in many areas there was a concomitant loss of interest in basic preventive measures. Even before the problem of mosquito resistance to the organic insecticides was recognized, Mr. Gray, in his Presidential Address before the joint meetings of the American Mosquito Control Association and the California Mosquito Control Association at Berkeley in 1949, voiced the dangers inherent in a control program based almost entirely on the use of insecticides, and he entered a plea for a return to basic sanitary practices.

It is difficult to determine when the concept of cooperation between seemingly diverse agencies in the practice of mosquito control first was voiced in California. Most probably your revered former colleague and friend, Professor Herms, led the way in such thinking. At least we know that as early as March 1920, during the initial conference of the group which became the present Association, he delivered a paper entitled "Mosquito Control an Important Factor—The Development of the State's Resources and the Necessity for Coordinated Effort."

From the beginning, the mutual interests of the Abatement Districts, the State Department of Public Health, and the University of California were recognized. These agencies have worked together steadily toward a common goal. With the formation of the Bureau of Vector Control in 1946, even closer cooperation was achieved between public health and mosquito abatement interests. Such cooperation is easily understood since mosquito control, for the most part, is actually but a phase of public health and rural sanitation.

An awareness of the part played by other agencies (in contradistinction to that of individuals) in the creation of mosquito sources became apparent early in 1947 when a body was appointed by your Executive Committee to "acquaint authorities in Sacramento with the potential mosquito problem to be created by the Central Valley Project and to ask for cooperation to keep mosquito breeding to a minimum." Later in that same year, it was recommended that the Bureau of Vector Control obtain the services of a Public Health Service engineer to study and to follow the construction of the Central Valley Project and to make recommendations for the elimination and alleviation of mosquito problems that might be developed therefrom. This served as the basis for a soundly developing program of cooperation with water resources development agencies which is producing gratifying results in behalf of mosquito control interests.

The concept of the need for inter-agency cooperation and coordination stems from the awareness that certain public agencies were creating mosquito problems in the pursuit of their legitimate and important activities, while others, the mosquito-abatement organizations, were attempting to alleviate these same problems. Also, it was realized that still other official agencies were pursuing aims that would, with proper coordination, actually support or augment the aims of the mosquito-abatement agencies. Thus, Mr. Harold Gray, at the 1950 Annual Conference of the California Mosquito Control Association, suggested that since some of the worst mosquito irrigation practices, your group should seriously consider problems in California were created by excessive, faulty implementing joint action with other agencies such as the Division of Water Resources, local rrigation organizatons, farm advisors, soil conservationists, county commissioners, county road departments, and farmers' organizations. Furthermore, other Mosquito Abatement District Managers, such as Messrs. Ed Smith and Bob Peters, have led the way to broadening the scope of cooperation through their outstanding efforts to bring together the various groups concerned with water resources.

Past issues of the Proceedings and Papers of the California Mosquito Control Association annual conferences reveal an increasing interest and awareness in these matters of coordinated effort and conservation. While Mr. Gray continued to press strongly for the employment of sound methods in mosquito source reduction, he was joined by an increasing number of sound thinkers, all headed in the same direction. It is recognized, of course, that this approach includes a pressing need for basic biological studies and investigations and that the importance of insecticides should not be disregarded. Two years ago, at the 19th Annual Conference, Mr. John M. Henderson of the Public Health Service talked to you about man-made mosquito breeding and improper irrigation practices. He pointed out the need to initiate long-term programs for preventing man-made mosquito breeding; he stressed cooperation among agencies concerned toward the goal of conservation irrigation, and made a strong case for placing emphasis on reducing existing mosquito-breeding places and avoiding the creation of additional breeding sites. At the 1951 meeting, the keynote address prepared by Messrs. Frank Stead and Arve Dahl, of your own State Department of Public Health, analyzed progress in mosquito control and cooperation with other agencies. At this same meeting, Dr. F. C. Bishopp of the Department of Agriculture also emphasized the need in mosquito control operations for cooperation with other agencies and groups concerned with highway construction, irrigation, drainage, waterways improvement, and land development. Last year, a symposium on "Agency Cooperation and Mosquito Source Reduction" was heard, with participation by representatives from the Bureau of Reclamation, Soil Conservation Service, College of Agriculture, California Irrigation Districts Association, California State Department of Fish and Game, the California Water Pollution Control Board, and the Public Health Service. It is apparent that the basis for coordination of effort and for the development of water conservation measures has been established. It remains only for each and every organization represented here today to bend its efforts toward building upon this base for the purpose of formulating sound future programs.

Conclusion

Without any doubt, you will note that the carefully organized program closely follows the general theme, stated earlier, of placing emphasis upon the return to sound abatement methods by stressing water conservation and general source reduction. A quick perusal of the various titles therein reveals the consideration of such subjects as agriculture, irrigation, drainage, mosquito source reduction, water conservation, more water with fewer mosquitoes, and the like. I am sure that by the time the constructive panel discussions and critical analyses of the coming three days have been presented, we will go our individual ways a much better informed and a thoroughly inspired group. It is with this in mind that I am reassured of coming proof for the statement that, by coordinated effort and conservation, we will achieve the permanent

way to substantial and lasting progress in mosquito control.

Vice-President Peters: Thank you, Dr. Ware. We had hopes to have Dr. Fred C. Bishopp present a paper. He wrote a short letter which I would like to read some excerpts from. "I appreciate your willingness to make a place on the program for me, even at the last minute, and regret deeply that I will not be able to be with you. I trust that you will extend my regards to members of the Association, and I hope that your conference will be productive of much good. I trust that you will make it a special point to emphasize the desire of the officers and directors of the American Mosquito Control Association to have a large representation present at its meeting at Daytona Beach April 12th to 16th, 1953, and we appeal to you to make substantial contributions to the program. We will be pleased to give consideration in the program for contributions from various members of the California Mosquito Control Association. Not only is an excellent program in prospect at Daytona Beach but also a number of interesting tours of the State, including some of the excellent mosquito control work going forward there; an opportunity to visit the Orlando Laboratory of this Bureau where research on mosquitoes and other insects of importance is going forward on a large scale. Sincerely, Fred C. Bishopp, Chief of Bureau."

I will assume the responsibility of reading a short summary from Dr. Twinn, the President of the American Mosquito Control Association.

GREETINGS FROM THE AMERICAN MOSQUITO CONTROL ASSOCIATION

The A. M. C. A. had another active and successful year in 1952. The high point of interest, of course, was the joint meeting of the Association with the Utah Mosquito Abatement Association held in the Hotel Utah, Salt Lake City, on March 24 to 27, under the able leadership of our Past-President, Dr. Don M. Rees. Nearly 50 papers were presented and many of these were subsequently published in the June, September, and December issues of Mosquito News, the cost being largely covered by proceeds from the Salt Lake City meeting. A useful feature at the meeting was the distribution of abstracts of these papers in mimeographed form to all attending. The Mayor of Salt Lake City, the Honorable Earl J. Glade, gave an address of welcome and presented the incoming President of the A. M. C. A. with a Key to the City, made of Utah copper!

The excellent attendance (fully representative of North America), the high calibre of the papers presented, the interest and enthusiasm displayed at meetings of the Board of Directors and at the general business sessions, were a fine demonstration of the growing vitality of this splendidly useful international organization. It was with sincere regret that the Board of Directors accepted the resignation of T. D. Mulhern as Executive-Secretary. Tommy was presented with a handsome chiming clock as a token of the esteem of his fellow members. To replace him we were fortunate in obtaining the services of Ted Raley of Selma, California. He, and the Treasurer, Rowley Dorer, of Norfolk, Virginia, have done wonders in placing the business and finances of the Association on a sounder footing.

Another important event during the year was the publication, in March, 1952, of A. M. C. A. Bulletin No. 2, entitled "Ground Equipment and Insecticides for Mosquito Control." This 166-page bulletin is well written and authoritative and essential to all engaged or interested in mosquito control. It was prepared by the Miscellaneous Publications Committee of the Association and edited by Dr. E. F. Knipling. Arrangements are being completed to publish a third bulletin under the title of "Mosquito Rearing Techniques", the manuscript of which has been prepared by Miss Helen Louise Trembley.

On July 30 and 31, an informal summer field trip of the A. M. C. A. was held at Ottawa, Canada. The officers and regional directors of the Association were informed of this meeting in advance, and it was intended to give it wider publicity through Mosquito News. Unfortunately, the June issue was distributed too late for this purpose. However, a good representation of members attended and all reported they had a most enjoyable and interesting time under ideal weather conditions. A full report of the event appeared in the September Mosquito News.

On the invitation of the Pan-American Sanitary Bureau, Dr. F. C. Bishopp and Mr. Harry H. Stage were named to represent the Association at the First Inter-American Congress of Public Health, held at Havana, Cuba, on Sept. 26 to Oct. 1. This Congress was sponsored co-jointly by the Bureau and the Government of Cuba.

An application for Class B (non-dues paying) membership for the A. M. C. A. in the Agricultural Research Institute, Washington, D. C., was made on Oct. 21, and Harry Stage was named as the Association's representative in the event that the application is approved. The purpose of the A. R. I. "is to provide a mechanism for the collaboration of industrial, academic, and governmental scientists in promoting agricultural research and practices that will lead to the best long-time utilization of the nation's agricultural resources".

The A. M. C. A.'s Good Neighbor Club is still going strong under Harry Stage's enthusiastic leadership, and additional contributions are welcomed to place subscriptions of Mosquito News and distribute other pertinent publications to worthy organizations and individuals in less favoured parts of the world.

The next outstanding event in the A. M. C. A. calendar will be the joint meeting of the A. M. C. A. and the Florida Anti-Mosquito Association, at the Sheraton-Plaza Hotel, Daytona Beach, Florida, April 12 to 17, 1953. Local arrangements are in the hands of a committee under the chairmanship of Sam Minnich, President of the Florida Association; Dr. F. C. Bishopp, Vice-President of the A. M. C. A., is chairman of the program committee. Advance notices of the meeting have appeared in recent issues of Mosquito News. An exceptionally interesting, profitable and enjoyable meeting is assured, and we look forward to the pleasure of seeing many of you there.

Vice-President Peters: We are fortunate in having some out of state participation on our program, and we are always glad to see fellow workers from the State of Utah. Today we have two papers from Utah, the first of which is "1952 Flood Mosquito Abatement Problems in Salt Lake City", which will be presented by Robert Wilkins, Manager of the Salt Lake City Mosquito Abatement District.

Mr. Wilkins: Mr. Chairman and members. Like you, I am very sorry that there are so many of our leaders present vicariously today.

"THE 1952 FLOOD—MOSQUITO ABATEMENT PROBLEMS IN SALT LAKE CITY MOSQUITO ABATEMENT DISTRICT, UTAH"

By Robert A. Wilkins
Superintendent

It is with a keen interest that I attend this educational Conference, not that my chronological visualized method of bringing to your attention the great Salt Lake Valley Flood of 1952 with its ramifications and added mosquito production problems will contribute to your benefit, but rather because once again, I have the privilege of listening to the scientific papers prepared by your many experts.

I might excite your sympathy in our behalf, because of what appears from the history of this great flood in pictures, accompanied by the numerous opinions and demands and organized groups, with their attorneys, through the 11 days of this terrifying experience, and you might be moved to resolve that our District employees are wonder workers, and entitled to merit badges for great efficiency, since our City mosquito population was not much greater, according to light trap catches, than in normal years.

There is actually very little new to be suggested from our 1952 problems and methods of control by larviciding, adulticiding and dredging to reduce larval habitats.

Mr. Jay Graham will hold up Exhibits 1 to 9 as I read the summary of events.

Exhibit No. 1 shows pictures of the first day of the flood on April 26th, with accompanying newspaper articles. Here you may see the Emigration Canyon Bridge ripped apart, and the motor traffic jam in the downtown area, and the new waterway forming between 9th and 13th South Streets. Five hundred volunteers started the sand bag canal, from 5th East to the Jordan River, at 8th West. The City of Ely, Nevada offered 8,000 bags to avert disaster. Five draglines are hurrying the construction of the new drain 30' x 6', to Great Salt Lake 9 miles distant. It is now 25% complete.

The S. P. R. R. Engineer, D. S. Burns and Col. C. C. Haug, District Engineer, Army Engineer Corps from Sacramento, California, were on the job, ready to assist after local resources were exhausted and awaited Governor Lee's declaring a state of emergency.

Exhibit No. 2 shows the City's desperate fight to construct the 13th South sand-bag and dirt fill channel, against a 40 block inundation. Pools covering 4 square miles formed on the west side; streets and yards were also blotted out. The Jordan River southwest of the City, burst over its banks along a 10 mile stretch of its course. Secondary roads were all unusable north and west of the City in the principal mosquito production areas. From Spanish Fork 55 miles south, to Ogden 40 miles north, flood waters were rushing into Salt Lake Valley. 18,000 sand bags arrived from the Naval Supply Depot, Ely, Nevada. 1,000 men were on a 24 hour basis.

The Mt. Dell Reservoir overflowed 550 second feet, twice the creek's capacity. The Jordan River, Emigration Canyon, City Creek, Big and Little Cottonwood creeks, all carried twice their normal flow, causing great damage.

Exhibit No. 3 gives conditions on April 27th. Flood damage reached $1,000,000.00. The aerial views show the torrents flowing through the City, and the lakes formed on the west side. A warning was given in the newspapers that mosquitoes are coming! The picture shows our work crew, and trucks, clearing clogged drain channels. The hiring of four draglinee by the County Flood Control and the cooperative drainage committee speeded the new outlet to the Lake.

Mayor Earl J. Glade met with representatives of industry, business, City and County, State and Army officials and the Flood Control organization to set up operations to save the City 5 to 10 million dollars property damage.

Exhibit No. 4 shows conditions on the 50 block area which was flooded to prevent greater property damage elsewhere. Four hundred families were evacuated. The Jordan River was sand-bagged by L. D. S. Church welfare workers, and many other units were represented. The City granted an extra $50,000 for surplus dredging from 21 St. to N. Temple.

Exhibit No. 5, also of May 2nd, shows views of various phases of the flood havoc. The traffic jams still cause many hours of waiting for City workers.

Exhibit No. 6 shows the situation on May 3rd. Officials met and made flood controlling decisions. The mosquito problem of moving the stagnant water in low areas, after the high run off, into the 50 block area began. All possible methods were considered, and the final efforts drained this area, after only one application of larvicides by airplane being made. This low flying plane was sanctioned by special meeting of authorities controlling low flying in residential districts.

Exhibit No. 7 exhibits conditions on May 6th. The flood at the mouth of Weber Canyon near Ogden, Utah was equally as severe as in Salt Lake. The Churches directed the housing of 1600 flood victims. The usual aftermath of law suits began, eleven firms seeking $121,805.00 damages.

Exhibit No. 8 covers the period May 8-11th. The threat of greater mosquito production grew as the flood waters subsided, leaving extensive low lands covered with stagnant water. A group of Salt Lake City women volunteered to learn inspection methods, and to furnish their own boots and cars, in an effort to spot and report all small pools containing larvae within the city limits. Four pumps ranging from 4" to 8" size were manned by mosquito abatement employees three days and nights, during the emergency period, lifting water into the surplus canal.

Exhibit No. 9 is dated Ma 27th. President Truman granted $250,000.00 for flood aid. The flood water drainage was then nearly complete. Damage to city streets, bridges, drains and equipment was listed at $563,240.00, not including individual loss to residents and business.

Two mosquito articles appeared in the newspapers. Airplane spraying was found to be the solution of treating inaccessible areas. Secondary roads were still inundated, and trucks with power sprayers worthless. Inspectors were compelled to make long walks daily around the perimeter of lakes newly formed, to flag spot spraying by the airplane. Photo maps showing producing areas (in color) were used by the pilot, who was well acquainted with the district. This phase of our control was the most effective. Applying 0.2 lb. of DDT as 25% emulsible in water or oil as required, per acre, resulted in a very satisfactory control. Even considering two heavy migrations of mosquitoes into our City, from areas beyond our control, each lasting approximately six days duration, our success was above expectations. Light trap average catch was 5, and progressively away from the city the traps run the same nights averaged 12 in Murray 6 miles away, 22 in Midvale 12 miles away, and 35 at Riverton 20 miles away, all in a southerly direction.

Fish culture and planting is a regular phase of control and the 1074 residence pools, 90 drains, 30 lakes and 81

gutters were stocked with 31,813 *Gambusia*. 750 field pools required 14,926 gallons of larvicide. 87 depressions were eliminated by filling.

The airplane covered 4,442 acres, using 7,141 gallons of larvicide, at 2 gallons per acre. 2,000 Tossits were used. Drains cleaned with Tractor D-4 and ditcher were 17 miles 3477 feet. Drains cleaned by hand shovels were 9 miles 1305 feet. New drain constructed was 1 mile 300 feet. The dragline worked 6,248 hours under cooperative drainage, costing $82,163.03, dredging was 12 miles, 4755 feet and excavating 303,443 cubic yards.

Vice-President Peters: The next participant on our program is also a representative from the State of Utah and the title of that talk is "1952 Tests of Heptachlor for Mosquito Control." It is a paper written by Don Rees, whom we all know, and J. E. Graham, Field Supervisor for the Salt Lake City Mosquito Abatement District. Jay Graham.

Mr. Graham: Mr. Chairman and gentlemen. Sometimes I feel sory for you people out here who have a real bad resistance problem, when we in Utah can still get by with DDT and some of the other chlorinated hydrocarbons. This past year we did some work with Heptachlor and I have the report of that work now.

1952 FIELD TESTS OF HEPTACHLOR FOR MOSQUITO CONTROL

By Don M. Rees
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During the summer of 1952, several experiments were conducted with Velsicol Heptachlor in the Salt Lake City Mosquito Abatement District. All experiments were conducted in the field and were in acordance with the normal operational procedures of the district. This was done in order that the results might be applied to the control program without further modification if warranted. Whenever possible, additional observations were made as to the effect of the insecticide on other forms of life in the area, particularly the vertebrates.

Laboratory tests by Soroker (1951) have shown Velsicol Heptachlor to be 8.6 times as effective as D. D. T. against larvae of *Culiseta inornata*. Stage (1951) reports almost perfect control of *Aedes sollicitans* and *Aedes taeniorhynchus* larvae at 0.05 to 0.1 lbs. per acre. This is in accordance with results from California where 85% control of *Aedes nigromaculis* larvae was obtained with 0.04 lbs. per acre (Anon. 1951). McDuffie (1949) reports a 73% kill of *Aedes* at Churchill, Canada with a concentration of 0.2 lbs. per acre. At the present time there is no data available for pupal control with this insecticide.

Heptachlor was found to be effective against adults of several species when applied at the rate of 10 mg. per square foot (Yates 1950). According to Yates, heptachlor does not give immediate knockdown results but resulted in complete mortality in 24 hours.

EQUIPMENT AND PROCEDURE

The spraying equipment used while conducting these experiments consisted of a "Champion" knap sack hand spray pump with a 4 gallon capacity and a "Friend" power spray pump with a 50 gallon tank mounted on a truck.

Some experiments were performed under close supervision for greater accuracy, while others were performed by regular field crews acting on instructions but without direct supervision.

Following is a tabulation of the experiments:

Test No.	*Mosquito*	*Instar or Stage*	*Area*	*Ave. Depth*	*Amt./acre*	*Kill*
1.	*Culex tarsalis* 1-10 per dip	2nd and 3rd instar	0.60 acres	4 inches	0.13 lbs.	100%
2.	*Culex tarsalis* 1-50 per dip	2nd and 3rd instar	0.70 acres	4 inches	0.09 lbs.	100%
3.	*Culex tarsalis* 1-30 per dip	2nd and 3rd instar	0.90 acres	4 inches	0.046 lbs.	100%
4.	*Culex tarsalis* *Culiseta inornata* 24 per dip	1st - 4th instar Pupae	0.87 acres	15 inches	0.09 lbs.	99% Larvae 00% Pupae
5.	*Aedes dorsalis* 25 per dip	2nd and 3rd instar	6.20 acres	3 inches	0.04 lbs.	100%
6.	*Culex tarsalis* *Culiseta inornata* 1-15 per dip	1st - 4th instar Pupae	0.56 acres	8 inches	0.02 lbs.	80%
7.	*Culex tarsalis* *Culiseta inornata* 13 per dip	1st - 4th instar Pupae	0.65 acres	10 inches	0.094 lbs.	100% Larvae 00% Pupae
8.	*Culex tarsalis* 5-15 per dip	1st - 4th instar Pupae	0.72 acres	8 inches	0.16 lbs.	100% Larvae 00% Pupae
9.	*Aedes dorsalis* 50-100 per dip Adults very numerous	4th instar Pupae Adults	0.54 acres	5 inches	0.46 lbs.	100% Larvae 30% Pupae 99% Adults

The following experiments were performed by a larviciding crew acting on instructions but without direct supervision. On the 26th of August, 1 pint of Velsicol Heptachlor 25% emulsion was mixed with 40 gallons of water in the tank of a power spray. The areas treated were of several different types, including pastures, borrow pits and marshes. Altogether 9 areas were treated and 38 gals. of mix were used against larvae of the following species: *Culex tarsalis, Culiseta inornata* and *Aedes dorsalis*. The kill approached 100% in 24 hours.

On the 27th of August the same crew treated 6 different areas with ½ pint of the emulsion in 40 gallons of water. The species involved were *Culex tarsalis* and *Aedes dorsalis*. Of the 6 areas treated 5 were borrow pits or ditches containing stagnant water. The kill in these areas was 100% in 24 hours. The other area was a marsh in which 20 gallons of mix were used on 8.1 acres. This resulted in an average of 0.032 lbs. of heptachlor per acre. The results were not satisfactory. Some parts of the area had a mortality approaching 100% while the kill in other parts was less than 50% when checked at 24 and 48 hour intervals after treatment.

TOXICITY TO OTHER ANIMALS

In all of the areas tested with Heptachlor, observations were made as to the toxic effects to other animals. In no case was any harmful effect noted, either by the men doing the work or by the owners of any livestock that were in the area. At the heavist concentration used, less than ½ pound per acre, no ill effects were noted on frogs or wild ducks that were in the area both before and after treatment. Lehman (1951) reports the LD 50 for heptechlor to the rate as 90 mg/Kg with symptoms of poisoning similar to aldrin, dieldrin and chlordan.

SUMMARY AND CONCLUSIONS

Velsicol Heptachlor emulsion was used against 3 species of mosquitoes, *Culex tarsalis, Culiseta inornata,* and *Aedes dorsalis,* in the vicinity of Salt Lake City during the summer of 1952. The insecticide was applied by both hand and power sprayers in concentrations varying from 0.02 lbs. per acre to 0.46 lbs. per acre. No difference in the results was noted for any of the 3 species of mosquitoes involved in the experiments. Against larvae a control of 80% was obtained with 0.02 lbs. per acre, and 100% control was obtained with 0.04 lbs. per acre and all higher concentrations. Pupal control started at 0.46 lbs. per acre but the kill was only 30% at this concentration. Further experiments on pupal control were not conducted. Almost perfect adult control was obtained with a formulation of 0.8% Heptachlor in water and used as a liquid spray.

Heptachlor is an effective and economical insecticide when used against larvae and adults of the above named species of mosquitoes but is more expensive than #2 fuel oil when used in sufficient amounts to destroy pupae.

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Vice-President Peters: The next paper on our program is entitled "Observations on the Seasonal History of Aedes squamiger" and it will be given by Dr. R. M. Bohart, Assistant Professor of Entomology, University of California, at Davis.

Dr. Bohart: Basic to insect control is the knowledge of the biology of each pest. I think that it is a fair statement that we do not have completely satisfactory detail of the biology of any of the California species of mosquitoes. The other authors on this paper, Mr. Mezger and Mr. Telford, and I have made some recent observations on the life history or seasonal history perhaps of *Aedes squamiger,* and I think that these remarks should be of some interest and for that reason I hope that you will forgive the injection of a few remarks on mosquitoes into this conference devoted almost entirely to the control of water.

OBSERVATIONS ON THE SEASONAL HISTORY OF AEDES SQUAMIGER

R. M. Bohart[1], E. C. Mezger[2], and A. D. Telford[3]

In 1902 D. W. Coquillett gave the name, *Aedes squamiger,* to a previously undescribed species from Palo Alto and San Lorenzo, California. An early record of the habits of this species was given by H. J. Quayle in 1906 and more detail was added by H. J. Lowe, working as entomologist for the Alameda County Mosquito Abatement District, in 1932. However, it was not until Bohart in 1948 distinguished between all larval stages of *squamiger* and its co-breeder, *A. dorsalis* (Meigen), that it became feasible to study critically the habits of the aquatic phase.

Although several papers, such as that by Aarons, et. al. (1951) have dealt with the habits of adults during the spring and summer, there is a decided paucity of information on the fall and winter activities of salt marsh mosquitoes of the Pacific coast. The erroneous opinion of Quayle (1906) that "the eggs remain over winter and hatch the following February or March" was finally laid to rest when the senior author found mature larvae at Bolinas, Marin County, in December of 1948 and 1949, and newly hatched larvae on October 27, 1950. This led to a theory that *squamiger* hatches with the first flooding fall rains. Additional proof on this point was found by E. Mezger, who collected newly hatched larvae on November 9, 1951, and by the authors who found first and early second stage larvae on November 21, 1952, after the first rains a week previously.

The purpose of the present paper is to set forth actual data dealing with a typical salt-marsh on a seasonal basis. The information has been gathered for *Aedes squamiger*

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during a single fall and winter season with the following objectives: (1) to determine whether a hatch occurs after each rainy period or, contrarily, if there is a succession of generations; (2) to record the duration of the larval and pupal periods; (3) to investigate variation in salinity as it relates to larval development; (4) to ascertain the nature of the progressive change in population composition; and (5) to observe the changes in ratio of numbers of *squamiger* and *dorsalis*.

Procedure

A typical salt marsh near Bolinas, California, was selected for the larval population studies. This salt marsh is ideal for natural habitat studies as it is not in a Mosquito Abatement District, and except for the limited grazing of cattle it is practically unaltered by man's activities. The area under observation is affected bimonthly by high tides which, if augmented by the winter rains, periodically flood the entire marsh.

The observational area was visited during the fall and winter season (September 15, 1952-February 15, 1953) shortly after each significantly rainy period. Fortunately these intermittent rains were rather evenly spaced, affording us a good chronological picture of population progress through the winter months.

Random samples of the larval population, totaling 400 to 500 individuals, were taken from areas considered to be most representative of the natural habitat. The samples were checked in the laboratory, and the larvae were segregated to species by means of the lateral saddle hair character for all stages, as described by Bohart (1948). The number of each instar of each species, and the total number of each species was then recorded for a final comparison.

At each point upon the marsh from which a sample was taken, a record was made of the salinity of the water medium. This was accomplished by means of a previously calibrated specific gravity hydrometer.

Results

Table 1.—Percentages of the various stages of *Aedes squamiger* collected from November 21, 1952, to February 3, 1953.

	Larva				Pupa	Per Cent
Date	I	II	III	IV	V	Salinity
November 21	98.0	2.0	—	—	—	2.7 -3.5
December 10	70.2	28.8	0.8	0.2	—	0.23-0.38
December 29	26.7	38.4	30.8	4.8	—	0.15
January 16	1.4	9.5	38.8	51.0	—	0.12-1.05
February 3	—	0.9	12.0	67.4	19.7	0.15-1.37

The larval and pupal data in table 1 have been treated graphically on Chart 1 and compared with rainfall. It should be pointed out that *A. squamiger* larvae mature slowly during the winter but nevertheless each of the five figures given for the first stage represents a new batch, as the previous brood has advanced one or two instars. With this in mind it can be concluded that at Bolinas this year major hatches took place following the first three periods of heavy rain. Subsequent rain produced very few larvae. No adults or pupae were observed before February and, therefore, a succession of generations during the winter is out of the question.

During the period of observation, temperatures did not appear to have an effect on hatching of *A. squamiger*. On the other hand they of course affected the minimum larval and pupal period which can be calculated at about 48 days during which time the mean temperature was 51.5 as measured at San Rafael.

The relation of salinity to the life history of *A. squamiger is* not entirely clear. Its importance can be judged by the fact that the distribution of the species is restricted to salt marshes or their immediate vicinity. There are a few records of larvae being taken from non-saline pools but accurate water analyses are not known for these cases. In our experience salinities in the neighborhood of 0.1 per cent are difficult to detect by the taste method. Observed salinities in pools containing *squamiger* larvae at Bolinas are given in table 1. The rather high November salinities, approaching those of sea water, were probably a result of excessive evaporation following the rains of the previous week. During the three months observation period six tides of over 5.5 feet were recorded. Each of these raised the water level on the marsh and doubtless contributed to its salinity but at present we have no evidence that tides alone, without rainfall, will promote a hatch of *A. squamiger*.

Population composition is affected by a series of overlapping broods and the progressive change in the 1952-53 season is illustrated by the bar graphs on Chart 1.

The relation of *squamiger* and *dorsalis* on salt marshes during the winter is an interesting subject in need of clarification. Our records over a period of years in the North San Francisco Bay Area indicate that *dorsalis* larvae are present in small numbers and in various stages throughout the winter. A large hatch takes place in early spring and adults of this brood often appear about the same time as those of *squamiger* which have been developing over a much larger time. This season's data are in agreement with observations of previous years. Larvae of *dorsalis* made up 1.0 per cent of the total *Aedes* catch on November 21, 1.4 per cent on December 10, 2.6 per cent on December 29, 20.6 per cent on January 16, and 10.7 per cent on February 3. Most of the January 16 specimens were in the first stage representing a recent hatch and on February 3 specimens from the same pools were mainly in the third and fourth stages with an occasional pupa.

Summary

Data is given on the development of Aedes *squamiger* during a single fall and winter season at Bolinas, California. Three main hatches were observed following major rainy periods and later rain produced very few *squamiger* larvae. The minimum developmental period of the aquatic phase during the relatively warm winter was about 48 days. Salinities varying from 0.12 to 3.5 per cent did not appear to affect progress of the larvae. The progressive change in population composition from first stage larvae to pupae was conditioned by a series of overlapping broods within a single generation. Less than 3 per cent of the total *Aedes* larval population was *dorsalis* during the six weeks after the first fall rains but this changed to about 20 per cent at 8 weeks and about 10 per cent at 11 weeks.

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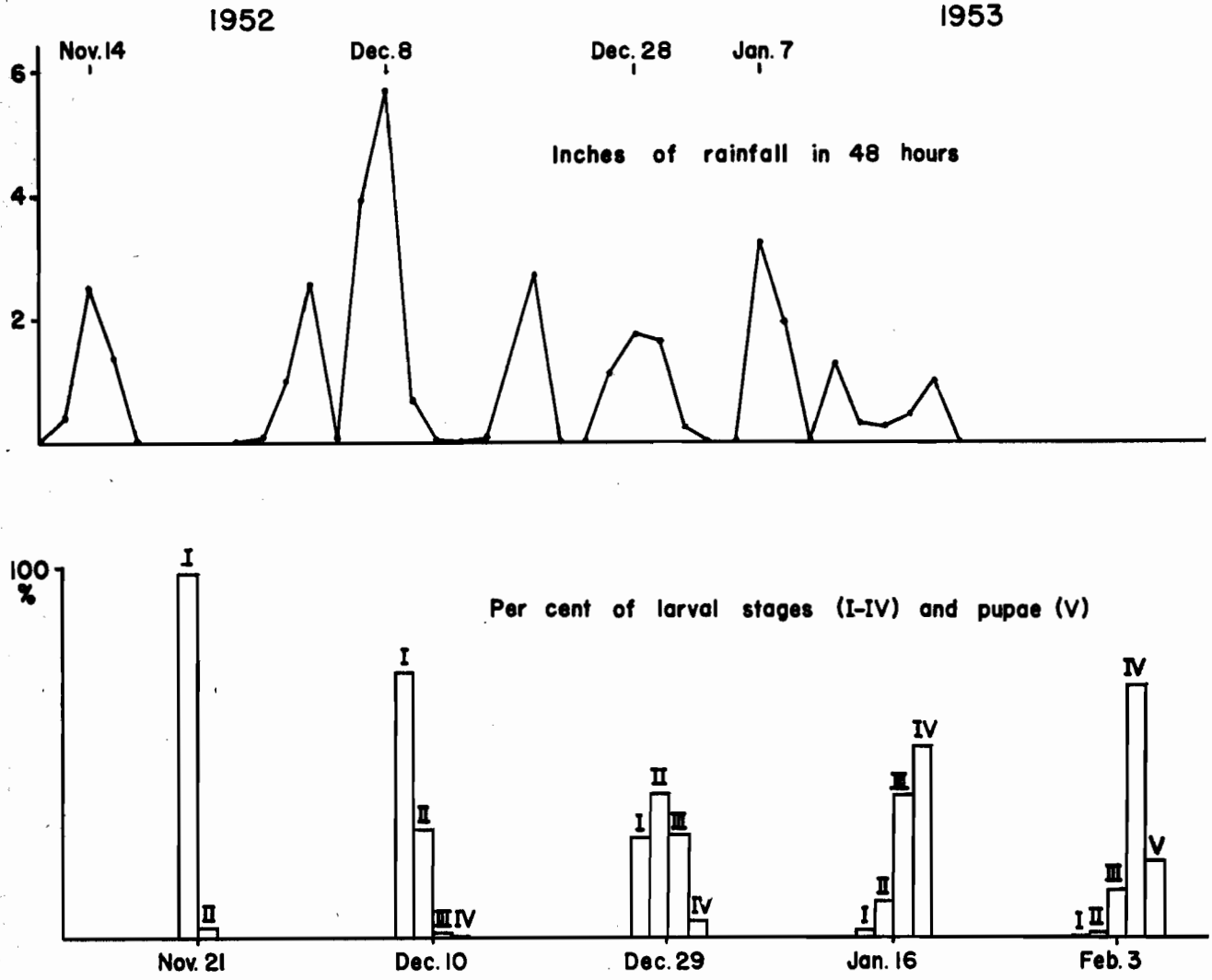
Chart I. Development of aquatic stages of Aedes squamiger (Coq.)



Vice-President Peters: The next topic on our program is "Organic Phosphate Insecticides—Their Advantages, Limitations and Hazards in Mosquito Control Work." I am sure that none amongst us is more qualified than the man who is going to present this paper, Art Lindquist, Entomologist in Charge, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Corvallis, Oregon.

Mr. Lindquist: Mr. Chairman, mosquito control workers and friends. Mr. Julian, who most of you know, a member of our staff at Corvallis, is not able to attend this meeting for the reason that he is on a special assignment at the United States National Museum in Washington, D.C. for a critical economic evaluation of some of our mosquitoes from Alaska. Mr. Yates, a member of our staff for many years, retired from government service last November. As you know, he has been interested in the activities in mosquito control work in California for many, many years. I think he is enjoying his retirement; he had a little illness or perhaps we could have persuaded him to be here at this time.

ORGANIC PHOSPHORUS INSECTICIDES—THEIR ADVANTAGES, LIMITATIONS, AND HAZARDS IN MOSQUITO CONTROL WORK
(Abstract)

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Mosquito Resistance to Insecticides.—Resistance of insects to insecticides has grown during the past several years from local difficulties to nation-wide problems. House flies were found to have developed resistance to DDT and other materials and it was not long until every part of the country found house fly control by insecticides difficult or impossible. Reports of troubles in controlling mosquitoes soon appeared and it was quickly demonstrated by laboratory and field work that mosquitoes were actually resistant to DDT in California and Florida.

There is evidence that the resistance of mosquitoes to insecticides is a rapidly growing problem. It is apparent that mosquito resistance is spreading in California and reports indicate that some species in other states are not

as easy to control as before. Obviously, mosquito control resistance is cause for alarm to mosquito control workers, to research people, and to the general public.

Mosquito workers in control districts are especially concerned. They are the ones who are directly responsible for control of mosquitoes with funds supplied by the local constituents. They have done a good job and now suddenly find their efforts are not producing maximum results; their weapons have lost fire power. Funds, men, and equipment totaling millions of dollars are involved. It is not surprising, therefore, that people are alarmed.

It would seem that we need to take stock and examine carefully all new methods and materials proposed for mosquito control. We must study toxicity hazards, evaluate effectiveness of chemicals, study the costs involved, and determine if new materials have a place.

Fortunately a few substitute chemicals have appeared which show bright promise in the control of resistant mosquitoes, at least for a period of time, perhaps two to four years. A few of the organic phosphorus insecticides have been tested and one especially, EPN, has been demonstrated to be highly effective. Many organic phosphorus compounds are available and they have varying degrees of insect toxicity as well as mammalian toxicity.

Gjullin *et al.* (1953) found in laboratory studies that EPN is 67 times more effective than DDT on resistant *Aedes nigromaculis* and 171 times more effective on resistant *Culex tarsalis* on an LD-50 basis. EPN was 30 and 29 times more effective than malathon on these species (table 1).

This work shows something that is of special interest to us. The suspension made from a wettable powder gave as good results as the emulsion. At 0.035 pound per acre 99 and 100 per cent control was obtained with the wettable powder. Preliminary work at Corvallis indicates the EPN wettable powder gave unusually good results when compared with an emulsion. Ordinarily wettable powders do not give as good kill of mosquito larvae as emulsions or oils. The important thing here, however, is that EPN wettable powder is not nearly as great a toxicity hazard to operators as is the emulsion. Perhaps we should study these findings further.

The matter of costs is important in mosquito control. Comparative commercial prices for these insecticides are not available but it is anticipated that variation exists and that control districts must make a careful evaluation of what they get for funds expended.

TABLE 1—*Parts per million of some phosphorus and DDT insecticides required to give a 24-hour LD-50 of resistant fourth-instar mosquitoes collected in Kern County, California*

Insecticide	*Aedes nigromaculis*	*Culex tarsalis*
EPN	0.000862	0.000649
Tetra-n-propyl dithionopyrophosphate, NPD	.0625	.0178
Malathon	.025	.0185
DDT	.0588	.111

In field tests EPN emulsion was 12 times better than Malathon on *A. nigromaculis* and about 20 times more effective on *C. tarsalis* (table 2).

TABLE 2—Field tests of organic phosphorus larvicides on four instars of *Aedes nigromaculis* and *Culex tarsalis*. Average of 2 to 5 replications.

Insecticide	*A. nigromaculis*		*C. tarsalis*	
	Pounds active ingredient per acre	Per cent mortality (24 hr.)	Pounds active ingredient per acre	Per cent mortality (24 hr.)
EPN:				
Emulsion	0.035	99	0.035	100
	.025	95	.025	98
	.01	89	.01	97
			.005	57
Suspension	.035	99	.035	100
	.025	98	.025	100
	.01	55	.01	97
			.005	70
Malathon emulsion	.4	99	.3	83
	.3	92	.2	97
	.2	83	.1	67
Tetra-n-propyl dithionopyrophosphate emulsion	.4	93	.3	99
	.3	89	.2	77
	.2	87	.1	76

A Review of Toxicity Studies.—Toxicologists have been studying some of the organic phosphates and the following information has been assembled from various sources. Obviously, toxicologists must work on laboratory animals—rats, mice, rabbits, and the like. The effects of various dosages of chemicals on these animals are compared so as to determine a toxicity rating. These figures serve as a basis in determining if the compound can be used in practical insect control.

In table 3 are given some data on the effect of a few organic phosphorus compounds on mice, rats, and rabbits. It will be noticed that toxicologists use several routes of administration of the toxicant, and that they differ in effect with different compounds. Also sex differences in susceptibility are indicated, as, for example, intraperitoneal administration of EPN on rats. Dermally the figures show technical parathion and EPN to be about of the same order of toxicity. Work with wettable powder shows a much higher safety margin. Frawley reported the LD-50 of EPN wettable powder to be 2000 mg./kg. on rabbits. Malathon figures for dermal application show enormous dosages necessary to kill (2460 mg./kg.).

Two-year feeding tests by Dr. H. C. Hodge, University of Rochester, showed no growth suppression of male rats on a diet of 150 p.p.m. for female rats. EPN at 450 p.p.m. showed similar injury to parathion at 50 p.p.m. on male rats.

Analysis of Hazards.—If EPN is adopted for use as a mosquito larvicide by organized mosquito control agencies workers can perhaps take advantage of the experience gained by the agricultural workers. Several organic phosphates have been used on agricultural insect pests for several years. The materials have been applied at rates of 0.5 to 1.5 pounds per acre. The use of insecticides in mosquito control is different from general farm usage of insecticides in that the district leaders have direct control of the few people who handle the material. Already EPN has been used in large-scale mosquito control work by the Kern County Mosquito Control District. Ex-

TABLE 3—*Toxicity of some organic phosphorous compounds to laboratory animals (data obtained from the literature)*

Compound	*Acute oral mg./kg.*	*Dermal minimum fatal dose, rabbits mg./kg.*	*Intraperitoneal mg./kg.*
Parathion 97% Tech.	5 (rats) 6 (mice)	40-50	4- 7 (rats) 5-10 (mice)
EPN	35-45 (rats)	30-40 1050*	108 (rats M) 26 (rats F)
	45 (mice)		58 (mice)
Malathon 90% Tech.	479 (rats) 885 (mice)	2460	750 (rats) 473 (mice)

* Wettable powder. Frawley reports LD-50 of wettable powder to 2000 mg./kg.

cellent mosquito control was obtained and as far as is known, no injuries to operators or others occurred.

The first hazard is to the operator himself when making dilutions. It does not seem that this hazard should cause too much alarm. Thought should be given to reduce high concentration of insecticides before the field men use the materials. Care should be exercised in applying the diluted material.

There does not seem to be a residue problem with the phosphorus compounds, at least at dosages of 0.1 pound per acre or less, although further information is needed on this point. The materials deteriorate rapidly and livestock feeding on grass sprayed with these insecticides are not likely to be injured. EPN did not cause injury to cattle grazing on pastures sprayed six times (Gjullin *et al.* 1953). It goes without sawing that mosquito workers should not apply sprays to animals or people.

The conditions under which organic phosphorus compounds are used in mosquito control appear to be much better than with agricultural sprays. The used is under direct control of competent leaders. The amounts used per acre are small and generally less than required in controlling agricultural pests. The final dilution of applied spray is low in concentration.

The problem of formulation is important and it appears that serious consideration should be given to the use of wettable powder even though some change in equipment is necessary to handle the suspensions. Granular formulations may turn out to be the best preparation, provided practical and economical equipment can be developed for their dispersion.

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Vice-President Peters: I am sure that all of us will be wanting to ask Art Lindquist questions during the progress of the conference on this subject. George Umberger, would you care to take over at this time?

Mr. Umberger: One of the highlights of the morning all of us have been looking forward to is the message from our Governor of the State of California. I take pleasure in introducing Mr. Fairbanks, Secretary to our Governor Warren.

Mr. Fairbanks: I think it indicative of the interest that Governor Warren has in the work of the mosquito control districts throughout the State that he accepted your invitation to come here this morning to say a few words of welcome to you. Unfortunately the Governor was called to an emergency meeting of the Board of Regents in southern California yesterday. He thought he would get back in plenty of time, but it was a very late occasion and he did not get to bed before three o'clock in the morning and he did wake up this morning with a very bad throat and so he asked me to tell you that he was awfully sorry not to be able to talk to you personally this morning. Governor Warren has a tremendously busy schedule. He makes it his business to be interested in just about every activity that goes on here in California. I think that the Governor being born and raised in the central valleys of California certainly is fully aware of the tremendous amount of vital work that is being carried on by the Districts in your 38 years or more of activities. He certainly has spoken to me often about the subject in relation to the problems of growth that we have here in California. You know we have a paradoxical situation; he knows that and it is those things that he is constantly looking toward in mapping his suggestions for legislation and in the administration of state government. We are adding here in the State a city the size of Los Angeles every six years, or a city the size of Oakland and San Francisco every three years. I don't believe there is any time in such meetings as this or in others that constantly people are not referring to the tremendous problems that are accompanying the growth of the State. Certainly you can see in it your efforts. We need to grow; we need the economy that goes along with that growth, and most certainly the basis of that economy is water. We are looking towards the future development of every drop of water in the State. We need it badly not only for agriculture but for the expansion of our industries and for the extension of our municipalities. But along with the development of water, along with the additional acreage brought under irrigation, with the additional acreage brought under rice culture, the crop lands, and the irrigated pastures, most certainly we are creating and have created here in the last few years an environmental situation that is favorable to the breeding of mosquitoes. So on the one hand we must develop, on the other hand we have the problem of wisely using this water in every possible way so as to make the job of the mosquito control districts easier.

If there is a challenge that you have not already accepted it is that challenge as an Association, and as mem-

bers working in the Districts throughout the State, of working cooperatively not only with all of the ramified governmental agencies at the state and federal level, but also with the many organizations and groups that are interested in this problem at the local level, and with the individual farmers and users of water at the individual level. We must work cooperatively so that we may develop as we must develop in the State of California but still have some sort of harmony between the development and this particular problem of control of mosquitoes and of the hazards that go along with it. The importance of your work is certainly demonstrated, and I have heard the Governor often repeat this, particularly in his Council meetings that he holds once a month when he gets all the departmental directors together to become current on things that have happened during the month. The thing that has emphasized the importance of your work is this serious outbreak of encephalitis last summer. Had we not had efficient districts which could undertake the emergency work that you undertook this last year, he is certain, and I think that all of us are certain, that our suffering and loss of life this last summer would have been much more pronounced. If there is some manner in which that problem and the problems that will face us again next year and in the years to come can be solved, they can be solved only through the continued operation of these Districts and through the diligent and progressive work that you men have been doing for many, many years. May I say again in behalf of the Governor that he is deeply sorry that he can't be with you personally this morning and he extends to you his greeting and his welcome and he hopes very definitely that your meeting here in Sacramento and at Davis will be enjoyable and profitable for each and every one of you.

Mr. Umberger: Thank you, Mr. Fairbanks. I will now turn the meeting back to you, Bob.

