PROCEEDINGS AND PAPERS

OF THE

Twenty-ninth Annual Conference of the

California Mosquito Control Association, Inc.

AND THE

Eighteenth Annual Meeting of the

American Mosquito Control Association

AT THE

DISNEYLAND HOTEL

ANAHEIM, CALIFORNIA

JANUARY 31 THROUGH FEBRUARY 2, 1961

Edited by
C. DONALD GRANT

CMCA Publications Committee:
W. DONALD MURRAY and C. DONALD GRANT, *Chairman*

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In Memoriam

LEON L. HALL

Leon was the highly appreciated Manager-Entomologist of the Fresno Westside Mosquito Abatement District at the time of his death this past year. His close friendships with many of our members and his contributions in activities of the California Mosquito Control Association are felt as a great loss, but we are filled with many grateful remembrances of the years that he was among us.

Dedicated to The Memory of

STANLEY BARRON FREEBORN, Ph.D.
1892 - 1960

EULOGY

STANLEY BARRON FREEBORN, Ph.D.

BY HAROLD GRAY

It should be a matter of great satisfaction to all of us that the officers of our two associations, without any prompting from the wings, have voluntarily decided to dedicate this joint meeting to the memory of the late Stanley Barron Freeborn, Ph.D., Emeritus Chancellor of the University of California at Davis and an Honorary member of the California Mosquito Control Association.

It seems to have become an established practice that these joint meetings of the American and California associations should be dedicated to some one of our members. In 1949, if you remember, we presented to the University of California at Berkeley the beautiful portrait of William B. Herms which now hangs in Agriculture Hall. Again in 1955 at Los Angeles you dedicated that meeting to this speaker upon the occasion of his formal retirement. Billy Herms and I were fortunate in that we could be present in person to be so honored, and your kindness to each of us I know were among the most cherished moments of our lives.

So too, I am sure, it would have been with Stan Freeborn could he have been with us in person today, for the highest award any man can have is the respect and esteem of those who know him best, his professional colleagues and associates.

Stan Freeborn was a wonderful person, as well as a distinguished scientist in his field. I shall not attempt to relate to you the details of his career; a brief sketch appears in your program. He came to California in 1914, when I first met him. Since then we have collaborated on quite a few projects. His sincerity and ability soon endeared him to me, and it was a real pleasure when in 1950 he succeeded Herms as a Trustee of the Alameda County Mosquito Abatement District, until administrative duties in the University called him to Davis.

His former students, his colleagues and his many friends will miss him. He left to us a highly valued legacy in his scientific work, in creative scholarship, in integrity, and in friendship.

Mr. Chairman, may I ask that we all stand for a moment of silence in memory of our friend, Dr. Stanley B. Freeborn?

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Lester R. Brumbaugh, Pres., CMCA, conferring with chairman of local arrangements committee by phone from his headquarters at Stockton. Myriad of details required much planning and conference.

Norman F. Hauret, Mgr., Ballona Creek M.A.D., addresses luncheon meeting of exhibitors, and others.

D. Manley Jobbins (N.J.), retiring president of A.M.C.A., presents gavel to new president, William E. Bickley.

Paul R. Meyer of the Jefferson County, Texas, Mosquito Control Program, examines flotation tire used on jeeps for marsh service.

Gardner C. McFarland, Mgr., Southeast M.A.D., and Jack Kimball, Mgr., Orange County M.A.D., co-chairmen of local arrangements committee, conferring by phone with Lester R. Brumbaugh, Pres. of CMCA.

Group at Exhibitors Luncheon pay close attention to speaker.

Edward S. Hathaway, Louisiana Mosquito Control Assn., registers at meeting.

Photos by Thomas D. Mulhern

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CALIFORNIA MOSQUITO CONTROL ASSOCIATION

FIRST SESSION

TUESDAY, JANUARY 31, 9:00 A.M.

GARDNER C. McFARLAND, President of the California Mosquito Control Association, presiding.

It is with a great deal of pleasure that I call this 17th Annual Meeting of the American Mosquito Control Association and the 29th Annual Conference of the California Mosquito Control Association to order. We in Southern California and the California Mosquito Control Association welcome each and every delegate, visitors, members of their families, and their friends. It is our earnest hope that everyone will obtain information of value and that the exchange of ideas and experiences will benefit each one of us and the agencies and organizations we represent. Also, as can be seen from the Program, the lighter side of the Conference is well covered, so we also hope that many of you and your families will be able to avail yourselves of the fun, sightseeing, and points of interest of fabulous Orange County and Southern California.

You will note that a short preliminary meeting of the AMCA is scheduled, so at this time it gives me much pleasure to introduce our esteemed and very able President of the American Mosquito Control Asociation, Dr. Daniel Jobbins, who is associated with the New Jersey Agricultural Experiment Station.

[Editor's Note—AMCA President Jobbins conducted a short business meeting for the AMCA in which the nominees selected by the AMCA Nominating Committee were announced by Ted Raley. A call for other nominations from the floor was made at the end of the meeting, but no other nominations were submitted.]

Pres. McFarland: We have a slight change in the program, and Supervisor Cy Featherly, of the Orange County Board of Supervisors will be scheduled first to welcome all of the delegates and visitors. Supervisor Featherly was Chairman of the Board in 1960, so he was immediate past Chairman of the Board of Supervisors, and I know that his work was highly acclaimed here in Orange County as well as by the League of County Supervisors.

As you know, Orange County is one of the fastest growing counties in the United States—I believe the population has doubled in the past few years, and it promises to double again in just a very few more years. In spite of all the problems of such rapid growth, they have been able to do a remarkable job during this past period. Without further introduction, I would like to call on Supervisor Cy Featherly of the Orange County Board of Supervisors.

Supv. Featherly: Thank you very much, President McFarland and President Jobbins of the AMCA.

A number of weeks ago our own mosquito control organization contacted me and Jack Kimball asked me if I would come out and welcome the delegates to this joint Conference, and I said that I would be very happy to do so. I mentioned at that time that by now I would be a past Chairman of the Board, but that I would still be glad to come out anyway; so, I find myself on the program.

It is indeed a privilege, of course, to welcome all of you to Orange County. This is not the first time that we have had delegations from all over the United States to visit our fair county, nor do we hope that it will be the last. Certainly, we like to have you enjoy the many things that we enjoy—the things that we feel are more or less commonplace to us here—but which may be novel to the visitors from all over the country. We like to have them share in the—and I will use the word attributed to Jack Kimball—the fabulous things that we have in Orange County.

We have endeavored to put on some weather for you that is a little different from that which you have been enjoying on the East Coast and the Middle West. We have been having some rather warm weather, but we on the Board of Supervisors adopted a resolution that we would do our best to have the weather here that you would like to have during your stay; so we shut off the rain, and we shut off the frost, and we have nice weather. We hope that that meets with your approval.

It is surprising that a short time in the past the place where you are sitting and the many things that you see in front outside of this marvelous location, just a few short years ago was nothing but orange groves or vacant land. Yet here we are in 1961 enjoying things that a few years ago people thought were nothing but a figment of someone's imagination and couldn't happen here. But it has happened, and will continue to happen. You will notice all of the work that is going on in front of the hotel here where a monorail system is going to go into effect and will be in operation before too long. We hope that you will avail yourselves, while you are here with your families, to visit the Knotts Berry Farm. There is something else that has grown up as an imaginative thing on the part of Walter Knott, but it has grown into something that is known not only throughout the United States, but is known throughout the world.

We have other attractions that I know will meet with your approval. We have in development and coming into being, the Newport Dunes, which is a marina type amusement center at Newport Beach, although it may be somewhat the wrong time of year to enjoy it. Many other things are in the making. It has been said that we are perhaps the fastest growing county in the United States, and I think that that probably is true. I sometimes wish—being a member of the Board of Supervisors—that it didn't grow quite so fast, because you can imagine the problems that it puts before us at our meetings. I am going to ask to be excused as soon as I am through here so that I can get back to the office, since this is our regular meeting day.

I hardly know how to express the Board of Super-

visors' compliments to you in choosing this place for your annual convention. Suffice to say that we are extremely happy that you saw fit to come here. We hope that you will enjoy it so much that you will want to come back. I am reminded a little bit of an annual convention of our own supervisors in California that happened in Novemebr of this past year over at Palm Springs. Of course, we were quite anxious, in Orange County, to try and get our convention here in '62, and we were competing with Los Angeles, San Diego and Long Beach. They were over there with all of their banners and streamers and everything making a pitch to all of the delegates to vote for their location when the time came to vote at their Association meeting. We were not exactly asleep at the switch, I can assure you of that. The day we got there we had a lot of Mickey Mouse caps and a lot of buttons here that flickered a little bit and gave different ideas. It seemed that every delegate over there wanted some of these Mickey Mouse caps and some of these buttons so that we proceeded to get rid of all that we had and sent back for more. A surprising thing occurred when the time came for choosing a location and letting the delegates choose where they want to go. It was about four o'clock on a Thursday that the matter came before our august group gathered there to make a decision.

The night before I had spoken to John Rogers, the Chairman of the Board in charge of this. I said, "John, we would like to have you come to Orange County in '62." And he said, "Why, that's where we are going." So, when President Bradbury came to that part of the meeting where he announced that we would have the fellows get up and make a pitch for the convention for '62, John Rogers got up and said, "I move that we go to Orange County and Disneyland." Somebody seconded it, and they couldn't even take a vote on it. Everybody got up and hollered "We're going to Disneyland." And that was it. The rest of the fellows didn't even get a chance to vote. It was really a very remarkable thing. I have never before seen such a thing happen in all my years of going to conventions.

Ladies and gentlemen: I will take no more of your valuable time. I am extremely glad that you are here; I hope that things will pan out the way that you want them to; and I hope that you will find time to enjoy all of the wonderful things that are available here. I can't give you a gold key or a gold card to get you into this place, that place or the other—I don't have that facility with me, and I couldn't do it if I wanted to. But let me assure you that we are glad of your being here and we hope that your convention will turn out wonderfully and many fine things will come from it. With that I say thank you again, and goodbye.

Pres. McFarland: Thank you very much, Supervisor Featherly.

I am sorry that he is unable to stay. When he mentioned the gold card, I thought he was going to say it was for keeping you out of jail.

Now, as you all know, the host District of this fine meeting and conference is the Orange County Mosquito Abatement District. With the able Jack Kimball of that District and the wonderful support and cooperation of the Board of Trustees of the Orange County Mosquito Abatement District, the meeting is going along in pretty good shape. We have with us a gentleman from their Board of Trustees who has been very active in this Association and who represents the City of Newport on their District Board, which, incidentally, is a very large one with twenty-three or twenty-four trustees serving the Orange County Mosquito Abatement District.

At this time I would like to call on Sandy Steiner, member of their District Board of Trustees, to welcome you.

Mr. Steiner: Good morning, ladies and gentlemen. Mr. E. E. Frisby, known to some of you as "Flick," who has been the charter member and charter president—still is the president—of our mosquito abatement district here in Orange County, has retired after a long career in the Orange County Health Department and is now on a well-earned vacation in—of all places—Florida, another beautiful sunshine state. We get a letter from him now and then, and he is having a beautiful time there after touring a great part of the country. He has been up in the North and East and has been really enjoying himself. He is a wonderful man; we love him; and we just re-elected him again.

I have, therefore, the privilege of welcoming you for the twenty-three trustees of the Orange County Board, for our very able and pleasant manager, Jack Kimball and our Entomologist, John Shanafelt, and the rest of the staff that we have there. I would like to mention to you, on behalf of Jack Kimball, that I want you all to feel free to come to our offices and shops, to inspect them and our equipment. We will be very cooperative in every way that we can. We would be pleased to help you with anything you want to know or see; and in his name, I am extending this invitation to you.

I would like to enlarge on some of the points of Orange County. Orange County is the greatest and fastest growing county in the United States, not one of them, but is *the* fastest growing as far as I can get the information. We have some wonderful sights to see in Orange County. The County has been growing so fast—I have been here for sixteen years, and if I don't go in a certain direction for four or five months, I find three or four new towns grown up entirely out of plain prairies and even swamps that are filled in, or hills that are cut down and terraced. Golf courses—we have some beautiful golf courses throughout the very near vicinity of this wonderful playland of Disneyland, which you can take advantage of, and we hope you do if you have some spare time or can stay after the conference.

I represent the City of Newport Beach, which is one of the most beautiful pleasure harbors in the world, and I would like to also welcome you in the name of my home town of Newport Beach. We have one of the most beautiful sailing and motor boat harbors to be found. We have wonderful eating places, we have clubs, and we have golf courses. We have excellent fishing fleets, if you would like to go fishing and can avail yourself of that pleasure. I happened to go out last Saturday with my boy and everyone on the boat caught their limit. We had a wonderful time and fishing is good. Personally, I will be happy

to help anyone here if you want to partake of some of this.

All I can say is that we welcome you in behalf of the Orange County Mosquito Abatement District and Orange County as a whole. Have fun and a pleasant return to your homes.