Vice-President Peters: Chapter 2 of our progressive cooperative relationship between mosquito control and agriculture will be written this afternoon at Davis. We would like every one of you to make it a point to be there and try to get there by 1:30. We must be prompt and carry the meeting along in rapid order upon arrival. The meeting this afternoon will be held in the Home Economics Building. I would like to have the persons who do not have transportation to kindly raise your hands now and those amongst you who do have transporttaion will you kindly make arrangements with them at this time. Are there any announcements from the floor? If not, then the meeting will be adjourned until 1:30 when we will meet at the Home Economics Building at Davis.

SECOND SESSION
WEDNESDAY, FEBRUARY 11, 1953, 1:30 P.M.
UNIVERSITY OF CALIFORNIA AT DAVIS

Vice-President Peters: Our meeting this afternoon will be dedicated to the second chapter of our cooperative educational undertaking, in which the Agricultural Extension group and the mosquito abatement agencies will compare notes. We hope that both of us will profit from the experience. I will introduce first Dr. Fred N. Briggs, Dean of the College of Agriculture of the University of California at Davis.

Dean Briggs: Mr. Chairman and gentlemen. We are happy that you have decided to spend at least a half day with us on this campus. I know that it must be the first trip for many of you. We are in the newest building on the campus and it is actually the first time I have been in this auditorium myself, except to just look in the door. We cannot lay claims to calling Davis or the University campus a convention city, but I think we are rapidly approaching the point where we can call it a conference city because during the past ten days or two weeks we have had a series of conferences here, as many as four in one day. That is the most we did have, as far as any one knows, in any one day at which there were probably fifteen or sixteen hundred people in attendance at the four conferences. I inadvertantly signed up to make some remarks at all four of them before I got wise to the fact that they were all on the same day and at the same hour; however I did manage to make three in about twenty minutes.

All of you, or certainly most of you, know better than I the size and ramifications of the problems created by mosquitoes. One of the earliest things that we learn in life is that mosquitoes are a pest as far as the human is concerned even though they may be harmless in other respects. Some of the relations of the mosquito to public health have been dramatically demonstrated in reference to yellow fever, malaria, encephalitis and so on, so that there is not much that I could add to that. We do come to the matter of associating mosquitoes and water. In California, in fact in the west, we also think of water and agriculture. On that I'd just like to comment a little on agriculture with reference to water, and to see if at times water doesn't have something to do with your problem. At the present time we irrigate about 7% of the total land in California, and that 7% of the land produces more than 80% of our agricultural wealth. We are committed to a policy of increasing our water resources for irrigation, which means that we will be irrigating more and more land in order to produce more food. That we all know we are going to need as our population continues to grow as we have every reason to think that it will. We are going to plant more land under irrigation. There will be more waste water in connection with irrigation water to stand in ditches and puddles and to increase the possibilities of even larger numbers of mosquitoes. The University is dedicated to the policy of avoiding waste in water and using the water resources we have more wisely, and if we could get a wide scale of acceptance of that idea there would not be so much waste water because no water would be put onto a field than could be used. Of course rice could be an exception, but if we can get a wide scale of acceptance of more careful irrigation it should be of great assistance to you.

Vice-President Peters: Thank you, Dean Briggs. The first paper on this afternoon's program will be "Agriculture and Mosquito Abatement Progress," by John J. McElroy, Director of Programs, Agricultural Extension Service.

AGRICULTURE AND MOSQUITO ABATEMENT PROGRESS

JOHN J. MCELROY
Program Director, Agricultural Extension Service, University of California, Berkeley

We live in a complex society with a multitude of needs. As a result, we have a complex social, political, and institutional organization. We—the State Department of Public Health and the Mosquito Abatement Districts Association, and the University of California—meet this afternoon as two agencies of government with interrelated interests.

Earlier on this program Dean Briggs forcefully pointed out that a growing population and a growing agricultural economy will bring growing problems. He emphasized that the development of irrigation will mean more irrigated crops and more possibilities of places for mosquitoes to breed. At the conference held on this campus last October, the purpose of which was to develop something of the principles of agriculture as the related to mosquito populations and mosquito control, we learned a number of important lessons. First, we learned something of each others organizations. We must know the purposes and objectives, the organization and the manner in which we work, if we are to achieve any degree of related action. Understanding each other is fundamental to good working relationships. We learned that we had common areas of interest. We are both interested in the agricultural economy as the basic economy of the state. We both wish to see it expand to feed the growing population of California and to increase the wealth of the state. We recognize that, in order to accomplish this, irrigation must play a considerable part in our agriculture. We are both interested in getting the water on to the land, into the soil, and off the fields. That is essential to good agricultural practice and to the reduction of mosquito populations. We learned that while the mosquito is a problem in California, we in our anxiety to assist the agriculture of the state had not too well recognized this problem in our teaching or in our publications. You in your anxiety to accomplish the purposes for which the legislature provided were cognizant of the need for knowledge of agricultural principles.

The Land-Grant College is a peculiar institution. It is unique among the institutions of higher learning in the world. It is an institution of three purposes—research, education, and Extension. Research is the finding of new knowledge. Education is the development of leadership. Extension is the extending of new information to the practical problems. This institution has conducted research related to mosquitoes—some of it basic and some of it applied. One has only to scan this group to spot the faces of those who have been trained on the campuses of this University. The very purpose of this meeting this afternoon is that of Extension—the bringing of newer information to you and to afford an opportunity to help you understand it in a manner in which you can apply it to the problems before you.

The Extension Service, which is the branch of the University carrying out this third purpose, is a part of the Division of Agricultural Sciences. It is an educational organization. It has no power to enforce its teachings. It can bring to people new knowledge, it can interpret the findings of many pieces of research into practical suggestions, it can help furnish understanding, but the decision for action depends upon those who receive this help. The Extension Service can furnish the elements for decision but the cooperator must make the decision.

There are ways in which we can work together to more efficiently serve the taxpayers who provide for both services. The information and the knowledge we have, the educational drive we make for the development of the agriculture of the state, and the effort which you make to control mosquitoes in the interest of savings to agriculture, public health, and the general well being of the citizens of the state can well meet and join hands. The University of California and the California Agricultural Extension Service are committed to the policy that the county Extension program must be locally developed through the cooperation of the local Extension staff and the citizens of the county. It must be fitted to the needs and the desires of the local people. The Extension Specialist and the research worker on the College contribute by assisting the local staffs and the local people in the development and the carrying out of such a program. Therefore, it would seem that the first point of contact would be that of the development of local programs of cooperation. You are certainly free with your Boards of Directors, who are local citizens, to explore the possibilities of such cooperation within each county. Each county Extension office is certainly free to cooperate as an education agency and, I can assure you, will be encouraged to do so by the specialist staff of the Extension Service and by those members of the University staff who recognize and are interested in the problems of mosquito control.

Later on in this program, John Spurlock, County Director of Extension in Sacramento County, will discuss for you a program of cooperation and integration understood and desired by the people in Sacramento County. This kind of cooperation can well become a model toward which we can work. It is sound because it comes from local sources. It will be lasting because there will be local responsibility. It will be effective because there will be local interest.

There can be encouragement and counsel from the state level. The Bureau of Vector Control and the State Organization of Abatement Districts, the Extension Specialists and the Experiment Station, can exert a great influence in the development of local understanding and cooperation. Our first task is to educate ourselves, to develop our own understanding of the purposes and objectives, and the possibilities and limitations of each other. Accomplishing this, we can develop effective and efficient ways of supporting and complementing each other that we will better serve the public, secure the support of those we seek to serve and bring about general satisfaction. It is by such working together that we best discharge our responsibilities as tax-supported citizens and agencies.

Vice-President Peters: The next subject on our program is one that we thought so important in our previous meeting that we wanted to kick it around a little more. The panel discussion is "A Review of Pasture Problems: Preparation, Irrigation, Drainage and Good Feeding Practice."

The moderator of this panel is a man who is firmly attached to mosquito abatement work. He has been a Trustee of a mosquito abatement district, and a Director of the California Mosquito Control Association, an officer of the United States Public Health Service, and has had a wide experience with mosquito control in several parts of the world. I take pleasure in introducing Dr. Stanley B. Freeborn, Provost of the University of California at Davis.

Provost Freeborn: Mr. Chairman and gentlemen, it is a real pleasure to get my fingers into mosquito control a little bit. I really think that Dean Briggs should have been the leader of this panel, as he is primarily an agronomist and the panel is concerned largely with the management of land and its crops. However, I am willing to occupy this seat because I understand that all a moderator has to do is to introduce the panel speakers. However, before I do so, I'd like to emphasize Mr. McElroy's statements concerning the relationship that should exist between the University, particularly the College of Agriculture, and mosquito control efforts. They are one and the same thing. It's almost unbelievable that the College of Agriculture shouldn't be connected with mosquito control work. If

history is any criterion, the first work that was done in mosquito control in the State of California was done by a professor at the University of California on his own (Professor Quayle), who undertook salt marsh control in the peninsula area in San Mateo County. And then of course the one man who carried mosquito control single handedly on his own shoulders for years and years before the State Department of Public Health, or anybody else in fact, was considering its possibility, was Professor Herms, who had, in danger to his personal safety, carried on mosquito control in some areas that were so hostile that he was threatened with being run out of town if he came around there and talked about malaria or mosquitoes. He carried that single handedly for many, many years until the State Department of Public Health became interested in it, and from then on it was a cooperative mission in the control of mosquitoes. I'm so happy to see that now we are getting to the point where the people who are primarily interested in irrigation and the people who are primarily interested in mosquito control can come together and discuss these problems for their mutual benefit. Anything that is good for mosquito control work is good for agriculture, and anything that is good for agriculture in the way of drainage is first class propaganda for mosquito control.

I would like to ask the panel to come down and take its place here. Mr. Booher, Dr. Peterson, Mr. Herms, Mr. Spurlock, Mr. Geiberger, Mr. Umberger, and Mr. Myers. It is my understanding that each member on the panel has a specific phase of this problem that he will present. They will take five minutes each to present their statement; you make notes of anything that you disagree with or anything that you want to ask questions about. I'll guarantee to get them through within the required forty minutes that these people have at five minutes apiece, plus what time I take in the interim, and then we'll have time left to fire those questions at these people, addressing them either to the panel as a whole, or preferably to the person who made the statement about which you are particularly interested. The first man on the program is Mr. L. S. Booher who is the extension specialist in irrigation. It is his job to keep the farm advisors of the various counties advised on good irrigation practices, to take the new practices, review them and bring back their problem to the University.

Mr. Booher: My field is primarily irrigation engineering, and I am very much interested in the relation of mosquito control to irrigation. The original mosquito control work in the irrigated areas in California was done mainly by drainage of excess water from the lands, supplemented by oiling where necessary. It was primarily an engineering problem. But about seven years ago we came into a stage of insect control by the new insecticides, and during this period the emphasis has not been placed on the engineering phases of mosquito control. The people were given false hopes that these miraculous insecticides would do the job effectively, but these hopes have failed to materialize. Now we are coming back again to the most effective means of controlling mosquitoes, which is by draining excess water from land surfaces. We have quite a problem on our hands in revitalizing this basic aspect of our work, for due to those false hopes based on chemical control we are nearly back to where we were fifty years ago in educating the people to the need for drainage.

We in the University Extension Service are working on this problem, trying to educate the farmers how to get rid of excess water, particularly surface water, not only for the control of the mosquitoes but to increase their income. I feel that if you can appeal to the pocketbook, showing the farmer how he can increase his income by drainage, you have gone a long way toward convincing him as to the need for drainage. Fortunately good agriculture and effective mosquito control go hand in hand. There is no area of controversy between your work and ours. But it is primarily a job of educating the farmers.

Some of the problems we are working on are proper slopes and proper lengths of runs for the most efficient use of water, and the effective removal of excess water which collects at the lower ends of irrigated fields. For years I have been convinced that drainage and irrigation go hand in hand—they cannot be separated. If you are going to put water on a field you must have some means of taking off any excess water. While we would like to see the farmer use only enough water to wet the soil to the proper depth, this is not always possible and it is not always the most efficient method, for sometimes by wasting a little water we can increase the efficiency of irrigation. It is these problems that we are working on and we are happy to work with you on them.

Dr. Freeborn: The next speaker on this panel is Dr. Maurice L. Peterson, Chairman of the Department of Agronomy here at Davis. He was picked out to succeed Dr. Briggs when Dr. Briggs became dean.

Dr. Peterson: I was quite relieved when your President a little earlier said you wanted to "kick" the *subject* of irrigated pastures around a little this afternoon, rather than the members of the panel. That may come later. I would like to discuss with you the grazing management angle of irrigated pastures. Here we are concerned with the handling of livestock, and the effect on both livestock and the pasture of different systems of management. It is comparatively recently that much attention has been paid to the production of pasture in relation to methods of pasturing livestock. Let us for a moment forget the livestock man's point of view and consider the animal as a method of harvesting grass. She differs somewhat from a mowing machine because she selects what she wants to eat, rather than taking everything off, and that certainly has an effect on the pasture.

The species of grasses on an pasture are varied, and those that are most palatable will be selected first, so that if this is to be permitted to continue the pasture may change from primarily palatable grasses to principally unpalatable grass. That is of course important as a progressive deterioration of the pasture with resultant reduction of meat or milk production.

There is another way where the cow differs from the mowing machine—she grazes only when she is hungry rather than when the operator thinks that the pasture or meadow ought to be mowed, and that has an effect also on the pasture because there has to be feed provided every day, rather than being cut at the best intervals, stored, and then fed to the cow.

It is well known that an pasture grass as it becomes older will grow more rapidly than when starting from the time that the pasture is cut back. The growth then for the first few days is rather slow, but as the plant gets taller it grows more rapidly. Therefore if you want to get maximum production it is desirable to let the plants get high enough so that you can cash in on this most rapid period of growth. But you can carry this too far, to the extreme where the quality of the feed becomes so poor that what you gain in quantity is lost in nutritive quality. The result is then no net gain in food value.

cause this water contained an insecticide that was dusted upon a closely adjoining cotton field. *Culex* species in the field apparently were not effected by this material. Water samples examined in the station showed that the water was toxic to *Aedes nigromaculis* and 1st instar *Culex quinquefasciatus* larvae.

Larval collections taken during each irrigation cycle showed that *Culex* species were more abundant in Cobb's pasture during 1952 than in 1951. Table 3 illustrates this comparison for the period from June 25 to November 25, 1951 and 1952. The total pasture shift from 50.02 per cent to 23.90 per cent for *A. nigromaculis* and from 10.22 per cent to 26.20 per cent for *C. tarsalis* shows that 1952 was better suited for *Culex* production than 1951. In 1952, from January to June 24, *A. nigromaculis* constituted 11.3 per cent of all species present. This indicates that up till mid-June the pasture produced many more *Aedes* than *Culex* species. This, however, is misleading since neither species produced adults in great abundance during this period due to the fact that in many cases standing water dried up before emergence could occur.

Light trap operation in Cobb's pasture during 1952 indicated the relative abundance of some species. *Aedes nigromaculis* showed two peaks of production. The first peak occurred in July and the second peak in October. Light trap collections indicated that during late August and most of September few *A. nigromaculis* adults were present in the pasture. A comparison of 1951 and 1952 collections showed that five times as many *A. nigromaculis* were recovered in 1951 as were recovered in 1952. However, the number of *C. tarsalis* collected were approximately the same during both years from July 27 to November 10th. Light trap measurements were not available for 1951 before July 27 but general observations indicated that *Culex* adults were not plentiful before mid-July in 1951. Light trap collections show a peak in September during 1951, and Shaub's pasture in 1950 showed the same peak in numbers during September. On the other hand, 1952 showed an extreme peak in June with a majority of the adult *C. tarsalis* occurring before mid-July. The mid-June peak of adult activity does not necessarily reflect pasture production and may have resulted from adults produced in the flood-ponds of the nearby San Joaquin River. All records indicate that Cobb's pasture produced *C. tarsalis* almost continuously from May 24 to November 10 during 1952, and that with increased standing water areas the pasture produced many more adults during 1952 than in 1951, although light trap samples do not reflect this difference. Of the 11,750 *C. tarsalis* taken in a light trap during 1952, 5,478 were taken during May and June. The remaining 6,137 specimens of *C. tarsalis* were taken from July to December.

Dissolved Oxygen:

Since a relationship exists between the time that water covers the surface of a pasture and the hatch of *Aedes nigromaculis* eggs, and because it has been shown that a lowering of dissolved oxygen in water will stimulate egg hatch in *Aedes vexans* and *A. lateralis* [= *sticticus*] (Gjullin, 1941), a study of dissolved oxygen in irrigation water was initiated during 1952 to study the possible relationships of such conditions to *A. nigromaculis* egg hatch. The Winkler method of oxygen determination was used. Samples were taken at 75 foot intervals the length of the field in selected checks. As the water moved down the check and passed over individual stations water samples from each station were measured for oxygen content. Simultaneous measurements were also made at all stations previously covered with water.

Table 4 shows the results of one of these measurements. It can be seen that as the water advanced down the field the front shows a gradual drop in dissolved oxygen content. Since hatches of *Aedes* have been seen to take place in several areas within 15 to 30 minutes after they were covered with water containing at least 5 ppm dissolved oxygen, the need for a lower oxygen tension at the time of *Aedes nigromaculis* hatch is questionable under these conditions. Further studies are needed to determine more accurately the dissolved oxygen content of water at the interface between soil and water where *Aedes* eggs are found. Station studies using water of high oxygen content have produced immediate hatches with eggs conditioned for two months at 80 degrees F. This indicates that field conidtioning may influence this factor.

Ova Studies

Investigations have shown that a stimulus is necessary to cause *Aedes* eggs to hatch. Gjullin, et al. (1939) and Connell (1941) have demonstrated the use of plant infusions to obtain egg hatching. Gjullin, et al. (1941) showed that low oxygen concentrations initiated egg hatch in *A. vexans* and *A. lateralis* [= *sticticus*], *A. cinereus, A. aegytpi* and *A. varipalpus* under certain conditions, and Abdel-Malek (1948) indicated that plant growth substances produced a hatch in *A. trivittatus* at definite concentrations.

Studies upon *A. nigromaculis* populations in the field have shown that low temperatures will influence egg hatching and that overwintering eggs may possibly be conditioned by low tempertaures to influence spring and summer hatching. Studies in the laboratory have shown that temperature will condition egg hatch but the extent of such conditioning and the influence of certain chemicals upon such conditioned *A. nigromaculis eggs* have not been investigated. The purpose of this study was to investigate the possibility of using chemicals to influence egg hatch as a tool in mosquito control.

Methods:

Field-collected female *A. nigromaculis* were fed a blood meal and held in individual vials until eggs were laid. After the eggs were laid all vials were maintained at a constant temperature of 80 degrees F. until the embryos were mature and the eggs were theoretically ready to hatch. Considerable work is being carried out to develop satisfactory techniques of handling the eggs to prevent variations in egg conditioning during storage and treatment. Tests were conducted using three auxins and several other chemicals. All tests indicated that considerable variation still existed in each group of eggs studied and that in order to obtain comparable results better methods will have to be developed to prevent variable egg conditioning and to determine, if possible, the biological variations induced genetically and in the process of embryonic development and laying.

Results:

The results obtained from preliminary studies indicate that hatch may be initiated chemically either through oxygen reduction or possibly through direct chemical stimulus. The degree of action of all the factors studied seems to be conditioned by temperature or by the action of several other factors upon the embyro either during maturation or during the storage following maturation. Low temperature has been shown to inhibit egg hatch.

eligibility to serve on committees and thereby having the opportunity to actively participate in Association affairs, each member shall receive, without additional cost, a Certificate of Membership suitable for framing (see attached example).

3. Each individual associated with administrative function in California agencies directly concerned with mosquito control be sent dues statements annually.

4. Place a Calfornia Mosquito Control Association membership advertisement in the "Mosquito News" annually.

5. Individuals and organizational grousp in the following categories be urged to accept California Mosquito Control Association membership:

a. *Associate Members*—personnel associated with the public health field of mosquito control.
b. *Sustaining Members*—primarily organizations interested in mosquito control progress.
c. *Corporate Members*—agencies directly associated with mosquito control activities.

Respectfully submitted,
Theodore Aarons, Chairman
Norman Ehmann
C. Donald Grant
Roy L. Holmes
T. M. Sperbeck

Vice-President Peters: If there is no objection, I move this report be accepted as presented. In order to conserve time, the prsentation of the various reports of the Operational Committee will be made by title and printed in the Proceedings. Copies of these reports I believe have been sent directly to each member agency.

(Note: This was done, and the several reports follow).

IRRIGATED PASTURE MOSQUITO ECOLOGY STUDIES—1952[1]

By Richard C. Husbands[2] and Bettina Rosay[3]

Operational investigations upon the ecology of irrigated pasture mosquitoes continued during 1952 in Fresno and Madera counties. With the increasing emphasis upon methods of eliminating or precluding mosquito breeding sites the pasture study directed investigations toward obtaining information relative to agricultural practices. It was felt that one of the first steps pertaining to this subject would be the proposed selection and development of a managed pasture, which, through control of irrigation water and other practices, would offer the greatest opportunity for study. In addition to the development of this proposal the following studies were considered:

1. A study of the ova of irrigated pasture mosquitoes. *Objective:* to investigate factors (chemical, physical, etc.) that influence egg hatch or oviposition.
2. A study of methods of colonizing several species of mosquitoes. *Objective:* To obtain a continuous supply of study material.
3. A taxonomic study of the major species of mosquitoes associated with irrigated pastures. *Objective:* to obtain additional biological information regarding speciations, segregation, and behavior.

[1] A cooperative study conducted jointly by the California Mosquito Control Association, Bureau of Vector Control, and Fresno Mosquito Abatement District, with headquarters at the Vector Control Field Station, Fresno, California.

[2] Entomologist, Project Director, Central Valley Mosquito Ecology Study, California Mosquito Control Association.

[3] Assistant Entomologist, Central Valley Mosquito Ecology Study, California Mosquito Control Association.

General Field Studies

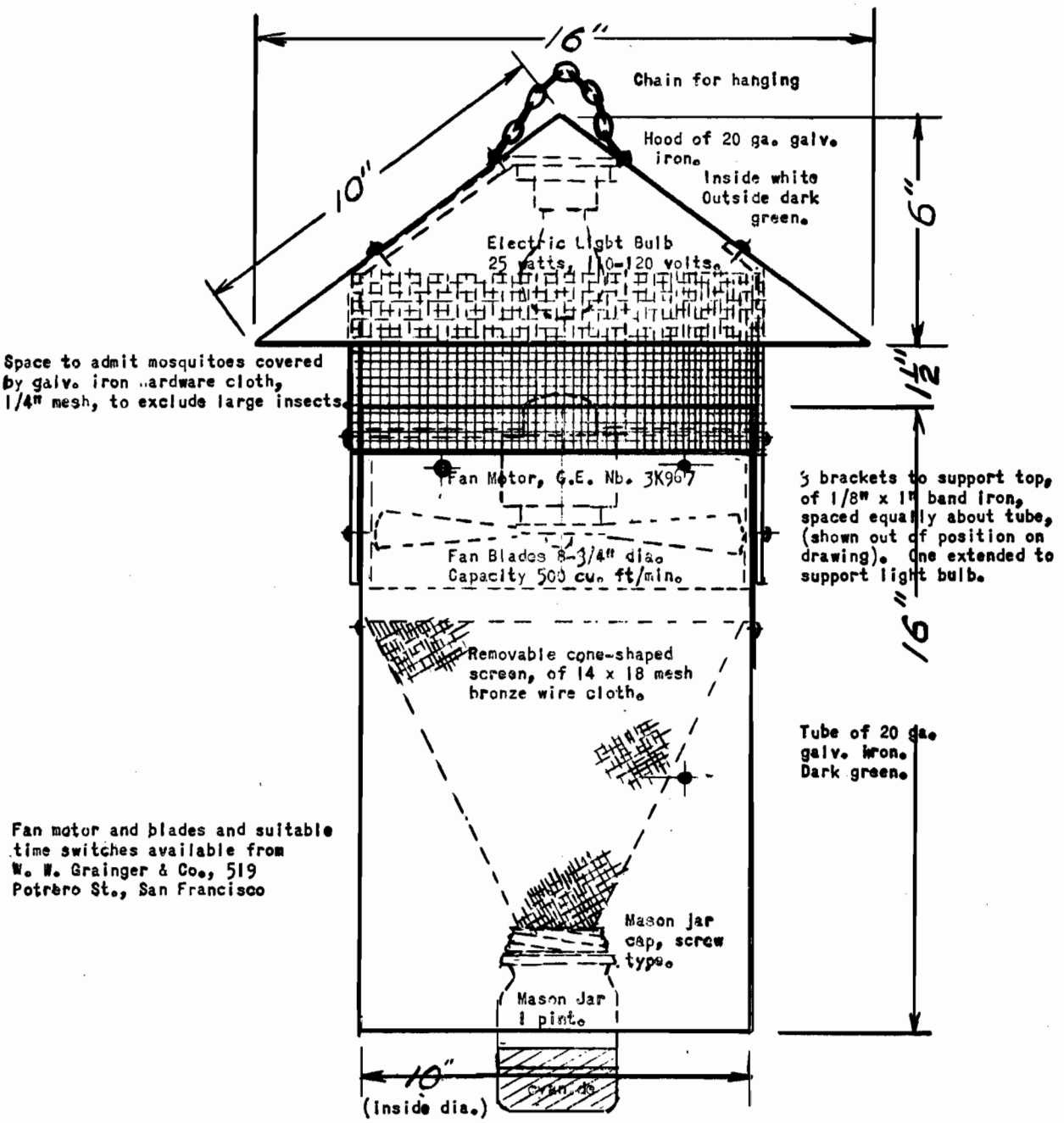
Methods:

General observations were continued in 1952 in Cobb's pasture based upon procedures established by previous studies (1952). Adults were collected with aspirators and by light traps. Larvae were sampled by frequent dippings at selected stations. Records were made for each irrigation cycle to show approximately the extent of irrigation, the areas covered with water for each day following a cycle, the temperature of the water and air, the depth of water at selected dipping stations, and hygrothermograph records and humidity. Records were also made of selected agricultural practices, such as: type of pasture grasses, weed areas, the frequency of irrigation, the depth of water in checks during irrigation and the handling of livestock on the pasture.

Results:

Eighteen irrigations were recorded during 1952 (Table 1). An average of 11 days occurred between cycles. This was much shorter than the average of 15 days that was recorded for 1951. One short cycle of 3 days and one long cycle of 34 days was noted. Four cycles of 12 days, two cycles of 11 and 13 were recorded. Single cycles of 5, 6, 7, 8, 10, 15 and 17 days' duration were also recorded. The more frequent application of water in 1952 apparently produced fewer *Aedes nigromaculis* (Ludlow) and more *Culex tarsalis* (Coquillett) (Table 2). This does not signify that the more frequent application of water resulted in this change in species composition alone but that such a change is one of the many factors that will lead to this shift. A critical examination of irrigation frequency and the production of mosquitoes shows that for various stations in the field during 1952 there was an increase in the time that water remained upon the surface. In Station One, a selected area productive of mosquitoes from June 23 to November 12, there were 5 periods of standing water with an average duration of 20 days each. In 1951 there were 10 periods of standing water with an average duration of 7.9 days. The extension of the standing water period in low areas reflects the incerase in *Culex* production. Cobb's pasture is about four years old and has shown a gradual change from small areas of standing water, which generally dried up between irrigations, to larger areas that generally remained on the field from one irrigation to the next. The gradual change in these ponded aeras is reflected in a change in pasture flora with Plantain and water grasses replacing the original pasture grasses. Measurements have shown that these ponded areas have doubled and tripled in size in a majority of the checks in 1952. The cause for this condition awaits a more critical analysis but there is some reason to believe that a decrease in infiltration rate along with more frequent irrigations and the possible use of more water may have contributed to this change. Station Five, which is located about half way down the west side of the field shows little change in size, and, interestingly enough, shows little change in species composition during the 1951 and 1952 study periods. (Table 3). On the other hand, Stations One and Six (near the end of checks) show an increase in the size of ponding areas and also show a great change in species composition (Table 3).

During 1952 each irrigation did not produce a brood of *Aedes*. Three irrigations failed to produce *Aedes* because the water disappeared from the field before larvae were mature enough to survive on damp soil (a condition that may occur with late 4th instar larvae and pupae). One irrigation, August 24, failed to produce *Aedes* be-



ESSENTIAL DIMENSIONS OF "AMERICAN" MODEL MOSQUITO LIGHT TRAP

The Bureau of Vector Control will maintain a running summary and will provide all cooperating agencies with current analyses on a regular, frequent interval basis.

Theodore Aarons, Chairman
Richard M. Bohart
Richard C. Husbands
Edmond C. Loomis
W. Donald Murray
John R. Walker

STANDARD ARTIFICIAL MOSQUITO RESTING STATION UNIT

1. Locating the collecting unit:
   a. The unit may be set directly on the ground or suspended above ground by means of ring hanger or hook. When locating the units in the field it is well to carry along a few large nails and a hammer in event natural objects are not available from which to suspend the unit.
   b. The unit may be set in areas such as weedy fields, row-cropped fields, rice contour dykes, etc. Sites protected from the sun and wind are preferred.
   c. Buildings may be utilized either by locating the unit on the floor in a suitable location or suspending it vertically above the floor, either on the wall or from the ceiling.
2. Collection schedule:
   a. The unit should be checked every seventh day at a scheduled hour.
3. Collecting procedure:
   a. Slide collecting tray into position under resting chamber and above wind baffle board.
   b. Remove cork plug. Anaesthetize mosquitoes in resting chamber with chloroform injected with a No. 15 DeVilbiss Nasal Atomizer. A dosage of 6 to 12 squirts of cholorform is usually adequate.
   c. After chloroforming, replace plug and wait 3 or 4 minutes for full anesthesia.
   d. Then slap sides of unit with palm of hand and shake vigorously to dislodge specimens.
   e. Remove collecting tray, tip trap over and examine resting chamber to see that all specimens are removed.
   f. Specimens may be identified, counted and sexed in the field from the collecting tray or they may be placed in adequately labeled pill boxes for subsequent laboratory determination.

Dr. Tinkham: Does this imply approval of the models shown in the exhibits?

Mr. Aarons: No, it covers only acceptance of this report as a progress report.

Vice-President Peters: The progress report does not bind any one to approve or use the suggested equipment or methods. Is there a motion to approve the Progress Report of the Culicidology Committee?

(It was duly moved, seconded and passed by voice vote that this progress report be approved).

Mr. Aarons: Another function of the Culicidology Committee was to prepare a list of desirable projects for operational investigations. I submit a list of projects currently under way, and suggestions for the future, and move that this type of work be made a continuing function of this Committee.

CULICIDOLOGY PROJECTS LIST
CULICIDOLOGY COMMITTEE

February 1953

I. Culicidology operational investigation projects currently in progress, CMCA—Bureau of Vector Control.
   1. Central Valley Mosquito Ecology Study on Irrigated Pastures. State of California Vector Control Field Station, Fresno. Principal species *Aedes nigromaculis* (Ludlow)
   2. Embriological studies. College of the Pacific, Stockton. Principal species *Aedes nigromaculis* (Ludlow)
   3. Insecticide & Toxicological Studies. Kern County Mosquito Abatement District, Bakersfield. Principal species *Culex* spp.
   4. Rice Field Mosquito Investigation. Sutter-Yuba Mosquito Abatement District, Yuba City. State of California Department of Public Health, Bureau of Vector Control. Principal species *Anopheles freeborni,* Aitken; *Culex tarsalis,* Coq.

II. Culicidology projects currently in progress in research centers.
   1. Telford, Allan D., Graduate student. Under direction of Richard M. Bohart, University of California, Davis. "Factors causing the hatching of *Aedes* eggs *(A. squamiger* and *A. dorsalis)."*
   2. Belkin, John N., Ph.D. — McDonald, W. A., U.C.L.A. "Chaetotaxy of California Anophelines."

III. Proposed list of culicidology projects which can be recommended to graduate students for thesis problems. (Projects to be developed with cooperation or encouragement of control agencies).

The Culicidology Committee recommends that lists of categories cited be kept current and circulated to agencies concerned with all phases of Culicidology. It is recommended further that the Committee be designated to serve as a clearing house for proposed investigation subjects and expedite the dissemination of "problem ideas" to potential investigation. In effect, this would constitute a liaison between the critical needs of the field and the facility of the graduate school.

(This motion was duly made, seconded and carried by voice vote).

Vice-President Peters: We will now have the report of the Membership Committee, by Chairman Aarons.

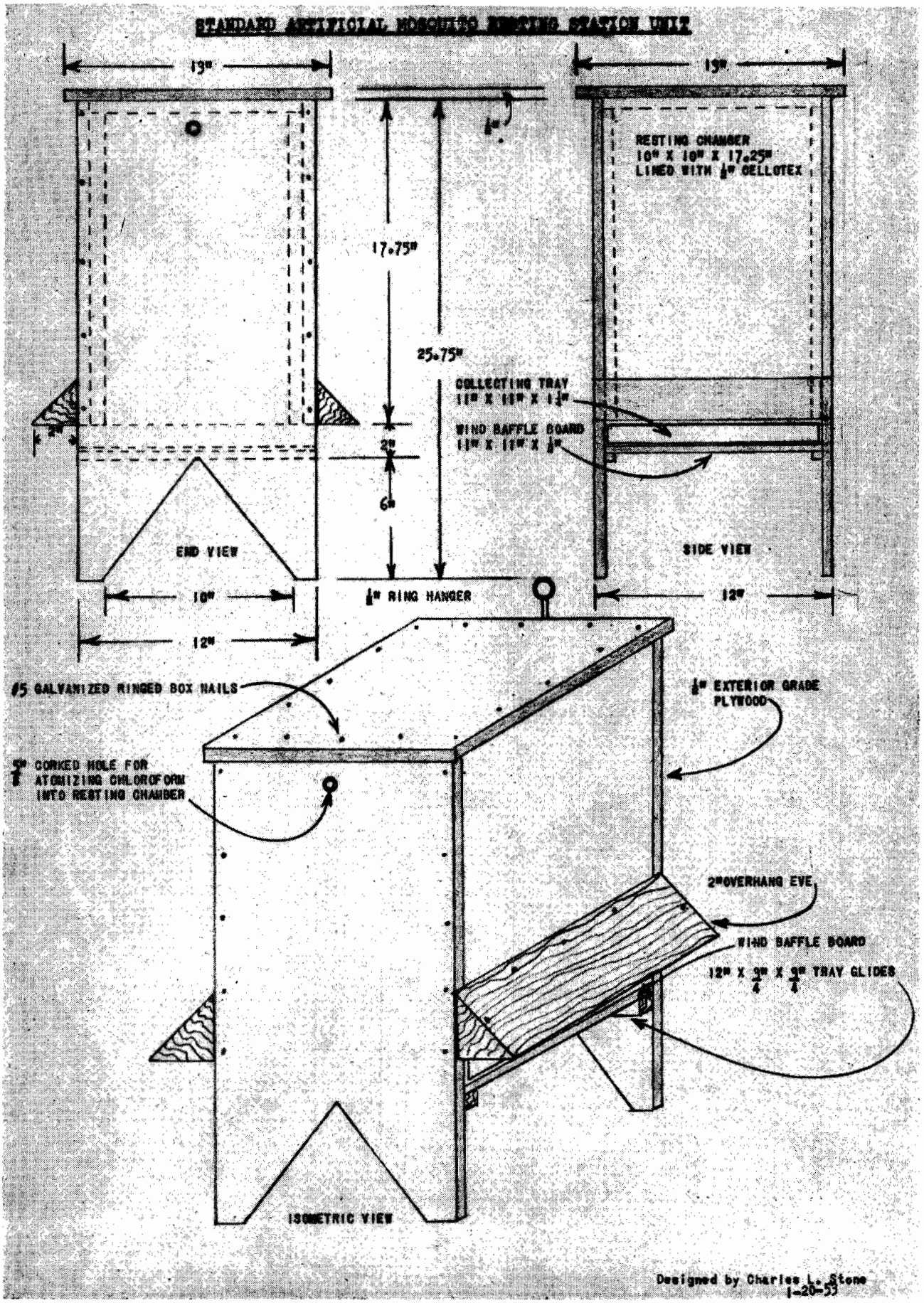
MEMBERSHIP COMMITTEE REPORT

The California Mosquito Control Association includes 26 Associate Members, 22 Sustaining Members and 39 Corporate Members. Personnel associated with Mosquito Abatement Districts, Health Departments and other agencies concerned with the field of mosquito control have not responded well to the membership drive this past year. The Sustaining Membership list is somewhat more gratifying. Corporate membership is discussed in the report of the Secretary-Treasurer.

The Committee recommends that the Board of Directors approve the following proposals:

1. Continue the practice of appointing each California Mosquito Control Association Regional Representative to the Membership Committee.

2. In addition to receiving the various benefits of the Association, including the Proceedings, news periodicals,


STANDARD ARTIFICIAL MOSQUITO RESTING STATION UNIT
13"
15"
RESTING CHAMBER
10" X 10" X 17.25"
LINED WITH 1/4" CELLOTEX
17.75"
25.75"
COLLECTING TRAY
11" X 11" X 1 1/4"
WIND BAFFLE BOARD
11" X 11" X 1/4"
2"
6"
END VIEW
SIDE VIEW
10"
12"
1/4" RING HANGER
12"
#5 GALVANIZED RINGED BOX NAILS
1/4" EXTERIOR GRADE PLYWOOD
5/8" CORKED HOLE FOR ATOMIZING CHLOROFORM INTO RESTING CHAMBER
2" OVERHANG EVE
WIND BAFFLE BOARD
12" X 3/4" X 3/4" TRAY GLIDES
ISOMETRIC VIEW
Designed by Charles L. Stone
1-20-53

each agency develop its survey program beyond the minimum requirements drawing upon all of the available supplementary methods and techniques which can be used to advantage in evaluating local conditions.

PROPOSED PLAN FOR MEASURING AND RECORDING MOSQUITO POPULATIONS

A. *Pre-adult Stages:*

1. It is recommended that area wide larval inspection and sampling be conducted by technically trained personnel working under the direction of the agency administration on the following minimum time basis:
   a. Ten man-hours per week for each agency having 500 square miles or less of problem area.
   b. One additional man-hour per week of larval inspection time to be applied for each 100 square miles of problem area above 500.
2. The purpose of the larval collections will be to assist the agency administration in recording on a weekly basis a critical subjective evaluation of mosquito species population, distribution and density.

B. *Adult Stage:*

1. Resting Stations
   a. The use of a standard artificial resting station unit is recommended.
      (See Appendix for resting station unit detail).
      (1) A minimum of ten resting station units to be used by each agency.
      (2) At least one resting station unit to be used for each principal population center within the control area; units to be placed so as to insure adequate geographic coverage.
      (3) Inspection of resting station unit to be made every seven days and data to be recorded on weekly report form. (See Appendix for detail of resting station unit operation).
2. The Standard Mosquito Light Trap
   a. One light trap is recommended for use in each principal population center. An agency having, for example, only one or two communities within its boundaries would correspondingly be obligated to operate only one or two traps. It is recommended that no agency be required to operate more than five traps. (See Appendix for trap detail).
      (1) Light traps to be operated from March to October inclusively. Light traps to be located in or adjacent to human population centers. Traps to be operated on a seven per week basis from 7:00 P.M. to 7:00 A.M. (See Appendix for light trap operation technique).
      (2) Light trap recovery data to be recorded on weekly report form. (See Appendix for density technique reporting).

C. *Reporting*

The Committee recommends that reporting be scheduled by all cooperating agencies on a uniform basis. It is suggested that copies of the weekly report forms covering artificial resting stations and light traps, as well as the agency administration's critical subjective evaluation, be mailed to the Bureau of Vector Control on the last day of each work week.

While it is anticipated that this procedure will incidentally satisfy the reporting requirements for those agencies receiving state subvention, it is strongly urged that all agencies be encouraged to cooperate in this program in order to provide the most complete record possible.

CULICIDOLOGY COMMITTEE REPORT EXHIBIT "A"

Station Unit # ..... AGENCY ..... TOWNSHIP ..... RANGE ..... SECTION .....
Zone ..... County ..... Date .....
Light trap # ..... Coll. ..... Hour ..... A.M. ..... P.M.

Larvae ..... Location ..... Average/dip .....

Type Water Source and/or Larval Habitat
Natural (type) ..... Industrial type) .....
Irrig.agric. (type) ..... Domestic (type) .....
Remarks (area size, etc.) .....

Adults
No. collected .....
Remarks .....

Identification	Larval species	1 & 2	3 & 4	Pupae	Total	Adult Species	M	F	Total
By									
Date									

A.B. 3095 is a bill to appropriate $300,000 for subsidies to local districts for the control of mosquitoes.

A.B. 697 is an act which eliminates the mosquito abatement districts from the provisions of the Districts Investigation Act.

A.B. 2809 is a bill strengthen and clarify the section of the Penal Code regarding the breeding of mosquitoes being a misdemeanor.

These Bills have been approved by the Board of Directors of the CMCA and the corporate members are asked to contact their State Legislators in order that these bills may receive favorable passage.

Respectfully submitted,
Legislative Committee
E. CHESTER ROBINSON, Chairman
THOMAS M. SPERBECK
HAROLD F. GRAY

(Ths motion was seconded and passed by a voice vote).

Vice-President Peters: We will now have the report of the Fish and Wildlife Committee, presented by Chairman Gordon Smith.

TO: All Mosquito Control Agencies
SUBJECT: Minutes of the Meeting of the Wildlife Committee, Dec. 2, 1952, at Berkeley, California.

This meeting was called to formulate certain recommendations pertaining to duck hunting and the operation of duck clubs which, if followed, would tend to alleviate the mosquito problem on duck clubs. These recommendations, when approved, will be sent to the State Department of Fish and Game for their approval and inclusion in the recommendations of that department to duck club operators.

The recommendations arrived at are as follows:

1. If it is desired to hold ducks in a hunting area, a certain proportion of the area be prepared as good sharp banked and properly maintained ponds and permanently flooded rather than flooding the whole area early in the summer to achieve this purpose.
2. An attempt be made to adjust the duck hunting season by smaller regions allowing for a later season in the Central Valley. This is concurred in by many hunters, however the setting of the season is done by the United States Fish and Wildlife Department and direct recommendation will have to be made to them.
3. Duck ponds should not be flooded prior to October 1st and when flooding is commenced it should be done as rapidly as possible.
4. Ponds should be constructed and maintained with clean, sharp banks and irrigated in an orderly manner.
5. Efforts should be made to control or eliminate cattails, tules and other emergent vegetation, especially in permanently flooded ponds.
6. Where seepage areas occur outside of ponds a ditch should be dug aroung the pond to cut off this water and the water in the drain ditch should be disposed of by draining into an existing drainage system or pumping back into the pond.
7. Ponds should be drained immediately after the close of the season.
8. The planting of food grains in the ponds should be done in such a manner that no mosquito problems can be caused.
9. When pond areas are used as cattle pasture between seasons the land be so prepared that good and proper pasture irrigation practices can be used.

Respectfully submitted,
GORDON F. SMITH, Chairman
Wildlife Committee, C.M.C.A.

(This report was duly approved on motion and a voice vote).

Vice-President Peters: I will now call on Ted Aarons to present the report of the Culicidology Committee.

Mr. Aarons: This report is a progress report, and we recommend that action on it be deferred until say the end of this year, when the Committee will be in a better position to evaluate the units more adequately, before recommending their use to the entire Association.

CULICIDOLOGY COMMITTEE REPORT
California Mosquito Control Association

Over a period of several years there has been an increasing need for standardization of methods used to measure mosquito prevalence throughout California. The urgency of this need, which has been jointly expressed by the California Mosquito Control Association and the State Department of Public Health, was made particularly evident in view of the circumstances associated with the unprecedented encephalitis outbreak experienced in 1952. Accordingly, the Culicidology Committee has been giving priority consideration to the promulgation of a more acceptable plan of measuring, recording and interpreting mosquito population density and distribution.

The application of principles of mosquito population measurement to evaluate control programs has been discussed extensively by various CMCA committees since 1946. During this period a considerable amount of study and experiment have been undertaken in this field, both independently and jointly, by various abatement agencies, the University of California, the U.S. Public Health Service and also the State Department of Public Health. To some extent nearly all of the methods, techniques and mechanical devices used elsewhere throughout the world have been tested against certain segments of our diverse mosquito fauna. Considerable imagination and constructive thinking has gone into the refinement of established techniques and the development of new ones. Significant contributions have been made in the field of soil sampling and egg density determination; improved seining methods have been developed for larval density measurement; and a number of improvements and new techniques have been applied to mechanical traps and other devices used to estimate adult populations.

In accepting its current assignment, the Culicidology Committee has focused its attention on a defined objective:

1. To develop a simplified standard plan of population measurement which will provide a reasonably valid estimate of mosquito numbers in relation to disease incidence, public comfort and economic damage.

2. To recommend minimum requirements of participation which will exert no undue hardship on any agency.

3. To recommend a standard system of recording and reporting which will furnish a current, seasonal and year by year biological audit on both a local and state-wide basis.

The plan developed out of this Committee action and herewith recommended is a compromise. It is unlikely that any agency will find the minimum requirements totally adequate at all times. Some agencies may find them entirely inadequate. The Committee therefore urges that

This report is furnished the Board of Directors of the California Mosquito Control Association for its consideration and action.

Respectfully submitted,
HAROLD F. GRAY,
Acting Secrtary of the Special Committee

Vice-President Peters: What is the pleasure of the Association in regard to this report?

(It was moved by Mr. Sperbeck, seconded by Mr. Holmes, that the report be accepted and approved. In the discussion, Mr. Umberger raised the legal question that since the acceptance or rejection of subvention was a function of the Boards of Trustees of the individual districts, it was out of order for the Association or its Board of Directors to take any action on the report, but instead it should be referred to each Board for whatever action it wished to take. Mr. Umberger's discussion, unfortunately, was very poorly recorded on the tape).

Mr. Gray: In reply to Mr. Umberger, if my recollection is correct this report has been approved by the Vector Control Advisory Committee of the State Department of Public Health, and also by your Board of Directors. It is entirely within the judgement of the voting members present as to whether you now approve the action of your Board of Directors, or whether you reject that action. I think that George Umberger brought up his point of order last year also, and while I do not like the manner in which he brought this point up, I consider that he is correct as to procedure. This is a matter of public policy, and we as employees of districts, or as Trustees, are controlled by the wishes of our Boards of Trustees, and it is up to the Boards of Trustees of the individual districts to act on such matters of public policy and financial policy as they shall determine, to approve or disapprove. Through their voting representatives they can control not only the actions of this Association, but for themselves they may accept or reject this additional subvention without regard to any action taken by the Association.

With respect to the Committee's recommendations as to how the additional subvention money should be apportioned among the districts, this is merely a recommendation and is not binding on the State Department of Public Health, which will apportion subvention money through its Bureau of Vector Control.

A Member: There are really two separate matters in the report, one a $300,000 item for increased subvention, the other an approximate $150,000 for studies and for mosquito enumeration. We should act separately on these items.

Vice-President Peters: We will vote then by roll call. The first vote will be on the additional $300,000 for additional subvention.

(The Secretary-Treasurer called the roll and the vote was as follows: 22 Yes, 7 No, 1 Abstain).

Vice-President Peters: The $300,000 additional state subvention is approved. The Secretary-Treasurer will now call the roll on the addition of $150,000 to the budget of the State Department of Public Health, approximately one-half of which is intended to be used for studies and investigations, and the other half is intended to be used for what may be called "intelligence service" to give information as to the prevalence of vector mosquitoes and of virus.

A Member: Does this $150,000 take the place of the $25,000 now being held out at the regular $400,000 subvention, and now used for studies?

Vice-President Peters: That is its intention. We assume that this item will be added to the budget of the State Department of Public Health, but we understand that a bill is prepared for introduction to the Legislature if necessary.

(The Secretary-Treasurer then called the roll, with the following result: Yes, 26; No, none, Abstain, 3).

Vice-President Peters: We will now vote on the approval of the report of the Special Committee on State Subvention, as a whole.

(A motion to this effect was duly made, seconded and passed by voice vote).

Vice-President Peters: The Resolutions Committee will now report.

Mr. Robinson: The Resolutions Committee offers three resolutions as follows:

No. 1. "WHEREAS, the California Mosquito Control Association is enjoying an informative and pleasurable annual meeting in Sacramento and at Davis February 11-13, 1853, which has been made possible by the efforts of many persons, officials and business organizations, now therefore
BE IT RESOLVED, that the Secretary-Treasurer be directed to send letters of appreciation to all who have contributed to the success of this Twenty-first Annual Meeting."

No. 2. "BE IT RSOLVED, by the California Mosquito Control Association assembled for its Twenty-first Annual Convention, at Sacramento, California on February 12, 1953, that the Bureau of Vector Control of the State Department of Public Health, and the United States Public Health Service be commended for the active part they have taken in developing inter-agency cooperation among the various groups working on water problems in California."

No. 3. "BE IT RESOLVED that the California Mosquito Control Association expresses its great regret at the death, on October 27, 1952, of Koichi Onishi, who for the past three summers was Assistant Entomologist for the Alameda County Mosquito Abatement District. He was a candidate for the degree of Doctor of Philosophy in medical entomology at the University of California and prior to California was a student of Professor Don M. Rees at the University of Utah. While pursuing his studies leading to the application of entomology to the field of public health, he completed research on *Culiseta inornata* biology and participated in recent California mosquito flight range and toxcity studies. His passing is a major personal loss and is the loss of a scientific heritage in that much of the finest in teaching and association was characteristic of his individual makeup.

Mr. Robinson: I move the adoption of these resolutions.

(This motion was duly seconded and passed by voice vote).

Vice-President Peters: We will now receive the report of the Legislative Committee.

Mr. Robinson: I present the report of the Legislative Committee as follows, and move that the Association approve the report.

REPORT OF THE LEGISLATIVE COMMITTEE

The Legislative Committee of the CMCA has introduced three bills in the Legislature through Assemblyman Ralph Brown of Modesto. They are:

from areas outside of local control agencies, into local control agencies, should be a matter of State interest, and the State appears to be the only agency available to cope with such situations, at least in emergencies.

3. In spite of the expansion of local mosquito control agencies in California in the past decade, and in spite of improved technology in mosquito control methods, the mosquito problem in California has grown at an even greater rate due to expanding irrigated acreage, increased industrialization and largely increased population.

4. The end of the expansion of the mosquito problem in California does not presently appear to be in sight.

The special committee then deliberated on the subject of eligibility for subvention and concluded:

(1) That all public agencies conducting mosquito control should be eligible for some amount of State subvention, under reasonable requirements set up and administered by the State Department of Public Health.

(2) That mosquito-borne disease endemicity (particularly encephalitis) and vector prevalence (chiefly, *Culex tarsalis)* be given their just emphasis.

(3) That consideration be given to mosquito production or problem intensity of the individual agency, and as a general guide that the following *approximate* percentage-wise recognition be given to the four categories of mosquito production—

(a) Irrigated acreage	65%
(b) Natural sources	15%
(c) Community and industrial liquid waste	10%
(d) Domestic sources	10%

(4) That recognition be given to peripheral areas that produce mosquitoes which invade a controlled area and therefore demand added control.

Next, the special committee expressed itself on the categories of mosquito control deserving of subvention and concluded that the following *approximate* percentage-wise guide might be used:

1. For the conduct of mosquito source reduction, correction and prevention measures	50%
2. For the support of needed technical and professional personnel (entomologists, engineers, agricultural experts, attorneys, etc.)	15%
3. For the development and maintenance of competent administrative services	10%
4. For the conduct of supplementary control measures (larviciding, adulticiding, etc.)	25%

Beyond the direct subvention to mosquito control agencies, the special committee endorsed the need for increased emphasis upon operational investigations of problem mosquitoes and their control, and the accentuation and improvement of mosquito population measurement.

Regarding operational investigations, discussion resulted in the following position being taken by the Special Committee, which position reflects previous resolutions adopted by the association:

(1) That the expense of operational investigations be by an appropriation within the Bureau of Vector Control, and not be subtracted from the subvention funds.

(2) That the Bureau of Vector Control conduct the needed operational investigations, studies, and demonstrations, cooperating with local agencies and utilizing to the extent possible their personnel and resources to accomplish solutions of the problems facing mosquito control, to include: mosquito ecology; technical development of control methods; appraisals of methodology and equipment; evaluation of observations made; and distribution of information upon the studies, demonstrations, developments and appraisals.

(3) That local agencies be encouraged to conduct specific studies into, and otherwise seek solutions for operational problems, particularly upon those aspects of mosquito control wherein lie the particular strengths and resources of the individual agency.

Regarding mosquito population measurement with relation to the responsibilities of the local mosquito control agencies, the local health departments and the Bureau of Vector Control, it was concluded:

(1) Within the boundaries of mosquito control agencies all (complete) mosquito sampling should be done by the individual local mosquito control agency with coordination and evaluation to be supplied by the Bureau of Vector Control.

(2) Outside local mosquito control agencies—elsewhere in the State—the Bureau of Vector Control should accept the responsibility for all (complete) sampling, but that their efforts should be directed only to the areas of the State which within the discretion of the Bureau are deserving of sampling. The areas deserving sampling might be determined by:

(a) The mosquito-borne disease endemicity or potentiality of the area.

(b) The mosquito discomfort characteristic or potentiality of the area.

(c) The prospect for local assumption of control.

The special committee also considered the problem of the matter of special funds with which to control mosquitoes in areas outside of local mosquito control agencies, if and when the State agency through its "intelligence" sources discovers the need for special control, for example, in the presence of an incipient disease epidemic. It was the opinion of the committee that there should be certain funds in the Bureau of Vector Control earmarked for such emergency purposes only.

Fiscal and Legislative Considerations

The special committee in considering the ways by which the objectives of its deliberations could be achieved concluded that legislative action sponsored by the association offered the most promising answer. In rationalizing the total amount of State funds which should be sought for all purposes, it was agreed that the amount probably could not be in direct ration to the full needs of mosquito control in California, but rather should be as modest as possible. This was translated to be an amount somewhat under a million dollars and approximately double that which is currently available. It was estimated by R. F. Peters that at least $150,000 would be required for the Bureau of Vector Control to accept and accomplish the responsibilities for mosquito population measurement and operational investigations as are herein outlined and proposed, exclusive of any emergency control funds. The special committee meeting was concluded recognizing that analysis of the individual characteristics of all the mosquito control agencies in California would have to be made to ascertain the approximate total amount of subvention to local agencies which should be sought, and which should possess the factors which are contained in the foregoing.

Meeting of the California Association of Soil Conservation Districts at San Diego late this month.

The committee wishes to propose a resolution of appreciation to the Buerau of Vector Control of the California Department of Public Health and to the U. S. Public Health Service for the part they have played in promoting a better understanding of mosquito problems among other state and federal organizations interested in water problems.

The committee also wishes to entreat all mosquito control workers to take full advantage of the possibility of help from all agencies working on water problems of mutual interest and to meet them more than half-way by offering something in return.

Respectfully submitted,
EDGAR A. SMITH, Chairman
Water Resources Committee

(It was duly moved, seconded and after discussion carried by voice vote, that this report with its recommendations be accepted).

Vice-President Peters: I will next call for the report of the Subvention Study Committee, Harold Gray, Chairman.

Mr. Gray: I do not recall that I was Chairman of that Committee; my signature was on it as Acting Secretary of the Special Committee. The report was distributed to all Districts late in November.

The Special Committee conferred with many people outside of the Committee. One of the strongest advocates of more money was Dr. Karl F. Meyer. If we are to assume that subventions are to continue as a part of the public policy of the State, then they should be reasonably adequate. We have no quarrel with the people who are against subventions, provided they are against *all* subventions. That means both Federal and State subventions —to schools, to public health, to agriculture, to business. If the objectors to subvention will go the whole way, we are willing to go along with them. But we have subvention to mosquito control, the same amount in 1952-53 as originally provided in 1945.

If we were to determine the need for subvention on the basis of, since 1945, the increase in irrigated area, the increase in population, the increasing threat of encephalitis, or the depreciated value of the dollar, we could very easily justify a subvention of at least one and one-half million dollars. But we doubt that such a sum would get by the Legislature, and we believe that the practically attainable amount is about $700,000. This will require $300,000 in addition to the $400,000 presently in the budget of the State Department of Public Health.

TO: Board of Directors, California Mosquito Control Association.

FROM: Special Committee on State Subvention for Mosquito Control.

SUBJECT: Report of Special Committee.

A special committee composed of the CMCA Legislative Committee and two members from the CMCA designated to serve on the Vector Control Advisory Committee met on November 6, 1952 in the office of the Bureau of Vector Control. The purpose of the meeting was to examine the present needs of mosquito control in California, to evaluate the present adequacy of State subvention for mosquito control, and to determine whether any modifications of the subvention program are necessary or desirable.

A corollary purpose was to prepare a fiscal basis for coping with the unmet problems of California mosquito control, particularly encephalitis prevention, in the years to come. Special Committee members present at the meeting were: Harold F. Gray, Ted G. Raley, E. Chester Robinson, Edgar A. Smith.

Absent were: T. M. Sperbeck, G. D. Winton.

As a basis for consideration of present problems, the committee had before it the following approximate figures, contrasting certain basic factors in 1946, the year in which subvention began, with the present year of 1952.

	1946*	1952*
Mosquito Control Agencies	30	50
Area, Organized Mosquito Control	6,500 sq. mi.	28,000 sq. mi.
Population	8,000,000	11,000,000
Comparative Purchasing Power of the Dollar	.75	.53
Irrigated Acreage	5,000,000	6,000,000
Rice Acreage	260,000	335,000
Irrigated Pasture Acreage	440,000	750,000
Cotton Acreage	360,000	1,400,000
Central Valley Project	A Plan	A Full Reality
Peak Encephalitis Year	1945—298 cases	1950—350 cases 1952—727 cases
Local Expenditures	$500,000	$2,400,000
Subvention	$400,000 (mosquitoes only)	$400,000 (mosquitoes & gnats)

*Figures are approximate.

The committee first discussed the need for and desirability of State subvention for mosquito control. The concensus of opinion was that subvention is necessary on several grounds:

1. In many areas local resources are actually or apparently insufficient to meet the requirements of an adequate mosquito control program.

2. Mosquito control in California is not entirely a local problem since

(a) the people of California travel widely within the state, and may thus be exposed to mosquito-transmitted disease in areas with inadequate mosquito control;

(b) the out-of-state tourist business can be adversely affected either by epidemics of mosquito-transmitted disease (witness the drop in tourist travel in the San Joaquin Valley during the height of the 1952 encephalitis epidemic) or by excessive prevalence of "pest" mosquitoes;

(c) dispersion or migration of mosquito swarms

The Board of Directors at its regular meeting of March 7. 1952 authorized the establishing of a Conference Fund of $415.39. This sum was the balance returned to the association after the 20th annual conference. These funds were derived from gifts, contributions and Sustaining Memberships received at the time of that conference. This sum is included in the total cash balance of the above report.

There are forty five (45) agencies, in this state, organized for mosquito abatement. Of these thirty six (36) have paid their Contractual dues, nine (9) had not. This is a very good standing in this, a purely voluntary association. Since December 31, 1952, three (3) of these have paid leaving at this date, February 12, 1953 only six (6) unpaid.

Associate Memberships totaled twenty three (23) which is a very poor standing within that catagory. Two have paid since December 31, 1952 making the total (25) today. It is my suggestion that the Board of Directors authorize the printing of formal Bill heads or Statements to be sent all persons and parties who have been Associate Members and Sustaining Members in the past and that these be sent all past members in the hopes of increasing the member participation.

I strongly urge that in the future the mailing address of this association be the address of the Secretary-Treasurer. This will expedite many matters and associate the association with its own headquarters.

Respectfully submitted,
G. EDWIN WASHBURN
Secretary-Treasurer

(It was duly moved, seconded that the Annual Report of the Secretary-Treasurer be approved and accepted).

Mr. E. A. Smith: I would like to see certain items on the recommendations of the Secretary-Treasurer separated. Three times now we have voted against moving the post office box. Moving the post office box might be all right if we were certain that we were going to have the same secretary from now on in one particular place, but as I recall the meeting just the other day there were several items brought up which cast considerable doubt as to whether our present secretary was going to be able to continue as secretary. We have had the same post office box for the Association for many years now and that address is well know. I can't see changing it this year and then we might have to change it next year and the year after that so I would personally prefer to see it stay as it is until there is something much more definite.

Vice-President Peters: If there is no objection, we will vote first on acceptance of the report, excluding the recommendation as to the address of the Association.

(This was carried by a voice vote).

Mr. Gordon Smith: I move that the address of the Association go with the address of the office of Secretary-Treasurer.

(This motion was seconded and passed by voting members as follows: Ayes, 20; Noes, 8; Abstain, 2).

Vice-President Peters: The Auditing Committee will now please report.

Mr. J. H. Kimball: Ed Smith and I have audited the accounts of the Secretary-Treasurer and found them in order; and we confirm the bank balance as of December 31, 1952 to have been $3,651.88 as shown.

We recommend that the next Board of Directors proceed with a previous direction to have the Secretary-Treasurer bonded to the extent they consider necessary. We also recommend, for the protection of the Secretary-Treasurer himself as well as the Association, that the Board of Directors consider the desirability of employing a certified public accountant to audit the accounts.

Mr. Gray: I move acceptance of the Auditing Committee report and that the recommendations be effected by the Board of Directors.

(This motion was seconded and passed by a voice vote).

Vice-President Peters: We will now have the report of the Publications Committee.

Mr. Gray: The Publications Committee as its report presents the "Proceedings and Papers of the Twentieth Annual Conference" held last year at Fresno, which you received about six months ago.

Vice-President Peters: We will accept that report, and we assume that everyone liked the Proceedings. Will you also please report for the W. B. Herms Committee?

THE BOARD OF DIRECTORS OF THE
CALIFORNIA MOSQUITO CONTROL ASSOCIATION.
Gentlemen:

Through an unfortunate oversight, no money was furnished for the William B. Herms Award in 1952.

It is therefore recommended that an additional amount be set up in 1953, say a total of up to $55, payable to the Mt. Diablo Council (formerly Berkeley-Contra Costa Council) Boy Scouts of America, to send two or three Boy Scouts to summer camp in 1953.

Very truly yours,
William B. Herms Award Committee
RICHARD F. PETERS
HAROLD F. GRAY, Chairman

(It was duly moved, seconded and carried by voice vote that this report be accepted and approved).

Vice-President Peters: Ed Smith, will you please give the report of the Water Resources Committee?

REPORT OF THE WATER RESOURCES COMMITTEE

This committee held only one formal meeting during the past year. Most of its business has been conducted by mail.

At the meeting on May 28th 1952 the committee decided to devote much of its time to exploring the extent of cooperation among agencies interested in water problems, both on a state-wide and a local basis, with the intent of promoting greater cooperation where it is most needed.

A questionnaire was sent out to all local districts with questions about cooperation from local agencies. A wide variation from district to district in the amount of help being obtained from other agencies was shown. A detailed summary is attached. A common comment was, "I didn't know that there were so many other organizations in my district interested in water problems."

During the past year considerable strides have been made in securing better inter-agency cooperation regarding mutual water problems on a state-wide basis. Numerour conferences have been held with the Bureau of Reclamation. A series of meetings with the University of California Agricultural Extension Service specialists led to the conference on Mosquitoes and Agriculture held at Davis last fall. The California Mosquito Control Association had speakers on the following programs: Convention of the California Farm Bureau and the 4th Regional California Conservation Conference (devoted to water conservation). Speakers are also scheduled for the Annual

When these fields are corrected, income is greater, values increase, and business develops. We can all correlate our work and be on the same team helping each other and all the State.

Dr. Furman: We ar a little past our time and I will now close the discussion.

Vice-President Peters: Thank you, gentlemen. Please remember the Hospitality Hour this evening at 6:30 p.m., and the business meeting begins tomorrow at 9:00 a.m., in Odd Fellows Hall in Sacramento.

THIRD SESSION
THURSDAY, FEBRUARY 12, 1953, 9:00 A.M.
ODD FELLOWS HALL, SACRAMENTO

Vice-President Peters: The principal item for this morning is the annual business meeting, and the items and reports on the agenda are numerous. I request that they be condensed to the minimum. It is usual for the President to give his report at this time, but as he is unable to be present I will read his written report.

PRESIDENT'S MESSAGE

It has been my extreme pleasure and honor to have served as President of the nationally known California Mosquito Control Association during the year 1952, and it is my sincere regret that it has been utterly impossible for me to attend this 21st Annual Conference.

In looking back over the past year, we have had some great disappointments and some hard work, but I feel we have developed a great fraternalism in this field of mosquito control. Thanks to a wonderful hard working Board of Directors the work of directing the Association has been extremely enjoyable.

During 1952 California experienced its highest case and death occurrence of Encephalitis in the State's history. The 722 reported cases are more than twice as many as in the previous year. This plus the ever changing problem of insecticides, and ever expanding irrigated acreage, increased industrialization and continually increasing population presents to Mosquito Control in the years ahead an outlook of great uncertainty and no forseeable prospect of mosquito control becoming any less costly or any easier. Even though we may be painting the picture for the future darkly, the ingenuity and cooperation of the chemical companies, association membership and your committees, I know, will do everything in the future that they have done in the past to keep California Mosquito Control at the front, in respect to new ideas, insecticides, and cooperation.

Now let us look at some of the accomplishments of this past year. As of November 1952, our Association reported approximately 24,000 square miles under organized mosquito control protecting 11.000,000 people. 6,000,000 acres were irrigated crops, 335,000 acres of rice, 750,000 acres of irrigated pasture and 1,400,000 acres of cotton. We have talked about big business in the past and now again I say, California Mosquito Control IS BIG BUSINESS.

One thing that has made California foremost in Mosquito Control in the past has been the tireless effort of the committees and their chairmen who also have done an exceptional job again this year in taking the initiative in their plans and proposals for their individual committees. Durng this year of 1952 more than ever before local mosquito control agencies have seen the need of a more realistic outlook in seeking to reduce the problem by corrective and preventative measures. This requires detail, work, cooperation, and perhaps even to some extent law enforcement with emphasis on abatement method as opposed to the repetitive type control methods. It has also become more evident that there is a need for better methods of measuring mosquito populations and determining the adequacy of the work done in order to better guide local districts and mosquito control as a whole for the future.

We have tried during the year of 1952 to keep the membership informed as to the work being done by the Board and the committees and I believe each one of you received notices of pending board meetings and committee meetings so that you might attend those that you felt beneficial to your immediate problems. Some of the business of the Association was handled by mail ballots in order to save time and expense and on most occasions a great number of you were in attendance at the executive meetings to gain information first hand and help to decide those issues of question, so I feel that it is unnecessary for me to enumerate the considerations and decisions of the board during the year.

I would like to extend my thanks again to the Board of Directors, to each and every committee, to Dick Peters and his staff in the Bureau of Vector Control, and to the Association as a whole, for the wonderful cooperation, support and work during the year of 1952, that so greatly helped in guaranteeing that California Mosquito Control would continue to lead in this field in the future. And of course we owe a great deal of appreciation and thanks to George Umberger, Bob Peters and the Conference Committee for all the work that has gone into the planning of another successful Conference.

Congratulations on another successful year of mosquito control, may you have a wonderful Conference and receive the "fire" that you need for the coming season. Good luck.

Sincerely,
ROLAND L. HENDERSON, *President*

Vice-President Peters: We will now have the report of the Secretary-Treasurer.

ANNUAL REPORT OF SECRETARY-TREASURER
FEBRUARY 12, 1953

Gentlemen:

Herewith is submitted the financial report of this association for the period February 2, 1952, when I was elected to this office, to December 31, 1952.

FINANCIAL STATEMENT OF THE CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC.
February 1, 1952—December 31, 1952

Balance on hand February 1, 1952		$2,775.42
Income		
Contractual payments	$2,160.00	
Associate Member dues	69.00	
Sustaining Memberships	78.00	
Contributions (conference fund)	415.39	
Sale of decals	5.40	
Sale of Publications	20.40	2,748.19
Total Monies received		$5,523.61
Expenditures		
Stationery	$ 89.81	
Postage & P.O. Box rent	95.90	
Proceedings printing	1,349.05	
Advance for 21st conference	300.00	
Secretarial fees	15.00	
Repair of Tape Recorder	21.97	$1,871.73
Bank Balance December 31, 1952		$3,651.88
Conference Fund Balance		115.39
Working Bank Balance		$3,536.49

many of the opinions are based on close observations of the animals, particularly the dairy cows; the dairy farmers are in contact with the animals continuously and are able to note changes in habits and characteristics of their herd and their animals and I think that many of their opinions might be regarded as bordering on the factual.

Vice-President Peters: The next speaker is Mr. William M. Herms.

Mr. Herms: I was talking with Deane Furman shortly after lunch and asked him if it would be in order to have a difference of opinion. Panels are enlightened when differences of opinion occur. Since dairymen have been mentioned, I am reminded of a story. A feed salesman was spending a vacation in Canada. He visited a friend who was in a similar business and this friend asked him if he wouldn't go to a dairy meeting which was to be held that evening and talk to those dairymen in Canada about some of the new developments in the feed industry. He reluctantly accepted the invitation, and spoke to those folks that evening on the subject of feed mixing and balancing of the proteins. In the middle of the discussion one of the French-Canadian dairymen in the back of the room sung out "My cow she die." The speaker was slightly flustered, but he continued on and divulged a lot of the information we have developed on the antibiotics such as terramycin and aureomycin. Pretty soon this fellow sang out again, "My cow she die." The speaker turned to his friend and asked "What is the matter with that fellow—what does he mean?" His friend said "Don't pay any attention to him. He merely doesn't like your bull." Evidently there was a difference of opinion there.

I had a job of selling an artificial insemination program to a group of dairymen, and I went on to a Portuguese dairy ranch to talk to the man about artificial insemination. I talked to some lengths trying to sell him on the benefits of that program. He didn't say a word and I thought I was getting by, but pretty soon he cocked his head on the side and said "Artifish insem she's a no good—the cow she needa tha bulls!" So we have two dairymen with exactly opposite opinions, and if you make a sufficiently large sampling of opinion of farmers on the benefits of mosquito control to agriculture you might get a lot of contradictions.

If I may, Deane, I would like to refer back to a point brought out in the previous panel because it relates to this matter of economics. We mentioned those pastures on which water stood and which were not producing as they should. The fundamental point there is that there should have been a better job of land preparation and levelling before that pasture was seeded. We have had a very fortunate experience with our Sacramento-Yolo mosquito abatement people. They have gone to our land levellers and have discussed this matter with them and have gotten some fine results in better jobs of land levelling. And in our office when anyone comes in to discuss seeding pastures, land levelling is one thing that we definitely stress. As I mentioned before, an extra ten dollars per acre spent at that time is going to pay dividends time and time again over a period of years. But that may not always be financially possible at the time to the man who has the problem on his hands of paying for the initial cost of the development.

I feel that a pasture is not going to be an economic winner, at present prices of beef on the hoof, unless it is prepared and managed for maximum feed production, and a farmer who cannot prepare pasture properly will sooner or later have to take it out of pasture and put it into some other crop, or he will go out of business.

From an economic standpoint there isn't any question that the livestock men benefit materially from mosquito control which also helps in other types of vectors and diseases. I don't believe that I can substantiate the scientific background of this particular statement, but I believe there are instances in which anthrax, anaplasmosis and this new disease we are finding in sheep could be transmitted by mosquitoes, flies and other vectors. I don't think mosquitoes have been proven to be incriminated in the spread of these diseases, but there is certainly evidence that they may be involved. These diseases are very definitely economic factors to the livestock man. Get an outbreak of anaplasmosis, or sore nose or blue tongue as they call it now, in a flock of sheep, and not only may the death losses be severe but you also have losses in those animals that are sick and not gaining properly. I think that is very definitely an economic problem and a place where you people do help the livestock people. There are undoubtedly other places where your help has shown itself in dollars and cents, and I think that I probably with this one example of disease control, have covered sufficient territory to indicate that there is considerable help from you folks.

There is one last thing I'd like to say. We all have our problems, we all have our points of view, and sometimes we wonder why the livestock man, the pasture operator, doesn't embrace the mosquito control program enthusiastically, but he is thinking in economic terms as I have mentioned, in pounds of meat per acre; he is thinking in terms of bloat, he is thinking in terms of irrigation, he is thinking in terms of where can I buy the cattle or lambs to put on these pastures, when am I going to sell these cattle, shall I send them into a feed lot, shall I send them directly to market, to the packer, or send them to an auction yard, and so on. He has many problems on his mind just as you folks do, and we need to be a little charitable toward him because just as all of us have, he too has his problems. We need to be careful not to use pasture men, rice men, I don't care who it is, as horrible examples. We need confidence in these men, rather than to ridicule them.

A Member: I think that Bill brought out an excellent point there. A great deal of improvement has been accomplished over the past five years, but we must remember that much of what we are doing is education, and education is a real slow process—it takes years and years to accomplish any objective in the educational field. Mosquito control is a continuous job, and as we go along we should be looking for evidence, real concrete evidence, of the economic value of the work you are doing. There are a lot of factors which haven't been sifted out yet, and the scientists will open up new evidence as time goes on, and this should be brought to the attention of the people.

I can think of two pieces of evidence of economic loss. In Sacramento on Second Street where farm crews are recruited we have seen trucks come in each morning in the pear picking season and go out with a different crew. Because of the mosquitoes on that ranch the crews quit and a new crew is needed each day. That is an economic loss. We have had some people in our district who heard last year there were some deaths from encephalitis, and promptly sold their ranch at a sacrifice and moved away. That was an economic loss to them. Such things reduce land values. Then there are the tourists. They will avoid places where mosquitoes are notorious, and go somewhere else where they can get a good night's sleep.

thought had records. In addition, we made two random contacts without regard to the farmer's location.

After interviewing several of the more progressive ranchers, it became evident that our quest for production records which might offer a clue to economic benefits would be difficult if not impossible to come by. It was found that even the progressive farmers failed to keep any records at all. After interviewing 47 farmers located in the 6 Mosquito Abatement Districts previously mentioned and failing to uncover a single meaningful record, we brought our mission to a close.

However, in our search we did obtain personal observations and similar subjective information which lent support to the contention that mosquito control benefited the agriculturalist. For example, 17 of the dairy farmers interviewed declared that judging from their own personal experience mosquito control aided milk production. Two beef ranchers stated that the rate of growth of their steer was increased as a result of mosquito control. Twenty-seven other ranchers contacted, including poultry, dairy, beef and sheep men, did not know about the economic benefits but they did endorse mosquito control work. Only one farmer, a sheep rancher, declared that the benefits from mosquito control activities did not justify the cost.

Here are some of the typical comments made by the farmers interviewed:

Mr. William Andrews, St. Claire Corporation, Gridley: "Since we have had mosquito control, I have noticed a marked increase in the weight of my animals, but I would not say how much. Anyway, the animals are more contented. Flies and mosquitoes are still great nuisances at times, but soon after my pasture has been treated by the local M.A.D., both flies and mosquitoes are very scarce for one or two weeks."

M. L. Hunt Ranch, Gridley: "I have noticed no increase in milk yield, but I suppose mosquito control does some good."

H. B. Shirley, Gridley: "I think that my animals are better milk producers since we have had mosquito control. I still have mosquitoes in my pastures at times, but they soon disappear after they have been treated by the local M.A.D. crews."

The William Pritchett Ranch, Gridley: Mr. George Aray, a ranch employee, stated, "I believe that the cows are producing more milk now than before the mosquito district was organized. They are much easier to milk and the flies are not nearly as numerous. The irrigated pastures have very few mosquitoes but the deer flies are very bad early in the spring."

A. E. Bettencourt Ranch Oroville: "I believe that since the mosquito district has been organized that my cows give more milk and do less running in the pastures."

O. Scheiber & Son Dairy, Marysville: "I think that mosquito control in this area has been beneficial to me and my neighbors in an increased weight and greater milk production. I have not seen any mosquitoes in the pasture for a long time."

M. Silva, Sutter City: "I think that mosquito control is very good and has increased my milk yield. Last year when I asked the mosquito district operator to spray my barns, he refused. Aside from this, I am very much satisfied with the mosquito control being done."

E. L. Malone, Alberta, Sacramento Count: "I think that the mosquito district operation in this area has done a great deal to reduce fly nuisances, as well as mosquitoes. It is possible that mosquito control has increased my egg production but this could also be due to changing the feed of the chickens from time to time."

Pollock Ranch, Sacramento County: "Mosquito control may account for an improvement in the weight of my beef cattle, but I don't believe it's due to mosquito control alone. I think that mosquito control has benefited me most by reducing the annoyances of mosquitoes around the ranch and making it more pleasant to work in the fields."

T. Kendall, Davis: "I think that mosquito control has increased my milk yield very much. I know that the cows feed in the pasture with practically no irritation."

The remainder of the 47 comments and opinions expressed is along similar lines, adding to the mounting store of subjective information but giving us nothing new factually. It appears now, even more so than before, that documentary evidence, particularly with respect to livestock production, must come from carefully planned experiments.

That is the general concensus of opinion on mosquito control in this area. I was trying to find one that was against mosquito control but I can't seem to find it. I might mention that we have two testimonials, one from the Stedman Ranch, located in Gridley, California. I'd like to read it because it does point out some of the benefits that come to orchards as well as to the beef and dairy people. "Stedman Orchards is a family partnership of which my brother and I are the managers. We have about 500 acres, mostly orchards and some field crops. The land lies on the Feather River close to Gridley and Biggs. We are among the larger tax payers of the county, and the money we pay in the form of taxes to the mosquito abatement districts is one of the most valuable of the tax dollars. We get efficient work from our employees because of the absence of mosquitoes in the fields. It certainly makes a better living for everybody in the county." I have another here that I believe might be worth while reading at this time also. It says, "Part of our land has been in the mosquito abatement district since 1923 and all of our acreage has been in the district since 1945. We have in the district 2500 acres of rice land, 3000 acres of irrigated pasture, 4000 acres of valley pasture and 20,000 acres of low foothill range, total of 30,000 acres. We have received the greatest benefit from the mosquito abatement in the irrigated pastures. The absence of mosquitoes makes it possible for our irrigators to work. The drainage program has increased the yields of the pastures and they grow a better grade of grass; this also reflects in the increase of weight in beef cattle. We now carry out many of the drainage programs introduced by the district to which we has objected when they were first introduced. The tax is 7 cents per acre on our irrigated pastures (I think that 7¢ is arrived at by dividing the total number of irrigated pastures by the total tax paid to the county for mosquito control). "The rice lands received the next greatest benefit from mosquito control and the tax is 4¢ per acre on our rice lands. The dry range received little direct benefit but the mosquito tax that it pays makes it possible to do more work on the irrigated pastures than the tax on the irrigated pastures alone would allow. Since the dry pasture and the irrigated pasture go together in the cattle operation it is no more than fair that the dry pastures be taxed also. The tax is 2¢ per acre on range land. Our territory would be a very undesirable place to live in without mosquito abatement. Signed E. S. Metchie, Crocker Land Co."

All of the information that I have given, all realize, will not stand under the close analysis of scientific appraisal; it is all circumstantial and opinion. However,

Land reclaimed from fresh and salt water marshes by drainage represents one of the most tangible indirect benefits to agriculture resulting from efforts to control mosquitoes, and is representative of one of the most cogent types of argument for securing cooperation from farmers who might otherwise fail to see in mosquito control activities a force compelling their active support.

Vice-President Peters: That is a good start. Now, Ed Smith, will you follow along, please?

Mr. Smith: I think it is obvious to us that circumstantial evidence is about all we have at the present time to back up any dollars and cents appraisal of the impact of mosquitoes on agriculture, but circumstantial evidence has hung men in the past so I guess that it has to be reckoned with. All of us who have been working in mosquito districts can cite example after example of farmers who have called us up for help in getting rid of mosquitoes simply because they couldn't keep men working in the fields, either their irrigator or the men picking fruit. I remember a call from a farmer who couldn't pick his strawberries; he had about one hundred acres of strawberries and he couldn't keep anybody in those fields to pick them because the mosquitoes were so bad, even though the mosquitoes were produced in irrigated pastures two or three miles from there. But apparently the strawberry patch was a very nice place for the mosquitoes to hide during the day so they effectively kept workers out of there. I could go on indefinitely on individual examples like that. It would be hard to appraise the dollars and cents from the standpoint of manpower.

It may be a little bit easier to show loss of production in the case of dairy herds. I've had two such examples in the last couple of years in which there was excellent circumstantial evidence of a definite drop in milk production from mosquitoes. One of those was a farmer about three miles southeast of Merced who called us one day and said that he wanted some help. The mosquitoes were so bad in his irrigated pasture that although the cows had been in that irrigated pasture longer than he usually left them they still hadn't cropped off the grass at all. It seems that there was one triangular corner in that field which was dry and as soon as they put the cows in the field they went over in that dry corner and they just would not go out into the grass at all. They did very little feeding and he said they had dropped in production about 20% in a matter of three days. So we did the very best job we could on mopping up the mosquitoes in that entire area. I think that most of you are familiar enough with Merced County so that you know what I'm talking about when I say that there are a lot of mosquitoes there; a good many of you have had the dubious pleasure of being taken out into those fields and having to turn around and run out. This particular place was far from town, and we did not have enough money to do the kind of job we wanted to do even for the populated areas, so we had to tell that farmer we couldn't promise him the kind of mosquito control we would like to give him, but we were interested in finding out what we could about his milk production and the mosquitoes. So we went there with our fog machines and the airplane, and we did a thorough job of mopping up on the mosquitoes in his pasture and all those for about a mile in each direction. He told us that within three days his milk production was back up to normal. Of course that is circumstantial evidence; there may have been other factors that had just as much influence on the milk production as the mosquitoes. We couldn't prove otherwise.

We had another case in which the percentage was identical; the man claimed 20% drop in his milk production. He said "I don't want to bother you; I know you don't have enough funds to give us all we want out there (this was about fifteen miles from town); however last year you came out and sprayed my pastures once and it knocked off the mosquitoes pretty thoroughly and my milk production went right back up to where it was, and I was wondering if you could do it again this year." So we did it for him again, and we also got his milk receipts for the entire season, for that year and the year before, and we were able to show a very definite correlation between his milk production and the build up of the mosquitoes as the season continued through until about the middle of August, which was the time we sprayed, and his milk production went right back up to where it was, within three or four days. So we feel we have fairly good circumstantial evidence in those two cases.

In the case of beef cattle I have a very good example on the Crocker-Huffman Ranch, but the introduction has already touched on it. Russ Fontaine tells me he has a letter from the production department of Lands Cattle Company so I'll just make one brief comment to assure Dr. Furman that in Mr. Merchant's statement about the increase in weight in his beef cattle he was taking into consideration the drainage as well as the mosquito control: he was attributing that to the mosquito abatement as well because it was the mosquito abatement that persuaded them to embark on a drainage program which they themselves have carried on since.

Vice-President Peters: Mr. Russell Fontaine is next.

Mr. Fontaine: I shall try to summarize the results of contacts our office made last year with various farmers in the Sacramento Valley. The motivation of these contacts was a letter from the Bureau of Vector Control to the mosquito abatement districts pointing out the desirability of obtaining factual data from the records of actual farmers showing increase in milk production or beef production under mosquito control. This letter further pointed out that the data on the public health effects of mosquito control are well known, and we have plenty of evidence of the benefits to recreation and real estate. But in the field of agriculture such data are sadly wanting. The letter asked the mosquito abatement districts to furnish names of farmers in their areas who might keep records, and to investigate and get their opinions, testimonials and information.

One of the first responses we received in our area office came from the Los Molinos Mosquito Abatement District. They gave us the names of four farmers who said they had such records. Three of them were dairy farmers and one has beef. None of them had records which could be correlated with mosquito control in the Los Molinos district. Each one of the four had definite opinions of the benefits of mosquito control. The three dairy farmers, for example, were very certain in their own minds that mosquito control had made a definite improvement in their milk production; when they had a lot of mosquitoes in their fields their milk production fell off. However, that wasn't the kind of data we wanted, so we decided to make more contacts throughout the Sacramento valley, in the hopes that we might uncover some factual data. So we contacted the Sutter-Yuba Mosquito Abatement District, Sacramento-Yolo, and Oroville Districts and asked for names of farmers who might keep such records. They very kindly provided us with the names of farmers who they

to disease transmitted by mosquitoes which appears in Herms and Gray's Mosquito Control Manual—including value of lives lost, cost of medical care and medicine, labor losses, property losses, loss of crops due to inability to work at the proper time, cost of moving in and out of endemic areas.

Heartworm of Dogs

Although heartworm of dogs is not by any means a major agricultral problem in California it does have nuisance value and in some cases, represents actual financial loss. The infection appears to be widespread in California. I. M. Roberts in 1949 described infection in 60 dogs, 38 of which were native to California, and may of which had not been out of the San Francisco bay area.

The infection is commonly believed to be transmitted by mosquitoes but there has been until recently no conclusive experimental demonstration of the transmission back to dogs by mosquito or any other insect. Numerous species of *Aedes, Culex* and *Anopheles* are involved—in these the immature stages of the worm develop and mature and emerge from the proboscis so the probable picture is quite complete. It remained however for Kume and Itagaki in 1949 to feed such mosquitoes on a known uninfected dog to definitely prove transmission. We know also that cat and dog fleas may be important vectors since the larvae *D. immitis* have been shown to develop in them. Epidemiological (Epizootiological) evidence is in favor of mosquito transmission.

Myxomatosis or "Big Head" of Rabbits

This is a usually fatal virus disease of domestic rabbits which is frequently transmited by mosquitoes. It is endemic on the west coast of North America and appears elsewhere in Mexico and South America. It is the agent introduced in Australia in recent years in attempts to control the introduced domestic rabbit which has gone wild there and is a serious pest. A heavy infestation of mosquitoes coupled with infection in a few animals may result in a rapid transmission sufficient to wipe out a commercial rabbitry. The fact that the virus may be transmitted mechanically should not minimize the importance of mosquitoes in transmitting the virus. The economic implications are self-evident. Note— Australians in 1951 produced evidence implicating *simulium* species (black flies) as vectors of *myxomatosis.*

Fowl Pox

Fowl pox is a viral disease affecting chiefly chickens and turkeys. It may cause death losses in poultry flocks ranging from 15 to 60%. It may be transmitted from bird to bird by direct contact with the broken skin. More significant however is the proven ability of mosquitoes of the *Culex, Anopheles, Aedes* and *Culiseta* to transmit the infection, either hours or days after an infective blood meal.

An affected flock in heavy egg production shows a rapid decrease in output. Accompanying this is an increase in thin, roupy appearing birds.

In commercial poultry areas of California, fowl pox is recognized as a continuing hazard and routine innoculations of young birds with fowl pox vaccine is practiced. The cost of the vaccine plus the cost of administration is a considerable drain on the poultryman.

Since the poultry are usually vaccinated for two or more things (Newcastle disease) simultaneously however, elimination of fowl pox and its vectors would save the poultryman only a portion of the cost of prophylactic treatment.

Means of transmission in addition to mosquitoes include wild birds, visitors, animals, second hand feed sacks, new adult or started stock, and misuse of vaccine.

Fowl Spirochaetosis

Fowl spirchaetosis is a disease occurring sporadically in California chickens and turkeys. Mosquitoes have been found infective for poultry in some experiments, but most workers are of the opinion that they are of no practical importance in the transmission of avian spirochaetosis *(Borrelia anserinum).*

Direct Losses

When considering direct losses attributable to mosquitoes in California one immediately thinks of effects of mosquito feeding upon weight gains of meat animals and upon milk production of dairy cows. As indicated earlier, there is ample circumstantial evidence to support the belief that mosquitoes play an important role here. As evidence is the statement emanating from the Crocker-Hoffman Ranch in the Merced Mosquito Abatement District, to the effect that animals grazed on pastures with mosquito control gained from 50 to 100 pounds each per year more than cattle grazed on pastures without mosquito control. Certain indirect effects may have played a hidden role here—such as an associated better pasturage incident to drainage, likewise decreased parasite burdens for the same reason. At any rate, the net effect seems to have been good.

Efforts made by MacCreary in 1938 to demonstrate decreased milk yield in dairy animals subjected to mosquito attack produced no definite conclusions. The obvious reason was that too many variables were encountered. Low or decreased milk production was associated with mosquito attack—but only with coincidental deleterious effects from short pasturage, attacks from horse flies and bad weather conditions. We could well stand additional information along these lines based on controlled experiments.

Of course the effect of mosquito control on taxable values of land is particularly evident in urban areas, but some reflection must inevitably be found in rural areas as well. A report by Headlee in 1926 pointed out and supported with data the fact that taxable values of land in New Jersey freed from salt marsh mosquitoes rose significantly over a ten year period when compared to land not similarly controlled.

Indirect Effects

The indirect economic impacts of mosquitoes and mosquito control activities are so numerous and varied that a few examples only will serve to indicate the range.

The observation made by Herb Herms to the effect that three pounds of 50% DDT per acre, not only controls *Aedes* in rice fields but also kills the tadpole shrimp, the crustacean pest of rice seedlings.

The impetus given to farmers to drain their land properly for increased crop protection, water conservation and reuse, supplied by cooperative services at cost from mosquito abatement districts where mosquito breeding is involved.

The effects of proper drainage upon internal parasite populations of livestock. This is difficult of assessment, but we do know that excessive moisture favors high population levels of many parasites of livestock such as liver flukes, stomach worms, large round-worms *(Ascaris),* lung worms and many others. Not that I mean to imply that proper drainage will eliminate these problems—for they are complex—but in many cases the population of parasites will rest at a lower level in well-managed, well-drained pastures, even in irrigated pastures.

and we had made no advance in irrigation and drainage problems?

Mr. Booher: I can only repeat my statement that after following the false hopes of control by these so-called miraculous insecticides we are now back to where we were nearly fifty years ago in the necessity for educating farmers as to proper methods of irrigation and drainage for mosquito control as well as for successful agriculture. In relation to agriculture, in general any water which stays on the land surface any longer than 48 hours is doing no one any good. We have stressed this at meeting after meeting of farm people.

Dr. Freeborn: This problem has been growing for the past ten years so fast that none of us has been able to do an adequate preventive job, and yet prevention is fundamental, and cooperation between all the agencies involved is essential to prevention. We will now close this panel exactly on time. Thank you, gentlemen of the panel.

Vice-President Peters: I'd like to make an announcement at this time. As was previously indicated, there are several pieces of literature available in the form of bulletins and such over in this corner of the room for any who would like some of them. Amongst others is included the annual report of the Sacramento-Yolo County Mosquito Abatement District. In the interest of economy, Mr. Umberger has asked that you in mosquito districts who might otherwise be having a copy mailed pick them up. Another announcement I'd like to make before we go on is that those amongst you who are in the farm advisory group are invited to our hospitality hour tonight that will be held at the Odd Fellows Hall in the Silver Room downstairs at 6:30. The other announcement has to do with those of you who have brought your wives who would be interested in the tour which will be carried on tomorrow. The ladies are asked to meet in the Venetian Room on the mezzanine of the Hotel Sacramento at 10:15 tomorrow morning. From there they will be taken on a tour of the more interesting spots of Sacramento.

The next feature of the program is a discussion of the economic significance of mosquitoes to agriculture in California. I believe that the most sensitive part of the human anatomy is that which is closest to the pocketbook. The participants in this discussion are Dr. Deane C. Furman, Associate Professor of Entomology, University of California at Berkeley, Mr. Herms and Mr. Spurlock who have been previously introduced, Russell E. Fontaine, Vector Control Specialist of the State Department of Public Health, stationed at Sacramento, and your Past-President, Edgar A. Smith, Manager of the Merced County Mosquito Abatement District. Will you gentlemen please come forward and be seated, and Dr. Furman, will you please present the introduction to the discussion?

THE ECONOMIC SIGNIFICANCE OF MOSQUITOES TO AGRICULTURE IN CALIFORNIA

By Deane P. Furman, Ph.D.
Associate Professor of Entomology, University of California, Berkeley

In introducing a panel discussion on the subject of the economic significance of mosquitoes to agriculture in California I realize that I am concerned with a topic which has already received much thought and been a matter for discussions among the members of this Association, not only at this meeting and at the meeting held at Davis last October, but in numerous presentations submitted at earlier Annual meetings of the California Mosquito Control Association.