Pres. McFarland: You can see that people in Southern California, Orange County in particular, are bashful about the qualities of their wonderful county.

Now we come to a portion of the program that it gives me a great deal of pleasure to take part in.

It isn't often in the life of an average person like myself, that one has the opportunity of introducing a dignitary and *V.I.P.* who is not only important but well liked as well. He is appreciated not only for his prominence as an elected public official, but for the fact that he has and is contributing and supporting fundamental and progressive legislation for orderly growth and development of a greater California.

Carley V. Porter is Assemblyman of the 69th District in the Compton area of Southern California and has been continuously re-elected since 1950. He was born in Chicago, which in my opinion is a credit to Illinois and has lived in California since 1917. He attended Loyola and Inglewood High Schools, Compton Junior College, and received his AB degree from the University of Southern California. He has a whole host of civic credits, including Presidency of the Compton School Board; member of Rotary; military service in the Air Force during World War II; Trustee of Norwalk State Hospital; member of Phi Delta Kappa, Phi Kappa Tau; Elks; Moose; and the Democratic Committee, 69th Assembly District.

In our legislature, he is a member of Committees on Education, Water, Livestock and Dairies, and Ways and Means. He is also Chairman of the Ways and Means Subcommittee on Agriculture, Natural Resources, and on the Committees for Development of the California Public Outdoor Recreation Plan, Veteran Affairs and Water Resources. Of great significance is his Chairmanship of the Assembly Water Committee. He has specialized in the field of State water problems and is co-author of the Burns-Porter Water Bond Act ($1,750,000,000) (Prop. No. 1) which was passed by the people of California at the last election.

As you can see, Carley is interested in water and this no doubt explains his interest in mosquitoes, for as many of you know, Carley Porter sponsored mosquito control legislation for the California Mosquito Control Association at the last legislature.

With this introduction that does not begin to give him due credit, I now give you Carley Porter, Assemblyman 69th District and Chairman of the Los Angeles County Delegation of Assemblymen.

MOSQUITO CONTROL WORK IN CALIFORNIA

ASSEMBLYMAN CARLEY V. PORTER

Sixty-ninth Assembly District
California Legislature

Thank you very much, President Gardner McFarland, for your most generous introduction. I should point out to you ladies and gentlemen that your President and I have been friends for a number of years so that he is to be excused for perhaps being a bit biased because of our friendship. We first met some years ago when Gardner was head of all of the Los Angeles County Milk Inspectors, and because of my long time membership on the Assembly Livestock and Dairies Committee we naturally worked on a number of matters of mutual interest. Some of our more humorous friends have pointed out that his work with dairies, as well as mine, and my chairmanship of the Assembly Water Committee had aggravated the mosquito problem so much it was time for us to try to help solve the problem instead of continuing to contribute to it; so he left his former field and obviously is now attempting to solve some of the problems which are found in the field of his former endeavor. But, even in the field of mosquito control we still continued our cordial relationship and he interested me in introducing the legislation which you needed in 1959; this legislation, I might add, was enacted into law because of the good work done by many of you people in your separate abatement districts throughout the State.

It is a pleasure to be with you this morning to bring greetings from Governor Edmund G. "Pat" Brown, the Legislature, and with Dr. Merrill, from our official state bodies. Governor Brown has asked me to express to you his regrets that because of very pressing duties in Sacramento he could not be with you today. While I know that we wish he were here, I can only say for myself that it affords *me* a great deal of pleasure to be asked to fill in for him today because of my long-time interest in the work which is done by you men and women in mosquito control work.

Governor Brown has often evidenced his interest in mosquito control, as has the California Legislature through its support of research, control, and investigative activities.

We, here in California, are particularly pleased that the American and California Mosquito Control Associations are meeting in our state in joint session. We wish you well in your deliberations.

In officially greeting you today and sincerely offering our welcome to California, it will be much safer if I don't talk too much about mosquitoes, about which I know very little, but rather confine most of my remarks to California about which I do know something. If I *were* to talk about mosquitoes, it would not only be useless for this group but it would also expose how little I know about them; and there is the danger if I talk too much about California that I will sound too boastful in the presence of guests. However, it is appropriate for us to say a few words about California and its physical makeup and then take a look at what we are doing in mosquito work under highly varied conditions. First of all, California is a remarkably diverse state. With some 1200 miles of sea coast, vast mountain ranges with peaks almost three miles high, and the bountiful, great Central Valley stretching 400 miles from north to south, California's life zones range from sub-tropic to arctic. Annual precipitation ranges from less than two inches in the Mojave Desert, mostly in Southern California, 10 to 20 inches in the Central Valley, to over 100 inches in the north coastal area. We have 18 million acres of forests, 14 million acres of cul-

tivated, urban, and industrial lands, and nearly a third of all the irrigated farm land in the United States.

It is not an exaggeration to say that much of this beautiful and productive area would be uninhabitable were it not for the valiant efforts of our little army of 600 mosquito control workers with their shovels, spray cans, jeeps, dozers, draglines and spray planes. The $5 million annual investment in health and comfort insurance represented here is in my opinion one of the best bargains our taxpayers can find. Figured in terms of an annual per capita expenditure of 30 cents, or the price of a two-day supply of an otherwise necessary repellent, it sounds like a real bargain among public services. I am afraid that much of the work of the many mosquito abatement districts in California goes unnoticed by most people. But we could not live as we do if we were not rid of these bothersome and disease-carrying insects as a result of the constant work of our many control districts. The importance of your job is like housework. It's never noticed unless you *don't* do it. Mosquito control is a fundamental necessity to the development of our state. In meeting this need we have, in our local mosquito abatement agencies, the largest mosquito control program of its kind in the world. If the need were not so great, we would be happy if we could boast about having the smallest program, rather than the largest.

In viewing our assets to meet this formidable problem, we, first of all, have a set of laws in the Mosquito Abatement District Act which have withstood the test of time since their enactment in 1915, with only minor adjustments. We can't help but be impressed by the extraordinary insight and keen vision on the part of its authors. As one of your legislative representatives, I can appreciate the kind of perception and clear thinking that was necessary in selecting the exact legal terminology required to facilitate the solution of mosquito problems, and at the same time, create a harmonious climate in which government, and citizens affected by government, can effectively work toward a common goal.

In a state which, throughout historic times, has been constantly subject to a major mosquito-borne disease threat, I am impressed by the success achieved in the virtually complete suppression of malaria; I am equally gratified by California's prominent role in encephalitis research. It is a real satisfaction to see local control agencies, the University of California, the State Health Department, headed by Dr. Malcolm H. Merrill, and the Public Health Service working together as one towards reducing the threat of this crippling disease. It was especially reassuring to witness the speed, thoroughness and flexibility of our mosquito control agencies in rising to meet the emergencies in the 1952 encephalitis epidemic and in the floods of the winter of 1955 and 1956.

As you have gathered here in convention, I know that you will spend countless hours in hard work, exchanging information, trading experience and making plans to do a better job. But some wise program director has probably sandwiched in, here and there, time enough for you to cross this busy boulevard and visit one of the outstanding wonders of the world—Disneyland. As you wander through this fabulous place, you will see Tomorrow Land and Frontier Land and Adventure Land and, in storybook fashion, Fantasy Land. We may well believe that we are in a fantasy land as we examine some of the formidable problems of the future in mosquito control when we look at the projected growth of California . . . and as we consider some of the science and technology we must use to do our job more effectively.

We are all, of course, familiar with the tremendous population explosion which is upon us throughout the Nation. In California, this tremendous increase in human population means that as more people settle here, more rural land is brought into use as urban development in order to house California's teeming population, now almost sixteen million.

I don't know whether the mosquito population in California is increasing at the same rate as the human population, but it seems *that,* as we have more humans, there are more people that notice the mosquitoes we *do* have. When we consider California's growing population, estimated to reach some 25 million by 1975, we begin to realize the threatening potential of the mosquito, as a pest, as an adverse economic factor, and as a public health hazard.

The suburban sprawl is bringing more and more people into contact with wilderness and agricultural areas, and with the tree hole and long flying irrigation mosquitoes.

In the active planning state, is the development of recreational lands in California, and in particular, our many mountain areas where campers, tourists, sportsmen and vacationers will be in direct contact with the hordes of snow mosquitoes which originate in the thaw waters.

This is another area where mosquito control must figure prominently in program planning and development. If we expect our citizens and our visitors to enjoy California's recreational facilities, we must make them both comfortable and safe from disease-bearing insects.

In spite of our control activities, there is a dearth of knowledge of how to deal with the mosquito in the complex agricultural - industrial - community situation. Accompanying our population growth is the increasing problem of organic pollutants to our waters, a condition which is favorable to the breeding of mosquitoes and aquatic gnats.

Historically, the mosquito was identified, and rightly so, with the stagnant waters of swamp and marsh lands. That was where mosquitoes came from. That is not so, any more, for these lands have been largely reclaimed.

Now the mosquitoes come from the very lands where our crops are grown, a situation which complicates control efforts. For we must literally go on to a grower's or rancher's property to control the mosquito; and in such a manner that we do not interfere with his production.

This problem will be compounded with the opening of marginal and sub-marginal lands to agriculture as irrigation waters become available.

Another perplexing problem is the failure of modern insecticides to completely cope with the mosquito, which quite readily develops an immunity to these insecticides. It is important to recognize that insecticides have a place in control activity, but they definitely play

a secondary role to the more fundamental measures of land and water management.

Ahead is the possibility of new biological control measures which only research can unlock. The state health department's Bureau of Vector Control has been conducting modest but rewarding research in this direction. But only through a vastly increased research effort will it be possible to stem the development of the mosquito in the years ahead.

In conclusion let me say that I believe the State of California must take the leadership in developing research facilities and in expanding control programs. The State might well consider the establishment of an ecology research center* as a cooperative venture of the State Departments of Public Health, Agriculture, and Fish and Game together with the University of California. Only by such a high level co-ordinated program can we meet the insect control problems which lie ahead.

Pres. McFarland: You can see that Carley Porter is aware of the problems in mosquito control; but as I said before, he has specialized in water, and when you specialize in water, you just can't get away from mosquitoes.

It is now time for announcements.

Mr. Hauret: Thank you, Gardner McFarland. We want to welcome everyone here this morning on behalf of the exhibitors. We have a wonderful group of exhibitors, we have wonderful displays set up, and we want to encourage your participation in viewing these displays. We are going to have a raffle at the end of the program each day, so be sure that when you visit and talk to an exhibitor, that he gives a raffle ticket. Put one portion of the stub in the box which is near the door to the rear of the exhibit area. Also, be sure that you are here at the close of the program each day, because if you are not here, we will not have any way of getting this to you. Tomorrow, at eleven o'clock, at the large parking area to the right or east of the building here, we are going to have a demonstration of large pieces of equipment. We would like to have every one over in that area as quickly as possible. It will last from eleven until twelve thirty, at which time we are going to have an exhibitors' luncheon and one of the exhibitors will be the speaker. We urge everyone to be there because the exhibitors play a very important role in the success of this program, as you perhaps all know.

RECESS

Pres. McFarland: It is indeed a pleasure to introduce our next speaker—a first for me—Harold F. Gray, known as the father of mosquito control in California, which is an honor he claims must be shared with William B. Herms. The only trouble is that to introduce Harold properly would take half of his allotted speaking time. Just in case there are a few here new to mosquito control, I'll list a few of his accomplishments.

Perhaps many of you may not know it is *Doctor* Gray (in Public Health), also Engineer Gray, also Parasitologist Gray, also Health Officer Gray, and so on.

Harold started his mosquito work in 1910, fifty years ago, and as you know, was Engineer-Manager of the Alameda County Mosquito Abatement District from 1930 to 1955, with 1955 being his retirement year. In this busy time he managed to be a consulting Sanitary and Hydraulic Engineer and teacher, as well as hold important positions in the APHA, Water Pollution Control Federation and several other organizations. He is a past-president of the California Mosquito Control Association and of the American Mosquito Control Association.

With this sketchy and inadequate introduction, it gives me real pleasure to introduce Harold Farnsworth Gray, who will say a few words regarding one of our "mosquito greats" and will then address us with a presentation entitled "Contrasts." Harold Gary.

*NOTE: This was recommended in report of the Governor's Committee on Public Policy Regarding Use of Agricultural Chemicals, Dec. 30, 1960.

CONTRASTS

HAROLD FARNSWORTH GRAY, GR.P.H.
Honorary Member, A.M.C.A.
Honorary Member, C.M.C.A.

At the end of the fourteenth century the people of Florence, birthplace of the Renaissance, being greatly afflicted with the ravages of successive epidemics of bubonic plague, determined to make a votive offering to appease the wrath of the Almighty, that the scourge of the "Black Death' might be taken from them. (Parenthetically, Florence, in common with much of Italy, suffered also from malaria).

This offering was to take the form of two bronze doors to the Church of San Giovanni Battista, generally known as the Baptistry. These doors were an important project to the citizens of Florence, and a special committee of citizens was entrusted with the responsibility of executing it properly.