As a basic premise I am sure we can state that mosquitoes, where abundant, represent an actual dollars and cents loss to agriculture. However, the ways in which this loss is represented are diverse and frequently difficult to recognize. Certainly there are numerous existing or potential factors whose inherent destructive qualities are quite well known, as for example, the man-hours which may be lost if malaria case rates rise; or more cogent still at the present time, the loss of property, health or life itself inherent in any season of high encephalitie morbidity.

Concerning other types of losses we are accustomed to making sweeping statements, the validity of which we seldom question, but the proof of which we might find ourselves hard pressed to find in terms of actual controlled data. For example, how many of the statements made regarding the relationship of mosquitoes to increased or decreased weight gains or milk production are backed by other than circumstantial evidence? Nor do I minimize the value of such evidence. It is usually on the basis of such information that hypotheses are made. However, it is well to prove the hypothesis in controlled experiments wherever possible before placing all reliance on the premise.

For convenience, the economic impact of mosquitoes on agriculture may be divided into three types:

1. Effects due to disease transmission.
2. Direct effects due to mosquito attack.
3. Secondary problems accompanying situations favorable to mosquito control.

The diseases carried by mosquitoes, which affect either or both livestock and man, have economic significance to agriculture. In California, mosquito-borne diseases in this category include:

1. Arthropod-borne encephalitides
   a) St. Louis
   b) Western equine
   c) California encephalitis virus
2. Malaria
3. Heartworm of dog—*Dirofilaria immitis*
4. Rabbit myxomatosis
5. Fowl pox

There is little necessity for my discussing here at any length the problems represented by the arthropod-borne encephalitides. The subject appears as such elsewhere in this program. Suffice it to state that this closely related group of virus infections represents our most acute problem of mosquito-borne disease in California.

Malaria

Perhaps our experience with restricted outbreaks of Malaria last summer was not entirely unfortunate, i.e., 9 cases in Nevada County* last summer, 3 cases probably in Santa Clara County. At least it served to emphasize the value of a continued program of *Anopheles freeborni* control and investigation. To refresh our minds as to the impact which mosquitoes have upon agriculture one has only to review the early—and not so early—history of the state when malaria was a very common affliction, particularly in the central valley.

You will recall perhaps the analysis of economic loss due

*(*Editor's note: As of June, 1953 there were 32 proven cases of malaria in this outbreak.)*

Dr. Freeborn: Mr. Husbands, the Project Director for the California Mosquito Control Association, At Fresno, was called home suddenly by the arrival of a new daughter, and his place will be taken by the most attractive member of our panel, his assistant Miss Bettina Rosay.

Miss Rosay: In our studies we have a test pasture near Turlock that is about four years old; we have been observing it for two summers and will continue observations on it. Between the summers of 1951 and 1952 there has been quite a change. The first summer we observed it there was a smaller amount of water applied, and the irrigations were so spaced that it had a chance to dry. This past summer the areas of water were much greater, the pasture did not dry between irrigations, and there was continuous standing water on the pasture all summer. In the summer of 1951 our mosquito population on this pasture was about 10% *Culex tarsalis* and 50% *Aedes nigromaculis;* in 1952 the proportions were 26% *C. tarsalis* and 23% *A. nigromaculis.* There has been a change in the pasture from typical pasture grasses to plantain and water grasses, and a decrease in infiltration and a worsening of drainage. The larger and continuous amounts of water favor the production of *C. tarsalis* and have a diminishing effect on *A. nigromaculis.*

Dr. Freeborn: Thank you, Miss Rosay. The panel members are now open to questions or discussions from the floor.

(Editor's note: Some questions or answers could not be deciphered from the tape, and are omitted.)

Question: What type of irrigation do you recommend?

Mr. Booher: That depends to some extent on the type of soil. In some places we recommend contour checks, which are really low dams to hold water. In the Oakdale area we recommend strip checks and over on the coast and in the Sutter Basin we recommend sprinkler irrigation.

Mr. Gray: Dr. McElroy pointed out a very important thing that people in mosquito control work should do, and that is to direct your problem farmers to the Farm Advisor and the Agricultural Extension Service for advice. Often when one person tells a farmer about better agricultural practice he will not believe him, but by the time the second person or the third person tells him, plus his reading it in a bulletin, and perhaps talking to other farmers, he may begin to think there is something in an idea. You can help both that farmer and yourselves by urging him to get advice from his Farm Advisor.

Mr. Spurlock: I might add to that, Mr. Gray. In our county it is surprising the number of people who are not farmers who are going into the farming business, and so we have many parcels of land that are being levelled and put into irrigated pasture by persons with no previous experience. They don't know there is a Farm Advisor in the county and they don't know about the mosquito abatement district until after they start having trouble with mosquitoes. Therefore one of our methods of combatting this situation is that when our men in their trips around the county see a carryall scraper moving dirt, they drive in, hand out one of these pamphlets, and start from there.

A Member: I have a question for Dr. Peterson. What is the life expectancy of an irrigated pasture in 1953, and what should it be?

Dr. Peterson: The life expectancy of a pasture is rather indefinite at present, but it should not be; that is a problem that will bear more investigation work than we have been able to give up to this time. Not many pastures in California as yet are grazed on the rotation scheme as illustrated in the pictures I showed you; they are usually put in and left almost indefinitely. But there are logical reasons why it should be plowed and reseeded occasionally with better grasses. There is a considerable expense to do this, so the farmer is not going to plow up his pasture soon, but it seems that in about six to eight years it would be advisable to cash in on the built up fertility of the field, and to repair the irrigation system.

A Member: Please don't sit down. What difference do the various practices of feeding have on this rotation picture?

Dr. Peterson: There has been a great interest in rotation in the last few years. If just one man does it for every magazine article that has been written about it there would be a large increase in the next few years. The advantages are that you don't have to set up the fences, and you don't have to provide water for the stock, and you cut down on waste and trampling. On the other hand it runs about five or six thousand dollars in equipment for a farmer to start in a modest way on this green feeding, and to meet such costs you have to be able to get quite a little added production of beef or milk, and it requires a rather large operation to do that. Rotation of green feeding may not always be adviseable, as much depends on soil conditions and the type of feed that can be grown to best advantage. Considering all the factors, I do not know as yet whether all the interest in green pasture rotation feeding is justified or not.

Mr. Herms: In our county, in some cases after the land has been in pasture for about six years it is turned into growing corn for silage or grain for hay, and they get very good crops. Then when it is turned back for pasture there is the opportunity for relevelling.

A Member: Where you have a farmer with strip check irrigation without proper levelling, so that at the lower end of the field there is a constant source of mosquitoes, and you suggest contour checks as a method of reducing the mosquitoes, and he insists on his right to irrigate as he pleases, how do you go about it to get that man to do what you think is best?

Mr. Booher: The only way we can get people to change their habits is by demonstration where they can see where somebody is doing it better. The extension service is building on domenstrations. We have test plots and other types of plots all over the state. Last year in order to encourage better care of pasture we had a tour in this county. We called it a More Meat Per Acre Tour, in which we tried to inveigle these farmers to come out and see how it could be done better. We not only had it in this county but in order to get better publicity we had it continuous, from one county to the other in some twelve to fourteen counties in that one tour, so that we could get reporters from the big newspapers and from the farm journals and make it worth their while to go on this tour. We showed in one county after another good irrigation pastures. Plans are under way to have a summer tour again in the Sacramento Basin. They have another continuous tour down along the coast area; we have a series of meetings on irrigated pastures in the Bay area, in Contra Costa County, Marin and Sonoma Counties. We are trying to demonstrate the desirability in improved practices. Maybe some of you fellows can help us out in getting publicity for these meetings and getting people to atend. There is no better way you can convince a man he can do a better job than showing him that someone else is doing a better job.

A Member: I would like to ask Mr. Booher a question. I think he made a statement that fifty years had gone by

house to stand in a pool and breed mosquitoes. Well, the poultry specialist on our staff can take care of that as a part of his educational program. The person on our staff who deals with orchard irrigation, rice field irrigation, etc., can stress the need for mosquito control measures, for drainage in orchards, for provision for drainage in the rice fields when levelling and setting up the checks. At the last annual meeting of the rice growers we stressed the proper setting up of the rice fields with proper drains to help mosquito control work.

I want to stress again that this is a cooperative educational job with each one of our staff doing his part in it, along with the mosquito abatement group. No one person can do it—the job involves a great many people in many organizations, and it is a sales job, a public relations job in which we all have a part.

Dr. Freeborn: The next speaker will be Mr. Raymond C. Geiberger, also Farm Advisor of Sacramento County.

Mr. Geiberger: A few years back we began developing a lot of irrigated pasture in Sacramento County, which naturally put out a lot of mosquitoes. At first we claimed that the mosquitoes came from Yolo County, but that alibi didn't go over so good, and after the joint bi-county mosquito abatement district was formed George Umberger began to pick on our irrigated pastures. So I told George that the only reason he had a job was because of the mosquitoes from our pastures. But seriously, in discussing the problem with George we found that we had many things in common, and that what was good pasture management was also good for mosquito control.

As Farm Advisors we think that what farmers ought to do for proper livestock management will largely take care of the mosquito problem. We have used the leaflet, which John Spurlock mentioned, to good advantage, and I think that Bill Herms has also used it in Yolo County. Incidentally, Spurlock failed to give Herms credit for his share of the leaflet, which was a joint county project.

Our general program of operation with the farmer is about as follows. We would start on his ranch, beginning say with the irrigation ditch. We would call attention to any mosquito problem in connection with the ditch, and give him a sketch of how to correct it. Down in the drain at the end of the check there would be another problem, and another sketch made to correct that. Or perhaps the check wasn't levelled properly, or the cross levees weren't put up, or the grades were wrong—more sketches. Then we would get into the things that Dr. Peterson was talking about—pasture rotation grazing to get the most out of the pasture, and give him a diagram of how his pasture could be used for rotation grazing. We may not have laid much stress on mosquitoes, but everything helped to get across the idea that proper land preparation, proper use of irrigation water and good livestock management meant greater profits and few mosquitoes.

A few days ago I went to a farm which the owner had levelled two years ago. Last fall he also put in a large fish pond, so t told him he should put in some mosquito fish as it might be a mosquito problem. He asked where he could get mosquito fish, and I told him to get them from Umberger. He asked "Who is Umberger?", so I proceeded to tell him. Well, I think that illustrates my point, because when he had levelled his land and provided drainage he wasn't bothered by mosquitoes, and so George wasn't going to be around and worrying him. So if the land is properly handled your mosquito men need not worry if the farmer doesn't know who you are—but he will know you if he has mosquito trouble.

Another interesting problem is with waste irrigation water. In cooperation with the Sacramento Municipal Utility District and our own engineer we studied the problem of how to use this cheap water, and developed the idea of low-lift pumps to recover and use it. The pamphlet on this project has been previously mentioned. In it little was said about mosquitoes, but the use of these pumps to re-use waste irrigation water has reduced mosquito breeding water in many places, and it has been sound economy as well as mosquito control.

To recapitulate, with regard to pasture management, we will all do well if instead of telling the farmer that he had better do something about the mosquitoes we convince him that he had better do a good job of getting the most out of his pasture.

Dr. Freeborn: The next speaker will be George Umberger, Manager of the Sacramento County-Yolo County Mosquito Abatement District.

Mr. Umberger: In our area our observation has been that about two pastures out of five create mosquitoes. We are trying to work on source reduction in such pastures—either a pasture develops mosquitoes or it does not—and while it may not be quite a simple problem to eliminate an entire source area, in essence that is what effective correction amounts to.

(Editor's note: Mr. Umberger then proceeded to exhibit an excellent series of slides showing various problems and their methods of correction, which he accompanied by explanatory comment.)

Dr. Freeborn: Those were interesting and informative pictures, George. The next speaker on the panel will be Lloyd E. Myers, Jr., Assistant Sanitary Engineer, United States Public Health Service.

Mr. Myers: I would like to emphasize that public health people and mosquito abatement people are interested in land preparation, proper irrigation practices, drainage, and good feeding practices, for all of these reduce mosquito production. Many of us have seen cases where the farmer plants his field immediately after levelling. Usually within a short time this field settles unevenly, with the development of depressions which hold water and can't be drained under normal practices. Rotation feeding can be a great help to the mosquito people.

We don't care whether irrigation water goes into the ground or into a drain ditch, provided it does not remain long enough on the ground to produce mosquitoes, but if there is soil compaction we have a mosquito problem. A good rotation program will minimize compaction. An extreme case which I saw was where a farmer kept his cattle on the pasture as a holding pen for all but four hours a day.

Maintenance of pastures is important. If Mr. Husbands were able to be here today he would have wished to talk about deterioration of pastures with an accompanying shift of mosquito population from mainly *Aedes nigromaculis* to mainly *Culex tarsalis*. This appears to be due to the development of low spots and their progressive enlargement with time, tending to hold water continuously.

I also call your attention to some pamphlets on drainage, prepared by the Merced County Water Conservation Committee, which are on the table.

It seems to be desriable to work out a system in which the growth is allowed to reach a certain height, which we now think is attained at about 25 to 28 days, possibly 30 days, and then graze it down quickly. Some people who have tried to use such a system have not put enough animals on the pasture so that they graze it down quickly, with the result that there is a lot of waste. There is a problem in adjusting acreage to carrying capacities. The exact time between grazings may be dictated more by the irrigation cycle than either the growth of the grass or the needs of the animals, because it is extremely important that the pasture not be grazed when it is wet.

One of the most frequent abuses in irrigated pastures is leaving the stock on pasture when it is wet at irrigation times. This results in pot-holes and in compaction of the soil so that it does not take water readily, and soon the operator has to leave the water on longer, and the problem gets worse with time. Feed production decreases and mosquito production increases under these conditions.

Dr. Freeborn: Before we go on I would like a showing of hands by any people in the audience whe were in mosquito control work before 1916. Apparently Harold Gray and I appear to be the only real old veterans present. In the famous mosquito survey of California conducted in 1916 our next panel speaker was twelve years old, but he went along with his dad, did a lot of leg work and collected a lot of mosquitoes. I was about the age of the students who went on the survey, and we had a pretty good time together, but we had to be careful not to mention any of them in young Bill's presence or he would run and tell his Dad. I now take pleasure in introducing that boy, William M. Herms, Farm Advisor of Yolo County.

Mr. Herms: I can assure you, Stan, that you can say anything you want at the present time and I wouldn't dare run and tell it any place.

My portion of this panel is to discuss the general effects of the mosquito control program as it relates to our local counties in my particular phase of extension work which deals mainly with livestock and dairy work in Yolo County. There is considerable common ground between mosquito control work, livestock work and extension work. We are all striving for one thing and that is for better family living, whether it is better farm family living or better city family living. You folks may go down one side of the street and we may go down on the other side of the street but we are going to end up at the same location and the same house and that is better family living. If mosquitoes are controlled and if other insect vectors are controlled, it is a greater assistance to the livestock man than to the livestock. If we can help in the way of leveling and increasing yields, we are going down the other side of the street but we are getting there together with a better economic condition for the persons that we are working for.

The livestock man has several things in mind when he is in the irrigated pasture business. I had the first irrigated pasture meeting in Yolo County in 1930. I guess there was probably not over a thousand acres of irrigated pastures as we know them today in the State. Since that time, irrigated pasture acreage is up to about eight hundred thousand acres in the State of California. The more we've worked these past years. I'm somewhat convinced, the less we know about them; however, when I look back at that first meeting in 1939 I can see that we've made tremendous strides in information. There has been a large amount of fine research work that has come out of this institution, and there has been a lot of fine field work. We don't have all of the answers but we do have many of the answers in connection with fertilization of pastures. With proper irrigation of pastures, and proper handling of livestock on pastures, many of those things have been worked out to much better satisfaction than they were back in the early days, so that now the livestock producer who is primarily concerned with producing more pounds of meat or milk per acre is a more efficient operator than he was many years ago.

The other thing that is facing the livestock man today is that most any one can make a living with 35¢ beef but today that beef is down on the hoof to around 22¢, at which price it takes an efficient operator to succeed. I think that is where we all come into this picture; we can help this livestock man, this pasture man to become a more efficient operator. We assume that the job you folks are doing is very helpful; I think this control of these vector insects is helping livestock men to control some of the diseases which they are faced with. We assume of course on the other side that many of the things we are doing are helpful and they are all primarily concerned with making this individual or this industry more efficient.

Dr. Freeborn: The next speaker on this panel will be John E. Spurlock, Farm Advisor of Sacramento County.

Mr. Spurlock: I would like to give some examples of what we have done and are doing in Sacramento County to coordinate good agricultural practices with effective mosquito control. Our staff members within their special fields of work recognize their responsibility to see that farming practices do not make mosquito control more difficult. Much of our work is directly educational. For example, Mr. Geiberger, who is here on this panel, has in cooperation with Mr. Umberger, our mosquito abatement district manager, prepared an especially good leaflet on mosquito control on farms, which has been widely distributed in this county and elsewhere. In cooperation with the Sacramento Municipal Utility District, he has helped prepare another leaflet on the prevention of unnecessary waste of water and on the proper use of necessary waste water. In support of our program, we have called in the agronomy and the irrigation specialists from Davis, such as Mr. Booher, who are working with us and with the mosquito abatement people.

What about the women—the home economics group—how do these people fit into the mosquito abatement program? As Mr. Herms has indicated, the women in the farm homes are vitally concerned about mosquitoes. There are many home economics units scattered about the county, and the unit leaders meet once a month in a county committee meeting. They discuss these programs, hear talks by some of your people as well as ours, and take leaflets back to their units, and then these local groups discuss them and decide what they can do about the problem.

We have a group which we call home project leaders, which consists of representatives from many different organizations such as the Parent-Teachers Associations, the Grange Women, the Farm Bureau women, the Garden Club leaders, civic improvement clubs, service clubs, etc. These representatives attend meetings to get information and develop programs, and one of the programs under consideration is on mosquito control and hazards around the home, such as water holes, dripping faucets, etc. Each time we have one of these meetings we reach about two thousand people.

The poultry people wash out their feed troughs once a day and the wash water is usually run back of the poultry

Water temperatures below 68-70 degrees F. in the field seldom produce hatches except in sheltered places. Low temperature conditioning of eggs in the laboratory will also prevent hatches or will delay hatches for several days or until the eggs have been reconditioned to hatch. There are some indications that plant auxins may influence the hatch of low temperature-conditioned eggs but considerable work will be needed before this can be analyzed completely. Interesting leads are now in the process of investigation.

Colonization

The need for continuous supply of the major species of mosquitoes associated with irrigated pastures is self evident. With the establisment of a colony of *Culex quinquefasciatus* from material originally obtained from the Kern M.A.D., further work was directed toward obtaining successful colonies of *A. nigromaculis* and *C. tarsalis* to fulfill this need.

The study of *A. nigromaculis* larval diets led to unsuccessful results with consistent failures and inability to produce surviving pupae. Since a colony was the main objective and not the study of larval diets, an outdoor colony was investigated. A twenty-five gallon caged tank, twelve inches deep was lined with pasture sod. Drainage from this artificial pasture pool was effected by a suitable outlet at the bottom of the tank which could be closed when needed. Flooding with warm water produced an excellent hatch, larvae and pupae developed rapidly, and adults emerged in great numbers within seven days after flooding. Since this technique was established in October not more than two cycles or broods were produced before cool weather prevented further work. Although larval development was highly successful, emerging adults failed to survive in the dry cage for more than three or four days, and therefore egg production was not completed. With the development of a method of protecting the adults (damp cloth sides in the cage) it is felt that this will prove to be a successful method of colonizing *Aedes* species.

The development of method of colonizing *C. tarsalis* was less successful since time was not available for this study.

Precipitin Studies

During 1950 the project undertook the problem of determining by precipitin tests the hosts most generally utilized for a blood meal by *A. nigromaculis* females. The results of this study will be published at a later date but a preliminary examination of the data indicates that out of 1,442 specimens examined about 64 per cent were positive for cow, 33 per cent showed no reaction, and of the total showing positive reaction, about .013 per cent were distributed among bird, dog, horse, human, and sheep, with horse and dog receiving a majority of the positive reactions.

Culex Tarsalis

The study of *Culex tarsalis* in irrigated pastures as a part of the total mosquito population, or as it relates to irrigation cycles and standing water periods, has progressed slowly. The accumulation of several seasons' records has provided sufficient data to make a preliminary report upon the aquatic phase of *C. tarsalis* as it relates to irrigated pastures. Dipping records following each irrigation cycle in two study pastures have been examined closely to determine the rate of development of the aquatic stages and the successful emergence of adults.

Results:

Dipping records obtained from stations that were dry previous to irrigation indicate that 1st instar larvae will begin to appear on the second and third days following irrigation. There is some indication that during the cooler temperature periods the first eggs deposited by *C. tarsalis* following an irrigation will not hatch till three days after irrigation. During the months from July to November the 4th instar will appear by the sixth day or in some cases it may be delayed till the seventh day. Although the exact time that *C. tarsalis* spends in the pupal stage is unknown, the projection of the larval rate of development through all stages to the adult emergence period could possibly indicate that successful emergence can occur by the ninth or tenth day following irrigation. If pupae can survive on damp soil and produce successful adults, as is the case with *A. nigromaculis,* then standing water that remains upon a field for six or seven days will possibly produce *C. tarsalis.* Tests to determine this relationship have been proposed for future work.

A correlation of aquatic species composition with periods of standing water following each irrigation in selected stations showed the importance of evaluating the rate of aquatic development of *C. tarsalis.* For example, Station One can be compared for the period from June 23 to November 12 for 1951 and 1952 (Table 3). The aquatic species taken at this Station showed the following composition: 1951, *Aedes* spp. 80.58 per cent, *Culex* spp. 19.39 per cent; 1952, *Aedes* spp. 36.78 per cent, *Culex* spp. 63.06 per cent. This shows the shift toward increasing *Culex* production. This shift is reflected by the fact that, although this station was irrigated 13 times during this period in 1952, the water remained ponded at Station One for at least five periods with an average standing water duration of 20 days. Thus, at this station during 1952, the number of standing water periods was more important than the number of irrigations, as far as *C. tarsalis* production is concerned. During 1951, at Station One, during the same period a total of 10 irrigations were recorded or one irrigation every 14 days. Within this period there were 10 periods of standing water with an average duration of 7.9 days. Thus, every irrigation in 1951 was followed by a dry period, and in this case the duration of the water standing in Station One following each irrigation determined *C. tarsalis* production. When irrigations occurred during 1952 while the water remained at Station One, then larvae remaining at this station would be flushed from the station and into the drainage ditch where they could be destroyed by fish. Large numbers of *A. nigromaculis* that followed these irrigations would influence the sampling of any remaining *C. tarsalis* larvae. Therefore, it can be seen that a comparison of aquatic dipping records in the same area for several seasons means little in terms of adult production unless certain environmental factors, such as irrigation frequency, duration of standing water, and standing water area, are taken into consideration at the time. However, the change in species composition in a dipping sttaion is significant in that it may indicate a change in environmental conditions that may be used to evaluate field conditions in terms of improvement or deterioration.

C. tarsalis adults held in a cage on a screened porch and fed sugar water, were able to survive for several months. Adults were placed in the cage on September 9 and the last adult was seen alive at the end of December. This showed that *C. tarsalis* could survive for approxi-

TABLE 1—*Irrgation Dates, Cycles, Aedes nigromaculis Adult Emergence Dates, Larval Growth Cycles in Days, and the Mean of the Maximum, Minimum, and Mean Air Temperatures for Cobb's Pasture—1952.*

Irrigation	Date Hatched	Date Emerged	Number of Days	Mean Temperature	Average Max.	Min.
1	4/23	5/4	12	59.7	72.4	46.5
2	5/10	None	..			
3	5/23	5/29	7	72.9	93.1	52.3
4	6/5	None	..			
5	6/13	6/20	8	69.4	74.4	51.6
6	6/25	7/2	8	67.5	83.9	51.6
7	6/30	None	..			
8	7/12	7/17	6	79.4	96.4	61.8
9	7/19	7/25	7	79.0	96.6	60.8
10	7/31	8/6	7	80.0	96.8	62.6
11	8/10	8/16	7½	73.9	90.1	54.3
12	8/21	8/27	7	74.3	94.9	53.1
13*	8/24	....	..			
14*	9/4	9/6 to 9/15	**			
15	9/9	9/18	10	67.2	86.6	47.3
16	9/21	9/28	7	76.2	94.7	57.7
17	10/7	10/7	10	65.2	81.7	48.7
18	11/10	few	***			

* Overflow of water from the cotton field occurred during these cycles. Samples of the water taken during the 8/24 irrigation period showed that the water contained toxic materials which destroyed first instar *Aedes* spp. of larvae. *Culex tarsalis* larvae were not noticeably affected by the toxic materials. Dusting of cotton was responsible for the adverse *Aedes* condition.

** Emergence here indicates that *Culex* spp. were dominant. Very few *Aedes* spp. were found in the pasture during this irrigation period.

*** Low temperatures produced few larvae and adults.

TABLE 2—*Aquatic Stages Species Composition—Cobb's Pasture 25 June—5 November 1951 and 1952.*

SPECIES	Per cent of Total Species		Per cent for Genus (Total of all genera)		Per cent of species within genus	
	1951	1952	1951	1952	1951	1952
Aedes sp.	17.92	12.22	78.21	38.99	22.88	31.40
A. dorsalis	4.51	2.84	....	....	5.76	7.29
A. nigromaculis	50.02	23.90	....	....	64.00	61.40
A. vexans	5.76	0.03	....	....	7.37	0.08
Culex sp.	6.49	20.01	21.76	60.45	29.82	32.98
C. quinquefasciatus	0.26	0.36	....	....	1.22	0.60
C. stigmatosoma	4.79	13.81	....	....	22.00	22.71
C. tarsalis	10.22	26.20	....	....	47.00	43.52
C. thriambus	....	0.07	....	....	....	0.11
Culiseta sp.	0.03	0.17	0.03	0.17	....	....
Anopheles sp.	....	0.01	....	0.01	....	....

TABLE 3—*A comparison of the percentages of the aquatic stages of each species found in stations 1, 5, 6, and 1 to 10 in Cobb's pasture from June 25 to November 5 for 1951 and 1952.*

SPECIES	Station 1 to 10 (Total pasture)		Station #5		Station #1		Station #6	
	1951	1952	1951	1952	1951	1952	1951	1952
Aedes sp.	17.92	12.22	27.50	14.22	20.80	18.94	11.0	16.60
A. dorsalis	4.51	2.84	2.56	3.68	4.60	1.82	3.95	4.61
A. nigromaculis	50.02	23.90	48.00	46.00	54.60	16.02	82.10	42.80
A. vexans	5.76	0.03	....	....	0.58	....	0.01	0.14
Culex sp.	6.49	20.01	4.94	15.91	1.90	21.79	0.68	15.10
C. quinquefasciatus	0.26	0.36	....	0.08	0.39	0.48	....	....
C. stigmatosoma	4.79	13.81	....	0.59	10.30	8.36	....	0.98
C. tarsalis	10.22	26.20	17.00	19.53	6.80	32.22	2.14	19.65
C. thriambus	....	0.07	....	....	....	0.21	....	....
Culiseta sp.	0.03	0.17	....	0.16	....	0.28	0.14	0.82
Anopheles sp.	....	0.01	....	....	....	....	....	0.64

TABLE 4—*Showing. the changes in dissolved oxygen content of pasture water during the September 9th irrigation.*

Stations	Time	Temperature	Dissolved Oxygen ppm*	Dissolved Oxygen at all stations by 3:45 P.M. ppm*
Ditch	9:45 A.M.	18.1	7.8	7.6
A	9:10	19.8	7.4	7.0
B	9:50	22.3	6.9	5.0
C	10:45	25.3	5.8	3.5
D	11:30	28.3	5.2	5.2
E	12:30 P.M.	28.	4.5	2.8
F	2:00	32.7	3.4	3.8
G	2:20	31.9	3.4	2.8

* Taken as water passed each station.

mately four months under these conditions and could possibly survive as long in nature.

Summary

Ecological measurements taken in Cobb's pasture during 1952 show the influence of certain environmental changes upon pasture mosquito pupulations. With the increase of standing water areas and more frequent irrigation cycles, the species composition of the pasture changed in comparison to 1951. *Culex* species increased and *Aedes* species decreased but only in areas where water remained on the field for comparatively longer periods. Light trap collections show two peaks of *Aedes nigromaculis* production from the pasture, one peak in July and the other in October. The decrease in production during the late August and September periods are reflected in aquatic stages species composition and in general can be attributed to the standing water conditions during these months. Measurements upon the dissolved oxygen content of irrigation water during September showed that during the period of actual *Aedes* egg hatch the oxygen content seldom dropped below 5.2 ppm. The study of factors that influenced egg hatching indictaed that some form of stimulus was necessary to produce hatch and that this stimulus could possibly act either through direct chemical action or through indirect actions, such as egg conditioning and oxygen reduction. The colonization of *A. nigromaculis* has progressed successfully by the use of artificial pasture ponds constructed in small tanks and should prove useful for future studies. Precipitin studies based upon the study of *A. nigromaculis* collected in Stanislaus County showed that a majority of the blood meals were obtained from cow. Humans, birds, horse, dog, and sheep were utilized for a blood meal but only by a very small percentage of the specimens examined. Under these conditions virus recoveries would be complicated by the size of the sample necessary to obtain suitable material. During mid-summer *C. tarsalis* can possibly complete development in the field, from egg to adult, in nine or ten days following irrigation or, if the pupae can survive on damp soil, within six or seven days following irrigation. Based upon this length of development, dipping records will not reflect potential adult populations of *C. tarsalis* unless the frequency of irrigation, duration of standing water, and water area are also carefully evaluated. However, a comparison of species composition can be useful in helping to deetrmine the trend in the evolution of irrigated pastures.

Acknowledgments

The following personnel were very important to the development of the investigations in the field and in the station: Johnson T. Prescott, Summer Assistant, CMCA; Malcolm S. White, Field and Station Assistant, BVC; Richard I. Church, Vector Control Officer, BVC; and James R. Holten, Vector Control Officer, BVC.

The project obtained very useful technical advice from Dr. Harvey I. Scudder, Scientist (R) USPHS, and Lloyd E. Myers, Jr., A. Sanitary Engineer (R) USPHS.

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A FEW OBSERVATIONS FROM THE PROJECT ON THE EMBRYOLOGY OF *AEDES NIGROMACULIS* (Ludlow)

By John R. Arnold

The CMCA supported project at the College of the Pacific has not completed its research on the embryology of *Aedes nigromaculis* and so it was decided not to attempt to present a summation but rather to submit a few observations which were thought likely to be of interest to the Mosquito Abatement Districts and others doing research on mosquito development.

1. It was observed by Mr. Gilbert Jones that, under laboratory conditions in which the average high temperature was 80.5° F. and the average low was 68.0° F., the eggs of *A. nigromaculis* seemed to reach full hatching maturity in about 120 hours. In one case eggs of approximately 120 hours of age hatched in less than 15 minutes (water temperature 75° F. and air temperature 74.5° F.) while eggs several hours younger flooded at the same time did not hatch for several hours. This seemed to indicate that further development was necessary in these eggs before they were capable of hatching.

2. In one instance a female *A. nigromaculis* laid her eggs in seven batches over a 45 hour period. A total of about 100 eggs were laid.

3. Obstervations by Mr. Gilbert White seemed to indicate comparable stages in development in an embryo of *A. nigromaculis* of approximately seventy hours (70 hours) and one of *Aedes vexans* (Meigen) of thirty days (30 days).

A few illustrations are submitted here from the laboratory reports of Mr. Marion Quessenberry, Mr. David Reed, and Mr. Gilbert Jones.

Figure 1. A drawing by Mr. Jones of a cross section of an egg of the pre-blastula to blastula stage. Blastula cell nucleus (bl); chorion (ch); yolk mass (y); and yolk cell nucleus (yc). A composite drawing from E32, slides 1 and 2, sectioned at 10 microns. Embryo 9-12 hours of age.

Figure 2. A drawing by Mr. Jones showing the early embryonic differentiation in a 32 hour embryo. Amnion (am; amniotic cavity (amc); chorion (ch); embryo proper (em); serosa (sr) and yolk mass (ym).

Figure 3. A photomicrograph of an over-wintering embryo from which the chorion has been partially removed but the vitelline membrane still remains.

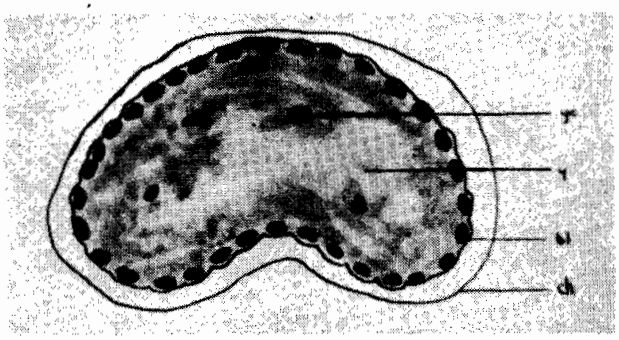


FIGURE 1

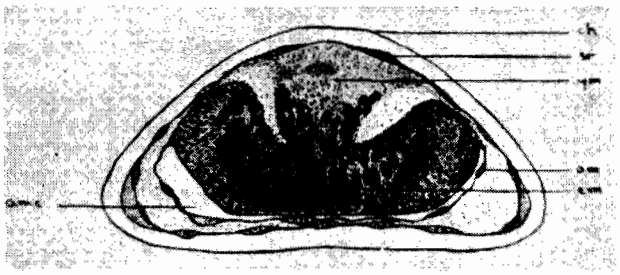


FIGURE 2

FIGURE 3

MOSQUITO TOXICOLOGY STUDIES IN THE KERN MOSQUITO ABATEMENT DISTRICT

By LEWIS W. ISAAK, *Entomologist*

The toxicological screening program conducted this past year has been for the most part accumulating a mass of negative information. A number of new materials look promising in the DDT, Toxaphene category, but nothing so far has approached the effectiveness of EPN. Now it will hardly be necessary for me to take up ten minutes of your time to tell you that nothing new has turned up red hot in the way of larvicides, but I will rapidly run through the list of several of the companies which have submitted samples, compare their materials, then dwell for a few moments on our use of EPN this past season.

Stauffer Chemical Company gave us 32 samples, in the Sulphonon and Fluorine families. One of the samples proved to be about as effective as Toxaphene, but not effective enough generally to warrant commercial manufacture.

The Geigy Company sent 3 samples which proved comparatively ineffective; they were 22008, 23611, and 23330. We are expecting several more samples from them, however, which are reportd to be much better.

McLaughlin, Gormley King Company sent a number of samples of Pyrethrum and Allethrin products with added booster concentrates. These compounds also fall in the DDT, Toxaphene class, but they are very expensive by comparison and are also very difficult to emulsify properly.

Art Bronson of the Richfield Oil Corporation has developed a larvicidal oil which has proved to be effective. It was tested on two, five-acre duck ponds where vegetative growth was very heavy. Results were 99% plus. Only an occasional pupae was seen alive where before we could average about 20 *Culex* per dip. On these ponds the oil was applied by airplane at 6 gallons per acre. I understand that some of the other districts who have tested this oil have experienced 100% control with even less oil per acre. The larvae in Kern County generally seem able to tolerate oil more than other localities in the state. Incidentally, it is my experience, that this oil is more effective on larvae than on pupae. Usually it is just the other way around.

The Shell Chemical Corporation submitted samples of Endrin and Isodrin which are steroisomers of Dieldrin and Aldrin. When tested with the colonized *Culex,* they proved to be not superior to Aldrin and Dieldrin, but I have not yet tested them on a resistant strain.

The Hercules Powder Company has graced my desk with 52 samples of new insecticides. So far only 24 of these have been screened, of which 5 appear to be as good as Toxaphene. These, likewise, have not been tested against an extremely resistant strain of *Culex* for final evaluation.

All in all we have yet to screen about 50 more new materials this winter, so there is still hope of running across something to take the place of EPN, if and when it goes the way of all DDT.

Although major work with surface active compounds is being adequately handled by Howard Greenfield and his staff in Salinas, we have done just enough experimental work with these compounds for the control of *Culex* in fire barrels, especially where we have thousands of these barrels to contend with as in the cotton gins. For the past two years we have been using Oronite D-40 at ¼ pound per barrel. Material that we applied two years ago is still effective in barrels where water has not been removed. A new material we have found to be about 20 times as effective, pound for pound, is Speakmans No. 700. In initial experiments, it has given us 95% control of larvae and pupae at 1 part in 50,000 parts of water. If we use it, however, it will be administered at 1-25,000 parts as an adequate margin of safety.

A report from Kern County could hardly be complete this year unless a word or two is said about EPN. As most of you are aware, Mr. Gjullin, Crafton Campbell and myself completed tests involving at least 75 good experimental plots on both *Culex* and *Aedes* larvae at various dosages. By jeep application, we controlled 99% of *Aedes* at .035 pounds per acre. On *Culex* .035 pounds per gave us 100% control. Airplane applications required slightly higher dosages for the same amount of control. As an adequate margin of safety, however, we make both jeep and airplane applications at .075 pounds per acre, and in areas of extremely dense vegetation, we augment airplane applications to .1 pound per acre.

Although Mr. Lindquist has very adequately covered the hazards involved in the use of EPN, I would like to enlarge slightly what he has said by illustrating with a few pictures just how we have circumscribed most of the dangers encountered.

PICTURES

In addition to these precautions, three power spray operators, the pilot and myself had cholinesterase activity tests taken every two weeks over a 5 month period when the spray program was at its height. At one time the pilot was accidentally exposed to a 1% spray as it blew back from a leaking pressure line. Some of it entered his eyes. He immediately landed the plane, went to the laboratory for a blood test, then to a doctor for clinical evaluation. The blood test gave no indication of cholinesterase inhibition and no clinical symptoms of poisoning were apparent.

Several of the spray operators who complained of headaches were given a blood test to determine whether the ailments might be due to a reduction of cholinesterase activity, but their counts proved normal.

Of a total of ten men, including several who spilled the 45% concentrate on their hands, blood tests revealed that in all cases, the cholinesterase activity remained within the normal range.

As for a residue that EPN may leave, there appears to be very little danger involved. In a locality where *Culex* are breeding continuously, we may find 1st instars alive 3 or 4 days after spraying.

So, in spite of the fact the DDT honeymoon is over, which almost seemed to be the theme of last year's meeting, we can still remain pretty intimately associated with several of the newer compounds until all breeding sources are abated.

RICE FIELD MOSQUITO ECOLOGY PROJECT PROGRESS REPORT—1952

ROBERT H. SOROKER,
Assistant Vector Control Specialist,
Bureau of Vector Control
Project Director Rice Field Ecology Project

Last year over 330,000 acres of rice were sown in California. This year the acreage promises to be even greater. Associated with the flooded rice fields are two mosquitoes of vector importance: *Anopheles freeborni* and *Culex tarsalis.*

Because the rice fields are usually under water from April or May to October, mosquito control operations have been both difficult and expensive.

In seeking effective control measures, the Rice Field Mosquito Ecology Project has sought to learn as much as possible concerning the biology of rice field mosquitoes. Considerable time was devoted to evaluating mosquito control practices as utilized by mosquito abatement districts in rice growing areas.

In 1950 and 1951, efforts to demonstrate the effectiveness of an early spring larviciding program were not outstanding. The 25 square mile study area in Sutter County, typical of many rice growing localities, proved extraordinarily difficult to cover. With the resources on hand it was found to be impossible to keep ahead of the reinvasion of larvicided areas.

In 1952 it was decided to carry on a final spring-time control demonstration in southwest Placer County. All water sources in this area were easily located and effectively larvicided.

Complete records were kept of the time the water was reinvaded after larviciding, the type and amount of area covered, gallons of larvicide utilized, and the man hours involved.

The area was thoroughly surveyed and inspected prior to the first operation. Twenty-four dipping stations in the treated area and thirteen in a comparable non-treated area were maintained until July 11, approximately six weeks after the last larviciding operation.

With the exception of one pupa found on April 24, no larvae or pupae were found during the week after the first spray operation was completed (April 9-16).

A check of the untreated area was made on April 24. All instars of *Anopheles* larvae and pupae were found. From May 5-9, the third week after the original spraying, the dipping records show that both anopheline and culicine larvae could be found in the water over most of the treated area. These larvae were in early stages of development and not numerous.

The second spray operation began on May 16 and was completed on May 22. By this time, most of the water was confined to the three main creeks and their tributaries.

By May 28, just six days after the second spraying of the area ,both anopheline and culicine larvae were found at a number of the regular dipping stations. After this, the larval density rapidly increased.

No significant differences were noted in larval population between the treated and untreated areas.

Ten adult resting stations were observed weekly in the treated area. It was found that anopheline adults, both male and female, were present in some of these stations each time they were checked.

The Moore rice field was the only field completely within the treated area. This new, cleanly cultivated field was flooded in early June. All water sources around the potential field were thoroughly larvicided. Yet this new field, contrary to our other studies, appeared to have as high a larval count as did the second year weedy fields outside the area.

An investigation of the effect of insecticides on the predator population and the subsequent mosquito larval densities would be of interest.

Resulting experience has indicated that only by an intensive ecological study of the mosquitoes and their relation to rice fields can we hope to find clues which will lead to improved control methods.

In 1952 cultural studies were coordinated with ecological studies to find means of abating rice field mosquitoes with methods other than the strict use of insecticides. Agricultural investigations include studies on the effect of various rice field cultural practices, herbaceous annuals and perennials, soil types, and water temperatures, on the mosquito population. Biological studies include limnological surveys of irrigation water mosquito density records, and the evaluation of the possible toxicity of certain blue green algae to mosquito larvae.

In May, 1952, four Placer County rice fields were selected to study the relationship, if any, between clean culture and mosquito production.

Two of the fields (Van yke and Ernst) were in rice for the first time and were cleanly cultivated fields with checks free of weeds. The other two fields were planted in rice for the second consecutive year and the old checks were dnsely overgrown with barnyard grass, cattails and scrub-willows.

At each of the four fields, five dipping stations were

selected. Three were in the rice field itself, one at a rice field seepage location, while the last was in a nearby drain ditch.

At each station a series of 10 dips were taken at intervals of five paces each. All larvae were counted and some preserved for identification.

Study areas were also located in Glenn, Colusa and Butte Counties so as to reflect a Valley-wide sampling of the larval and adult mosquitoes. Mr. C. L. Stone, Agriculturist for the Project, will review the work in those territories.

One study check in each field was reserved for a complete limnological survey. Mr. Gerhardt will discuss this phase of the work.

The overall peak for *Culex tarsalis* larvae at all Placer County dipping stations was reached on June 9 when an average of 6.9 larvae were recorded. On June 24 and July 10 minor peaks were reached—each averaging more than three larvae per dip.

Culex tarsalis were far more numerous in second year fields with dirty checks than in first year fields relatively free of weed growth.

Anopheles freeborni larvae did not reach the expected late summer peak in the Placer County rice fields studied.

The first year fields reached peaks on July 10, July 24, August 14 and September 2. As noted from the graphs, the larval densities in the new fields caught up and slightly exceed the old fields late in the summer.

The seepage and drain ditch stations contained an average of 10.4 larvae per dip on May 27 and, at this time, exceeded the rice field dipping stations.

The major peak for these stations was reached on June 9 when an average of 18.09 larvae per dip was recorded. After June 16 there was a very sharp decline in the numbers of larvae found. It may be surmised that the mosquitoes move to the rice fields when the rice plants are far enough advanced to furnish cover and protection. The sharp increase of predators in the seepage and drainage ditches may limit the larval population.

The fruit box mosquito resting stations were first employed last summer by the Project as a means of measuring adult mosquito populations within the rice fields.

The top of the box is covered with box shook and hinged at the midway point. The box is set on end and propped against the hinged lid at approximately a 60 degree angle. To collect mosquitoes, the lid is closed rapidly and chloroform, applied with an atomizer, is introduced through a small hole near the top of the resting chamber. The box should be hit with the palm of the hand to dislodge any clinging mosquitoes. Adults may readily be collected from the bottom of the box for identification.

Records obtained from boxes placed in the summer on rice field checks show a close correlation between the numbers of resting adults and the larvae counted at the dipping stations.

The adult *Culex tarsalis* mosquito peaks in June and July occurred twelve to fifteen days after the larval peaks were reached.

As many as 140 *Culex tarsalis* adults were observed resting in a single box.

Records from our Glenn, Colusa and Butte County rice fields show the boxes attracted large numbers of *Anopheles* during the months of August and September. Though the three fields are many miles apart, there appears to be a general coincidence in peaks of adult populations.

On three occasions observations were made in the evening. Each time it was noted that mosquitoes left the boxes shortly after sundown.

The number of mosquitoes resting in the box appeared to reach a daily summer peak around 2:00 P.M.

Time of collection and prevailing weather conditions (wind, temperature, humidity, etc.) may affect the number of mosquitoes attracted to the box.

Numerous adults have been collected when box temperatures have been over 90° F. This appears to suggest that ground humidity may be an important factor.

Undesirable features as experienced in the fruit box summer field trials resolve around the difficulty of removing speciments rapidly without damage; the frequent invasion of predators; and the non-waterproof character of construction. All such faults should be easily corrected.

The fruit box had other features that were worthy of further consideration, such as lightness, ease of operation, adaptability to various rough terrain, and their ease of concealment in the rice field environment. The inexpensive construction is also not to be overlooked.

During the months of November, December and January (1952-1953), old and newly constructed boxes were established within pump houses, barn, tank houses and bridges.

Newly constructed, varnished and caulked boxes are not being used as resting stations by the mosquitoes. The odors from these boxes may repel the mosquitoes.

Old and weathered boxes placed in man-made resting stations have and continue to have very good reception. Mosquitoes resting in some of these old boxes are more numerous than they are in an equal area anywhere else in the building.

This winter new and old boxes placed out in rice field checks, in open brush piles, and in Sacramento river bottom areas, have been avoided by mosquitoes. This is thought to be due either to a low density of adults in wild areas, competition of natural resting places or, most probably, to the lack of movement of any distance in the winter months.