This committee asked the leading artists of the time to submit models of the proposed doors, and after spirited competition and much prayerful consideration the model by Ghiberti was adjudged the best, and he was commissioned to design and construct the doors.

For twenty-three years Ghiberti and his many assistants worked on the two doors, casting and recasting, constantly striving for perfection. Finally in 1424 the first pair of doors was completed and swung in the Baptistery. Today, after more than five centuries have passed, Ghiberti's bronze doors are still beautiful, still admired for their perfection. The people of Florence did not complain that the cost of the work exceeded the estimate, or that the job was not completed within the contract time, or that nonresident labor was employed on the job. And it is doubtful that the Mayor (he was called Gonfaloniar) got even so much as a new cloak out of the project.

At roughly the same time the city of Florence was still building its great cathedral, the Duoma. It had been begun in 1298 by Arnolfo li Cambio, as an enterprise of the entire populace. Its beautiful campanile, Giotto's Tower, was finished. By 1418 the main church was completed up to the base of the great dome. The

construction of the dome was under the auspices of the guild of the wool merchants, the Arti della Lana, and the architect Brunelleschi was commissioned to construct it. The Dome, which is even larger than the dome of St. Peter's in Rome, was completed in 1436 and the church was consecrated by Pope Eugenius IV. Today it is still one of the architectural marvels of the world. Even the bestial Hittlerite Germans could not bring themselves to its destruction.

It was built with sweat and sacrifice and stone and mortar, but more to the point it was built with prayer and piety, with civic consecration, with pride of workmanship, with skill in design and artistry, and with a sense of beauty.

Let us now go forward a little more than four centuries. The Board of Trade of Bradford in England had decided to construct a new building for the conduct of its business. Its members had heard that there were then many queer styles of architecture about, and they did not want their building to appear ridiculous. And so they asked John Ruskin to come to their Yorkshire city and tell them how they should build their temple of commerce. In an address of great strength and beauty Ruskin told them that they could not expect to build well merely by asking other people's advice upon occasion—that all good architecture is the expression of national life and character, and is produced by a prevalent and eager taste or desire for beauty.

Finally, after chiding them for their worship of their Goddess of Getting-On, he concluded—

"Continue to make that forbidden deity your principal one, and soon no more art, no more science, no more pleasure will be possible. Catastrophy will come, or, worse than catastrophy, slow mouldering and withering into Hades. But if you can fix some conception of a true human state of life to be striven for—life good for all men, as for yourselves; if you can determine some honest and simple order of existence, following those trodden ways of wisdom, which are pleasantness, and seeking her quiet and withdrawn paths, which are peace—then, and so sanctifying wealth into 'commonwealth,' all your art, your literature, your daily labors, your domestic affection, and citizens' duty, will join and increase into one magnificent harmony. You will know then how to build, well enough; you will build with stone well, but with flesh better; temples not made with hands, but riveted with hearts; and that kind of marble, crimson-veined, is indeed eternal."

The Board of Trade of Bradford built their temple of commerce, but there is no evidence that they took Ruskin's advice.

Let us now come down to the present day. A public building is to be erected. Too frequently there is political jugglery in the determination of the site, and the architect may be selected either because his fee is cheap, or because he is a relative or friend of the Chairman of the Board. He is required to get out the plans and specifications the day before yesterday if possible, and in any event not to waste time on the job.

When the plans and specifications are ready, bids are called for on the basis of the lowest price, with a penalty for non-completion within a specified time. The general contractors who are bidding shop and chisel with sub-contractors and material men, decide on the venality of inspectors, figure how they can beat the specifications, estimate the graft they will have to pay out, and put in their bids with prayers that nothing will go wrong with their calculations. Of course, things are not always that bad, but the general idea may hold quite frequently.

Well, you may get a useful and reasonably good-looking building under our modern methods. But the Cathedral of Florence and Ghiberti's bronze doors are still the admiration of the world. Will our modern buildings, five centuries from today, be even in existence? I wonder!

This civilization of ours has given us many material possessions; it has greatly reduced some of the hazards of existence, while adding others; it has given us many comforts and conveniences; but do we really build better, either of structures or of men? Such contrasts between mediaeval Florence and almost any modern American city make us realize that perhaps we have not progressed so very much, if at all.

Have our public officials as much civic virtue as the Signoria of Florence; have our industrialists and shopkeepers as much public spirit as the old guild of the wool merchants; are we intrinsically better citizens than those fifteenth century Florentines? I wonder!

But this was only some five centuries ago. Shall we go some twenty centuries further back?

History can show no greater contrast between two neighboring and contemporary civilized peoples than that between the Phoenicians and the Ionian Greeks from the sixth to the fourth centuries B.C.

The Phoenicians were a skillful and enterprising people whose dominant interests were business and the accumulation of material wealth. They were the master bankers, manufacturers, middlemen and shippers of antiquity. They possessed trading stations on the west coasts of Europe and Africa, and even passed the Cape of Good Hope to trade in the Indian Ocean 17 centuries before Vasco de Gama. They lived in a fertile country, along the shores of modern Israel, and astride one of the most important of the world's trade routes. They grew rich and powerful, flourished for a time, and then decayed and vanished before stronger and more virile peoples. They left to posterity no great works, or literature, or science, or philosophy. Their history contains little beside a record of petty trade wars. Yet their rise and fall may well be a warning to a present-day materialistic and mechanistic civilization.

The Ionian Greeks, in contrast, were devoted to what a Phoenician must have deemed a waste of time. They chiselled blocks of marble into statues intended to please their fancy. They attended dramatic contests, and presented the victor with a worthless sprig of laurel. They listened to stories told in verse by poets in the market place. They enjoyed great athletic carnivals, and the victors therein became national heroes. The carvings on their houses, even their kitchen utensils, were as delicately moulded as if intended for a royal palace. They discussed endlessly abstract and useless questions in metaphysics, psychology and mathematics, as if these things could be used for something more than mere talk.

They seemed to assume that the creation of beauty, and the discovery of original ideas, or the interpretation of life, are what a human being should aim at.

And yet they knew very well how to carry on war, and trade, although with them secondary as a means to an end, was reasonably successful.

When we read understandingly the history of the ancient Greeks we can almost believe that here were the most gifted, happiest and resourceful men who have so far lived upon this earth. To them we trace the origins of the sciences, from mathematics, astronomy and physics to biology and psychology. Their annalists first realized that history is an interpretation and not a mere chronicle. Their city-states were the prototypes of our modern forms of self-government. Their inquiring minds, their poetry, philosophy and ideals, are inwoven into the very fabric of our lives today.

Remove the heritage of ancient Greece and what it has engendered in this world, and western civilization would wither at its roots. When in the Dark Ages that heritage was lost or obscured, western man reverted almost to barbarism; and when under the Renaissance in Florence, the Grecian heritage was restored to us, there was an efflorescence of intellectual and cultural inspiration and progress which is one of the miraculous events of human history.

No one who has read the history of ancient Greece can be brought thereafter to think of his fellows as merely merchants, or doctors, or politicians, or laborers, or even only as mosquito chasers. No one who has read the Funeral Oration of Pericles, or a speech by Demosthenes, can be content either with abritrary power in government, or with anarchy or license. Those who have come under the influence of the Greek conception of life have developed a sense of personal liberty, of reasonableness in social life, an eagerness for understanding, a love of beauty, and a desire for perfection in workmanship.

As compared with the "standard of living" of the wealthy Phoenician merchants, the Greeks must have seemed poor indeed in material possessions. However, to the end of recorded history men will draw inspiration and beauty and hope and ideals from the Greeks—but who will remember the Phoenicians?

So what? What does this old stuff mean to us today?

I have said nothing new. I have liberally stolen from the writings of numerous scholars. I unblushingly admit the burglaries. But what has all this to do with us as "Mosquito men."

I shall not "spell it out" for you in detail. There is hardly any one in this room so dull that he cannot do this for himself, though perhaps with a little effort. All of us are trying to make a living by working. But we have to live, not merely make a living. And life requires ideals to live by.

Fortunately, most of you, either consciously or subconsciously, have had before you the ideal of service to your fellow men. Your work has not been just a job. Fortunately, you have been in a work which has been tremendously interesting. Each year there have been new problems to solve, new challenges to meet. One of the outstanding characteristics of this group has been its constant concern to do a better job, to learn more about the "why" and the "how" of it. You have been apt at operational investigations and appreciative of the values of basic research. And your dedication to the cause of the public health and comfort has been superb.

This has been true not only of your technical and managerial staff, but also of that group of men to whom too little accolade is given—your administrative and policy-making boards, your trustees or commissioners. They too have caught the Grecian spirit, and serve with a sense of dedication, without pecuniary compensation. Few of you have been as the ancient Phoenicians or the merchants of Bradford. You have built, at least to a degree, in the spirit of the Renaissance Florentines.

You have built well and can be proud of your past record. Continue in that spirit of eager inquiry, of intellectual integrity, in the joy of a good work, and with a pride of workmanship.

This is my hope for you and your future.

Reference Sources

Young, G. F., 1910. The Medici. Chap. III.
Ruskin, J., 1866. The Crown of Wild Olive. Traffic, last paragraph.
Warbeke, J. M., 1931. The Searching Mind of Greece. Chap. I.

Pres. McFarland: One of the pleasant pleasures of my office and providing for "my day in the sun," lies in the privilege of introducing top leaders in California. This is one introduction that I lucked into, since Dr. Lee Russell, Health Officer of Orange County, was unable to attend this meeting.

Malcolm H. Merrill, M.D., Director of the California State Department of Public Health is no stranger to any of us, since he has become an international figure of great stature. He is one of the great pioneers in viral studies of mosquito-borne encephalitis and was co-discoverer of the Eastern strain of encephalitis virus.

He has been a member of the team of the California State Department of Public Health since 1934 and has headed it since 1954. Even though he has been directing a tremendously time-demanding program, he still has found time to serve in 1960 as the President of the American Public Health Association, to serve on many National Public Health Committees, one of which was as a member of a five-man team officially touring Russia in 1957, and—I could go on and on, but you are present to hear Dr. Merrill and not me.

It is my rare opportunity to present to you Dr. Malcolm H. Merrill, who will address us on "The Challenge in Mosquito and Other Vector Control." Dr. Merrill.

THE CHALLENGE OF MOSQUITO AND OTHER VECTOR CONTROL*

Malcolm H. Merrill, M.D.

My appearance before you today is appreciated as providing another opportunity to reaffirm the cordial and effective working relationship which our Depart-

* Presented before the joint 17th Annual Meeting of the American Mosquito Control Association and the 29th Annual Meeting of the California Mosquito Control Association, Anaheim, California, January 31, 1961.

ment has enjoyed with the California and the American Mosquito Control Associations for a considerable number of years. It is my hope that following this meeting all of you who travel north, and can arrange to do so, will pay the Department a visit—both at Fresno, where our vector research activities are centered, as well as the Berkeley headquarters and laboratories.

In California we soberly recognize the problem of mosquitoes and other vectors as one of the significant threats to our state's growth and development. With the population in California expected to reach 26 million by 1975, and exceed 40 million by the turn of the century, and with the attendant urban, agricultural, industrial, and recreational expansion, it appears inevitable that mosquitoes, aquatic midges, domestic flies, and other noxious arthopods will also be competing for living space in the years ahead. This deduction seems elementary in light of knowledge that our vector problems today are largely man-made, and are forever taking on new dimensions. At somewhere near the halfway mark in our water resources development program, we now have well over eight million acres of irrigated land, or about one-fourth of the nation's total. I am sure that the California people on the mosquito firing line would just as soon not have these awesome statistics to brag about. Before quoting too many California statistics, enthusiasm might well be tempered by remembering the Texan who, when confronted once too often with the Alaska area comparison, countered with ". . . just wait 'til it melts—it may be smaller than Rhode Island."

Specific mention has thus far been made of only three insect groups—mosquitoes, aquatic midges, and domestic flies. Terrestrial gnats, both the biting *Leptoconops* species and the non-biting *Hippelates* eye gnats, are of growing significance in many areas. We are being made increasingly aware that these groups constitute major needs for intensified research and improved control technologies.

The Mosquito Problem

Refocusing on mosquitoes, we are encouraged by the increased emphasis and at least moderate progress made in recent years, both in mosquito prevention and source reduction. The inescapable fact remains, however, that with the projected plans for development of the water resources for maximum domestic, industrial and agricultural use, the worst is yet to come. Based upon the extraordinary concern about water, exemplified by the variety of legislative bills being considered during the current session of the California State Legislature, it is apparent that water in all its ramifications receives uppermost attention in this state. The Bureau of Vector Control, through its water projects activities in collaboration with the Public Health Service, has been successful in obtaining cooperation from the various federal and state water resources development agencies, leading to incorporation of mosquito prevention features in the design and construction of impoundments and water delivery structures. The obligation of these agencies terminates, however, upon delivery of new water to the local receiver. The difficult part remains largely to be done; the big job is that of getting the water-distributing agencies to provide for drainage in land newly developed for irrigation, and getting the farmers to use water properly, in accordance with the needs of the crop. A matter of great significance in which the mosquito abatement districts in the San Joaquin Valley have participated during 1960 is a proposed major drain extending the length of the San Joaquin Valley for removal of unusable waste water. Such a provision appears to be a vital requirement to the present and future needs of mosquito control.