It is believed that thorough studies of the ecology of rice field mosquitoes will in time bring to light new concepts of mosquito control and lend support to some of the corrective cultural practices advanced by mosquito abatement district managers and entomologists.

PRELIMINARY LIMNOLOGICAL INVESTIGATIONS ON FOUR CALIFORNIA RICE FIELDS

RICHARD W. GERHARDT[1] and EUGENE J. SHERMAN[2]

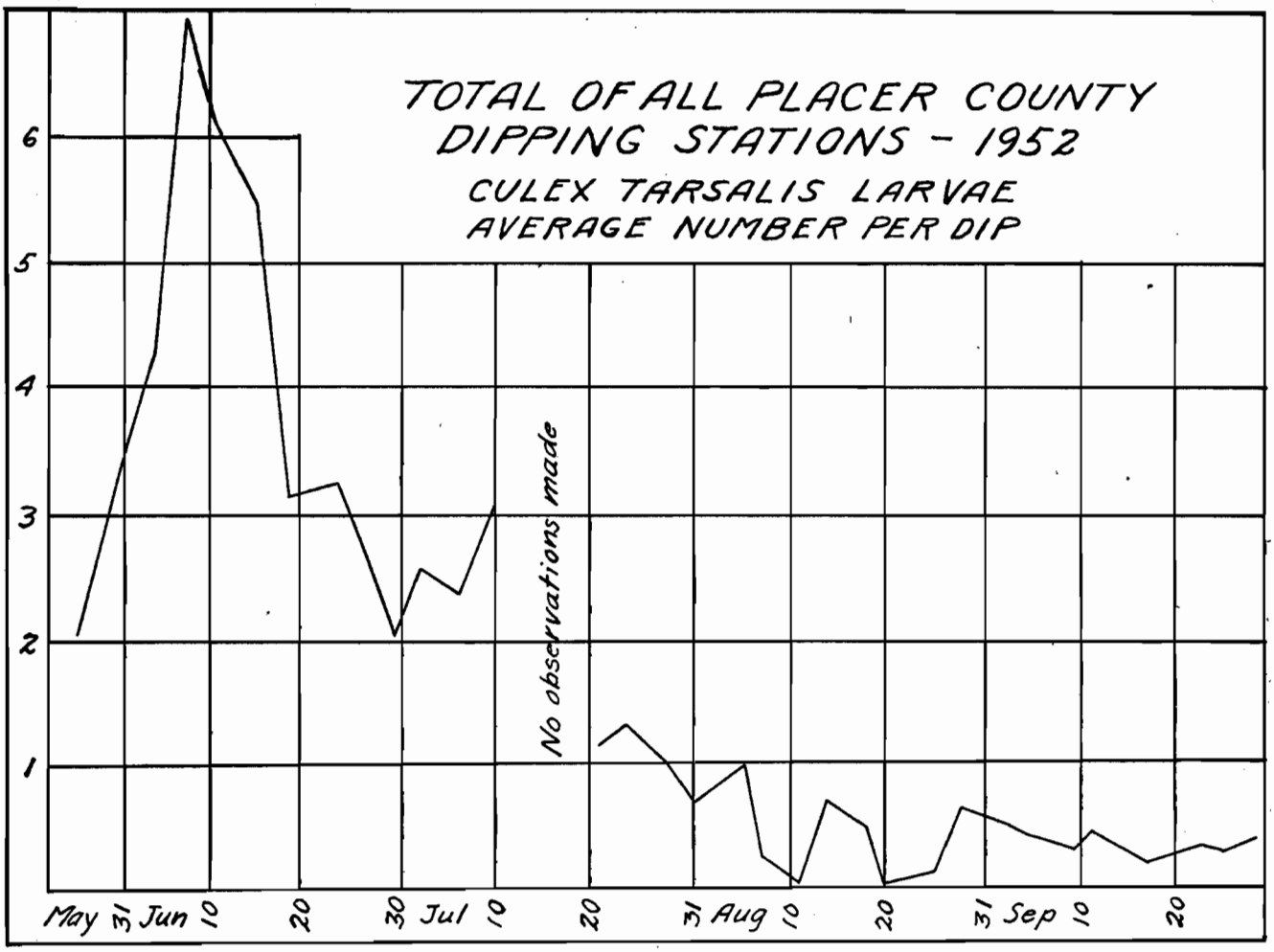
INTRODUCTION

The Rice Field Mosquito Ecology Project included in its program for the 1952 season, a limnological study of four rice fields. This type of critical examination of the aquatic environment of rice field mosquitoes is necessary if the complete ecology of these insects is to be understood.

In addition to the primary objective of learning as much as possible about these aquatic environments, the work was designed to help evaluate the observed difference in the numbers of mosquitoes produced by old, weedy fields as compared with newly prepared, clean fields.

This report is concerned with the latter mentioned supporting work.

[1] Assistant Project Leader and Entomologist, Rice Filed Mosquito Ecology Project, California Mosquito Control Assoc.
[2] Vector Control Officer, California State Department of Public Health, Bureau of Vector Control.



A limnological study of rice fields was conducted by Purdy in 1919 and 1920 (Purdy, 1924), in the Nelson, California area. Purdy's work included mosquito population studies and an evaluation of the aquatic environment similar to this study. In general, the data are parallel.

Purdy also studied certain algal species present in the Nelson area which seemed to effect the larval populations of the rice fields. This aspect of Purdy's work is being evaluated by the senior author of this paper.

Methods

Four fields were studied. Two fields, the Dumas and Temple Ranch, were examples of old fields, while the Van Dyke and Ernst fields were newly prepared for rice culture.

Periodic examinations performed on the irrigation water of the study fields included measurements of the dissolved oxygen, carbon dioxide, pH, alkalinity, dissolved nitrates, sulfates, chlorides, and iron. Quantitative plankton counts and larval population counts were performed regularly.

Results

The data of the seasons work have been averaged and are presented in tabular form. Space does not permit the presentation of all the tables, graphs, and comparative data gathered from each field.

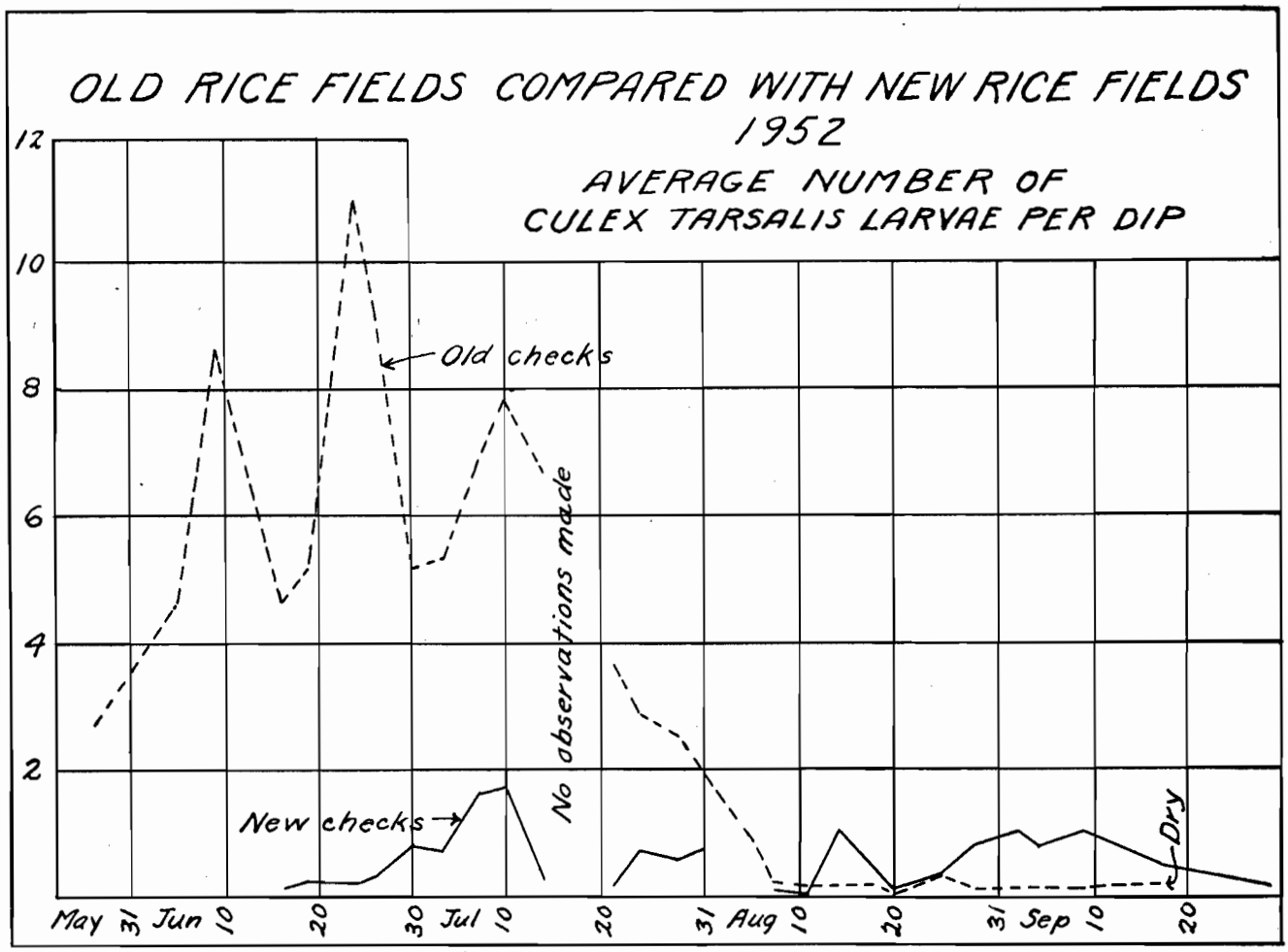
	New Fields	*Old Fields*
pH	7.6	7.2
Alkalinity	53.6 ppm	124 ppm
Nitrates	1.07 ppm	.36 ppm
Sulfates	1.08 ppm	10.63 ppm
Chlorides	6.5 ppm	66.05 ppm
Iron	.61 ppm	.31 ppm
Dissolved O_2	5.73 cc/L	5.60 cc/L
Dissolved CO_2	12.8 ppm	10.9 ppm
Culicine Larvae	.67 /dip	7.37 /dip
Anopheline Larvae	.34 /dip	1.12 /dip
Plankton (total seston)	70.9 /cc	124 /cc

Discussion

Examination of the chart presented reveals that, with the exception of nitrates and iron, all of the dissolved solids are more concentrated in the old fields than in the new. The most probable explanation for this condition lies in the fact that the old fields, having been in cultivation for a longer period, have had more time in which to accumulate these ions on the surface. The lack of nitrates in the case of the old fields may be due to the demand of the rice for nitrogenous compounds. No reason can be offered for the difference in the amount of iron present except natural variation in abundance.

The dissolved respiratory gasses do not differ significantly from the amount expected in any shallow aquatic environment.

Examination of the figures given for plankton and mos-



quito larvae populations indicate considerable difference in the biotic potential of the two environments. Evidently, the old fields are the more mature, biologically. The more protected environment provided by the weedy check banks may contribute to oviposition by adult females and the more abundant aquatic biota may contribute to the survival of the larvae in the old fields. In the case of the more abundant plankton of the second year fields, it is evident that there are more spores, cysts, and other resistant stages surviving in the old fields. These, when given the proper conditions in the spring, provide an almost immediate build up of the aquatic biota.

Conclusions

Second year rice fields studied by the Rice Field Mosquito Ecology Project, were found to be more productive of mosquito larvae than were the first year fields. The physical environments of the fields studied did not vary sufficiently to account for the great difference in the numbers of mosquitoes produced. On the contrary, those fields producing the most mosquitoes were found to have the greatest concentration of salts.

Biologically, the old fields were generally more productive than were the new ones. The greater amount of time available for the accumulation of the aquatic biota and the more protected environment offered by the old fields may account for the difference.

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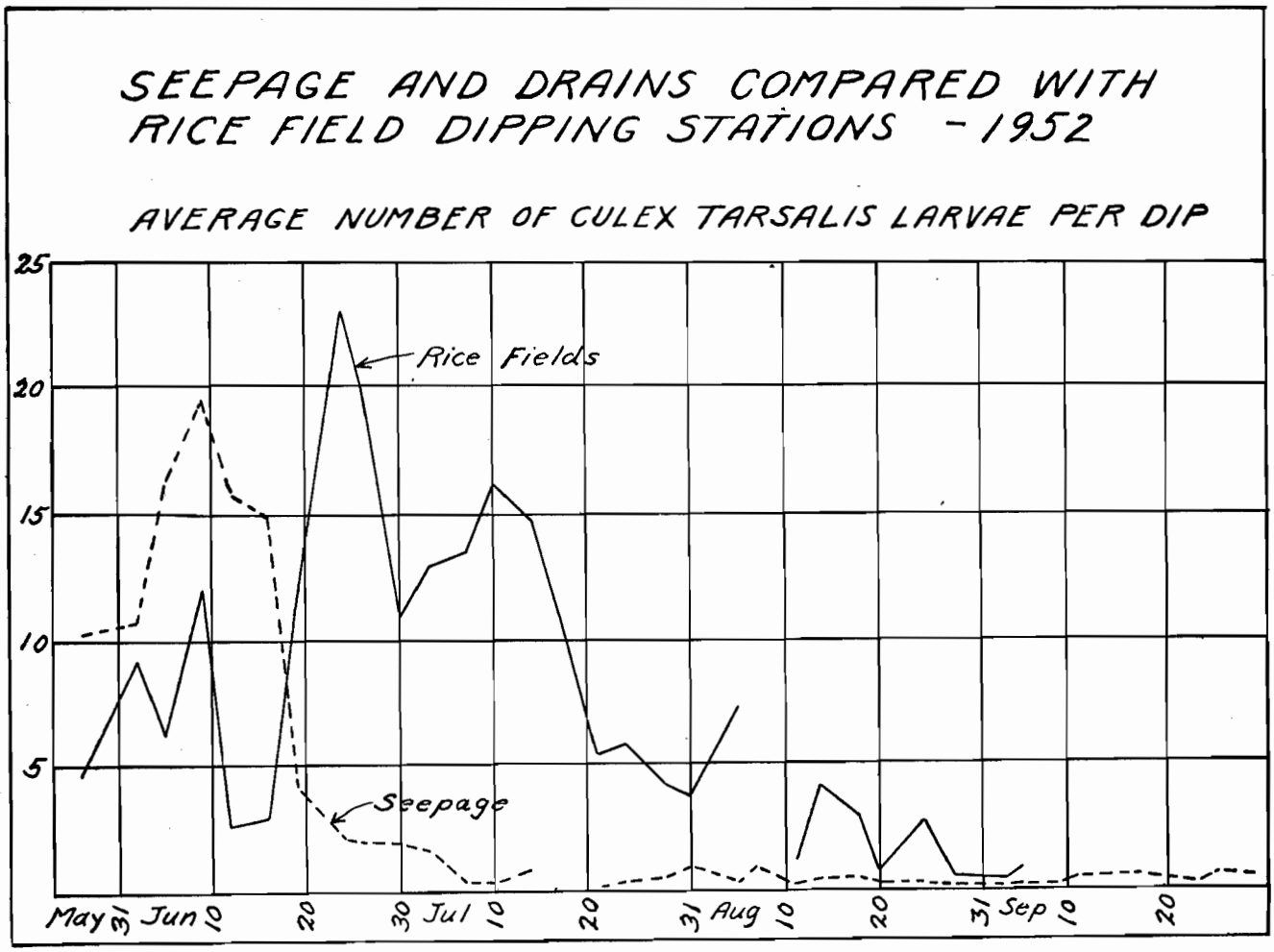
LATE SUMMER PRODUCTION OF MOSQUITOES IN RELATION TO RICE CULTURE IN THE SACRAMENTO VALLEY

Charles L. Stone[1]

During the late summer of the 1952 rice growing season studies were conducted to determine the production of mosquitoes under varying rice cultural practices in the Sacramento Valley. Study areas were located in Glenn, Colusa and Butte Counties so as to reflect a valley-wide sampling of the larval and adult mosquitoes on a comparable basis.

The study methods used were triple replicated dipping areas representative of, (1) average circulating rice irrigation water, (2) slow circulating or ponded rice irrigation water and (3) adjacent ponded seeps or stagnant drains. Ten dips were taken at each station at bi-weekly intervals to appraise the number of larval forms present. Measurement of adult mosquito incidence was obtained by the use of the fruit box resting station located adjacent to the dipping areas in sites representative of, (1) rice

[1] Professional Assistant, Agriculturist C.M.C.A. and B.V.C.



contour border check, (2) interior rice contour check and (3) on ditch, drain or canal bank.

The environmental conditions of all three study areas were typical of Sacramento Valley rice growing districts and may be classed in general as the average conditions under which the great majority of rice is grown in California. All study areas were infested with varying stands of predominate rice weeds. The age of the rice fields under study varied from two to six years and each was subjected to a comparable cultural pattern.

Water temperatures at the Wylie Area located in south west Glenn County were taken from recording thermographs in cooperation with the Division of Irrigation, University of California, under the direction of Robert M. Hagan, Irrigation Technologist, Davis, California who was conducting "Rice Cold Water Studies" for the Rice Growers. Other water temperatures were taken with pocket thermometers at time of dipping. Air temperatures and relative humidity were taken in the Wylie Area with a standard recording hygrothermograph at ground-water level located on a contour border check. Other air temperatures were obtained by use of maximum-minimum recording thermometers, located on rice contour checks 18" above the ground level and shaded by dense stands of watergrass.

Plankton samples and water analysis samples were taken in each of the study areas to evaluate the biological-chemical content of the rice water in relation to larval production.

The accompanying chart, Figure 1., indicates the numerical count of Anopheline and Culicine larvae as obtained in the three study areas from the varied dipping stations under conditions enumerated above. The chemical analysis of the rice water samples as taken September 2, 1952 are given in Figure 2., along with larval count, soil series, source of irrigation water supply and mean surface water temperatures. Plankton counts or density of organisms at each study area are given in Figure 3., along with larval counts and key rice cultural information. The findings of the adult mosquito survey will be related by another member of our staff at this conference of the California Mosquito Control Association.

The conclusions reached by this brief survey indicate the following findings:

1. That approximately *18 per cent* of rice field mosquito larvae are produced under conditions where there is a normal or average circulation of rice irrigation water in the rice growing areas.
2. Some *32 per cent* of mosquito larvae are produced in slow circulating or nearly ponded rice irrigation water.
3. That *50 per cent* of mosquito larvae are produced in adjacent dead seepage water or stagnant rice water drains.
4. In total over *80 per cent* of mosquito larvae are produced in and around rice fields under conditions that can be corrected by good rice cultural practices. In other words ponded-dead-end rice growing areas, along with excess seepage water and stagnant-weed-infested drains should be eliminated not only as a

Rice Field Mosquito Ecology Project

DIPPING STATION RECORD*

Location:	"A" Average Circulating Rice Water			"B" Slow Circulating & Ponded Rice Water			"C" Adjacent Seeps & Drains Non-circulating Rice Water		
	Anopheline	Culicine	Total	Anopheline	Culicine	Total	Anopheline	Culicine	Total
Wylie Station #1	20	16	36	119	139	278	24	141	165
Wylie Station #2	11	2	13	10	1	11	40	30	70
Wylie Station #3	38	40	78	65	60	125	0	108	108
Lenahan Station #1	16	4	20	12	0	12	4	0	4
Lenahan Station #2	10	21	31	14	4	18	0	0	0
Lenahan Station #3	106	89	195	122	95	217	167	181	348
Llano Seco Station #1	29	9	38	48	55	103	88	257	345
Llano Seco Station #2	8	10	18	14	13	27	72	84	156
Llano Sect Station #3	22	0	22	33	1	34	51	43	94
Totals	260	191	451	437	388	825	446	844	1290
Percentages	58%	42%	18%	53%	47%	32%	35%	65%	50%

* Based on bi-weekly dipping, of 30 dips per Stations, or a total of 360 dips per Station, and 3240 dips for 9 Stations conducted over a period of 6 weeks from Aug. 11 through Sept. 22, 1952.

Rice Field Mosquito Ecology Project

RICE WATER ANALYSIS, LARVAL COUNT, SOILS AND WATER SUPPLY

Station:	pH	Turbidity p.p.m.	Hardness $CaCO_3$ p.p.m.	Alkalinity $CaCO_3$ p.p.m.	Chlorides p.p.m.	Sulfates p.p.m.	Nitrates No_3N_2 p.p.m.	Iron Total p.p.m.	Iron Soluble p.p.m.	Larval Count (120 Dips) Total	Mean Water Temp.
Wylie, #1-A Genevra Clay. Sacto River Water, GCID.	7.7	16	42.0	50.0	2.1	1.2	1.1	0.50	0.10	36	68.0°F.
#1-B	7.0	40	68.5	100.0	20.0	3.4	0.4	19.0	0.30	278	72.4°F.
#2-A	7.1	2	45.0	56.0	2.7	4.8	0.0	3.0	0.05	13	71.0°F.
#3-A	7.3	1	79.0	113.0	12.8	1.4	0.1	0.4	0.03	78	72.0°F.
Lenahan, #1-A Willows Clay, with moderate to strong "White Alkali" Re-circulated Sacto River Water, C.D.I.D.	7.4	5	111.0	141.0	32.9	26.9	0.5	1.25	0.04	20	74.0°F.
Llano Seco #1-A Stockton Clay. Sacto River & Butte Crk Water, P.P.I.D.	6.9	30	61.5	77.0	2.4	8.6	0.0	15.0	13.0	38	72.0°F.

Rice Field Mosquito Ecology Project

PLANKTON AND MOSQUITO LARVAL COUNTS IN RELATION TO RICE CULTURE

Station:	Plankton Count Per C.C.	Larval Count (120 Dips) Anopheline	Culicine	Total	Mean Water Temperature	Rice Production Pounds Per/Ac. Study Plot	Fertilizer Am. Sulphate Pounds Per/Ac.	Density of Rice Weeds Scale (1-10)
Wylie, #1-A.	30.2	20	16	36	68.0°F.	1000	60	8
Wylie, #1-B.	271.3	119	139	278	72.4°F.	500	60	10
Lenahan, #1-A.	140.0	16	4	20	74.0°F.	2500	40	6
Llano Seco, #1-A.	51.4	29	9	38	72.0°F.	7000	80	4

mosquito control measure, but also to improve the conservation of irrigation waters and increase rice production.

5. Mean water surface temperatures of a continuous nature above 70° F., appear to be congenial to the production of larvae in rice water.
6. As an observational inference, without detailed supporting data, dipping stations of dense weed infestations tend to produce the most rice field mosquito larvae.
7. Chemical analysis of rice water samples has not, as yet, yielded any trend that is of significance to the rate of larval production.
8. The high plankton counts from the samples taken during this study suggest a possible relationship with high larval production. A more intense survey must be undertaken in the future to sustain this point more fully.

Vice-President Peters: We will now have the report of the Nominating Committee.

Mr. ROLLAND HENDERSON, President,
California Mosquito Control Association,
467 South Larkin Street,
Tulare, California.
Dear Sir:
The Nominating Committee of the California Mosquito Control Association, having met at Modesto, California, on December 12, 1952, hereby makes the following nominations for officers of the Association, to be elected at the 1953 Annual Meeting:

President . . . . . ROBERT H. PETERS
Vice-President . . . . . C. DONALD GRANT
Secretary-Treasurer . . G. EDWIN WASHBURN
Trustee Director . . . . . ROY L. HOLMES

Respectfully submitted,
T. M. SPERBECK
T. G. RALEY
E. A. SMITH
E. C. ROBINSON
HAROLD F. GRAY, Chairman

Mr. Gray: I move that the report of the Nominating Committee be accepted, and that the Secretary cast a unanimous ballot for the nominees.

(This motion was seconded and carried by a voice vote, and the ballot cast).

President Peters: The members of the four regious are requested to get together during the noon hour, elect their Regional Directors, and report at this afternoon's meeting.

PRESIDENT'S ACCEPTANCE ADDRESS

ROBERT H. PETERS

As incoming President of our Association, it occurs to me that this year has a particular significance. As you know, this is our twenty-first Conference and it might be said that we as a group have come "of age."

Each of us can recall that glorious year of our lives when we were struck with the realization that being twenty-one meant suddenly growing up. We were suddenly cognizant of the fact that responsibility was ours and that individually each of us was standing at the proverbial crossroads where decisions of the future were ours.

Why individually we chose the road which today finds us collectively gathered to determine new ways of reducing the mosquito population, perhaps might be referred to as questionable judgment.

Nonetheless, it can certainly be said that never before in the history of mosquito control have we faced such a difficult future in this expanding State of ours. Needless to say, we have had problems of control thrust upon us faster than we have been able to solve those with which we began. Water use is consistent with progress and the outlook for California can be summed up in no other words than future progress.

Consequently, our Association should play an even stronger part in unifying our approaches toward a more satisfactory mosquito control. New methods and techniques must be devised to keep pace with these ever-increasing control problems which we face. Perhaps, fundamental policies should be devised by our Association to meet our combined responsibilities, thereby assuming a positive position on maters concerning Agencies collectively.

I do not believe any of us would by choice consider any other form of mosquito control than that by our local Agencies. To continue in this pattern, I firmly believe is the prime function of our Association. As such, the time has arrived to objectively analyze our position in the total picture and attempt to build a still stronger Association for the future while recognizing our obligations and ascertaining that we are proceeding in the most effective way to accomplish our objectives.

It will be the purpose and intent of your incoming officers to function to the best interests of local mosquito control in the expanding future of our State.

FOURTH SESSION
THURSDAY AFTERNOON, FEBRUARY 12, 1953
1:30 P.M.

President Peters: I will first announce the results the results of the election of Directors from the four regions. They are:

Sacramento Valley . . . GEORGE UMBERGER
San Joaquin Valley . . W. DONALD MURRAY
Bay Area . . . . . HOWARD GREENFIELD
Southern California . . . NORMAN EHMANN

According to regular procedure under our By-Laws, the immediate past-President would serve as a Director. However, our immediate past-President, Rolland Henderson, is no longer in mosquito abatement work and will not be able to serve as a Director. Therefore the Board of Directors at its next meeting will fill the vacancy.

The first part of this afternoon's program will be a Panel Discussion on "Current Trends in Mosquito Abatement." The Moderator will be Edgar A. Smith.

Mr. Smith: Actually there are two panel discussions this afternoon, both dealing with the same general subject. The second panel will be an actual meeting of the Merced County Water Conservation Committee; we have brought to Sacramento the chairmen of the various subcommittees who will present their reports for discussion by the entire committee. I believe that this will give you a better insight into how our committee operates than would reams of written description.

Both panels will be concerned largely with water source reduction, and in the first panel we have asked Harold F. Gray to give an introduction to the general subject. But before he begins, I will present the other members of the panel: Jack H. Kimball, Orange County; Gordon F. Smith, Kern; Ted G. Raley, Consolidated; Robert H. Peters, Northern San Joaquin; and George Umberger, Sacramento-Yolo. Please remember that we are to confine our remarks primarily to mosquito source reduction.

"TEMPORARY CONTROL METHODS VS. MOSQUITO SOURCE REDUCTION"

By Harold Farnsworth Gray
Engineer-Manager, Alameda County Mosquito Abatement District

AN INTRODUCTION TO A PANEL DISCUSSION "CURRENT TRENDS IN MOSQUITO ABATEMENT"

Among this world's most unpleasant and thoroughly disliked persons is the man who says "I told you so." The fact that he has been right only makes him the more irritating to those who have not believed his prognostications and have been proved by him to be wrong. Therefore the Chairman of this discussion has placed me in the position of possibly losing whatever popularity I may have had in this group, by asking me to present an introduction to this discussion on "Current Trends in Mosquito Abatement." During the past forty-two years (and Billy Herms before me) we have been "telling" you that the most logical, effective and economical methods by which mosquito prevalence can be reduced to the lowest practicable minimum in California are (1) to eliminate, or reduce the extent of, water in which mosquitoes develop; (2) where this is not practicable, use methods which make irreducible waters relatively unattractive to mosquitoes; (3) use biological methods, such as predatory fish *(Gambusia,* etc.) where they are applicable; and (4) use appropriate larvicides where necessary to "mop up" such larvae as cannot be controlled by these methods. We certainly never suggested the community-wide use of adulticides prior to the advent of DDT, and in 1949 (Presidential Address, American Mosquito Control Association) I labelled the use of adulticides as an "advertisement of failure" to abate the mosquitoes.

Also in that 1949 Presidential Address (Proceedings, page 38) I stated "Over the past forty or more years, both experience and logic have indicated that the basic function of mosquito control is to eliminate or minimize the *production* of mosquitoes. All successful practice in this field, in temperate climates and civilized areas, has been based on this concept. The introduction of new insecticides of greater toxicity as larvicides or adulticides has not changed this basic postulate of mosquito control."

Well, what happened? Nothing! N o one paid any attention. You were all bemused in the phantasmagoria of DDT—wonderful stuff! Just spray it all over the landscape and the skeeters disappear like magic! But, along toward the end of 1949 doubts began to appear in some quarters—DDT didn't always work 100%. The ugly specter of resistance began to raise its head. By good fortune the Program Chairman of the 1950 meeting gave me another opportunity to talk and I fired the other barrel, so to speak, in my "Which Way Now?" talk. This time most of you listened and began to believe that perhaps there was something valid in the old-fashioned ideas. And some of you have begun to do something about it, not only by talking about it here in our meetings, but practically out in the field where the problems are. You perhaps have been asking yourselves the question "Why produce them wholesale and then try to kill them retail?" Silly idea when you look at it, isn't it?

There are certain concepts of mosquito operations for the benefit of the public which we ought to examine as a preliminary to this panel discussion. These are the ideas respectively of control, abatement and eradication. I shall not atempt to go into a semantic dissertation as to the exact dictionary connotation of each term, for no one that I know uses these terms consistently as mutually exclusive categories of ideas. In New Jersey the term "extermination" is use, but that is wishful thinking, not an accomplished fact. Here in California we term ourselves mosquito "abatement" districts, and in other areas "control" projects are spoken of. We also use the term "control" somewhat interchangeably with "abatement." It will probably be very difficult or impossible to pin everyone down to a precise and circumscribed use of these various terms, and certainly I shall not attempt the impossible, but we can set up the several concepts of our operations so that they can be delineated with reasonable clarity.

Let us then begin with the idea of "control." This may be most clearly understood, perhaps, in the field of malaria control, where we have known for many years that there is a fairly definite, though variable, number of female *Anopheles* vectors per capita of humans necessary to maintain a continuous, or endemic, malaria in a region. If the relative numbers of *Anopheles* vectors per capita of humans in that area is kept well below that critical number, malaria will tend to die out in that area, and we say that we have "controlled" the *Anopheles* and eliminated (eventually) the malaria.

A somewhat similar situation occurs with relation to urban yellow fever. It is a matter of observation that if we can keep the numbers of *Aedes aegypti* below a point at which larvae are found on less than five per cent of the premises in a region, yellow fever cases are unlikely to appear, and will not become epidemic.

But with infectious virus encephalitis we have no such population-vector relationship or index, and we do not know how few *Culex tarsalis* females per capita of population we must have to prevent the epidemic spread, or even the sporadic transmission, of the encephalidites.

At any rate, experience has shown us that we can control some mosquito-transmitted diseases by methods which will leave appreciable numbers of mosquitoes in an area, and these numbers may even be high enough to be somewhat of a nuisance.

With "pest" mosquitoes the situation is somewhat different. Here we usually speak of "abatement" rather than "control," and if the abatement is not fairly close to 100%, the customers usually complain loudly and are not inclined to accept excuses. If a farmer, or an industrialist or business man, or housewife, is paying taxes to get rid of mosquitoes, he or she expects to have no mosquitoes, period! This is partly our fault, because at times in certain areas we have achieved practically 100% control, and the taxpayers expect that as standard performance.

Then there is a third idea, that of eradication. As a rule this concept has been applied only in relatively limited areas and in relation to a single species of mosquitoes. You are all familiar with the practical extirpation of *Anopheles gambiae* in northern Brazil and in the Nile valley, and with the extirpation of *Aedes aegypti* in many South American and Central American cities. We have evidence that *Aedes squamiger* has been extirpated from considerable areas of salt marsh in the San Francisco Bay area, and it would be entirely possible to exterminate this species in this region by well-executed measures within a few more years.

But in temperate climates we seldom hear any one suggest the idea of extirpation of a single species of mosquito,

and certainly no one has suggested that extirpation of all species of mosquitoes in a region is economically practicable. But fantastic as the idea may appear at present, I believe that some of you may be able some day to come close to this idea, even in the central valley of California.

I won't be here then, but when that time comes I hope you will remember that I suggested it as a mark to shoot at.

I shall not say much about that which we term "naturalistic control," not because I do not consider the idea valuable, but simply because we have not been able to get you to give it the serious consideration it deserves. The idea is very simple—merely change the ecology of a mosquito source in some relatively minor way so as to make it unsuitable to the production of a particular species of mosquito. On salt marshes, by alternate flooding, draining and drying, we have been able to free large areas from *Aedes* production. I have hopes that some day you will find out how to change the ecology of rice fields, by some simple procedure so that *Anopheles freeborni* and *Culex tarsalis* will not develop there in significant numbers, if at all. Even irrigated pastures may be subject to some ecological change which will materially reduce or even eliminate *Aedes nigromaculis,* but you will have to change the basic concepts of your thinking in order to find out how to do this.

Experience in the past few years has shown us that the mosquito problem in California is enormous, and increasing in extent and intensity. Years ago when Billy Herms started, conditions were much simpler and good control was achieved relatively easily, by the application of a little "brain sweat" and a lot of muscle, and with little equipment. Today you have lots of equipment as a substitute for muscle. How about some more "brain sweat"?

Most of you are again becoming convinced that source reduction is the only possible answer to the present problem in California. But source reduction does not necessarily imply drainage, or reduction in use of irrigation water, or the use of larvicides. These methods will be useful in various degrees, but why not see what can be done to make ecological changes, either in addition to drainage, restriction of water use, and larviciding, or as an effective substitute in some situations?

Finally, let us not be too impatient for rapid, spectacular results. Long experience has shown me that the steady, continuous application of even modest effort in the right direction, will in the long run produce good results in mosquito reduction. But what do we mean by "in the right direction"? Are we going to put most of our efforts into mosquito source reduction, or are we going to continue with major effort on temporary measures of larviciding and adulticiding? Which, in the long run, is best for the taxpayers who pay for mosquito abatement? I hope that the panel discussion which follows will shed some bright light on this important question.

Mr. Smith: Thank you Harold. You will notice on the program that we intend to discuss current trends relating to source reduction under four main headings:

1. The Scope of Education
2. Inter-Agency Cooperation
3. Financial Aid
4. The Place of Law Enforcement.

We will take up educational measures first, and I will ask George Umberger to lead off.

Mr. Umberger: One of the most important phases of our work is the education of the public. The small mosquito sources around the home or industrial plant, contribute mosquitoes that we don't find even with the normal degree of control, and these little spots have been putting off a few mosquitoes that make our work, in some cases, look ineffective. In our public relations and education, we are trying to point out the desirability of the people themselves eliminating these many mosquito sources around their home. The education of the people at home automatically carries us on up to the small business man and to the larger operator. We must approach them for a correction . . . if we have worked on individuals we have a basis of understanding to carry our discussions along and to reach a quicker solution. So that to me is one of the most important and basic reasons for education of the public in source reduction.

Mr. Smith: Do any of the other members of the panel agree that that is one of our principal functions as a mosquito abatement district, to educate the public to help themselves to take care of the problem? What about the rest of the panel members? Anyone want to contribute?

Mr. Gray: We take the position that the Division Foreman and Operators continuously must do educational work as well as corrective work We make use of pamphlets, yes. But the direct contact of the individual employee of the district with the people he meets is always the opportunity for an explanation of how each individual can take care of his own problem.

Mr. Smith: We will get into the means of education in just a minute. Let's stay on the more general subject. I didn't hear any one disagree. I take it then that we are fairly well agreed that education of the public to help them to take care of their problem is a principle aim. I'll throw this question then, first at Ted Raley. "What would you say out of your total budget is spent on education?"

Mr. Raley: In the past I would say about 2%. But probably under our new pattern about 7% or 8% of our total budget will go into public education.

Mr. Smith: Jack, what would you say on yours?

Mr. Kimball: We have no evaluation. Our approach to education is on a long term basis.

Mr. Smith: Gordon, could you give any estimate?

Mr. Gordon Smith: I think that is a debatable question. Are you going to estimate just on the basis of what you budget for education, or are you going to do that on the time of the individual operators?

Mr. Smith: No, just on what is budgeted. We will get into that other in just a moment. Suppose we get into what the different means of education are and look at it from that point.

Mr. Gray: In our district each year in the annual report we put in an actual accounting of how much we spend on educational work. I don't remember what it was for 1952 but it is very close to 5%. This does not account for the individual time spent in the field.

Mr. Umberger: I have here our annual report for this year. I was just checking to see what was expended last year; it is $1300. I believe that under education one of the very desirable things a mosquito abatement district can do is to make an annual report which can be given to the public. It is one thing to have canned news that you give the newspaper, but an annual report, even minimal, with a financial statement and a total of the work that was done, plus a narrative of interesting events, and what work is done during the winter months, is valuable. Ev-

erybody says to a mosquito man "What do you do in the winter when there are no mosquitoes?" This report tells that story. It cost over a thousand dollars, but we have such demand for it (even requests from Europe, South America and as far away as Australia) that our Board thought it was a good investment for our people and it might in some degree help mosquito control in all California.

Mr. Smith: Let's go on to the types of education that are being used and can be used in mosquito work. Gordon, would you discuss the principle methods that you feel are of most value?

Mr. Gordon Smith: I think that all methods are valuable, but I believe we are tending to emphasize more and more individual contacts. People will read a newspaper but maybe it won't sink in. Sometimes they will get a special report; it depends on how interested they are in the subject matter just how much that sinks in. A business man will go to a service club and some of them will listen to a talk and some of them will be thinking about the conference they have that afternoon involving $15,000 or something. But when you find the problem and take the person who is causing it and point it out to him and explain why, then you have showed somebody exactly what is going on. If they are really interested, they will pass it along to their friends, and I think that type of direct information is extremely important in our work. How well it is done depends on how well your men are trained in explaining and contacting the people.

Mr. Smith: Jack, would you discuss further some of the methods that you are using?

Mr. Kimball: We have lined them in five different approaches that I have listed here. The first one is what we consider the most important. Like Gordon, we consider the individual approach worthy of most of our time. The individual we refer to is that individual who is creating the most mosquito breeding problems in our area. The ones who we wish to make corrections are the ones we want to spend our time on and explain to them the reasons for making the improvements we recommend. The second most important is education of the various other local agencies in the county involved in some way or other in work that effects our program. We have a so-called agricultural round table in the county at which various agencies who are concerned with agriculture get together once a month. These agencies are Flood Control, the Road Department, the Farm Advisor's office, the Health Department, the dairymen, etc. By meeting with them once a month on a round table discussion of what our program is, they are becoming acquainted with our program and seeing where parts of their program can be of assistance to us and visa versa. The third and fourth are important on a long term basis. The third is education through the schools, especially the grammar schools about the fourth and fifth grade level where they are just getting their introduction into science and metamorphasis of the various insects. Our mosquito picture and a life cycle of a mosquito is an excellent demonstration to them in their classes, and their teachers welcome it. We don't push that; we take it on a request basis. The schools also go up into the high school level with the agricultural program, where they are studying to be farmers, and they have worked up a program of once a year exposing those students to the problems of mosquito abatement, in their agricultural drainage and irrigation practices. The fourth group is the service clubs. These are taken on request, and a certain number in each club are always surprised to hear of the program that is going on. This gives another outlet to explain the program to our people. The fifth, and in our opinion the least important approach, is through the newspapers and radio talks. We believe in saving these outlets for seasonal changes in conditions, rather than for day to day progress reports; for occasions when you would want to get a particular message across. They you will get the attention you would not have if the work was continuously before the people in these media. These are our five approaches to education in one county.

Mr. Raley: I should explain why our public education budget has increased so greatly. My Board of Trustees has given me permission to hire four men to carry on public education along the individual approach pattern. I believe our District is the first one to develop the idea and practice of the "trouble shooter." Frankly, that's a poor designation to use, especially in signing letters, and if you have a better term I would certainly like to hear it.

We are budgetting the salaries and field expenses of these men as a part of our public education program. Their operations are directed mainly at source reduction through educational methods on an individual basis. Even in the short time we have had this program we have good evidence that over a period of years these men are going to definitely pay their way in source reduction.

Mr. R. H. Peters: I strongly support the idea of the idea of the individual approach. Every one of us is or should be a salesman of mosquito control, and the thing that we should sell the most is the idea of source reduction as the basic principle of mosquito control. We ought to keep our personnel trained in and appreciative of this method of approach. I will admit that some persons can do a better job of individual contact than others can, but by training we can obtain a sound, positive impression to be left on the individual rather than a negative impression left by an incompletely informed employee.

Mr. Gray: One of the important facts which we appear to overlook is that our population is not static, and there is a tremendous influx of new people each year in California. These people know nothing about mosquito problems; they don't even know you have a mosquito abatement district. Perhaps the old timers do, but not the newcomers. I am almost ashamed to admit the number of times in a year our offiice is called by people who say they have been bothered by mosquitoes for several days or even weeks, and when we ask them why they didn't call us sooner they will reply that until then they did not know there was an abatement district in the county.

Another group that I think you should bear in mind in your public education program for source reduction is your public officials of all kinds, including your county grand juries. We pay particular attention to them as they can help or hinder us in many ways. I think Ed Smith has done a very fine job in getting many groups together in his county, even though he doesn't have full support from his rather difficult Board of Supervisors.

Mr. Umberger: I understand we are to have a television broadcast station in Fresno very soon. I am quite interested in the possibilities of that station. Has anyone here used television yet?

Mr. Smith: As far as I know the only one who has been on television is Ted Aarons of Alameda County, on the "Science in Action" show. My information is that the Fresno station will be in operation in about two months, and a station at Sacramento shortly thereafter.

Mr. Kimball: About a year ago Los Angeles had a television program on mosquito control, in which mosquito fiish were the principal actors.

Mr. Gray: At the American Mosquito Control Association meeting at Salt Lake City last year the local station put on a television show on mosquito control with Dr. Fred Bishopp and Dr. Don Rees.

Mr. Smith: We had better sum up the subject of education before we go on. We are all agreed that the fiirst line of attack in the educational program is that each individual employee out in the field meeting the public constantly has the best opportunity to present the facts about mosquito life to the public and so enlist their help to reduce mosquito sources. But at the same time all these other methods which are open to us should be uitlized. In our own case every year. in discussing our budget, we have said "Education in the long range is our best bet and the thing that is really going to do us the most good," but we gave it lip service, because when it came down to preparing the final budget, that was one of the first things knocked out. I think that it deserves more importance, and that is one reason I started the discussion on that line. The percentage that we mentioned is really a fraction of what we spend on education, because there is so much other that is education that is taken care of in our normal operations. Let us go on to the next section, on District and Inter-Agency Cooperation for source reduction. George, would you start on that?

Mr. Umberger: I feel that this is tremendously important and it is going to be more important, because in the meetings we are having we are asking the participation of these other agencies, the Central Valley Project, for example, and I believe that we are going to have to be careful in our approach and in our relationship with them. In my own experience, after the job is done it is important to go back to them to see if they believe what was done was the right thing and the job is taken care of. What is the other person's viewpoint? It is somewhat like selling an automobile, isn't it? It's not the first sale but a continued relationship.

Mr. Smith: We can't expect cooperation without giving cooperation. The panel right after this one is going to be specifically on inter-agency cooperation, so I would like to spend our time right now on the matter of cooperation on the part of the District with the farmers who have the problems. How can the mosquito abatement districts help solve some of these water problems that the farmers have? I will call first on Bob Peters to explain just what he has been doing in that direction in Lodi.

Mr. R. H. Peters: Our program in the Northern San Joaquin County District has been one where we have actually done the job. We feel that it has been extremely successful because the results have justified the end, the participation has been very satisfactory, and best of all when the job is done it is reasonably to our satisfaction. Our District owns two large tractors which we have used to advantage in various ways. Our initial program was begun for the purpose of clearing river bottom lands and it was done on a cooperative basis whereby the taxpayers were not charged, but it was paid for by the party who owned the land and who was going to put the land to some useful purpose. The project has extended into minimization or source reduction of water in industrial situations such as wineries and canneries, and it has definitely given us a very satisfactory position in cutting down the actual cost of control within our district. We are heartily in favor of this cooperative method of source reduction.

Mr. Smith: There are several ways in which a mosquito district can help solve the problem of standing water, either as Bob has suggested, offering to do the job at cost (and that also is the way our own district is handling it) or by being in a position to advise as to how that can be done, or in some cases by partial contribution of the cost of the job. Now I think that we can throww all those suggestions out for general discussion.

Mr. Aarons: On this inter-agency discussion I wanted to interject one comment. We have a habit, in our county, of visiting with our Supervisors. I would like to impress upon the group the worthwhile results that will come from that practice. We have talked about these other groups that we are interested in having cooperation with, but you will benefit tremendously if you will get in the habit of talking with your Supervisors.

Mr. Gray: I might modify that, Ted. I never bother the Board of Supervisors as a Board of Supervisors, but I sure see them as individuals, at lunch or at lodge or something of that kind.

Mr. Smith: Are there any further comments on this? Let's get into this matter of financial aid by putting up a portion of the cost of the project or renting the equipment at cost.

A Member: In our District we do some source reduction work on a share the cost basis for two or more reasons. One of them is where it is a hardship case; the farmer doesn't have too much money and he says he can't afford to hire a dragline. We can do it at cost to the farmer less expensively than he can hire it done, and he can usually pay at least a part of the cost. Frequently he can pay it all. Secondly, when we do it ourselves the job is designed for mosquito control as well as to help the farmer. If we do it, the drain is cut with square sides and properly designed to get the maximum benefit for mosquito control purposes. All of our work is done on a cost basis; we charge the farmer by the hour for the equipment. When we get the job lined up and the farmer agrees to it, he is given an estimate. We guarantee not to go over the estimate; occasionally it does cost us a little bit, but it is designed to be done on a cost basis for the farmer.