Liquid wastes from the household, the community, and industry continue to increase with the growing population.

The snow mosquito problem in high elevation recreational areas has only begun to be experienced, and its full impact upon the public only awaits development of the recreational resources. During the past season we were able to initiate some basic studies of this problem as a result of our good fortune in obtaining the services of Colonel Stanley F. Carpenter, a distinguished scientist well known to all of you. I understand he was allowed to enjoy retirement for about a week before we put him to work.

The growing evidence during 1960 of mosquito resistance to organophosphorous insecticides, although not yet constituting a crisis, adds another uncertainty in mosquito control practice and points up the need for effective alternate control technologies.

The Midge Problem

As previously indicated, the non-biting aquatic midges are also taking advantage of the increasing amount of available water. Various impoundments, small and large, fresh and foul, from sea level to high elevations, are becoming production sites for prodigious numbers of these insects. Liquid waste discharges of community, industrial, and agricultural origin are proving to be ideally suited to these midges. Underground water recharge basins and major flood control and irrigation impoundments are also proving to be productive habitats. Clear Lake, which only a decade ago, appeared to be relieved of its gnat problem through treatment with the chlorinated hydrocarbon insecticide, DDD, is again confronted with a baffling control need. After only three DDD treatments between 1949 and 1957 the fish population in this lake was found in 1959 to contain sufficiently high DDD levels to contra-indicate further use of this chemical. Regrettably, no substitute material or method for controlling these midges is as yet available which can be applied safely, economically, and effectively, although the Lake County Mosquito Abatement District is valiantly seeking ecological and toxicological solutions to this problem. It is also my understanding that some important ecological work on aquatic midges is presently being undertaken by the University of California at Riverside, and by the San Mateo County and Lake County Mosquito Abatement Districts.

The Domestic Fly Problem

Knowing that most of you are more familiar with the vector problems emanating from water, it may come as a surprise to hear a prediction that the domestic fly problem originating fom solid organic wastes is progressing toward the point where it will

rival or even exceed the mosquito and midge problems in importance. Like mosquitoes and midges, domestic flies are also taking advantage of a vast array of new man-made conditions in which to propagate. Again, agricultural, industrial, and community wastes are giving rise to these insects. The house fly and certain other domestic flies which were thought to be on the decline with the disappearance of the horse as a mode of conveyance, and again during the magic spell of the DDT era, has reappeared with a vengeance. It is difficult even for those of us in the midst of it to appreciate fully the rapidly-changing agricultural scene. Through the development of new technology, farm output has increased 35% since 1940, while the acreage used for crops has declined 2%. As an example, the egg production per unit has increased 47% in the past 15 years. Where there once were poultry farms, there are now egg factories—and potential fly factories. The story of milk production is similar. California also leads all states in the slaughter of cattle. There are about 550 commercial feed lots in the state which market over a million head of cattle annually. As these situations become surrounded by the urban sprawl, fly control becomes an acute problem.

Despite marked improvement in recent years, approximately 80% of California communities still are characterized by open-dump disposal of community refuse. In many areas deficient refuse storage, collection, transportation and disposal practices are responsible for a significant percentage of the fly problem. Again, with over 1,500 new civilian residents arriving in the state each day, there is a critical need for city and county governments to accept the moral, financial, and technical responsibility for bringing the refuse management practices out of the dark ages into the modern technological era.

From the reports which come to me, it is evident that the vinegar fly, *Drosophila,* is the most critical problem confronting the food-processing industry in California today. Wineries, canneries, the dried fruit industry, and certain other food-processing establishments are continuously frustrated by this insect, which emerges from fruits awaiting processing and swarms in during the period of processing. The federal and state food and drugs restrictions against *Drosophila* infestation of processing plant and products have resulted in a considerable loss of income to processors.

The Role of Local Mosquito Control Agencies in Meeting the Challenge

As I attempted to convey in my address before the 1957 meeting of the California Mosquito Control Association, we have come to regard mosquito abatement districts as an integral part of the environmental health program of this state. The role of districts in the field of vector control is approaching the crossroads of decision. Some mosquito abatement districts have already undertaken midge, terrestrial gnat and even domestic fly control. We have heard uncertainty and concern expressed about the propriety of mosquito mosquito control lest they invade the prerogatives of local health departments. Our viewpoint on this is that the agency best able to accomplish the objective be selected rather than to choose arbitrarily between agencies. The great variety of topography, climate, population pattern, economy, and dominant industries which characterize the various regions of our state have resulted in great variation in the structure and pattern of public health practice within local departments. A similar situation exists within mosquito abatement districts. It is, therefore, not possible to say categorically which agency, mosquito abatement district or health department, should conduct various aspects of the program needed for vector control. This determination should be made locally after an analysis of the local circumstances.

The architects of the Mosquito Abatement District Act foresaw the possibility that these districts might control insects other than mosquitoes for they are clearly empowered to control "mosquitoes, flies, and other insects." The flexible structure and latitude provided a mosquito abatement district affords it certain advantages not as clearly enunciated for local health departments. The ability of a district to abate insect sources beyond its boundaries has extraordinary advantages when dealing with such a dynamic program as flying insects, which understand no political boundaries.

Mosquito abatement districts in undertaking broadened Diptera control activities should do so with the closest kind of defined cooperative relationship with the local health department and the local agricultural agencies. The programs must be complementary. Furthermore, my remarks should not be taken as a suggestion that mosquito abatement districts immediately embark upon extended vector control operations. It occurs to me that a careful entomological survey and appraisal of the vector problem should first be made and, subject to the findings, assuming public support for an expanded program exists, decision can be made concerning the kind and magnitude of effort required.

It is impressive to recognize that within our statewide local mosquito control programs there are approximately 50 entomologists and biologists equipped to accept broadened responsibility in vector control.

It is possible to anticipate the question running through many of your minds at this point: What must be done and how much will it cost to achieve, for example, effective fly control? It is not possible to supply completely definitive answers to these questions, although an increasing amount of experience data is becoming available through our Bureau of Vector Control. It can only be ventured that the principles employed in mosquito control are generally compatible with the control of a variety of other vectors. The mosquito abatement district philosophy of source reduction and the practice of problem-solving would appear likewise to underlie each and all of the programs required. The place of public education is obvious. The need for reliable vector control methods is a matter over which we have all expressed major concern.