Mr. Smith: I would like to discuss our own operation in that respect just briefly. Before we purchased the dragline we were participating financially by putting up a percentage of the cost of a drainage project when it could be shown by our district records that it would reduce a mosquito problem. That was a very successful program. We accomplished a number of drainage programs which would not otherwise have been done. We had cooperation on a number of these jobs, with other organizations such as the Soil Conservation District, the Irrigation District, or the Road Department. Since we purchased the dragline, we do not engage in that type of subsidy. We do rent the dragline out at cost to solve a problem involving mosquito reduction. In a good many cases we have met with up to as many as twenty or twenty-five farmers to discuss the best method of solving a drainage problem. We have our attorney present at the meetings, and we provide them with legal services necessary in obtaining rights-of-way and granting each other the rights-of-way. We have provided an engineering service, either doing it ourselves, or providing somebody to do it for them. We have given them the use of the equipment at cost. When we first purchased our dragline, there was some question as to

whether we could keep it busy. We have had it over a year now and there hasn't been a single working day when the weather was not too bad, when that dragline was not working, and for the last year we have had about six months work lined up for the dragline, so there doesn't seem any doubt as to the demand for its service in drainage jobs which are helping us to reduce mosquito problems.

Now jumping back for just a moment to inter-agency cooperation, I'd like to relate one incident where we certainly have gotten excellent cooperation to solve a problem. Our Board of Supervisors for some time has been pursuing the policy of discouraging the flooding of county roads by farmers. In one particular case not far from the City of Merced, there were about five farmers who had a drain which didn't go any place except up against the county road. The Road Commissioner and the District Attorney notified them that that must cease. They invited them to a meeting at the Court House with the District Attorney and laid down the law to them about what would happen if they didn't solve their own drainage problem, and we were present to propose to them the method of doing so at the least cost to them. They didn't hesitate for a minute; they agreed to do the job right then, and it was accomplished, and the road hasn't been flooded since. That was certainly a matter of excellent coordination and cooperation between agencies. Do we have further comments now on this matters of financial aid and use of equipment? Harold, do you have anything to say about your operations?

Mr. Gray: Our program on the surface is entirely illogical and opportunistic. In practice it works out, and we have usually received back from the land owners more in the way of cooperation and projects for mosquito abatement than we have put in ourselves. We go on the idea that we will do at least part of the work ourselves, and that usually stimulates the land owner into something that is even more expensive than if he had done it for his own purposes. We cooperate with our Flood Control District and County Surveyor's office which runs the roads, and I think invariably we get more back from these other agencies and individuals than we have put in.

Mr. Raley: We have taken the position that the one creating the source should be responsible for its correction. We tested our wings in the beginning of our District on household problems, and have been able to carry that along in good order. Over the years we finally established our position with industry, and now have that in good order. Dut to the 1952 epidemic, we feel that we are in a good position in relation to agriculture, and although our program is rather new it shows very good promise and we have every reason to feel that it will work just as successfully as the other phases of our activities. We do have one problem, and that is the fixing of responsibility, and I can visualize that it is going to take us perhaps two years to actually work that out to where we can determine the relative responsibility for the elimination or reduction of known mosquito sources. In the Valley it is rather hard to separate natural and man-made waters, but I am thoroughly convinced that as we establish our position we will be in a more favorable working relation than with the idea of contributions. I've never had anything cut my throat so wide open as contributing financial help to a particular project because I had the unfortunate experience of having every other project in the District wait until we were able to get around to furnish financial help to that problem. I had that experience in Marysville and I think Dick Sperbeck suffered from it to a certain degree. Since then I've tried not to become involved in mutual contribution projects. Our point of view has worked in household drains, it worked in industry, and we have every reason to feel that it will work in agriculture. It is amazing how agriculture will respond as people begin to understand your problem and how it will benefit them in the process.

Mr. Smith: George, there are two things I'd like you to comment on. One is the use of rehabilitation prison labor in drainage, and the other is your work with drainage districts.

Mr. Umberger: Our main corrective or source reduction work in Sacramento County is done with road camp prisoners. Last year when our encephalitis picture began to get out of hand, we went before the Board of Supervisors, explained our problem and advised them that we just had to have help. We have two large road camps in Sacramento County; one of them has about three hundred men in it and the other has about two hundred and fifty. Every man in those two road camps was put out digging ditches. We had a hundred and twenty five of them assigned to our District directly. One of the costs of our permanent control as far as it shows on our report, is buying tools and boots for those men. We pay them no salary; they are each given a five cent pack of Bull Durham a day; that is their contribution from us. Working in the field they get a third meal, which the County pays for. The balance of the road camp prisoners were assigned to the County Engineer. Those men took the vegetation out of drainage ditches along the roads, and in the special drainage district which has been set up in the County. Between four and five hundred men working every day during the months of late June, July, August and September, right on through the winter has been a contributing factor in the success of our larviciding program. It is an illustration of the development of our inter-agency cooperation, and exploring all possible sources of help. When we started out with the thought of using road camp prisoners we didn't dream that the program would develop and tie in so favorably, because in many people's eyes and the County government it wasn't the mosquitoes they were interested in as much as the drainage. We have a terrific drainage—summer drainage. In one area right across the river, we checked last year and there were thirty-two new swimming pools being constructed in back yards. These gals all have to be like the Joneses; if they have two Cadillacs, it is two next door, and if they dig a swimming pool why there has to be a swimming pool dug next door, and you can just imagine the swimming pools that exist in that rural community with thirty-five or forty being constructed each year. When that water is released, we just haven't the channels to take care of it. The water was going all over the country, and it was one of the jobs of these men to develop channels so that water could move on down to its final discharge into the Sacramento or the American River.

Mr. R. H. Peters: I might say, Ed, that to a certain extent maybe my faith in human nature was reduced somewhat by having come from the sanitation field. I often wondered how many cesspools or septic tank drains I could have abated had I been able to carry a shovel on my shoulder instead of a little card or notice book. Based on that, I think that a more rapid and perhaps a more satisfactory result can be obtained by District participation in some of these measures.

Mr. Gray: Don't you think that we are getting out of our province, inasmuch as there is another agency set up by law which has the responsibility? Don't you think that the matter of open septic drains should be referred to the Health Department, rather than to make policemen out of our employees?

Mr. Peters: Well, I was merely generalizing.

Mr. Gray: Here is a point worth consideration. I don't believe that mosquito control men should be doing police work, because we lose our effectiveness. The Health Departments have the responsibility of sewage disposal, and we should obtain their cooperation to get these open septic drains taken care of.

Mr. Peters: I think there is no question about that. They are better prepared to do the job, but I merely made the point that by doing the job yourself sometimes you can accomplish considerably more.

Mr. Smith: We will be getting into enforcement in just a moment, but let me comment briefly. I agree with Bob that we can sometimes do a lot more if we are willing to do it ourselves, but I'm not sure whether we should be willing. I recall last summer we hired a few women inspectors during operation *Culex tarsalis;* they were highly successful. The principal reason for the excellent cooperation we got on that inspection program was the publicity that *Culex tarsalis* was getting. Every previous year when we have run a concentrated survey of the disposal units in the County, we averaged about 50% cooperation—that is, about 50% of them were willing to go along with us on what we asked. But last summer it was 90%, and I think that the public relations and education program put on last summer on *Culex tarsalis* was responsible. However, there was one case in which it didn't work. One of our women inspectors found a particularly bad situation and in discussing it with the man of the house suggested that it was in pretty terrible shape: in fact, a child could fall through the rotting very easily. He said "Well, you look like a big girl. If you want it done why don't you do it yourself?"

In summing this up, I think that it is obvious from the discussion that we are taking some advantage of interagency cooperation. Perhaps some of the comments have shown avenues of approach to some of the rest of you that you haven't already taken advantage of. I think there is a lot more to be done—a lot of things that can help us all. As to how we are going to solve these individual water problems in the field, whether we are going to do the work ourselves, whether we are going to serve strictly in an advisory capacity, whether we are going to put up part of the money, or whether we are going to rent equipment at cost, of course that all depends to a great extent on the local situation, but all those avenues are open, and I think that we will all be exploring one or more of them in the near future.

The last subject we have for discussion on this panel is "The Place of Law Enforcement in an Abatement Program." That I think can be very interesting, and I think the place to start that is with Harold Gray, as he has drawn up a detailed procedure under the various methods available by law.

Mr. Gray: The problem of law enforcement as contrasted with a service function is one that we have kicked about in these meetings for a number of years. What happens ultimately is that although we start out with the idea that we are going to serve the public, we eventually come to the place where patience wears a little thin, and then we decide to turn the problem over to the District Attorney. What we should turn over to the District Attorney is a matter of policy. Policy should be determined by the Board of Trustees rather than by the employees of the District. As far as I am concerned personally, I would like to proceed first with the method of persuasion and education, then secondly you might say somewhat on the basis of demonstration, in which we do the problem work ourselves, and as a last resort for those people who are stubborn and recalcitrant, we will just have to apply the law. I will give you one little demonstration of what I mean. Last year we had a very bad outbreak of *Culex pipiens* right in the very center almost of Oakland in an abandoned quarry. This abandoned quarry is now being filled in. It had a big pond at the bottom of the old quarry pit, and we had it stocked with fish and it gave us no trouble. When they started to fill it, they filled in with rubbish, garbage and God knows what in addition to earth. The fish were killed and then our troubles began. They threw in a lot of brush and floating wood, and we had a situation in which the production of *Culex pipiens* was going on underneath the floating debris on top, which the insecticides could not penetrate. Even when they filled it in later on we still had problems, because there was water under the fill, and the fill cracked. We couldn't get any results at all. So we simply went to the District Attorney, and now the burden is on the person who is handling that fill, and he is practically under indictment, with understanding that either he controls the mosquitoes there or it is a matter between him and the Judge. I don't think the Judge is going to be very lenient under the circumstances. With some people you have to have the big stick in the background. I personally would rather not have to use the stick. I think you get better general public relations, and I think you get better compliance in the long run without it, but there are some people you have to use it on. We, frankly, are getting down to the point in our District where we are a little more incluned to use the legal process, because after twenty three years we feel that we've about reached the end of what we can do by persuasion.

Mr. Smith: How many times have you used legal means?

Mr. Gray: Oh, so far only about three or four times, and then only as far as a citation by the District Attorney.

Mr. Smith: Four times in twenty-three years. Have any of the Managers sitting here resorted to the legal method of abating a mosquito nuisance?

Mr. Raley: In condemnation of a right of way we have taken several to the District Attorney. Ours can hardly yet be called using the law for source reduction. We have used the law for right of entry, and in one case we did have a real reason for condemnation, but as yet we haven't had the experience of going to court on a source reduction problem. It won't be long, though.

Mr. Smith: Gordon, would you relate your instances?

Gordon Smith: We have never actually had to go to court yet, but we have had occasions when we have gone in and spoken to the District Attorney or had the County Counsel attend a meeting of the Board of Trustees when a recalcitrant individual was brought in. We have found that a letter from the District Attorney or a citation from the District Attorney's office, or in one instance a telephone call from the Justice of the Peace, was quite sufficient to get the job done. We have never taken anyone to

court yet. Law enforcement is a good place to use inter-agency cooperation where you can get it. We have a working agreement with the Kern County Sanitation Department on cesspools, where they have on occasion taken the people in to court because they refused to correct the cesspool problem. We find the cesspools through our urban operators walking the yards, and we then turn that work over to the Sanitation Department for correction.

Mr. Peters: I think that to a certain extent the proper use of the law in our work can actually be educational. I had one farmer who said he would throw anybody off his place that had the idea he had mosquitoes on his property. Under the circumstances I had a Deputy Sheriff go out with me. The use of the law educated this man that what I was saying to him was not just so much wind coming across his field. We have had no difficulty with him since that time. There are other ways that the law can be utilized to educate; certainly a properly arranged and educational session in the District Attorney's office is the only way you can open some men's minds to reason.

Mr. Gray: It is more effective to have the District Attornye cite him to appear, and thus put him to the trouble of coming in.

Mr. Kimball: In five years of operation we haven't reached the point yet where we even had to request an informal talk with the District Attorney, or even with our own Board.

Mr. Umberger: We have never had a court case. The only person that has ever been threatened was the State of California.

Mr. Smith: I think that there is a proper place for law enforcement, but as has been brought out in this panel it is a matter of last resort. As we started out here with the subject of education I certainly feel that in many cases a man with a mosquito problem is going to correct it by himself, once he is aware that he has it, and knows what he can do about it. Of course that isn't true in all cases. Next we discussed the matter of cooperation. I think that it is certainly far beter for us to go to a farmer that has a serious drainage problem and offer to help him solve it, rather than to merely point out that he has a problem and he should do something about it. Then finally we get down to the matter of offering some concrete help, whether financial (some are opposed to that), or whether it is a matter of using equipment. I think that will in some cases persuade some people that would not otherwise be persuaded. Then we get down to the individual who is not cooperative, who does not understand and does not want to understand what the program is, and has no intention of doing anything about it. There is the proper place for law enforcement, and as Harold brought out it is a matter of Board policy. In our own District the Board of Trustees adopted a set of policies several years ago; we must put first emphasis on the progressive elimination and reduction of mosquito sources, they said; second, emphasis should be on the matter of cooperation with the farmers and other agencies in the reduction of mosquito sources; a supplemental method should be larviciding or adulticiding; and then finally, as a last resort, taking the difficult cases to court when that appeared to be in the public interest. I think that from the discussion of the panel we have put each of these various things in their proper perspective.

Mr. Umberger: There is something which I might touch upon. In our discussion here we have mentioned the little fellow, the individual farmer. Different Districts have different problems and areas, but in the thinking of our problems we should look at the big problems. The construction of an eight mile channel by the U.S. Engineers and the State Reclamation Board created a mosquito problem for us that was about three hundred feet wide and eight miles long. We went through the various State agencies, talked it over with those engineers, and everybody whistled. So we were going to bring suit against the State of California and the U. S. Engineers. It all terminated in the Attorney General's offiice, and the problem was solved, after talking about it and being told by a number of people that funds were just not available. In our work, I think some of our unsolvable problems may be the big problems, not the little fellow.

Mr. Smith: But that certainly is getting back to the inter-agency cooperation. Are there questions from the floor that anyone wishes to address to the panel as a whole or to any member?

Dr. Tinkham: I would like to address this question to the panel. In this particular case let us assume that a man is running the waste water from cotton fields to the ditches along the side of the road, creating quite a mosquito problem, and you have talked your head off in trying to educate him for a long time. You have four or five possibilities. You can continue to talk, or you can go in there and divert the water for the farmer and get a bad name for the District. Or you can take him to the District Attorney, but in previous years the County Road Department has taken similar cases to the District Attorney and he would throw them out of court. So what should you do in a case like that?

Mr. Raley: We went to the Board of Supervisors and talked with them and asked them to support the laws as they now exist in relation to dumping of agricultural water on road rights-of-way. I would suggest that you start first with your Supervisors and get that support before you try to go much beyond that.

Mr. Gray: Law is really majority public opinion. As long as the majority of public opinion is behind a law, it will be fairly well observed, and you can without great trepidation make use of it. To give you an example of what I mean, we have laws against robbery, with penalties; I think that is pretty well supported by the majority of public opinion. No district attorney, unless he is bribed or corrupt, has any hesitancy about prosecuting a man for theft or burglary. In mosquito abatement, if you start law enforcement in an area where public opinion is not very strongly behind you, you will find considerable difficulty in law enfircement because the District Attorney will sense that public opinion is not behind him and he will let you down in various ways, even if he doesn't deliberately refuse to issue citations or prosecute. We have known situations where that occurred. So ultimately law enforcement is going to come right back to the proposition of public education. If you have your public education to the point where the majority of people want mosquito abatement, you need not worry about law enforcement when it is necessary to resort to the law.

Mr. Smith: We have time for just one more question. Dick Sperbeck?

Mr. Sperbeck: I would like to ask the ones that own their own equipment and are doing this outside work, what criticsm or opposition you run into from your private operators and private contractors? Do you have any trouble along that line?

Mr. Smith: In our case the biggest private operator in the County is the one who sent the dragline salesman over to us, telling him "The mosquito district certainly needs one and you had beter sell one to them." He worked very closely with us. We referred jobs to him and he refers jobs to us, so we have no difficulty there whatsoever.

Mr. Greenfield: When we bought a dragline, and word got around town that we were doing drainage work, all of the commercial companies came over to see how far we are going to extend operations, and they were quite concerned about our doing that type of work.

Mr. Smith: Let me put it this way—we prepared well in advance by pointing out that we are not using our equipment for anything except the solving of mosquito problems. Our District records have to back up the fact that there was a mosquito problem present. With that we will close this panel. Thank you very much, gentlemen.

President Peters: The next topic to be considered is "Water Conservation Program in Merced County Effecting Mosquito Source Reduction." Would you like to take over at this point, Ed, and introduce the participants in this discussion?

PANEL 3:10 P.M., THURSDAY

Mr. Smith: I think that it was obvious the last panel was informal; this one also will be informal.

(Editor's Note: We regret that an adequate recording of this panel discussion was not available).

FIFTH SESSION
FRIDAY, FEBRUARY 13, 1953, 9:00 A.M.
ODD FELLOWS HALL, SACRAMENTO

President Peters: The program calls for the presentation of a paper by Dr. Longshore, of the State Department of Public Health, on the epidemiology of encephalitis. Dr. Longshore is late in getting here, and therefore we will ask Dr. Reeves to give his paper on "The Knowns and the Unknowns in the Natural History of Encephalitis," and have Dr. Longshore give his paper after Dr. Reeves.

THE KNOWNS AND THE UNKNOWNS IN THE NATURAL HISTORY OF ENCEPHALITIS [1]

W. C. REEVES, PH.D.
The George Williams Hooper Foundation for Medical Research, San Francisco, and the School of Public Health, University of California, Berkeley

The subject of encephalitis has not been discussed at these conferences since 1948. Before that time, it was a most conspicuous part of the program at every conference from 1940 through 1948. I am sure that this four-year interval of rest and respite was most refreshing to many of you who were beginning to be bored and doubtful of the value of repetition and prodding. However, events of the past summer are sufficient reason, I trust, for my having been asked to discuss the subject which your program committee selected.

[1] This investigation was supported in part by a research grant (E31 C5S) from the National Microbiological Institute of the National Institutes of Health, Public Health Service, and is a contribution from a cooperative project with the Communicable Disease Center, Public Health Service, Federal Security Agency, Atlanta.

In preparing for this discussion, I reread the extensive series of papers which appeared in the proceedings of the Conferences from 1940 through 1949, and they are well worth perusing. As a matter of fact, I soon reached the conclusion that the representatives of mosquito control agencies should be the best-informed group of public officials on this subject in the United States. The development of knowledge is clearly seen by following these papers, but perhaps the easiest and least painful method is for me to summarize pertinent knowledge and unsolved problems which we face today, solely with reference to California.

In a paper on encephalitis presented at the 1940 conference, Dr. Tommy Aitken summarized the unknown in the following way:

"What we want to know is:

1. If the disease is mosquito-borne?
2. Can we associate an outbreak of encephalitis with an increase in the mosquito population of the particular area concerned?
3. Can we catch the offender red-handed in the field?"

Today I believe we can answer all these questions with an unequivocal "yes."

At the 1945 conference, Frank Stead posed the following questions:

"1. How is the disease transmitted to man?
2. What are the principal vectors?
3. Where are the endemic areas?
4. How is the disease kept alive in endemic areas?"

Today I believe we can answer all these questions except the last one, and it at least in part.

However, enough of looking over our shoulders—let us attempt to summarize what is known and what remains to be learned. Let us clarify and restate the consensus, where possibly the picture has been confused.

As Dr. Longshore will clearly present the case, encephalitis—particularly of the Western equine and St. Louis types—is a public health problem, actual and potential, in the state of California. What you may not realize is that there is no other area of the United States where such accurate and complete records are available as guides to program planning and action. The areas where the various viruses are present and their level of occurrence are adequately delineated.

SOURCE OF HUMAN INFECTION

The occurrence of human cases leads us into our first contact with the natural history of these viruses—namely, where, when and how does man contract his infection? Present evidence leads to the belief that it is through a mosquito vector, and in California principally through one species, *Culex tarsalis.*

Let us examine the evidence in this State upon which this conclusion was based:

1. Proven cases of W. E. and St. L. infection have been limited to a seasonal (summer) period. Authentic exceptions to this have not been found. This is generally accepted as one supporting fact that an arthropod vector is the probable source of infection.
2. The observed number and activity of mosquito populations have been compatible with the hypothesis that they might serve as vectors.
3. The seasonal population curve and feeding habits of *C. tarsalis* have been compatible with its serving as a vector.

4. Each year naturally infected mosquitoes, primarily *C. tarsalis,* are present prior to and at the same time as the onset of confirmed human infections.
5. Correlations are observed in the infection rates and seasonal occurrence of the two viruses in *C. tarsalis* and the clinical attack rates of confirmed cases of each type.
6. Reduction of *C. tarsalis* populations by control in limited areas has been accompanied by a decrease in clinical attack rates in man. This trend reversed when the control program was unable to contain the *C. tarsalis* population.
7. The highest infection rates of *C. tarsalis* demonstrated in any year preceded by several weeks the peak of the past summer's W. E. epidemic.
8. The ability of many species of mosquitoes to transmit these viruses from animal to animal has been repeatedly and clearly demonstrated in the laboratory.
9. *C. tarsalis* is a frequent feeder on human hosts.

The type of evidence thus far presented is the basis of the premise that mosquitoes are the vectors of these viruses to human hosts. It is frequently mentioned that the most important and critical proof of this premise has not been attempted; specifically, infection of man by the bite of infected mosquitoes under controlled conditions. This is true. Experimental infection of man by the bite of artificially infected mosquitoes, or preferably by the bite of naturally infected mosquitoes, would be further conclusive proof of their role. However, the likelihood of such demonstrations appears remote.

It should be pointed out that the same reservation can be raised concerning the acceptance of the method of spread for innumerable infectious agents accepted as arthropod-borne and for those accepted as being spread by other means. A primary objective of detailed epidemiological investigations is to provide convincing evidence without such critical experiments of a direct and dangerous nature. It is anticipated that this restriction will continue in the case of the encephalitis viruses under study.

In summary, a concensus of the opinions of scientists in this field is that all circumstances indicate that mosquitoes are the source of human infection with W. E. and St. L. viruses. Furthermore, in California it is agreed that all evidence points to *C. tarsalis* as the principal species implicated. There is no suggestion that any group of arthropods other than mosquitoes are playing an important role as vectors to man. Currently, there is no proof of any other important means of natural spread of infection to man.

Is the necessary information available to allow the direction of a vector control program at one or a few species of mosquitoes, with assurance that the efforts are concentrated upon the primary vector? The answer in California would appear to be definitely "yes." The observed distribution of virus by species is most indicative that *C. tarsalis* is the primary vector. While the majority of such isolations have been made in Kern County, studies by the California State Deartment of Public Health in other areas have resulted in similar findings. The distribution of isolations by all agencies has been as follows: Western equine—*C. tarsalis* 177, *C. stigmatosoma* 5, *C. quinquefasciatus* 2, and *A. dorsalis* 3; St. Louis—*C. tarsalis* 69, *C. quinquefasciatus 3, C. stigmatosoma* 2, and *A. dorsalis 1.* These findings, supported by other epidemiologic data, indicate that the species other than *C. tarsalis* found naturally infected are secondary vectors and their infection probably reflects the activities of *C. tarsalis.*

The problem of developing permanent control measures or effective temporary insecticide control measures, and financial resources to accomplish these measures is outside the scope of the present paper.

The opportunities to evaluate the possible effect of a vector control program on encephalitis infection rates have been limited. In California, available data provide a sound basis for the development of a concept of a vector control program which should be effective from a thoretical viewpoint. To change this from a concept to a documented accepted fact is largely your responsibility.

Harold Gray has raised the question of the vector index level required for the spread of these viruses, and used malaria and epidemic yellow fever as examples. It must be pointed out that in these examples man is the sole or principal source of vector infection. The vector indices of concern are those in intimate contact with man and the levels of vector population are those essential to continual transfer of infection from person to person. In the case of the encephalitides, we are dealing with a widespread infection of many animal host species in nature with man an accidental host. Up to the present time, circumstances have not permitted adequate study of the relationships of vector population indices to the complex range of hosts including man. Available data would indicate that high index of *C. tarsalis* in the early summer period will lead to ready spread of Western equine virus while, in contrast, a high vector index in late summer or early fall will lead to an upsurge and widespread occurrence of St. Louis infection.

The Basic Infection Chain in Natfre

Up to this point, the basic infection chain essential to the survival of these viruses has been discussed only in its relatonship to the drect infection of man and the phases of most direct and immediate importance to mosquito control agencies. It is equally important for you to understand clearly our current knowledge of infection in arthorpod vectors and animal hosts upon which the continued existence of these viruses may depend. It is commonly accepted that the viruses under consideration are normally parasites of arthropods and lower animals and that their spread to clinically susceptible hosts, such as man, may be accidental. A complete knowledge of the ways in which these viruses propagate and maintain themselves in the natural hosts and vectors is essential basic nowledge and the objective to which much of present research is dedicated.

Vectors

Mosquitoes

The general picture of the occurence of virus in naturally infected mosquitoes in California has already been discussed in sufficient detail for the present purpose.

Mites

I am sure that you all have the impression that mites parasitic on wild and domestic birds are in some way involved in the encephalitis picture. Your individual versions of their importance would probably range from the assumption that they are the reservoirs of infection and essential to the maintenance of infection in nature to the viewpoint that they are of no importance.

What is the actual present state of knowledge in this regard, and particularly with regard to California? Collections of mites of several species parasitic on wild and domestic birds have been found to contain W. E. and St. L. viruses. Such findings have been made in a number of areas, including California. It must be understood clearly

that such findings alone do not prove that mites play any role as vectors or reservoirs, and the majority of studies in other areas have shown similar findings. At present, there is general agreement among authorities in the field that mites play a very minor, if any, role in the maintenance of these viruses in nature, and much more conclusive and convincing evidence must be found in California before we come to the conclusion that they are of importance, or before we further spread ungrounded information to the public.

Others

There is no evidence at this time that any other vectors outside of mosquitoes are playing a role in the spread of these viruses in California.

Biology of Vectors

Comprehension of the biology of the vector of concern is essential in understanding its relationship to the spread of disease, and it must be known in order to put selection and establishment of vector control procedures on a sound basis.

The problems of measuring vector populations for administrative and control purposes and the presence or absence of specific biological knowledge are considered in such detail in other parts of this program that I shall go on to another phase of the problem, although I should like to emphasize the absolutely essential and invaluable nature of such data.

Vertebrate Hosts

Insofar as we know in California, only two hosts become clinically ill when infected with these viruses—man and horse—and the latter only with W. E. This phase of the problem will be discussed by the following speaker.

Inapparent infection with these viruses in animal hosts is so important epidemiologically that determining its distribution has been one of the main aims of investigatons,—yet, we have only scratched the surface.

You have undoubtedly had well-fixed in your minds acceptance of the statement that domestic birds, such as chickens, are important sources of vector infection with both W. E. and St. L. viruses. However, it must be realized that all evidence indicates that wild birds are of equal or greater importance. There is evidence of past infection in all common species of wild birds which have been tested in any numbers in California during the summer. Out of several hundred species of wild birds known to occur in Kern County, California, five common species were carefully studied and appeared to be equally efficient hosts or better hosts to these viruses than were chickens.

Present evidence may be summarized as indicating a widespread source of vector infection in a variety of wild and domestic bird hosts. Infection in these birds in California is characterized by a complete lack of clinical disease, the appearance of virus in the bloodstream in large amounts for a short period of time, and no evidence of chronic infection or a carrier reservoir stage.

The Reservoir Problem

There is a complete lack of knowledge of what or where is the true long-term reservoir of infection for these viruses. There is no difficulty in finding evidence of virus activity in vertebrate hosts or vectors in the Central Valley of California during the summer months. Up to the past year, research has been centered largely on infection during the summer months. This has been dictated to a considerable extent by the obligation to determine the source of infection of man to allow the development of means of protecting the human population exposed to risk.

Discovery of the process by which these viruses carry through a "dormant" period of approximately eight winter months is essential to further epidemiologic advance. At this time, there is no evidence of where or how these viruses persist in an area such as the Central Valley of California from one year to the next. Mosquito vectors and avian and mammalian hosts are being studied currently as possible modes of transmission.

I am frequently asked: Will we have a "bad" encephalitis year this coming summer? Gentlemen, I must confess I cannot answer such a question with an adamant "yes" or "no." However, the following factors should be kept in mind. We cannot think of encephalitis in the same way as those diseases in which the occurrence of an epidemic will preclude the occurrence of a subsquent epidemic due to the development of immunity in the majority of the people. All evidence indicates that a large proportion of our population are still in the susceptible non-immune category, and this is constantly being added to by the increase in population through immigration from other areas. The viruses are here to stay for some time as they have been for an unknown period. Each summer they are active and the degree of activity is undoubtedly closely allied to vector populations and suitable climatic conditions of high temperatures for rapid development of the viruses in the vector. Given a year of high vector populations and suitable climatic factors added to the presence of viruses and susecptible people, and you will have a potential problem in any year and one about which present knowledge will not allow long-range predictions.

We would appear to be at a point where we have evaluated our problem, where we know its extent and truly appreciate its actual potential importance. We have a good basic knowledge of essential epidemiologic factors involved in summertime spread of infection.

The public can be educated concerning the above knowledge so that they understand the problem and the ways in which they can assist official agencies and themselves in combating the problem by proper handling of water in such a way as to prevent mosquito breeding, and by screening and repellents for individual protection. We have the knowledge—the challenge is in applying it.

President Peters: Thank you very much, Dr. Reeves, for a very concise and informative picture of encephalitis in California. I hope the inverted sequence of speakers will not prove a detriment to Dr. W. A. Longshore of the Bureau of Acute Communicable Diseases, State Department of Public Health, who will now speak to us on "The Epidemiology and Public Health Significance of Encephalitis in California."

Dr. Longshore: I am sorry that I didn't get here in time to take my assigned place on the program. I have been in contact with Dr. Reeves before, and I find it is always safer to be in the room with him when he talks than to be out of it. I have no idea what he said concerning my absence. My explanation is that I am not familiar with Sacramento and its various Lodges, and neither are its taxicab drivers. I was taken first to the B.P.O. Elks, then to the Moose, and finally we found some one to direct us to the Odd Fellows.

Considerable false wordage has appeared in newspapers and magazines discussing the events of the past summer. For example—"Terror stricken farmers and townsmen hastily packed their families off to the high Sierras or to the seashore as the number of cases mounted week by week," quoted from Harper's; or—"New virus causes Valley encephalitis," quoted from San Francisco Chronicle; or—"Five times more deadly than polio," quoted from Life magazine, and—"Korean veterans bring virus encephalitis to fifteen," quoted from Fortnight Magazine. Harper's also says in effect that the sick people would not have been sick if "the army of investigators" had not insisted on it. Well, let's look at the facts we have on hand and their possible interpretation.

The historical development of encephalitis in California is already familiar to most of you. Suffice it to say that much has been observed since the recognition of Western equine virus infection in the central valley of California about 1938, and St. Louis virus in 1939. What is the magnitude of the problem as we see it today as far as humans are concerned?

In 1945 there were 302 reported cases, with 54 laboratory confirmations, of which 26 were Western equine and 28 St. Louis. In 1946 we had 160 reported cases, with 28 laboratory confirmed, 18 being Western equine and 10 St. Louis. Here I would like to pause to read something that Dr. Lester Breslow said to you at your meeting that year—"Another factor, which should be mentioned as having probably influenced the reporting of cases, was the publicity concerning the encephalitis study program in general. When a wide campaign of this sort is carried on, it is to be expected that reporting of the disease by physicians and hospitals would be more complete than is usually the case." But in 1946 we were unable to find more than 160 cases with the special effort that went on at that time.

In 1947 there were 127 reported cases with 38 laboratory confirmed, of which 32 were Western equine and 6 St. Louis. 1948 was a good year—there were only 71 reported cases, with only one laboratory confirmed, which was St. Louis virus. If we could find out what happened in 1948 and reproduce those conditions, we would have the answer to our problems.

In 1949 there were 80 cases reported, with 31 confirmed in the laboratory, 10 being Western equine and 21 St. Louis. The year 1950 was the maximum up to this last year; there were 351 reported cases, with 157 laboratory confirmed, of which 88 were Western equine and 69 St. Louis virus. In 1951 we slipped a little—there were only 146 cases reported, with 55 laboratory confirmations—22 Western equine and 33 St. Louis. For 1952 the provisional figures at present are 754 cases reported, with 411 confirmed by laboratory tests, of which 369 were Western equine and 42 were St. Louis. There were some 3,000 paired blood specimens submitted to the State Virus and Rickettsial Laboratory. Fifty-three deaths were reported but not all have been confirmed as being due to virus encephalitis. Some had an encephalitis and were hit by a truck, but they still had encephalitis on their death certificates. Consquently we still have to weed out those cases which died either violent or natural deaths after recovering from this illness. Therefore the death figures are provisional only.

Do 754 cases of this disease constitute an epidemic? Certainly on a five year median or any other basis which public health workers use as criteria this would be an outbreak, and is as far as the State of California is concerned. Over 50% of the reported cases were confirmed by laboratory tests. The crude uncorrected totals give a rate of 33.8 per 100,000 population for the twenty valley counties in California. If poliomyelitis reaches a rate of 30 per 100,000 in any of the counties in our state we consider that to be epidemic. Here infectious encephalitis has a rate of 33 per 100,000 for the central valley, and as I will show you later some of the counties reached extremely high rates. These rates are crude rates based on the 1950 census populations.

As expected, the epidemiology of the disease followed very closely the patterns which had been outlined in previous years. For geographic distribution, 46 of the 58 counties reported cases, but laboratory confirmation was secured in only 24 of the counties. Five new counties (Contra Costa, Mariposa, Nevada, San Luis Obispo and San Diego) had confirmations this year, making 25 counties over the years in which the disease has been confirmed. The highest number of cases, as would be expected from past experience, came from the Valley counties, as follows: Kern, 222; Fresno, 121; San Joaquin 86; Sacramento, 63; Stanilaus, 38; and Tulare, 37. On the basis of the 1950 census populations, the highest attack rates, per 100,000 of population, were: Kern, 97.2; Sutter, 61.0; Yuba, 49.1; Yolo, 46.8; Madera (which, according to its Health Officer had no epidemic), 46.1; Fresno, 43.8; San Joaquin, 42.8; Merced, 35.8; and Kings, 35.2. The rest of the counties had rates of less than 30 per 100,000. You can see that these rates are decidedly high, and if they accurred in poliomyelitis would be considered epidemic. Therefore I think we are on safe ground in pointing out that last summer's activities of the encephalitis viruses were certainly over and above our usual expectation.

Some 400 horse cases were reported, but these were widely scattered and included the coastal counties and southern California, as well as the central valley counties. Strangely enough, we have horse cases in many counties from the coastal area, from which we have been unable to obtain laboratory confirmed cases in humans. We do not understand the reasons behind this situation; perhaps there is a different vector along the coast which transmits the virus to horses but not to man; perhaps man does not live in as close contact with horses in the coastal counties as in the valley counties; or perhaps there are other factors which may explain the marked difference in distribution of human cases and equine cases.

Of the few laboratory confirmed cases attributed to the coastal counties, we have been able by our epidemiological investigations to place them, during the incubation period of the disease, in the valley counties.

The seasonal distribution has fitted into the pattern established in previous years. The restriction of cases to the period from June to October has again occurred. The medical syndrome of encephalitis is reported to the State Department of Public Health throughout the twelve months of the year, but laboratory confirmed cases of virus encephalitis do not occur except in the period from June through October. At present there is a possible case with an onset given as November 11, but he is a Spanish-speaking Mexican, and as soon as we can get some one who can speak a little more convincing Spanish perhaps he can be talked into an October onset!

During 1952 there were no confirmed cases prior to June. In June there were 26 Western equine and no St. Louis cases; in July, 196 Western equine and 3 St. Louis; in August, 126 Western equine and 7 St. Louis; in September, 19 Western equine and 22 St. Louis; in October, one Western equine and 10 St. Louis; and in November

the one Western equine case already mentioned of doubtful date of onset.

This syndrome of encephalitis, as you know, can be caused by many factors, such as influenza, measles, mumps, whooping cough, following smallpox vaccination, following anti-rabies inoculations, and so on. While case reporting goes on during twelve months of the year, the heavy reporting comes during the particular season, and I think it is only natural that when a physician is confronted with a syndrome in which the etiology is difficult to determine he will diagnose the disease which is "in style" for that season. This has been true for polio; if a person has a headache, fever and a stiff neck, and it is during the polio season, it is called polio; if it is during the influenza season, it is called "flu"; and if it is during the virus encephalitis season it is called encephalitis. It is only natural that our reporting becomes heavier on the "fringe" cases during the season of prevalence of a particular disease, merely because physicians, normally as you and I, play the percentages. An additional factor is that there a lot of insurance policies that pay off if the illness is called polio, and which don't pay off if you call it mumps, and so if the etiology is unknown it might as well be attributed to polio.

The seasonal difference between Western equine and St. Louis was again noted in the 1952 cases. Laboratory confirmed St. Louis cases began a month later than Western equine. Western equine was predominant in June and July, but St. Louis tended to take over in September and October. For example, in September there were 19 confirmation of Western equine and 22 St. Louis; in October there was one confirmation of Western equine and 10 of St. Louis.

However, the ratio of Western equine cases to St. Louis cases is unusual in California experience, with the possible exception of 1947, in which year the number of St. Louis cases was about one fifth that of Western equine cases. In 1952 the ration was 42 to 369, about one St. Louis to eight Western equine. But in 1949 and again in 1951 St. Louis cases actually exceeded Western equine cases, and in 1950 St. Louis cases were about 40% of the number of Western equine cases.

This leads to speculation as to possible causes of this marked difference in proportion of cases in different years. Was it, in 1952, due to the *Culex tarsalis* emergency control program which came into effect in August, and which possibly held down the rate of transmission of the later starting St. Louis virus? Or was it due to a natural disappearance of virus? Or was it due to natural resistance on the part of the host, or the development of an immunity of the hosts, which prevented them from developing this type of illness? We may have some clue, when the virus isolations from mosquitoes are completed, as to whether or not the virus was present in large quantities and yet there were small numbers of persons who actually came down with the St. Louis type of illness. The distribution over the months was the same as we would expect; it is only the quantitative relationship between the numbers of confirmed St. Louis and Western equine cases which apparently has been disturbed. This may be a perfectly normal occurence or it may have something to do with mosquito control.

The age distribution of cases is interesting. It has again been substantiated by the age distribution of Western equine encephalomyelitis in California that this disease is a pediatric problem. Of the reported cases in Californa in 1952 (June through October—729 cases), 137 or 18.9% were under one year of age, and 269 or 37% were under ten years of age. This follows closely our previous findings, but this series is the largest series on record and gives us a series of cases upon which we can base a follow-up program with regard to residual effects, which may be important in encephalitis. With nearly one-half of the confirmed cases being under ten years of age, possibly an approach to control through vaccination of this age group in certain areas of the State may be indicated.

The curve of age incidence for Western equine starts high in the under 1 year group, and drops rapidly toward age 20, and then rises again in the age group over 50 years, so we have a "saddle back" curve of age distribution. For St. Louis virus, on the other hand, this year we had none confirmed in the group under one year of age, and in the past five years we have had only 2 cases in this age group. For some reason St. Louis virus seems to ignore this group, or if there is infection it does develop any recognizable illness. Many explanations are possible, among them the possible transfer of maternal antibodies to the child, and we hope that a study of this possibility can be made this summer. St. Louis type disease shows up in the age group from 5 to 10 years, and particularly in the 20 to 40 age group, but it does not have as high an incidence as Western equine in the ages over 50.

As to sex distribution, the ratio is about 2 males to one female. We think this may be due to occupational exposure—the men are out on irrigation and on farms and are more exposed to mosquitoes. But when you study the group 5-9 years of age this two to one ratio still occurs, and this can hardly be attributed to occupation. Whether there is some hormone factor involved remains to be studied.

There are some miscellaneous items of interest. We had one instance, and possibly several others, which will be reported in a pediatrics journal, of *in utero* transmission of the virus. A pregnant woman became sick close to her delivery time with an illness which she did not particularly recognize, and which was not severe enough for hospitalization. She was then delivered of twins, who came down with convulsions and fever the day they came home, and who were then returned to the hospital. Their convalescent bloods showed high titres for Western equine encephalitis. Upon a complete investigation it was shown that in all likelihood the mother was infected, that the children received the virus in utero, and developed the disease at their leisure, coming down with it upon their release from the hospital nursery. There was no opportunity that we know of for a mosquito to bite the infants. Their first bloods taken when they left the hospital were negative. Bloods taken 10 days later were positive, showing that the antibodies had been produced in the infants themselves. This is the first demonstration of *in utero* transmission of Western equine virus.

Special laboratory studies are being carried on and are particularly interesting. The complement fixation test, which can be run the most rapidly, is being compared with the neutralization test, which has been used previously and is thought to be the more reliable. Dr. Lennette is attempting to correlate a large series of these two tests this year, to decide if possible whether both tests will be necessary for diagnosis. Another aspect is the time interval necessary to obtain an adequate rise in antibodies. In Kern County it was noted that in some individuals who have had a good clinical case according to the physician,

bloods taken 10 to 14 days apart were negative for Westenr equine, but the specimen taken a month later became positive. Interestingly enough this delayed response appears to occur only in adults, whereas the rise of titre in children seems to occur in 10 to 14 days. In adults it may be necessary to take blood about one month following the onset, in order that sufficient time is allowed to produce antibidies, if we wish to confirm some 10% or 15% of the cases which we would otherwise believe negative. This problem also requires further study.

Another phase to be followed is the duration of antibody titres in individuals. Last summer we frequently found titres which were equivical and we didn't know whether this meant a recent infection in 1952, or whether they had been infected in previous years and were still carrying evidence of that encounter with the virus. We are attempting to follow as many of the 369 people as we can find who will cooperate, to determine the duration of the titre for a period of at least two years. If we can establish the fact that those who have high titres of complement fixing antibodies lose them within a year or within six months, or that they keep this evidence of infection over a period of two years, it will aid in the interpretation of laboratory tests—as to whether we have current infections, or whether the individuals were infected in previous years.

There are a number of "laboratory negative" bloods which are extremely interesting. After eliminating the positive specimens there were quite a number of patients who had a clinical illness resembling encephalitis but whose bloods were negative to Western equine and St. Louis even after three or four months. These specimens have been run against mumps and some of the other better known encephalidites viruses and have remained negative. The question as to which virus might be responsible for those illnesses remains unsolved, and many of us are convinced that there are viruses in the central valley which produce a syndrome of encephalitis, clinically indistinguishable from either Western equine or St. Louis disease, and which are as yet undiscovered. Dr. Reeves and Dr. Hammon pulled the California virus "out of the hat" in 1946, but their evidence is very disheartening if we wish to blame any number of these cases of unknown etiology on the California virus. They have been able to find only three cases in which the California virus might have been resopnsible.

We expect to test many of these negative bloods against the California virus, Eastern equine, Japanese B and other exotic viruses to see if we can find any evidence of activity of these other viruses in California.

We plan a study to determine what percentage of persons who experience an attack of encephalitis, have residual effects. The text books tell us that residual pathology varies according to the virus involved: that it may be anywhere from 2% to 40%. In California thus far our experience has been that about 1% to 2% have some residual finding. There is of course the possibility that in very severe cases the patient may become "a blob of protoplasm" or a so called "vegetable" who will require institutional care thereafter. Our information on this point is very inadequate, and it is felt that the large number of cases in 1952 makes it worth while to apply for a research grant to follow these individuals for 10 or 15 years to determine whether the encephalitis they had as children cause any residuals or sequelae.

We badly need a much simpler, more rapid, and less expensive test for immunity or antibodies than we now possess, which can be applied to large segments of the population. At present our survey method consists in taking venous blood, and it is difficult to get many people to cooperate, particularly if repeated too freqeuntly. It is hoped that we may be able to develop a skin test by which large groups of people can be readily tested and their immunity status determined. This test is in the experimental stage, but it is an attempt to make possible the evaluation of the status of the population in California so that we may know how many are immune and how many are not. On the basis of such information, it can be decided whether or not vaccination programs would be indicated.

The question of vaccination against encephalitis is another problem, and if our experience indicates that control of encephalitis by means of mosquito control is not possible, then some other approach may be necessary, and that may be the protection of the host. I quote a statement by Dr. Merrill and Dr. Lennette in a recent issue of "California's Health":

"Where de we stand now with reference to control of the encehalidites in which the etiology is known? . . . Concerning Western equine encephalomyelitis and St. Louis it is now recognized that these diseases are mosquito-borne. The most evident point of attack has been control of the vector mosquito. We have progressively intensified mosquito control operations in California during the past six years. Nevertheless, we have experienced this year the most intensive outbreak yet recorded. There is no way of knowing, of course, what would have happened to the incidence of the disease had there been no mosquito control. Nevertheless, it is now evident that either there must be a greatly increased and competently directed mosquito control operation, or there must be devised some other point of attack to break the chain of infection. Perhaps control of a disease caused by such an ubiquitous virus cannot be accomplished by an attack on the vector alone. . . . In that event, effective vaccines for human use will have to be developed and evaluated."

I do not know which method will be found effective, but certainly it is true that if mosquito control is not the answer, and we are unable to reduce the disease incidence by that method, then vaccination as an approach to a change in the human host will be a step which will have to be taken. We hope that the analysis of the data collected in 1952 by our various personnel will give many leads as to the activities which should be undertaken, as far as the human population and the disease in the central valley are concerned.

As to prevention and control, we plan to set up an alerting mechanism; to use hospital admissions and the receipt of blood specimens at the Virus and Rickettsial Laboratory as a warning index; to place medical student "observer-reporters" in several hospitals in the central valley area; to promptly evaluate the mosquito counts reported by abatement district collecting stations throughout the State; to explore the possibility of having virus isolations from mosquitoes done currently to give us information as to whether or not virus is present in the early part of the summer. One or more of these activities we hope, will alert us early enough to take what steps we can to prevent a repetition of last year's experience.

Much basic data concerning the relationship of the infectivity rate of mosquitoes to the incidence of human disease needs to be gathered, and we hope that through your cooperation with the State Department of Public

Health much of these data will become available so that the relationship between prevalence of mosquitoes, of virus, and of disease in humans can be evaluated.

Encephalitis is a problem of public health importance to the central valley from several angles. There is the cost of hospitalization of the ill individual; the loss of man-days in production, resulting from the illness; the expenditure of public money for mosquito control operations especially against the *Culex tarsalis* mosquito; the educational activities that have to be carried on; and the $250,000 from the Governor's emergency fund—all have tended to make encephalitis a public health problem, and the problem still remains of working out a satisfactory solution for its prevention and control. From our last summer's experience we have more knowledge than we ever had before, and once the analysis of that knowledge is completed we will have data on more cases than have ever existed and been thoroughly studied heretofore. With this added knowledge we hope to go forward with some definite plan for meeting this problem in California.

In spite of Harper's claim that we "dug this one up," we in the State Department of Public Health feel that we have had an extremely high incidence—the highest on record. In Kern County, where we have obeserved this disease for many years, and where we did not intensify our activity, the increase in the disease was first noted, and was the highest they had ever experienced. We think that this experience was widespread in the endemic area for encephalitis (the central valley). There is much yet to be done. Dr. Reeves presented the problems we face in the natural cycle of the disease—the unknowns in that area. We have many areas which are still unknown in the human aspect, and in the control of the disease. By cooperation in the summer ahead, as we cooperated last summer, much new knowledge can be gained. As to predictions for the summer to come, I agree with Dr. Reeves—I don't think we can tell now if we will have the conditions necessary to produce an epidemic, and if we don't have the appropriate conditions we won't have an epidemic. That is non-committal, but I can assure you that we are going to attempt to foresee any possible epidemic, and to take whatever steps can be taken, either against the mosquitoes or by immunization of the human host, in sufficient time to be effective.

President Peters: That this talk was both interesting and important has been evidenced by the numerous note takers. I think we now have a clearer picture of the epidemiology of the disease. Dr. Reeves stressed the importance of the natural history of the mosquitoes, and Earl Mortensen of the State Department of Public Health will now present some notes on the over-wintering habits of *Culex tarsalis.*

OBSERVATIONS ON THE OVERWINTERING HABITS OF *CULEX TARSALIS* COQUILLET IN NATURE

EARL W. MORTENSON
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Several workers have reported the occurence of *Culex* and *Anopheles* mosquitoes in natural resting places. Reeves, Washburn and Hammon (1948) in their work on the effectiveness of residual DDT deposits on adult *Culex* mosquito populations in Kern County during 1945 reported that a relatively small proportion of *Culex tarsalis* Coquillet enter man-made shelters, in that they seem to prefer natural resting places. Ryckman and Arakawa (1951) reported the occurrence of *Anopheles freeborni* Aitken in wood rats' nests near Redlands, California during November 1950 and February 1951; no *C. tarsalis* were found at that time.

The purpose of this preliminary work was to obtain more specific information on the resting habits of *C. tarsalis* in nature during the winter months. The first objective was to locate potential resting places in hollow logs, stumps, under bark of trees and in animal burrows. The second objective was to develop a method of collecting the mosquitoes that were found in these nature resting places. The third objective was to observe the conditions of the females insofar as the feeding activities were concerned.

PROCEDURE

A survey was made of potential resting places in logs, stumps, animal burrows and rock formations and along stream beds. After a potential resting place had been located, a mosquito net was erected over the shelter. The collector then, therefore, crawled inside the net and sprayed the opening with a light charge of chlorofrom using a "flit" spray gun. This chloroform charge acted as an irritant to the mosquitoes driving them out of the shelter. They then came to rest upon the net and were collected with an aspirator. The work was started in December 1952 and will continue for the spring and summer months of 1953.

RESULTS

The results of the mosquito collections in natural shelters for the period of December 1952 and January 1953 for Kings, Fresno and San Joaquin Counties are presented in Table I.

C. tarsalis was the predominate species found in the natural shelters. The other species were *Culex quinquefasciatus* Say, *Anopheles freeborni* Aitken, *Anopheles franciscanus* McCracken and *Culiseta maccrackenae* Dyar and Knob. A larger number of *C. tarsalis* were collected in hollow logs, tree stumps and brush piles along stream beds than were collected in rodent burrows associated with earth banks. In many cases the natural shelters served as dens for small mammals. In one hole in a sandstone ledge near Farmington, San Joaquin County, 31 *A. freeborni* and 8 *C. tarsalis* were collected.

C. tarsalis specimens taken from natural resting places did not show evidence of having taken blood meals nor did any show a gravid condition until the week of January 19-26, 1953. During that week 38 per cent of the total number of *C. tarsalis* females collected from six driftwood piles near Centerville, Fresno County, had taken recent blood meals. Upon dissection, four specimens of this group were found to contain mature eggs. Two weeks prior to this collection the same drift wood piles were sampled and these earlier collections did not reveal any blood-fed *C. tarsalis.*

Adult mosquito collections were also made in man-made shelters concurrently with the natural shelters. *C. tarsalis* was found to be proportionately more abundant in the natural shelters.

DISCUSSION

This preliminary work poses several interesting questions:

1. Does *C. tarsalis* use the same type of natural resting place during the warmer months?

TABLE I—*Mosquito collections made in December 1952 and January 1953 from natural resting places in the San Joaquin Valley.**

Date	Location	Type of resting place	*Culex tarsalis*	*Culex quinq.*	*Anopheles freeborni*	Other
12/ 8/52	Fresno County	Rodent burrow	5	..	..	..
12/ 8/52	" "	Rodent burrow	7	..	..	..
12/ 8/52	" "	Willow stump	5	..	..	..
12/10/52	" "	Uprooted tree	6	..	..	..
12/10/52	" "	Driftwood pile	8	1	..	1 *Anopheles franciscanus*
12/10/52	" "	Driftwood pile	13	..	..	1 *Anopheles franciscanus*
1/ 9/53	" "	Wood rat nest	7	..	..	2 *Anopheles franciscanus*
1/29/53	" "	Driftwood pile	5	..	..	..
1/29/53	" "	Driftwood pile	9	..	..	..
12/15/52	San Joaquin County	Under log pile	5	..	..	..
12/16/52	" " "	Tree stump	9	2	..	..
12/16/52	" " "	Tree hole	3	4	..	..
12/18/52	" " "	Under tree roots	21	4	..	..
12/18/52	" " "	Animal burrow in rock ledge	8	2	31	..
1/ 5/53	Kings County	Hollow log	6	6	..	..
1/ 5/53	" "	Hollow stump	16	2	..	..
1/ 5/53	" "	Tree hole	3	..	..	..
1/ 5/53	" "	Hollow log	65	1	..	..
1/ 5/53	" "	Uprooted tree	7	1	..	..
1/ 5/53	" "	Hollow log	41	..	..	..

* All numbers for the mosquito species listed are for females.

2. What is the behavior pattern of the adult female during the winter months and during the period just prior to the first egg deposition?

   (Bates (1949) points out in a general manner that the speed of egg development in mosquitoes, like other physiological processes in insects, is dependent on environmental temperatures. He further relates that a single blood meal is sufficient for the development of eggs.)
3. What portion of the total overwintering *C. tarsalis* population utilizes natural resting places in lieu of other available types of shelters?

It is anticipated that further study on the ecology of *C. tarsalis* in California will provide the answers to many of the questions that we have about the overwintering habits of *C. tarsalis* as well as its diurnal behavior during the summer.

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President Peters: We will now ask Mr. Frank M. Stead, Chief of the Division of Enviornmental Sanitation in the State Department of Public Health, to talk on the subject of "Planning for More Water with Fewer Mosquitoes a Decade Hence."

Mr. Stead: When this subject was first proposed, I think it read "Planning for More Water with Fewer Mosquitoes in 1955." Now I see it is a decade hence, in 1963. The date makes little difference—the principle remains the same. I ask you to concentrate on that part of the subject that does not have a date. What we are talking about in the very near future is planning for more water with fewer mosquitoes—*period.* We are talking about the entire problem of mosquito control. Practically all types of mosquitoes are of great importance in our way of living.

The first thing we should do is to realize that there will be more water in California. More water will be distributed and used in a manner to produce more breeding places for mosquitoes. The bill which has been introduced into the Legislature, and which I feel certain will pass, to establish a department of water resources in this State, means one thing if it means no other—California intends, come what may, to proceed with a plan of development of its water resources, bringing excess water from areas of surplus to the areas of deficiency. What is of importance to us is that the putting of all this water to municipal, industrial and agricultural uses means opportunity for mosquitoes. Therefore let us get that first proposition behind us. There is going to be more water.

As to the second question, are there going to be fewer mosquitoes? If there is any lesson which history teaches us, it is that the standards for our environment, the comfort and the enjoyment of life, never go backward—they always go upward. People demand better and better living standards, whether it is from the standpoint of freedom from disease, or simply the opportunity to engage in the normal pursuits of life, or for financial benefit, or simply enjoying living. We must have a better environment mosquito wise, and we will have it so.

There is going to be more water and there are going to be fewer mosquitoes. Once you adopt this principle you can set your own date line—1955 or 1963—it makes little difference. These are the ground rules for the next ten years. How are we going to get there? I do not think I have increased a defeatist attitude among mosquito control and public health people by sensing some misgivings, some grave doubts, some wonderings as to what we are to do next. This feeling of a disturbing situation expresses itself in several ways and we seek an "out." The first which some desire is a new miracle insecticide or drug to take the place of the miracle insecticide which has just fizzled out on us. I don't think we had better count on that—at least not on a miracle. The second type of "out" is typified by the emergency program which we went in together during the last summer. This is a concept which may be described as a "walled city" concept—in other words, that our cities and towns are something that may be callled refuges kept reasonably free from mosquitoes, and to which the population could return at nightfall as did ancient peoples to their walled cities, as they recognized that their outlying areas were not safe for people to be in at night unarmed. We adopted some of that concept in last summer's outbreak, but that is no good for a permanent program, from the standpoint of freedom from mosquitoes. We are not now talking about an emergency measure of a few month's duration to cope with an unusual occurrence of disease; we are talking about making the whole of California a suitable place in which to carry on all sorts of activities including, remember, this basic right of man to have a comfortable life.

So the walled city, or city of refuge, concept is no good. Therefore there is the last desperate try—if it is true that the development of the water resources of this state is going to make the mosquito control problem four times as big as it is now, that is simple—we will appeal to the Legislature and to the governing bodies of our Districts and other local agencies for four times as much money, and immediately step up the governmental cost of mosquito control to something like ten million dollars per year, and if that doesn't do it, we will make it 20 million per year.

Well, I am not an infallible prophet, but I think I am a good enough prophet to call the percentages on that, and it is no go. The expenditure of public money probably will be increased next year. The bill sponsored by your group for an increase in subvention funds has a good chance of passing, and there is a proposal for funds to improve our methods of measurement of mosquito and virus prevalence, and for improving techniques of mosquito control. But whether or not these bills go through, the amount of money for mosquito control will not be spectacularly changed. By no stretch of the imagination will it be increased even as much as 50%. So this third "out"—the problem is say ten times as big, therefore give us ten times as much money—is no go.

Where, then, are we? We are in a fix. We have tried three times to find an easy way out, and there is no easy way out. All we can see staring us in the face is the handwriting on the wall, in red letters—there is going to be more water and there shall be fewer mosquitoes. Does that sound pessimistic? Well, at this juncture permit me to take a look at history. Many times when you are really stumped and are looking for an answer to a new problem, if you run back in history you may find an answer.

About 1540 a small group of desperate men commanded by one Hernando Cortez set out on one of the most improbable ventures in history. About two hundred strong, with very little equipment, they set themselves to the job of overcoming one of the most powerful nations of the then world, the Aztec empire of Mexico. The first thing this little band of men did, after they landed, was to strip all the hardware and cordage from their ships, and burn the ships. They "burned their bridges" behind them. In their first encounter with this warlike race Cortez had a couple of aces up his sleeve—a miracle weapon. He had horses. The Aztecs had never seen horses, and Cortez counted on the fact that these horses were inhuman monsters to the Aztecs, and Cortez was able to win his first battles against terrific odds simply because he had this miracle weapon at his disposal. When a horse was killed it was buried quickly so that the natives did not find out that it was not an inhuman device. But they were not able to bury all the killed horses, and eventually the Aztecs learned that the horse was separate from man, and not immortal. So then the miracle was dispelled, and from then on the Aztecs developed a stout resistance.

But Cortez started his march to the City of Mexico, and what could a mere two hundred men do against a nation. But he had the answers. He obtained cooperation in his adventure by first defeating and then making allies of the Tlaxcalans, a warlike fraction of the Aztec empire, and by so doing he multiplied his forces many fold. He finally got to the City of Mexico, but he still had not conquered the Aztecs, and he was in a sense a prisoner surrounded by the Aztecs. But he studied this race and he discovered a biological weakness—the Aztecs worshipped their emperor Montezuma. So Cortez decided that if he could capture the emperor he could capture the Aztecs.

By devious methods he succeeded in inviting Montezuma and his nobles to a banquet, whereupon he seized them, and through control of the emperor he got command of the city. But then came a dark cloud of trouble. A courier came from Vera Cruz saying that the Spanish crown had sent a military force there to take over the conquest of Mexico from Cortez. So Cortez thought "These guys can ruin me, but maybe I can get them on my side." So with about one hundred men he marched back to Vera Cruz, attacked the crown forces under Narvaez, several hundred strong, in the middle of the night, and with stratagem and surprise first conquered them and then convinced them to join him. Adding their forces to his he returned to the City of Mexico stronger than ever.

Finally, however, this biological phenomenon of the Aztec race he was dealing with began to develop resistance, and finally the Aztecs threw Cortez and his gang out of town, bag and baggage. They lost their horses, they lost their cannon, they lost their weapons, and on a bleak morning Cortez and about 50 of his men found themselves sitting on top of a hill with nothing but their britches and shirts, and there he was.

And there we are now, facing the great problem of erasing the mosquito population, with apparently far less prospect of doing a more successful job than ever before!

So what did Cortez do? His bridges were burned behind him. He had no choice but to win or perish. By sheer genius he convinced his people that they could succeed. He surrounded himself with allies from the country, and so vividly and skillfully spelled out a new plan of attack that they all saw it would work. From his former vessels he transported the cordage and hardware to the lake around the City of Mexico, and his one shipwright taught thousands of natives to construct a fleet of sailing boats

from timber they could find in the country. Then via water they proceed to attack and recapture the city.

That may be a parable, but here we stand in relation to the mosquitoes in better case than Cortez did with relation to the Aztecs. Now, we have enough resources to make the same old play that we have been making in past years, using the same weapons that have been, to some extent, discredited. So what should we do? If we can take a page from Cotez's book, we can say that each of us is the quarterback of a small, very select and very resourceful group of men, but the team work with which we are going to conquer the mosquitoes is not ourselves alone, not merely this small versatile group, but a large army of people that we find in the central valley, in the cities and counties of California ready to be sold a plan, ready to see how they fit into such a plan, so that we will outnumber even the mosquitoes when we get through.

I don't think I need to labor this parable any further. The rest of the story I guess is up to you, beginning next Monday morning.

President Peters: Thank you, Mr. Stead, for your thought provoking talk. We are all looking for interagency cooperation for the betterment of mosquito abatement, and we will now hear from Dr. Elmer Bingham, Health Officer of the San Joaquin Local Health District, who will talk on "State and Local Relationships in the California Public Health Program."

Dr. Bingham: You gentlemen are now in your third and final day of these elaborate discussions, and I imagine that you are reaching the saturation point, so I will be brief. But I would like to digress a moment. Perhaps you are worried about a highly successful mosquito control program which will not leave unanswered all these problems which Dr. Reeves and Dr. Longshore related this morning. But at the present time it appears that we may maintain an area in southern San Joaquin County where there will be no mosquito control, where encephalitis can continue to spread, and with which you can compare the good results you get in other parts of the valley.

We should perhaps entitle my remarks "The Big Change." The big change in relationship between the State and local health agencies took place in 1947, when the State decided it was time they gave some assistance to local health departments. It took the form of financial assistance through a state subsidy, and I think the whole complexion of State and local relationships has been drastically changed by this subsidy and its accompanying legislation. The legislation is unique in that in addition to setting up funds to assist local health departments, the law spelled out definite participation by the local health departments in the administration of the act. There was established a legally constituted conference of local health officers, and there was delegated to this conference certain powers. For example, the State Health Department could administer the subvention fund only after consultation and advice from a Conference of Local Health Officers, and shall consult with the Conference in regard to standards of education and experience for people to be employed in local health activities. The law provides that local governments shall pay the expenses of the local health officer in attending the regular meetings of the conference, not to exceed two in a year.

I assure you that the Conference has not spent its time at these meetings discussing just those two points—administration of the subvention money, and personnel standards. We have gone into the technical field, the scientific field, as well. The formula for dividing up the State subsidy was established early, and has not been changed. There have been a few changes in standards for personnel employed under these funds. But the bulk of the time of the conferences has been devoted to the administrative and working problems of local health departments. In all the deliberations of the Conference there has been an extremely close relationship between the State Health Department personnel and the personnel of the local health departments. I don't think there is anyone who participates in the work of the Conference who hasn't been greatly benefitted. I might quote the present Secretary, who said that at the end of the year he had learned more from the Conference than he did in his post-graduate course at John Hopkins. This Conference is in effect an in-service training for health officers which cannot be beat, but to get anything out of it you have got to participate, and I am sure that all who have participated have had a great deal of help from it.

One of our difficulties has been that we have sometimes tried to accomplish too much too quickly. Dr. John Philp, formerly Health Officer of Butte County and now with the State Department of Public Health, said that in his last year in Butte County he devoted forty-five days to Conference business. The law states that the Conference shall have certain officers, and these officers form an executive committee, which does a great deal of work. The Conference also set up a Committee on Administrative Practices of about a dozen men, and under it there have been established five study committees, each chairman thereof being on the main committee. They carry a large amount of resonsibility to keep the wheels turning.

Our statute is now in its sixth year, and I think that the success of the law, and the careful manner in which it was drawn, is shown in the fact that it has not been amended. On the other hand, your mosquito abatement district act has been frequently amended. But now the health officers are talking about changing our law in only one feature, that is, the income aspect. When the law was set up in 1947 the value of a dollar was much greater than it is today, and we feel that this should be given consideration.

Will this type of organization work elsewhere? I think its biggest asset is that the Conference is a legally constituted body, that travelling expenses for the health officers are legally defrayed, and the operations of the committees are taken care of through funds set up in the State Health Department. Of course some health officers have to spend considerable time outside of their jurisdiction, aside from the two regular meetings per year (I mentioned Dr. Philp's forty-five days a few moments ago), and there might be a challenge on an official being so much away from his local duties, but usually the fact that such expenses are paid by the State offsets that argument. But the time used on committees reflects the fact that perhaps we have tried to do too much too rapidly.

There have been occasional suggestions of schism in our organization. A recent one was concerning the feeding of raw garbage to hogs. The city health officers were forced by their city managers to take a stand against legislation on the matter, whereas the county health officers were faced with the problem of garbage disposal in their areas and favored legislation on the matter. But most of our problems have not been serious and we remain on speaking terms with each other.

The California Conference of Local Health Officers has replaced previous organizations, such as the health officers' section of the League of California Cities.

If the present organization of mosquito abatement districts is going to consider a similar type of activity, it should consider whether it can be operated effectively without legal backing such as the health officers have, and secondly, they should consider what persons should be included. Our law says that all local health officers belong to the Conference. It leaves out all other health department personnel. Recently one of the engineers in a local health department suggested that it was ill-advisd for the health officers to form committees on santiation matters, but such committees dealing with environmental problems should be made up from sanitation officials. But the fact remains that only health officers are members of our Conference. If a mosquito abatement organization was set up in similar fashion, you would have only managers of your districts as members.

But the Conference of local Health Officers has stimulated other groups, for example a state organization of laboratory directors, which is a voluntary organization. There have been many times when we have wished we had the direct assistance of other members of our staffs during our deliberations, but as yet we have not seen how we can bring these people in officially as part of our organization. This is one area in which our type of organization may be defective, and if other groups should consider legal organization they should decide who beside the heads of the departments should be included.

I think that we can say that this conference has advanced public health in California more in the past six years than any other single factor in the history of the State. It may be that similar organizations in other fields of interest, by following this pattern, might obtain similar results. I am sold on the Conference 100%, and in spite of the time we had to devote to its official duties last year I consider it well worth while and I am well repaid for the time spent.

I assume, Mr. President, that time will not permit a discussion of this subject, but if some of you people are interested I will be glad to go into details later as desired.

President Peters: Thank you very much, Dr. Bingham. As the final speaker for this morning I will call on my twin brother, Dick Peters, Chief of the Bureau of Vector Control, State Department of Public Health, who is to speak on "Strengthening our Offense Against Mosquitoes and our Defense Against Encephalitis."

(Editor's Note: Unfortunately an adequate transcriptio of Mr. Peters' talk is not available).

SIXTH SESSION
FRIDAY AFTERNOON, FEBRUARY 13, 1953
ODD FELLOWS HALL, SACRAMENTO

President Peters: We will now take up the panel discussion which we had to postpone from this morning's program, for lack of time. The title is "Methods of Measurement of Mosquito Populations" and the Moderator will be John R. Walker of the Bureau of Vector Control. Jack, will you please introduce the members of your panel?

Mr. Walker: Will the following members of the panel please come forward and be seated at this table: Dr. Harvey I. Scudder, Technical Coordinator, Bureau of Vector Control; Gordon F. Smith, Manager, Kern Mosquito Abatement District; Thomas D. Mulhern, Associate Vector Control Specialist, Bureau of Vector Control; Edmond C. Loomis, Associate Vector Control Specialist, Bureau of Vector Control; and Theodore Aarons, Assistant Manager, Alameda County Mosquito Abatement District.

One of the proposals of the California Mosquito Control Association to the State Department of Public Health and to the Legislature this year was that there should be a method or program set up by which we could measure both virus presence and mosquito populations so that we could have some warning as to the excessive prevalence of either or both to alert the health and mosquito control agencies in time to take necessary preventive measures. This panel will consider the problem of measurement of mosquito populations by the various methods and devices available to us, and discuss their uses and limitations. The first speaker on the panel will be Dr. Scudder.

(Editor's Note: Dr. Scudder's remarks have not been cleared with the U. S. Public Health Service, and we are therefore unable to present them).

Mr. Walker: The next section of this panel will now be given to Gordon Smith.

THE USE OF NATURAL RESTING STATIONS IN THE KERN MOSQUITO ABATEMENT DISTRICT

GORDON F. SMITH

The only method of assessing the efficacy of any endeavor is some means of systematically measuring the results obtained against those desired. In mosquito control, the efficiency of operation is indicated by the numbers of adult mosquitoes which are able to emerge successfully from the aquatic form and live to disturb the population in the area under control. Therefore it behooves a mosquito abatement district to set up, for their own information and use, a system of estimating the adult population as a check on the efficiency of its program, both in portions of the district and in its entirety; for immediate use, and for long-term analysis to indicate the progress of the program and to aid in planning the future.

There are number of methods of estimating the adult mosquito population emerging successfully. All of these methods are subject to the interference of variable and uncontrollable factors. There is none that is not open to criticism. However, until someone develops a "perfect" method, we shall have to do the best we can with what we have.

In selecting the method to be used for a district's own purposes, a number of factors must be considered. The final decision should be arrived at only after suitable trials. The topography, geography and meteorology of the area in question may have a great deal to do with the selection of the primary method used. The species of mosquitoes to be counted may also have a considerable influence and may require more than one technique. Finally, economics have a definite place in the picture. How much time and money can the district afford to put into the program? It appears then that, for the district's own purposes and information, the selection of method will depend on the local conditions. If it is desirable to broaden the mosquito adult picture beyond the district level for some particular purpose, such as general analysis of vector prevalence or comparison of mosquito levels within the district with

those found in uncontrolled areas, it may be well to further modify techniques or to resort to dual methods in order that the broad coverage may be as uniform as possible.

In the Kern District, the resting station count was selected as the method of choice since, at the time the counting program was initiated, our primary interest in assessing population levels of *Culex tarsalis*. Light traps, body counts and larval surveys are given limited use where special situations indicate. I believe, however, that the remarks I shall make apply to a greater or lesser degree to any method used for population measurement within controlled areas.

In operation we have used two types of Counting Stations, Permanent and Random. Permanent counting stations are for long range studies. These stations are visited regularly at weekly intervals throughout the year. Since they are to be checked for permanent recording purposes as an aid to long range analysis, they must be selected with considerable care. If possible several sites in the area where a new station is to be established should be counted regularly for a period of time. After this observation period the most representative of the sites under surveillance is selected for long term counting purposes. The number of these stations used must in a large part, be determined by the area to be surveyd and limitations set by the economics of the particular area against the information to be obtained.

Random stations are of more value for an immediate indication of locations in the district where an unusually high population of adults is present. These may indicate the need for more concerted effort in a particular area. The counting sites may be any shelter where mosquito adults are commonly found. Observation is casual rather than on a regular basis. This type of counting will serve to fill in the gaps between permanent stations in supplying information concerning current trends in field developments.

In selecting resting shelters for either permanent or random counting, any sheltered place should be considered. Chicken houses, porches, barns, tank houses, cellars and culverts are among the types of shelters we have used. On occasion, when no shelter was available in the location to be sampled, one has been provided in the form of a box or barrel.

In operation, we have found it advantageous to assign a specially trained inspector to carry out the counting and selection of all permanent stations to obtain the greatest measure of uniformity and leave the entomologist free for special proects. When not occupied with this work he identifies material, makes random counts, aids operators in locating difficult to find sources and aids the entomologist in investigating special problems. All regular personnel should be sufficiently trained to do random counting and should be encouraged to do a limited amount of adult checking to better inform themselves of conditions in their zones.

Although a large part of the heavy mosquito producing area in the state is now in abatement districts, it would be well to establish some system of population survey in uncontrolled areas to develop normal trends, both immediate and long range, for comparison with trends in controlled areas. A well balanced program of adult sampling should lend itself to interpretation in various ways of advantage to the district.

Current trends in adult population and the location of trouble spots within a district may be interpreted and the need for greater effort in particular direction may be indicated by a combination of random and permanent station counts.

Long range trends may be developed from the comparison of data obtained from permanent stations year by year and with such climatological data as may be available. These trends, to be of maximum value, must be carefully gathered over a period of years. They will tend to indicate the progress of the control program. Also, since economically most control programs are fairly static in degree with regard to the development of the problem, the records may indicate cyclic trends. These trends, when compared with weather data, may give information of value in planning spray programs.

In district interpretation of data obtained by this type of a program, especially the assessing of immediate movements based on actual numerical counts, the trends established must be in large part subjective, and based on an intimate knowledge of all the problems and the factors present. The analysis of long range trends within a district should also be influenced by subjective as well as objective interpretation, based on a knowledge of the past and probable future development within the district of factors influencing mosquito breeding.

In any interpretation of data gathered from a number of districts, even though counting methods are *supposedly* comparable, extreme caution should be exercised in attempting to compare area with area by actual numbers. This data should be of great value, however, in developing general overall population movements, both current and long term.

The amount of benefit obtained from adult counting will be determined by the care taken in carrying out the program. If the program is carefully planned and carried out, it will replace much guess-work with factual data of considerable value in planning and surveillance of a control program.

Mr. Walker: Tommy Mulhern will now discuss the use of mechanical traps in measuring mosquito populations.

THE USE OF MECHANICAL TRAPS IN MEASURING MOSQUITO POPULATIONS

By Thomas D. Mulhern
Associate Vector Control Specialist, Bureau of Vector Control, State Department of Public Health

As introduction to the remarks that follow it may be worthwhile to review the concept upon which was based much of the development work with mechanical traps for measuring mosquito prevalence or annoyance.

Mosquito control agencies are in existence today because female mosquitoes bite humans. These female mosquitoes may have come from sources nearby, or may have flown many miles to reach the point where they attack. Generally the most intense attack period occurs about dusk, for at that time most common species of mosquitoes are very active, and the greatest number of persons are exposed while attempting to enjoy the out-of-doors at their residences. If we can determine with reasonable accuracy the numbers of female mosquitoes in residential areas during the evening hours, we shall have a firm basis for an opinion as to the need for mosquito control, or for the intensification of mosquito control if there is a program already in operation. Furthermore, if we can determine

what species of mosquitoes are involved in the attack upon humans, we may correlate this information with our knowledge of the types of sources from which the various mosquitoes come, thereafter intensifying our work against the sources of the offending species. The trapping problem. then. becomes one of measuring the numbers of female mosquitoes of all species which are about human habitations in the eveninng or night hours, when all of our important species are active.

The need for establishing such an "index of attack" or "index of potential annoyance" has long been recognized. Many efforts have been made to establish an index by using human collectors who would catch all mosquitoes which attempted to bite, recording the time and numbers caught. The difficulties and inconsistencies of this plan are well known to all of us.

As early as 1922 Headlee published a detailed appraisal of this problem, urging that efforts be put forth to develop a mechanical substitute for the human collector. Rudolfs, in 1925 reported upon three years work which had been done with chemicals, lights, humidity, temperature, etc., in an effort to determine what baits might be used to attract mosquitoes to a trap. His conclusion was that the human breath, largely carbon dioxide, was the strongest attractant, and he also indicated the attraction of light.

In 1927 Headlee tested a light trap (without any means of moving air) which used a dry cell battery to power a small light bulb. This was observed to attract some mosquitoes, but a few were caught, due to the lack of a positive means of entrapping the mosquitoes which came near the entrance.

With this substantial basis of study and experiment as a starting point, a number of successful fan equipped light traps were built and tested within a few years, as reported by Headlee 1932, and Mulhern 1934.

After ten years of testing and field use of about 40 traps of the 1934 design, enough information had been accumulated about this model to warrant the preparation of a circular of instructions for use (Mulhern 1942). Many thousands of traps of this design have been used by many agencies, and a considerable number are still in use. However, during World War II, manufacture of the heavy duty motor and fan (capacity 360-400 cu. ft. of air per minute) about which the trap had been designed was discontinued and has never been resumed. Many of the wartime traps, were therefore, equipped with substitute fans of sub-normal air moving capacity, these traps being not comparable with the original in ability to catch mosquitoes. Great emphasis is placed upon the need for equipping traps with fans capable of moving not less than the standard volume of air for a deficient air movement through the trap means a lessened catch. When mosquitoes are numerous the escape of mosquitoes from a deficient trap may be readily observed. It appears that they are alarmed or repelled when they approach the entrance to the trap, and can fly away from it if the fan be subnormal. They cannot escape if the air is moving through trap at the standard rate.

In 1948 a fan and motor became available which was even better for the purpose than the initially specified unit, due to being of sturdier construction, with sealed case, permanently lubricated and protected from dirt. Unfortunately, this fan was slightly larger (500 cu. ft. of air per minute) than the original model, but because it was so much more suitable than any other available, it was deemed justifiiable to redesign the trap to accomodate the new unit, and incorporate a number of refinements not included in the original design. (Mulhern, 1952).

Several effective special purpose traps have been designed and reported in the literature (W. C. Reeves and W. McD. Hammon 1942, R. E. Bellamy and W. C. Reeves 1952, J. C. Chamberlin and F. R. Lawson 1945, H. H. Stage and J. C. Chamberlin 1945.) These special traps should receive the attention of workers interested in this field of measurement. The present writer has experimented with several 6-volt traps, none of which were very effiicient, and has observed two large traps, built by other workers in an effort to develop a unit that would provide control in a limited area. These traps have been able to catch large numbers of mosquitœs, but they have not proved to be adequate as a control measure, and descriptions have not been published.

Thoughtful attempts to appraise the light trap have been made by several workers. Evaluation of the data taken has been difficult, due to the absence of any fixed base line to which results might be compared, and the existence of many variable which affect the results. Huffaker, 1943, compared the light trap with other means of sampling and concluded that it did not catch all species of mosquitoes equally well. VanDerwerker, 1935, 1939, 1937, considered the variations in the habits of various mosquitoes with respect to attack on man, and concluded that the light trap records were comparable to and fairly represented the relative attack rates and annoyance caused by the mosquitoes which were present in the area where he was working. It is probable that there are variations in the rate at which the various species of mosquitœs are taken, and it is likewise probable that equally great variations in attack habits exist, but it was noted in 1952 that all of the important species of mosquitœs in California do enter the light traps in considerable numbers. Future comparative studies may enable us to determine precisely the variations which exist.

It appears that the use of these traps offer certain advantages over some other means of collecting data, when the purpose is to appraise the degree of mosquito annoyance in a community:

1. The human factor is reduced to the minimum, thus eliminating one important source of error.
2. Through the use of time switches and cooperators, nightly collections may be taken throughout the season, at relatively low cost.
3. The entire night period may and should be sampled, thereby eliminating another common source of error which exists when short-term collections are taken.
4. The trap catches a reasonable number of all the important species of mosquitœs which may demand control in California.
5. The trap samples the active adult mosquito population which is causing human annoyance, whereas resting or feeding stations count in animal shelters, etc., may be in fact a measure of a localized concentration of mosquitœs, not representative of the mosquito annoyance in the area.
6. Operation of the light traps may be standardized, so that records taken can be comparable from time to time, and from place to place.

Certain disadvantages have been noted:

1. Care must be taken in locating a light trap to insure that it will not be unduly influenced by competing attractants, or by repellents in the area.
2. The trap may catch more mosquitoes and more other

insects than some other methods, thus increasing the amount of labor necessary in sorting and identifying the catch.

3. When temperatures fall below 60°F., the effectiveness of the trap is reduced.

It is the opinion of this writiesr that the advantages markedly outweight the disadvantages.

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Mr. Walker: The last speaker on this panel will be Ted Aarons.

Mr. Aarons: It is generally appreciated that over the period of the past several years there has been an increasing need for standardization of methods used to measure mosquito prevalence. The urgency of this need, which has been jointly expressed by the California Mosquito Control Association, Inc., and the State Department of Public Health, was made particularly evident in view of the circumstances associated with the unprecendented encephalitis outbreak experienced in 1952. This past season the Association asked the Culicidology Committee to give priority consideration to the promulgation of a plan of measuring, recording and interpreting mosquito population density.

Various panel members have discussed diverse techniques used in the control operations to evaluate mosquito population density and distribution. These methods have included the use of artificial mosquito resting units, baffle traps, bait traps, light traps, natural resting stations, leg and body counts, larval sampling procedures, etc. Many of these methods apparently lend themselves to the operational project. However, the problem of using methods which tend to standardize population density evaluation on a regional and statewide basis has yet to be worked out to the satisfaction of the majority of technical workers. The application of principles of mosquito population measurement to evaluate control programs has been given extensive consideration since 1946 by the Association. To some extent nearly all of the principal methods, techniques and mechanical devices used elsewhere throughout the world have been tested against certain segments of our diverse mosquito fauna. Considerable imagination and constructive thinking has gone into the refinement of established techniques and the development of new ones. Significant contributions have been made in the field of soil sampling and egg density determination; improved seineing methods have been developed for larval density measurement; and a number of improvements and new techniques have been applied to mechanical traps and other devices used to estimate adult populations.

AN ACCEPTABLE PLAN

The objectives of an acceptable recommendation would be:

a. To develop a simplified standard plan of population measurement which will provide a reasonably valid estimate of mosquito numbers in relation to disease incidence, public comfort and economic damage.

b. To recommend minimum requirements of participation which will exert no undue hardship on any agency.

c. To recommend a standard system of recording and reporting which will furnish a current, seasonal and year by year biological audit on both local and state-wide basis.

Any plan developed for recommendation to a large number of agencies must of necessity be somewhat of a compromise. It is unlikely that any agency will find the minimum requirements adequate at all times. The Report of the Culicidology Committee, contained in full in these proceedings, details a proposed plan for measuring and recording mosquito populations. The plan gives consideration to both the pre-adult and adult mosquito stages and includes a discussion on reporting procedures, construction and operation of standard light traps and adult mosquito resting station units.

The evaluation of any plan can only be had after a fair trial. The discussions of the panel have been elaborations of certain ideas used in the recommendations of the Culicidology Committee report. We now are in a position to put these recommendations into field practice and consider changes and modifications as experience dictates.

It is well to keep in mind that all of the methods of measurement are but tools by which one may be aided in arriving at a reasonable evaluation of the efficacy of control. The final evaluation of the operational control program will, of course, be more fully appraised as a result of the overall experience of the project director.

Mr. Walker: This concludes the panel presentation, and the matter is now open for general discussion.

(Editor's Note: This discussion was not clearly recorded for transcription).

President Peters: Thank you, gentlemen of the panel. I will now ask Dr. Tinkham to discuss the control of eye gnats by soil larvicides.

CONTROL OF EYE GNATS BY SOIL LARVICIDES

By Ernest R. Tinkham, Ph.D.
Manager and District Entomologist, Coachella Valley Mosquito Abatement District

Aside from a few short introductory remarks, I wish to concentrate my fifteen minutes of conference time to the subject of Gnat Control by Soil Larvicides. I do wish to say, however, that in Coachella Valley we have 5 species of *Hippelates,* 4 of which are pestiferous and one, named in honor of the late Professor Hermes, is noteworthily not a pest. Of the four species only *H. collusor* is the real pest and all remarks henceforth refer to that species.

H. collusor breeds almost entirely in freshly tilled, damp, friable sandy soils and the problem of gnat control stems entirely from the fact that practically all of the date and citrus growers insist on cultivation. Thus each discing during the hotter months from April and May to October or early November produce a new generation of gnats, and it is possible to have 8-10 generations per season. The peak of the population curve is in late August and early September when a square yard of cultivated soil in the gardens may produce from 200 to 400 *collusor* gnats.

In the late summer of 1950 it became apparent that the field application of our 1949 laboratory findings on the use of the chlorinated hydrocarbons as adulticides was not practical or economically possible. So then we turned to the relatively new field of Chemical Irrigation with the results so promising that in 1951 our District expended $5,000 in chemicals to further explore this new field. Due to many factors, too numerous to enumerate here, chemical irrigation was supplanted by larviciding methods which we were sure would ensure more uniform distribution not only on the surface but in depth. In these experiments the chemical, either in the emulsifiable concentrate form or as wettable powders, were sprayed directly from a 24 foot boom, 20 inches above the soil, directly down upon the soil surface. The farmer or grower cooperated by following behind the spray rig disking in the chemical. We insisted that this disking be done the very day of the spraying, or otherwise in our hot valley the heat would bring about the rapid deterioration of the chemical. The rates of application were 2 to 3#/acre for Aldrin, BHC, Chlordane, Dieldrin and Heptachlor and 8-22#/acre for DDT.

By the end of 1951 we knew that the concentrates were superior to the wettable powders, not only from the control angle but from the application cost factor for BHC especially gummed up the spray nozzles constantly and even the machine.

On the basis of the 1951 findings we chose Aldrin as the best and endeavored to apply 2800 gallons of 25% concentrate during the 1952 season from April 1 to the end of August. We did not quite succeed because of lack of equipment and manpower but we did apply approximately half of that and despite the peregrinations of gnats were able to demonstrate a fair control in the Indio Control region.

We now have on hand approximately 4400 gallons of Aldrin 25% emulsifiable concentrate for the big 1953 Larviciding Season which actually got under way on January 22. By June 21 we hope we will be able to treat all the cultivated date and citrus gardens in Coachella Valley in addition to those treated last summer. For this purpose we have three spray rigs of 240, 300 and 500 gallons capacity and three to five operators taking turns at the spray job. Our aim is to treat every cultivated date, date-citrus and citrus grove in the valley, hoping thereby to reduce gnat populations by at least 75 per cent.

Now let us examine the chart depicting the evaluation of the 1951 Larviciding Program after 16 months of evaluations from the summer of 1951 until the late fall of 1952. For evaluation we use yard square emergence traps and keep an entomological record of not only every species of gnat emerging but of all the additional insect fauna coming out of that square yard of soil. By comparing emergence on treated and untreated soils we can determine the measure of control by entomological means. Later on we may set up a lab to determine chemical residues in the soil by chlorimetric methods which would perhaps not only corroborate the entomological methods but expedite determinations on the residual nature of the soil insecticides.

Referring to this large colored chart before us which portrays in colors the six larvacides concerned, we note the following. On the ordinate scale we have plotted Gnat Emergence and on the abscissa or horizontal bar we have the Number of Trap Settings. Thus under Aldrin we note 313 trap resettings. This does not mean that we used 313 different traps but that perhaps 50 different traps were reset 313 different times during the 16 months of evaluation. For Aldrin we note that 313 traps produced only 52 gnats as compared to 257 check traps producing 717 gnats to give us approximately 94 per cent control.

For BHC we see that 323 treatment traps produced 240 gnats as compared to 692 gnats for 269 check traps. The control heer is evidently low and is approximately 34%.

For Chlordane we have 251 treatment traps producing only 36 gnats as against 369 gnats for 11 check traps. Here the control is evidently good and is approximately 89%.

DDT likewise is very good for 251 treatment traps produced only 46 gnats compared to 695 gnats for 245 check traps. This is approximately 93.4 control. This looks very good but we must remember that the rate here was 8 to 22 pounds per acre and even though the cost per gallon of DDT concentrate is low, the application of such poundages per acre is prohibitive.

A glance at the Dieldrin columns reveals that 111 treatment traps produced 54 gnats as compared to 533 gnats for 101 check traps. This indicates approximately 90% control but when we interpolate 111 treatment traps against 313 for Aldrin we note that the percentage drops to approximately 70%.

Heptachlor, on the other hand, permitted the production of only 18 gnats for 124 treatment traps against 350 gnats for 115 check traps. Here we have roughly 95% control and in relationship to Aldrin 313 traps would produce 42 gnats and the percentage control would still be around 95%.

Thus we see that Aldrin and Heptachlor are in first place, Chlordane second, DDT third, Dieldrin fourth and BHC in a poor fifth.

Why should this be? Why should there be this difference? What is it that makes one chlorinated hydrocarbon superior to others as soil larvicides? The answer lies not in one factor but in a combination of factors that complicate the issue. Briefly stated some of them are as follows:

1. Relative Toxicity Factor of the Insecticides. This is an important factor and derives not only from the purity of the chemical but the insecticidal nature of the chemical itself. Thus of the six chemicals Aldrin and Dieldrin are rated at 85-90% toxic, Hetpachlor and DDT 70 to 80% and BHC lower still. The reason that Chlordane rates only 50% or less is that Chlordane is full of impurities and that it contains only two active insecticidal principles, one of which is Heptachlor. Likewise, with BHC the only toxic isomer of four is the gamma isomer. Thus a BHC solution contains little toxic material in addition to the gamma isomer unless it be the Beta isomer.

Additional factors are as follows:

2. Stability of the Insecticides as regards to Heat. Thus Aldrin and Dieldrin are stable up to 100° C.; Chlordane breaks down 20% at 60° C., or approximately 135° Fah. Heptachlor dissociates 12% at 60° C. and 51% at 100° C., BHC 46% at 60° C. Lindane (99% gamma BHC) dissociates about 50% at 20° C. and hence would be of little value as a soil larvacide.

3. Alkali Resistance Rate—very important if you have alkali soils.

4. Compatability of Insecticide with Irrigation Water. In Coachella Valley we have an acre inch of salt, mostly gypsum, in every acre foot of irrigation water.

5. Formulation—the addition of certain mineral oils to the chemical concentrate could conceivably increase the contact surface of the chemical in the soil since there would be greater cohesion between the oil carrying the insecticide and the surfaces of the soil particles. Thus the chance of the *Hippelates* larva contacting insescticidal material over that of plain crystalline insecticidal particles occupying a much smaller area would be four to eight times greater. From these considerations we can see that many factors govern the characteristics of the chlorinated hydrocarbons when they are used as soil larvicides. In general, taking all factors into consideration it appears that Aldrin will be hard to beat. However if, on the other hand, we find that four pounds of Chlordane per acre can give us as good a control as 2 pounds of Aldrin per acre, then by the purchase of 75% emulsifiable Chlordane, containing eight pounds of the chemical per gallon, we could cut our costs in half. However, we must not lose sight of the fact that the cheapest larvicide in the long run is the one that will give us the longest control in years.

Being an ecologist by training and desire I do wish to point out that the Chemical Control of Eye Gnats is demonstrated but that this is only a stop gap until the time we can educate the growers of the date and citrus gardens how to produce better crops by non-cultivation methods which we know positively will not breed gnats. When we accomplish this we can pack up our bags and consider the job completed and well done.

President Peters: We will now have the annual reports for the four regions of the State. We will first hear from the northern part of the State.

Mr. T. M. Sperbeck: The only material I have been able to obtain comes from the Sutter-Yuba, Shasta and Lake County Districts, and I ask leave to have these printed in the Proceedings.

A REPORT ON 1952 SUTTER-YUBA MOSQUITO ABATEMENT DISTRICT

Like every other year, 1952 was unusual. Weather was cool until about the first of July but from then on it remained consistently warm day and night until October. Day temperatures didn't reach the peaks of other years but there seemed to be less fluctuation and night time temperatures generally remained above 60 degrees.

Our first major problem concerned river seepage. A long area varying in width from less than 100' to a ¼ mile or more and extending for more than 7 miles where the Sutter By-Pass empties into the Feather river created a serious *Culex tarsalis* problem. For most of it we used a plane and mopped up with jeeps. There were other lesser areas that also caused a similar problem. The river remained at a high level later this year than ever before. Our floodwater problem this year wasn't as serious as in the past although we had a few scattered outbreaks of *Aedes incerpitus, A. sticticus* and *A. vexans.*

We finally succeeded in promoting improvements in the Marysville and Yuba City sewer farms. The two sewer farms are located so that any mosquitoes that escape are sure to bother both the two cities. In Marysville the most troublesome part of the area has been two large percolation beds, almost impossible to do a reliable job. We prevailed upon the city engineer to go ahead with his plans to grade the area and divide it into smaller beds. When the job was done including roadways around all the beds, the engineer admitted that now they could handle 50% more water and had an additional 2/3 acres of land for use.

We have continually had a lot of trouble with the Yuba City sewer farm, a jungle area across the river from Marysville. This last spring the city completed a lot of work in blocking off the ends of the lagoon and cleared and built roadways. There still remains more clearing work to be done but the most costly part is completed. As a permanent solution, the city hopes to eventually chlorinate and eliminate the ponds altogether.

The Encephalitis emergency tended to help us magically solve some of our more difficult problems. The Yuba County Supervisors turned over the county road gang for our use. The only cost to the district was the foreman's wages and a few supplies. The crew completed four jobs of clearing. The work was completed in time so that we could compare the time it took to spray an area before and after clearing. One job that has required frequent spraying every year usually took 3 men a day to finish. Now two men can do the job in an hour. A 7½ mile stretch of borrow pit ordinarily was a week's job for 3 men could now be completed in a day.

We continued house to house surveys of communities. In July we had inspected one area of 800 residences and found 140 mosquito sources. Before the summer was over we had located 607 new sources, 371 of them being open sewers and drains. Addresses of places with improperly covered sewers were turned over to the Health Department who actively cooperated with us in correcting the faulty house drains.

We also worked out an arrangement with Yuba county for the use of a dragline—the only cost to the district being the operator's wages.

Along construction lines at our main depot, we installed a hydraulic lift in the shop to speed up repairs and lubrication and erected a Quonset building to house the equipment. We added two jeeps during the year to make a total of 21 now with 6 trucks.

SHASTA MOSQUITO ABATEMENT DISTRICT HIGHLIGHTS OF 1952 MOSQUITO CONTROL PROGRAM

It was necessary to do much more larviciding in the spring of 1952 than had been necessary for several years, because of the heavy rains during the winter of 1951-52. Larviciding was started in February and continued until November 1.

Most of the Districts in Shasta County were started in the early '20's. They were very small, consisting of from four square miles to fifteen square miles. During 1952 we were able to consolidate three of these districts into one. On July 1, the Anderson, Cottonwood, and Redding Mosquito Abatement Districts were consolidated into the Shasta Mosquito Abatement District.

Because of the Sleeping Sickness emergency in the Central Valley during August and September, it was necessary to add extra employees to keep the *Tarsalis* mosquito under control. The *Culex Tarsalis* is the most prevalent mosquito in our District during July and August. Considerable larviciding, inspection, and aerosol work was carried on outside of the District, in the most heavily populated areas which we suspected of being sources of *Culex Tarsalis*. There were no proven cases of human Encephalitis listed in the Shasta Mosquito Abatement District. There were eleven horse cases in the County, four of them being within the Shasta District.

There were 2,336 acres larvicided during the summer, along with 411 places, 67 wells, 164 coolers and drains, and 1,324 septic tanks and drains. Our adulticiding activities included 8,570 acres aerosoled and 42 basements, and 587,342 square feet of residual spraying.

These activities required the use of 3,022 gallon ½% DDT, 4,566 gallon 1% DDT, 1,094 gallon 5% DDT, 223 gallon Lethane, and 1,691 gallon ½% Toxaphene.

Because of the swampy condition existing in our district, and very poor drainage conditions, the biggest problem confronting the District is drainage. Because it is impossible for the mosquito abatement districts to do all of the necessary drainage work, we are attempting to get cooperation from the County Road Department, Irrigation District, and the State Highway Department and other agencies in cleaning their own drains. The mosquito abatement work resulted in the removal of 166 cubic yards of soil and rock from drain ditches.

During the first part of 1952, it was necessary to do considerable brushing along the Sacramento River, Churn Creek, and many small drains. Since the end of the larviciding season, the operators have been busy cleaning drains and brushing the Anderson and Cottonwood sections of the District. It has been necessary to do considerable brushing along Cottonwood Creek and many other swampy areas of our District.

In many cases we are trying to kill back the brush along the drains using the new brush killers. This will relieve the necessity for hand brushing many of the drains every year. To keep down the heavy growth of weeds and brush, 1,466 gallons of 24D and 245-T were used to spray 1,106,900 square feet of brush; 1,469 gallons of drain and diesel oil were used to spray 1,283,000 square feet of weeds and brush. There were 200,359 square feet of brushing and 458,700 square feet of oiling and burning using 2,047 gallons of drain and diesel oil.

THE DEVELOPING MOSQUITO CONTROL PROGRAM IN LAKE COUNTY

By Thomas S. Loeber
Lake County Mosquito Abatement District

Because its attention was centered on the suppression of the Clear Lake Gnat during the first three years of its existence, the Lake County District is only in its second year of full-time mosquito fighting. Due to the increased awareness of the importance of mosquito control we expect to have a very active season in 1953, indeed, it has already begun. Not only must the fight against mosquitoes be stepped up, but we are also planning another full-scale treatment for the gnat again this year.

Besides the more than one thousand per cent increase in permanent pasture experienced in the last five years and the spread of *Aedes nigromaculis,* our problems are growing equally as fast along other lines. Known as "The Poor Man's Tahoe," Clear Lake attracts a growing number of vacationers every summer. Unfortunately, the peak of the vacation season coincides with the climax of the mosquito population. With a total of perhaps a quarter of a million visitors every summer, the ecology of humans and mosquitoes overlaps more and more every year. This condition creates an obvious effect upon the demand for mosquito abatement.

In our attempt to meet this growing need, the emphasis is upon the establishment of a sound ecological evaluation of the habits of each of the principal pest species with which we have to deal. The habits of any given species vary in accordance with the habitat in which they are found, and in our district this study is of utmost importance. Unless we can adapt our equipment and techniques to meet the particular control problems presented, no amount of money or labor will produce the required results.

Some of our difficulties can be surmounted by permanent control methods where man-made conditions are responsible. Our Board of Trustees is developing a program to bring this about. At present they are aiming at the reclamation of a one hundred and twenty acre swamp cut off from the lake by an abandoned levee.

Our efforts are somewhat restricted by limited funds, but not as much as by the nature of the problem encountered. Clear Lake has a shoreline about one hundred miles long. Twenty or twenty-five of these miles produce mosquitoes at one time or another during the warm part of the year. *Culex tarsalis* and *Anopheles freeborni* thrive with equal success in this area. Depending on the time of year, water leevl in the lake, and the constancy of the prevailing wind direction, the focus of mosquito production along the shore frequently shifts more rapidly than we are able to follow. When the wind stays long from the west we can count on heavy *Anopheles* breeding in offshore algae mats along the western shoreline. This is because the low hills and fringes of willows, cottonwoods, and oaks keep a west wind from reaching the water surface close enough inshore to provide a normal wave action. When the wind shifts the algae is broken up and the larvae drown. A west wind may prevail for a month or longer.

As water is drawn from the lake for the Yolo rice fields new breeding spots appear around the lake by the creation of mud flats and the collapse of the tules in shallow water areas create still water by inhibiting wave action. Our problem, then, is one of locating these transient mosquito sources and establishing the chronology of their occurrence in relation to lake and meteorological conditions. Airplane control using 5% DDT in diesel oil is partially successful in some areas. However, the irregularity of the shoreline, thickness of the tule mats, and obstruction of the flight path by trees eliminate the airplane as a means of control in most cases. We foresee some sort of adaptation of a weasel, with all of its expensive maintenance and repair drawbacks, or other type of amphibious vehicle as being the eventual solution to these problems.

In the meantime we are forced to conduct regular periodic aerosolling during the tourist season. We have had surprising success with Jeep aerosolling, and this year we are planning the purchase of a full-size aerosol generator, probably a 10 h.p. Insect-a Fog machine. We have been using a home-made 5% DDT in diesel oil solution with 2% lethane, but plan to test the comparative effectiveness of Lindane aerosols in 1953.

We have a mapping program under way at the present time and have found it to be an excellent method of uncovering new breeding sources. The maps we are using have a scale of four hundred feet to the inch and it is possible to make a detailed record of each individual mosquito source. With only a small permanent staff thorough mapping should provide more efficient coverage of our district and better coordination of effort.

Many new homes have been built on the wooded hills overlooking the lake, and tree hole mosquitoes now require considerable attention. We know of at least eleven different species of trees that produce mosquitoes in our area. A dry mix of cement and sand is proving very satisfactory for filling tree holes. Rain water does the rest. This method has consumed about twelve hundred pounds of the dry mixture in the last year and will probably continue for many years to come.

We find that *Culex tarsalis* breeds very heavily in the bilge water of rowboats and cabin cruisers during the summer months. With the use of an outboard motor boat it is easy to cruise from boat to boat and squirt a little DDT concentrate in any that look suspicious. *C. tarsalis* is the most prevalent mosquito in Lake County and we feel fortunate that we had only three verified cases of human encephalitis in 1952.

Lake County has its own private mosquito. This insect, *Aedes bicristatus,* was first found and described in 1950. It is a strict winter breeder beginning its larval development early in December and reaching the adult stage in late February or early March. Although we have endeavored to establish its status as a pest mosquito it is still unclassified in this regard. It has been found in company with *Culiseta* species in homes where biting has been reported and will bite out-of-doors. The larvae are very numerous this winter and we hope to make some profitable observations on the adult habits as soon as emergence begins. It is not uncommon to find the larvae thriving in completely ice-covered pools, but they are very difficult to rear under artificial conditions. The adults experience much difficulty in emerging and unless the water surface is well covered with grass they cannot escape the old pupal skin and soon drown.

No discourse on the insect pests of Lake County would be complete without a mention of the Clear Lake Gnat. After an absence of two years the first few adults appeared in our light traps in the fall of 1951. It was not until the following fall, however, that they began to appear in noticeable numbers.

The reappearance has been a rapid one. From July, 1951 to October, 1952 two net samples of the larvae showed a fifty-thousand per cent increase. We were unable to find a single larva in hundreds of bottom samples taken from the mud bottom of the lake in 1951, but by late fall of 1952 each sample taken contained an average of ninety-two larvae per square foot.

All previous investigations of the larval habitat showed it to be fairly well restricted to no closer than several hundred yards from shore and most concentrated in the deeper parts of the lake. It had never been found in the shallow sloughs and back waters of the lake. At present the highest concentrations of larvae are found in dredged-out irrigation inlet canals more than a mile back from the lake and in the lake proper they are numerous up to within fifty or a hundred feet from shore.

This drastic change of habit is very surprising. Several tests have been made to determine if there has been any change in the susceptibility of the larvae to the original TDE concentration which was so successful in 1949. No lessening of susceptibility has been found, but more tests are to be made before the final bid for furnishing the insecticide is accepted.

President Peters: We will next hear from Roy L. Holmes, Trustee of the East Side District, on operations in the San Joaquin Valley.

(Editor's Note: Mr. Holmes' remarks were unfortunately not recorded, and no written report has been received.)

President Peters: The next report will be from the San Francisco Bay Region. Don Grant will present it.

SAN FRANCISCO BAY REGION REPORT

By C. Donald Grant (1952)

The Bay Area group includes eleven Districts which engage nearly sixty personnel in mosquito abatement work on a permanent basis. Recently Santa Clara County has elected to undertake mosquito abatement on a major scale through the Public Health Department, thus leaving only a small percentage of our total marsh area without District coverage. A general consensus of opinion also notes that a greater efficiency in abatement is being attained, which is a result of improved methods, personnel, and source reduction.

With the emphasis that was placed on source elimination at our last conference, our Districts, who have *always* realized the merits of such work on the salt marshes, have effected significant amounts of drainage, leaving our marshlands in ever better condition. Howard Greenfield in North Salinas Valey, and Paul Jones in Marin have done much with their draglines, but it might be said that their accomplishments were not without some difficulties.

Alameda District came through with a policy towards duck clubs and private owners of acting more as a consultant service and laying the responsibility of abatement on the owners. Ted Aarons will say more for Alameda District. In the North Bay some of the Districts cooperatively employed a helicopter for aerial application of DDT to the marshes in extensive areas and as a result their marsh mosquitoes were at a low ebb during 1952. It might be said that in the cooler portions of the Bay area

no appreciable resistance to DDT or our other insecticides has been determined as occurring either in field or laboratory tests. It is our hope, however, that direct comparative resistance tests might be carried out in this area by the same personnel and methods employed in the central valley in order to standardize our results.

One notable observation might be made concerning our sale marsh mosquitoes: the reign of *Aedes squamiger* as one of our major pest mosquitoes may be drawing to a close for much of the Bay area. Basically this might be attributed to the fact that it has proven itself less adaptable to a changing environment than have many of our other mosquitoes. This in turn has been due to its apparent normal characteristic of having but a single brood annually which prevents a rapid evolution through the slow establishment of genetic variations. That is, it is able to respond genetically to survival pressures only once each year, and this, for the present, is inadequate to keep pace with the environmental changes brought by man. Eventually it may be able to adapt itself to a wider range of breeding habitats and again become a major problem. This species' perpetuation or racial survival is principally dependent on the prolonged viability of the egg, and were it not for this, it might readily be wiped out as a population in our area. I say this reservedly, however, for fallacies in abatement efforts, and the often capricious alterations of insect behavior under pressure, render such statements at best in the realm of hopeful probability. It has been noted in Alameda County, San Mateo County, and elsewhere, that as conditions lower the breeding potential for *Aedes squaminger* on our marshes, *Culiseta inornata* is ready to take over. Many situations indicate that this trend is not solely due to the recent high annual rainfalls.

In regard to our salt-marsh mosquitoes, the future appears encouraging, yet, we are not without our problems. For instance we are still at a loss to cope with *Aedes varipalpus,* which is so prevalent in the numberless oak trees of our residential areas. Another more significant and indirect problem arises from the great population increase suffered in the Bay area and the resulting demand on our services. Although this is a situation which can only be settled by our Boards of Trustees, it is mentioned because it reflects a growing pressure in many districts for increased activities and personnel. A mosquito-conscious citizenry is demanding an ever higher level of abatement. We hope to supply it.

Again, the pressure of organized residential groups is demanding certain specific answers in regard to the question of mosquitoes and disease. Although many of these answers are available for the valley region and where endemic virus encephalitis has been studied, our Bay area districts will soon be forced to present more tangible evidence in regard to the status of disease potentials through vector mosquitoes to some two million people within our area.

On the basis of the fine work done elsewhere in the state on encephalitis, and from the very helpful reports afforded by the Department of Public Health and local agencies, many of us during the past year have possibly gone out on a limb in answering some of these requests. We have drawn the logical conclusion, based on known evidence available, that the known distribution of mosquito borne encephalitis cases indicates that no significant reservoirs of Western or St. Louis strain of virus encephalitis has been demonstrated to occur within our area, that much of our residential area does not suffer from a high prevalence of *Culex tarsalis,* and that, statistically from past known records, except for rare cases, mosquito borne encephalitis does not appear to be an imminent danger to our population centers. However, we recognize our uninformed status and cannot deny the existence of disease potentials through our mosquitoes, remote as we may consider the possibilities, nor could we be forgiven for a lack of action where such possibilities exist.

Therefore it behooves us to seek aid in determining the status of mosquito borne diseases within our area, through the study of our possible vectors and reservoirs, in an effort to provide some answers to these questions with direct evidence.

In Contra Costa county it has been noted by Ernie Campbell that an unusually high number of *Culex tarsalis* have been found overwintering, also that muskrats are causing trouble to his levees especially near gate installations.

In the Napa District Bill Rusconi is worrying about some 5,000 acres of new empondments by the salt company there. We're hoping that proper flooding will ease the potential mosquito problem for the next year or so.

The Bay Region has planned a two day training schedule for most of its personnel which is to be held on March 4-5 in San Mateo County.

President Peters: The fourth and last regional report will be from Southern California. These have been prepared by Norman Ehman, and as the hour is late they will be presented by title only, and printed in the Proceedings.

REPORT OF THE BALLONA CREEK MOSQUITO ABATEMENT DISTRICT

E. J. Buemiller, *Manager*

This was an exceptionally wet year with its heavy and extensive rains in the winter months. This invited early mosquito breeding which continued into the summer months, and as a result, the operation of the District required many changes and adjustments to effectively control breeding.

A variety of problems arise each year in the control of mosquito breeding, even in the same control area.

Large sump basins, which were installed to receive irrigation lawn drainage by the way of street gutters, have a tendency to spread the water, which makes control work difficult. Therefore, we instituted a method of installing a ditch with high banks at the outlet of the sump basin to concentrate the water there. This reduced larvacide spraying to a minimum. This same procedure was also followed in reducing the spread area in what is known as the Airport ditch.

I am glad to report that the dikes and tide gates in our swamp area worked very efficiently in preventing the reestablishment of *Aedes taeniorhyncus* breeding areas. Due to climate, salt water action and chemicals discharged into swamp canals, certain of the tide gates and some of the piping connected to these gates deteriorated to a point whereby it was necessary to replace them. There are still more replacements to be made during the coming year.

Two of our larger drains, namely Kittyhawk and Centinela Creek, were blocked with considerable heavy rubbish deposited by the winter rains. This kept our crew jumping from place to place to keep up our spraying program and at the same time keep drainage areas free flowing.

The complaint rate was higher this year, not neces-

sarily because of the higher breeding rate, but because of the fact that our service is becoming better known among the increased population of the District. A definite percentage of the complaints investigated were found to be caused by flies and other insects rather than mosquitoes.

In the new factory subdivision between Century and 104th Street we had trouble with the loading ramps of these buildings. This was caused by clogged drains which were cleaned by our men to prevent mosquito breeding.

This year mosquito breeding has been extremely heavy along road gutters.

We are confronted with the problems of cleaning such grassy growths at all times. Chemical sprays had been tried but have not proved successful. It is vitally important that these ditches be cleaned so that grasses will not hang over the sides and provide mosquito breeding areas by blocking and silting in the ditch proper. Weed cleaning of relatively flat surfaces is also a year around project to keep these potential breeding areas free of water-blocking growths.

The idle thought that control measures are not really necessary when there are no mosquitoes present creates a halo of false security. Any relaxation of control measures by the personnel can quickly bring about a surge of mosquitoes to harass the populace.

REPORT OF THE ORANGE COUNTY MOSQUITO ABATEMENT DISTRICT

JACK KIMBALL, *Manager*

We feel that during the year 1951 to 1952, our district has completed two particular projects which will help us in carrying out our permanent mosquito abatement program.

These projects are briefly summarized as follows:

1. A procedure for the prevention and/or control of waste water disposal problems resulting from dairy farm operations was developed by the local agency concerned with the construction and operation of dairy farms in Orange County.

The Planning Commission, building department and Health Department will require all new dairy installations to proivde minimum standards for the prevention of mosquito breeding sources as recommended by this district.

The correction and maintenance of waste water disposal facilities on existing dairy farms will be initiated by this district.

2. All mosquito breeding sources were classified by type and inventory. Operating records were set up to give accumulative records of time and material requirements for control of each source. This information is being used to determine the direction and extent of our permanent abatement procedures.

LOS ANGELES CITY HEALTH DEPARTMENT REPORT

The Los Angeles City Health Department which controls primarily pest mosquito problems on a routine basis experienced one of the busiest years since its program began some seven years ago.

The combination of torrential rainfall during the winter of 1951-52 and the attention focused upon the presence of encephalitis in California served to set a galloping pace for control personnel.

The heavy rainfall materially increased the high water table problem in the west end of the San Fernando Valley. There a sewer main broke and the sewage was subsequently diverted into the Los Angeles River until repairs could be made. The heavily overloaded river channel presented problems of drainage of cut off pools and rechanneling for several months after the rains had stopped.

The attention focused upon encephalitis on a state level served to stimulate the regular incidence of citizens service requests. Everyone with one mosquito in the house expressed his fear of contracting this dread disease. As a result the program of necessity became top heavy with complaint answering and some other projects had to go by the way for a while.

We are very pleased to report that this last year evidenced an unprecidented success in our program of solving mosquito control problems and in most cases aiming at permanent control measures by working with and through other city, county, state and federal, and private agencies and interests. To name only a very few, we had the pleasure of working with:

1. State Division of Parks in regard to making Gambusia stocking ponds available to us at sites of historical monuments.

2. State Highway Department regarding mosquito control problems along freeways now being built through the city of Los Angeles.

3. State Water Poultion Board in regards to a pollution problem at fish stocking slough.

4. U.S. Army with a storm drain water problem at Camp Fort MacArthur.

5. U.S. Army Engineers aided us in eliminating certain breeding habitats in their jurisdiction along the Los Angeles River.

6. County Flood control engineers drainage problems along the Los Angeles River and in some settling basins.

7. Orange County Mosquito Abatement District—Mutual dairy drainage problems in areas where our Milk Division inspectors have some jurisdiction.

8. Ballona Creek Mosquito Abatement District—Mutual surface drainage problems.

9. We planted fish in County areas, at their requests, adjacent to the city Shoestring Strip.

10. City Department of Recreation and Parks. Tree hole and surface drainage. Girl and Boy camp environs.

11. City Department of Street Maintenance.

12. City Storm Drain Department. Storm Drain design.

13. City Planing Commission. Drainage of new housing developments.

14. City Board of Public Works. Sewer Maintenance Section. Previously mentioned sewage problems.

15. Department of Airports. Airport drainage.

16. Movie Studios—Boat and lake probelms.

17. Ice Plants—Industrial waste.

18. Pickle Factory—Barrels.

19. War Surplus—Boats, etc.

20. Wilshire Country Club—Ditch.

Some of our main problems for the immediate future lie in finding an adequate and satisfactory method of dealing with such problems as:

1. Drainage from new housing developments where storm drains have not been provided.

2. Improving our cemetery program.

3. Stepping up our general gutter water control program.

All in all we are looking forward with anitcipation toward a very active interesting year ahead.

RESUME OF MOSQUITO CONTROL IN COACHELLA VALLEY

The Mosquito Control Department of the Coachella Valley Mosquito Abatement District experienced considerable activity and change during 1952.

During January and February emphasis was placed on ditch cleaning and the elimination of tules, grass and weeds from several bad breeding locations in the valley.

In mid-February time out was taken to prepare the booth at the Riverside County Fair and National Date Festival held in Indio, February 18-22. The talented artist Donis, wife of Sherman Thomas, Entomologist in Charge of Mosquito Control, decorated the booth walls with colored chalk cartoons illustrating various phases of the biology and control of mosquitoes. A special award ribbon by the Fair officials indicated the popularity of this exhibit. Some 1600 pamphlets on Mosquito Control prepared by the Thomases, were given out to the public during the course of the Fair.

In March the department went into daily routine and chemical control operations using DDT and in May and from then on until mid-October Toxaphene was used.

An urban operator was added to the staff in mid-May and later that month Mr. Mayer of the Hercules Powder Company came down and with the help of the personnel gave instructions in ditch blasting.

Our dominant year-round misquito is *Culex tarsalis,* the Encephalitis mosquito. Encephalitis cases were three, all from the small town of Coachella; two of the cases were St. Louis and one Western Equine Encephalitis.

During the very hot months of July, August and September the three day mosquito, *Psorophora confinnis,* erupts with explosive violence. Such is the rapidity of its metamorphosis that on Sept. 11-12, two operators attempting to larvicide the flooded Kirby Date Garden of 10 acres were outclassed; the mosquitoes matured faster than the operators could spray. With adult populations averaging 500 or more per pant leg, the new fogger, designed by Sherman Thomas, was called in. A rather cool day with light breeze made it possible to obtain a 100% control of adults by going up and down one side of the date orchard. Then with the adults knocked out, the larviciding was resumed and finished.

In the fall considerable change was instituted when the Manager and District Entomologist, Dr. Ernest R. Tinkham, assumed full charge of the department. Eliminative Mosquito Control was largely substituted for Temporary Chemical Control methods. This new program was prosecuted with courtesy and firmness to all—big outfits received the same treatment as small. All big departments responded except the California State Highway Department which ignored the request for action. On the other hand, the taxpayers and renters gave very good cooperation, especially when the grape vine spread the news that we meant business. Only one recalcitrant, a farmer who had had a cesspool open for three years, insisted on his inalienable rights and prerogatives as an American citizen to do as he damned please. It took the Manager and the County Sanitarian part of an afternoon to correct such ideas but not without considerable trouble. Fortunately, such individuals are very few, but every district probably has one or two. The zone operators became enthusiastic about the new program for they soon observed that the harder they worked in obtaining the cooperation of the public in covering fallen in cesspools, completing open sink drains, correcting leaky coolers, etc., the easier became their work in the future. One farmer with a number of riffraff rental units and with children playing around, actually had five fallen in cesspools, several open sink drains pooling under the houses, a leaking well pump and cistern, as well as a jungle of fallen trees and brush around the houses. He was given a deadline to meet after we had waited a month for him to return from New York.

On November 24, the department went over from inspection and control work to the big winter Eliminative Control program. One big drainage project commenced in late September by certain farmers was pushed to a conclusion. The department worked two weeks to put a new ditch and road down the notorious Shady Lane of cattails and swamp (Shady Lane is close to Coachella and probably accounts for the three Encephalitis cases) for one mile and then carried it east along a county road another mile. At this point the farmers took over and completed 1¼ miles of ditching. The County Road Department and the County Water District cooperated by supplying equipment for the job. The mutual cooperation of the Mosquito Control Department and the farmers on one hand and the County Road Department and Water District on the other, was a lesson of great value to our valley. Word has spread through our District that not only do we expect the cooperation of all but that we are really willing to work to accomplish our aims. In return the taxpayers get more than cash value for their tax monies. These aims are better mosquito control at a reduced cost through all parties cooperating in eliminating mosquito breeding sources.

Submitted by
Ernest R. Tinkham
Manager and District Entomologist
Coachella Valley Mosquito Abatement District

Dated: Jan. 22, 1953

President Peters: The hour is long past our scheduled time of adjournment. There are a few additional papers which I will ask the Editor to publish in the Proceedings, at his discretion.

I certainly want to thank all the people who have contributed so much to the successful planning and conduct of this meeting. We are now adjourned.

POPULATION TRENDS OF *CULEX TARSALIS* IN THE CENTRAL VALLEY OF CALIFORNIA

By Edmond C. Loomis

Associate Vector Control Specialist, California State Department of Public Health, Bureau of Vector Control

The encephalitis epidemic of 1952 in California has been referred to as "an accident of climate."[1] In part, this is true, but the potentialities of the foremost vector, *Culex tarsalis,* should be given careful consideration. The wet 1951-1952 winter provided numerous breeding areas, while the mild winter temperatures permitted a large overwintering mosquito population to survive, so that by late spring a large number of *tarsalis* mosquitoes were ready to "spill over" into populated centers. The best authorities believed that this mosquito had a flight range that averaged only one to two and one-half miles at the most,[2] that the female preferred to lay her eggs in permanent or semi-permanent water pools,[3] that they did not readily enter human dwellings and that they preferred avian blood. Although it was known that this mosquito was not strictly limited to these characteristics, we know

AVERAGE COUNTS PER STATION PER WEEK *CULEX TARSALIS* 1952 AND THREE YEAR MEDIAN 1949-52 AND REPORTED CASES OF INFECTIOUS HUMAN ENCEPHALITIS 1952 AND SEVEN YEAR TOTAL, 1945-1951 BY MONTH, CENTRAL VALLEY OF CALIFORNIA

		JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC	MONTH NOT STATED	TOTAL
Average *Culex tarsalis* per week per station	1952	4	2	3	5	16	31	48	35	20	12	5	4		185
	3 year 1949-1951	2	1	1	2	10	6	30	35	32	15	5	3		142
Reported* cases infectious human encephalitis	1952	2	2	5	3	6	40	330	286	96	27	7	1	0	805
	7 year total 1945-1951	35	30	29	32	34	51	241	331	275	90	37	26	31	1242

* Reported cases are for entire state
Source: State of California Department of Public Health, Bureaus of Acute Communicable Diseases and Vector Control.

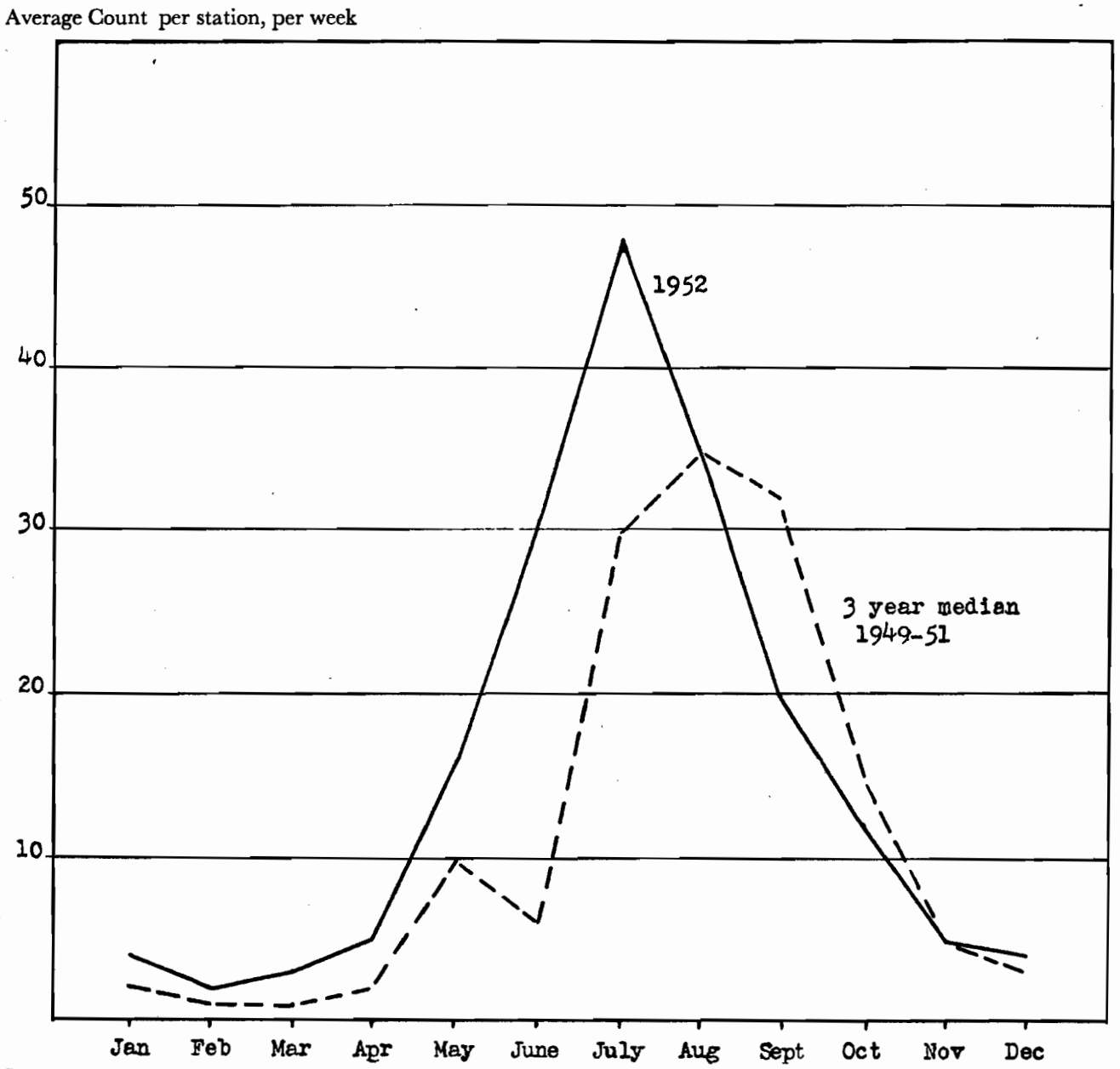
from last year's experience that this mosquito is exceedingly adaptable. There were, however, other factors which undoubtedly played a role in the occurrence of last year's epdidemic. But unfortunately there is insufficient information available on such factors as: per cent of the population which are either immune or non-immune, the availability of natural hosts, and the viremia in them, and perhaps the role of resistance to insecticides. From the standpoint of the mosquito control worker, what did the 1952 epidemic add to the already complicated epidemiology of the arthopod-borne encephalitides recognized in California?

First of all let us look at what appears to be the so-called normal trend of the *tarsalis* population and its relationship to encephalitis. In previous non-epidemic and epidemic years, the general population pattern of this mosquito within the Central Valley passed through two peaks. Characteristically, there is a moderate peak in the population between the latter part of March and May. The population then tapers off for a short period and subsequently builds up to a much higher and more significant peak which extends through the latter part of July, August and September (Graph I)[4]. This occurs roughly in a south to north direction. The number of reported cases of human infectious encephalitis, calculated on the basis of a five year median, reaches a peak during August. The number of positive Western Equine and St. Louis cases reach their peaks in July and September, respectively.[5] To answer the previously mentioned question, we can turn to the 1952 experience in which we find that the general trend of the *tarsalis* population underwent a complete reversal (Graph I). Adult collection stations indicated a larger than normal overwintering population; in fact, in a few areas the records indicated twice the population for this period over that shown by a three-year median.

The preponderence of *tarsalis* larvae over those of *vexans* and *sticticus* in some of the river bottom areas during the spring and early summer months was indeed impressive. Equally so, was the finding at later periods of higher numbers of *tarsalis* larvae than those of *stigmatosoma, pipiens* and *quinquefasciatus* in waters heavily polluted with sewage. *C. tarsalis* also constituted from 70 to 90 per cent of the total number of mosquitoes taken in collection stations from both non-controlled and controlled areas between early May and July. Thus, what appears to have been an abnormal and unparalleled peak, was attained by the end of May and was sustained through June and the early part of July. The expected second peak during the later period was never reached in 1952, or if so, the peak was one of much smaller intensity than normal. The peak of reported cases of human encephalitis occurred one month earlier than expected, in July, but the peaks for Western and St. Louis occurred at their usual time—July and September.

This analysis of the *tarsalis* trend has been presented in broad generalities. The data was taken from approximately 65 per cent of those mosquito abatement agencies in the Central Valley whose records lent themselves to a four year statistical analysis. Admittedly, there are many control areas of exception, and which do not fit this composite trend, both as to the normal and to the 1952 records. In fact, many areas had peaks which varied from year to year and indeed varied from area to area within the same year. One such area in 1952 showed a higher second peak in the middle of August than the primary peak which occurred in the middle of June. Another area in 1952 evidenced its *tarsalis* peak in the middle of July and never experienced a second peak. Still another area in 1952 recorded its first *tarsalis* peak in the middle of August and had a second smaller peak during the end of September. Other exceptions, for example, are areas which reported extremely small numbers of *tarsalis* thorughout the epidemic years of 1950 and 1952, but experienced a large number of cases of encephalitis. With reference to the correlation of the deevlopment of the *tarsalis* population and temperature-irrigational cycle relationships, there are certain areas in the northern part of the valley which should be transplanted to the extreme southern portion—the opposite is also true. In many areas, as few as one-third of the collection stations, and in some instances only one collection station, greatly influenced the 1952 peak record of *tarsalis* so that the population trend was therefore biased on the basis of these

AVERAGE COUNTS PER STATION, PER WEEK OF *CULEX.TARSALIS*, 1952
AND THREE YEAR MEDIAN 1949-1951, BY MONTH;
MOSQUITO ABATEMENT DISTRICTS, CENTRAL VALLEY OF CALIFORNIA



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areas. The same holds true for these stations in the respective areas during the non-epidemic years, 1949 and 1951. Of added interest in these two years, are the higher indices of *tarsalis* from such stations when compared to the low indices during the previous epidemic year of 1950. These exceptions may be perfectly valid and then again they may be meaningless. We all realize the diversified nature of our great Central Valley, the variation in temperature changes, the crop and irrigational-cycle changes, the adaptability of *tarsalis* and most important, the difficulty of establishing the area in which the human cases acquired the disease.

What do these *tarsalis* population trends mean? At best we can interpret them only on an individual area basis. Theer are too many variables. It is hoped one variable which may be eliminated or controlled and therefore be of greater assistance in evaluation, is the standardization of mosquito sampling methods. We are not alone in this problem of correlating the factors involved in the *tarsalis*-encephalitis relationship. Our fellow colleagues are faced with an equally difficult task in dealing with the human population. The attempt last summer to obtain greater accuracy in reporting, more complete case histories, and more blood samples, are only a few examples of the problems which when evaluated may help tie some of the loose ends together.

Therefore, those of us in mosquito control, by improving on the methods of mosquito sampling and recording, and in the careful and accurate maintenance of mosquito records, can be of value not only in attaining a higher de-

gree of efficacy in control operations, but can be of assistance in the study of the epidemiology of this disease.

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SELECTING THE PROPER HOSE

By L. L. Hall, *Assistant Entomologist*
The Butte County Mosquito Abatement District

During the past year this District has experienced the deterioration of certain hoses when they come in contact with insecticide formulations normally used in our mosquito control program. Some of these hoses have been recommended as resistant to various oils and other components.

Considering the time lost, inconvenience and expense incurred by the use of faulty or improper hose on our equipment (handcans, TIFAs and power sprayers, etc.) a simple experiment was set up to determine a type of hose to fit each insecticide formulation best or one which would work satisfactorily for several formulations.

Sample of various types of hose available were cut into short lengths and immersed in pint fruit jars containing different formulations or components of insecticides. These samples were kept in the laboratory and checked at intervals over a period ranging from three to four weeks. Records were kept on each individual hose as to the degree of swelling, parting of rubber and fiber, constriction of bore or inside diameter, outer distortion of rubber and general measurements.

These tests proved to be very interesting, and has resulted in a knowledge of which sample hose will probably best fullfill the qualifications for certain formulations. These experiments will continue into the field this summer giving each selteced type of hose a chance to prove its worth more fully. Other types of hose will be tested until satisfactory ones have been found.

A comparison chart showing how each hose is rated (depending on how they held up in the various formulations and components) is shown here. It will be noted that no hose sample stood up well in all the insecticide formulations and components; some held up well in oil base formulations but not in emulsions; most hose samples were affected by xylene; none of the samples were affected by the spreader Triton-B1956. There are probably other factors yet to be considered in a check such as this but we feel that it gives an excellent guide to the purchase and use of hoses.

This sample testing procedure can be used to determine proper hose types for other insecticide formulations.

The Gates Rubber Company and The Resisto Flex Hose Company furnished some of the samples used in this experiment.

Hose Sample	#1	#2	#3	#4	#5	#6	#7
5% DDT-OLS	D	A	A	B	A	A	D
10% DDT-OBLS	D	A	A	C	B	B	D
5% DDT (Xylene) Emulsion	A	C	A	B	D	D	C
25% DDT-EC (69% Xylene)	B	D	D	D	D	D	D
Diesel Oil #2	D	A	C	B	A	A	
Base Oil	C	A	C	B	A	A	
Analos #7	D	C	D	D	B	A	
Triton B-1956	A	A	A	A	A	A	
Special Emulsifier	B	A	D	C	A	A	
Lethane	B	A	B	B	A	A	

"A" Excellent—No Evident Damage
"B" Very Good—Slight Noticable Affect
"C" Fair—Definite Affect but not extensive
"D" Poor—Definitely affected and not recommended for use

NOTES ON THE CONTROL OF *AEDES VARIPALPUS*

By Robert F. Portman
The Butte County Mosquito Abatement District

This small mosquito, known as the tree hole mosquito, has been reported by the California State Department of Public Health as being found in forty-three counties in California. In certain limited areas it occurs in sufficient numbers to constitute a serious pest during the spring and early summer.

Although it is referred to as a tree hole mosquito the author has found it breeding in crotches and in recesses in the bases of the trunks of olive trees. And in 1947 he found it breeding on the University of California campus in Berkeley in a discarded porcelain fixture which contained rain water and leaves.

In late July 1951 females were found biting viciously at an elevation of over 3,000 feet near Clipper Mills in a very arid stand of pines. On July 27, 1952 both sexes of adults were found at an elevation of 2,700 feet at Forbestown. It has been found that when sprinkler irrigation systems are used in olive groves that the breeding of *Aedes varipalpus* may be prolonged well into July, whereas normally the breeding would cease in May. About the middle of January 1952 second and third instar larvae were found in Bidwell Park near Chico and the first adults appeared in the District's collecting stations on March 31st, the same week as in 1950.

In 1949 the aerosolling of Bidwell Park did not give lasting results presumably due to the emergence of later broods. That winter a limited program of filling the tree holes with sand and capping them with concrete was undertaken. It was found that this method of control was not financially feasible in Bidwell Park which contains many thousands of trees. Therefore, early the next spring the lower tree holes in a portion of the park were treated with 5% DDT in diesel oil. This reduced the problem in the area but did not produce the results desired.

Several years ago Arthur F. Geib informed the author that the Kern Mosquito Abatement District had obtained excellent control of *Aedes varipalpus* in olive groves for three years by treating the holes with a small amount of DDT dust.

During the period of February 25th through March 17th, 1952, sixteen thousand one hundred and fifteen trees in twelve olive groves were inspected. And, with the exception of one grove, all the holes and cavities found were treated with either a 5% DDT wettable powder suspension or a 5% DDT water emulsion. Subsequent

inspection of these groves showed that ten of them produced no or very few mosquitoes. It also showed that in one grove in which the adults were emerging during the time of treatment, and in a grove which had been only partially treated, the resultant numbers were much less than in previous years. In the partially treated grove more mosquitoes were found in the treated area than in the untreated area, with one exception. But it is believed that the adults originated in the untreated area.

These twelve olive groves were thoroughly inspected for larvae during the following winter in December 1952 and January 1953. No larvae were found in eleven of the groves. In the grove which had adults emerging during treatment larvae were found in certain areas. It is presumed that either the workmen were not thorough in these areas or that some of the females were able to lay eggs before being affected by the DDT residual deposits, and that the DDT if present was inactivated before the following winter when the larvae hatched.

It has been found that some trees, particularly large valley and live oaks, may have larval breeding sites which cannot be seen or treated from the ground. Some tree holes containing larvae have been found to have external openings less than one-half inch in diameter. Crotches and depressions in and at the base of a tree containing larvae may also be over-looked because they are often covered with debris. Such breeding sites may account for the presence of the small numbers of adults which were found in some of the groves after treatment.

The results obtained by systematically treating with DDT all of the tree holes, crotches, cavities and depressions which hold or may hold water and serve as larvae breeding sites or which may serve as adult resting places indicate that this is a satisfactory method of control of *Aeeds varipalpus.*

Observations indicate that this method of control will either eradicate *Aedes varipalpus* in a given area or reduce it to such a minimum that it will be at least several years before it has multiplied into sufficient numbers to constitute a pest problem.

CHEMICAL SOAKED CLODS—A NEW SLAP AT MOSQUITOES

By Edwin Washburn, *Manager*
Turlock Mosquito Abatement District

The use of pelleted or granulated insecticides for mosquito control purposes is not entirely a new development. Whitehead[1] reported in 1951 upon the use of pellet-borne insectcides to control rice field mosquitoes in Arkansas. The use of these materials in California, as far as I know, was begun in 1951 when the Turlock Mosquito Abatement District experimented with a granular material containing 10% of Toxaphene. The results of these tests looked so promising that we engaged the manufacturer to produce sufficient volume of material for us to use in considerable quantity. The name Pel-Tox was finally adopted for this material. It is solely manufactured by Chemurgic Corporation of Turlock.

During the past (1952) season the Turlock Mosquito Abatement District used more than 7 tons of Pel-Tox and at least two other mosquito abatement agencies, the Madera County Mosquito Abatement District and Butte County Mosquito Abatement District used about another 1,000 pounds. We have in our district an area of considerable acreage of deciduous orchards. This amounts to some 12,000 acres. "In the production of deciduous fruit crops such as peaches, apricots, plums and grapes, irrigation plays a most important role. These crops are irrigated by several methods, namely furrow, basin flooding and check flooding. In any of these methods the water is applied during the growing season at rather frequent intervals (2 to 4 weeks) especially just previous to the ripening of the fruit. This water may remain on the soil for periods of from 3 days to a week, usually in the furrows, low spots, and in lateral ditches. Since the water is shallow, warm and partially shaded, *Aedes dorsalis, Aedes nigromaculis, Culex tarsalis,* and *Culex stigmatosoma* find it an ideal habitat. The presence of these mosquitoes seriously handicap the harvesting of the fruit by molesting the picking crews to such an extent that they often refuse to enter the orchards, or at best the maximum harvest per day is materially reduced."[2]

The problem of controlling these mosquitoes is difficult since each orchard is usually irrigated according to its own particular needs. Further, in most cases the soil tends toward a high clay content, which after irrigation, is very difficult walking with from 1-2 feet of mud to be contended with in larviciding operations. Until the advent of the Pel-Tox the only satisfactory method of control found to be practical for us has been to send spraymen into the orchards with knapsack sprayers. These have been cumbersome and need frequent filling necessitating many trips to the supply source.

In the use of Pel-Tox we still employ man power, however, by using an alfalfa seeder the crews are able to carry large loads more easily and to treat from 3 to 4 times the area treated with a hand can. One man can carry from 12 to 16 pounds of Pel-Tox which is sufficient to treat approximately 3 to 4 acres.

We have experimented with many rates of application and have established four (4) pounds per acre as being adequate to give complete kill in from 1 to 6 hours. When the rate was increased to 10 pounds, a residual effect was noticed. At times it was sufficient to give complete kill of all mosquitoes for two irrigations. The residual effect was not consistant, however. Some orchards gave good results and others did not, hence we were forced to treat all orchards alike to be certain of obtaining satisfactory control.

All larval stages of mosquito species present were destroyed, even fourth stage larvae. No pupal kill was indicated.

Aircraft applications were attempted, both in Turlock and in Madera and Butte Counties. The latter areas gave satisfactory controls, however we were not able to obtain an airplane with the proper seeding attachment to enable us to distribute the Pel-Tox uniformly. This method was abandoned for the time being.

The use of Pel-Tox in this orchard area has enabled us to obtain a degree of mosquito control never before accomplished in that zone. The material is light, flows easily and penetrates heavy vegetation, leaves no residual on crops. It can be used in many areas where sprays will not obtain satisfactory controls.

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