The Role of State Agencies in Meeting the Challenge

As many of you are aware, our Department has been gradually developing a research program on mosquito ecology and control technology over the past decade. The California Mosquito Control Asso-

ciation has expressed its desire for an adequate research program to prepare the way for solving the increasingly complex problems of mosquito and related vector control. The urgency of a well-defined and properly balanced vector control research program in California has become more evident each year.

During 1960 it was possible to bring the vector research needs of California into perspective and to submit a concrete proposal. In June Governor Brown appointed a 15-member special Committee on Public Policy Regarding Agricultural Chemicals to study and review the many ramifications of this broad problem and to recommend a sound public policy. The primary interest was with respect to the public food supply. The committee concluded that at this time the food supply is safe and that no apparent hazard exists to the public from the present pattern of agricultural chemical usage in California. The various aspects and needs of this broad subject area were appraised by the committee and its report concluded with the recommendation that "... research in all areas pertaining to agricultural chemicals should be conducted by government, university, and industry in order to increase understanding as to how pests may be controlled more successfully, and to establish ever more clearly how pesticides may be used without injury to public health." It further exhorted the need to "... search for better pest control measures, safer pesticides, and alternative measures, including biological control." By way of proposing a specific course of action, the committee recommended "... that an Ecology Research Center be established at the University of California, Davis, under the direction of the California State Department of Public Health ... to provide needed scientific information on vector control and other related problems involving pesticides, and ... to make available facilities and information to the Departments of Agriculture, and Fish and Game, and other agencies, for needed use." It further urged that contractual funds be made available to underwrite needed research where competent investigators are located.

The plan of this proposed Ecology Research Center visualizes the closest kind of interagency cooperation among other interested state departments and particularly between the State Department of Public Health and the several branches of the University of California engaged in phases of research having a bearing upon vector control. The role of the Department is seen to be that of coordinating, stimulating, and conducting needed research on the highest priority vector problems requiring attention. A framework of research staff is needed to pursue research on ecology, ethology, biological control, physiology, toxicology, and certain engineering problems, as they relate to all vectors of concern. It is possible that federal funds from the Public Health Service would be available to aid in the establishment of such a research center at Davis. It is our hope that steps will be taken during the current legislative session to implement this vital proposal. We shall, of course, look forward to continued research cooperation and collaboration from the U. S. Department of Agriculture, the U. S. Public Health Service, the U. S. Fish and Wildlife Service, and other federal, state and local agencies in our joint program areas.

Objectives and Outlook

It is evident that the vector problems confronting us are complex, both as to cause and effect. It is no longer possible for any level or agency of government or industry to plan ahead for major projects without coordinating efforts, nor can these broad problems be distinctly defined and assigned to any one agency to deal with unilaterally. Cooperative teamwork between public health, agricultural, conservational, and educational agencies affords the only prospect for success where community, industrial, agricultural, and recreational areas are so interrelated. Equally important, private enterprise must be encouraged to contribute the special magic of American ingenuity to the solution of the problems. In one respect public health has unique entre in environmental planning since our mission has no vested interest other than maximizing the public health and well-being. Our role in agriculture, water resources, recreational areas, and fish and wildlife is confined to this objective.

In dealing with most insects which adversely affect the public, it becomes increasingly evident that the most effective results can be accomplished by directing control effort at the source. The insect groups to which I have made reference today originate from water, organic matter, and soil. While these three media appear to be distinct and different, a fascinating interrelationship exists among the three. We visualize the long-range solutions to each of these problems to be basically conservational in nature. Water and land managed efficiently would make for greatly reduced mosquito production. In like manner, solid organic wastes, converted through composting on a comprehensive basis into valuable soil additives, offer a realistic goal toward which to work in the interest of domestic fly prevention.

In response to the ever-mounting pressures of a vigorous and rapidly expanding population, it is inevitable that our problems in mosquito control specifically, and vector control in general are going to increase in magnitude and complexity. If we are to respond to this challenge we must prepare to face it now—while we can still obtain the advantage of that "ounce of prevention."

CONCURRENT SESSION

TUESDAY, JANUARY 31, 1:30 P.M.

SUBMITTED PAPERS ON BIOLOGY

HOWARD R. GREENFIELD *Presiding*

AEDES SCHIZOPINAX DYAR IN THE WESTERN UNITED STATES[1]

LEWIS T. NIELSEN

Department of Zoology and Entomology
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DISTRIBUTION

Aedes schizopinax was described by Dyar (1929) from larval collections and reared adults taken in southwestern Montana in 1928; type locality, Story Creek railway crossing, Gallatin County, Montana, IV-6-28. Dyar also reported other larval collections from Gallatin and Jefferson counties, Montana and Mammoth Hot Springs, Wyoming.

No additional records were known until Rees and Nielsen (1955) reported *A. schizopinax* from two localities in northern Utah. In 1956 Richards et al. noted collections from Utah and California. The presence of *A. schizopinax* in California was confirmed by Chapman (1959b) and Grodhaus (1959). The range of this species was extended to Nevada by Chapman (1959a).

A considerable number of unpublished records of *A. schizopinax* which greatly extend its range in the western United States are known to the author. These are listed below by state, county (italics), locality, date and collector. Collections listed without collector's name were made by the author.

CALIFORNIA:

Alpine: Hope Valley, V-10-59 (F. C. Harmston).

COLORADO:

Gunnison: Doyleville, VI-10-60 (F. C. Harmston).

Park: Buffalo Cr., VI-?-59 (L. Ogden); Fairplay, VI-10-60 (F. C. Harmston).

San Miguel: Norwood, VI-9-60 (F. C. Harmston).

IDAHO:

Blaine: Carey, III-29-57; V-6-56 (T. Davis).

Franklin: Preston, VI-9-57 (F. C. Harmston).

NEVADA:

Douglas: Genoa, II-25-60 (H. C. Chapman).

Elko: Ruby Lake, V-4-60; V-26-60 (H. C. Chapman).

Lander: Kingston Canyon, V-2-60 (H. C. Chapman).

White Pine: Ely, V-3-60 (H. C. Chapman).

OREGON:

Lake: Valley Falls, V-16-59 (F. C. Harmston).

UTAH:

Cache: Mendon, V-3-57 (F. C. Harmston); Logan, light trap (♀) summer, 1956 (A. Mail).

Kane: 6 mi. W. Long Valley Jct., V-18-56; V-18-57.

Morgan: Trout Sprgs., Weber Canyon, V-5-56.

Tooele: Dugway, light trap (♀), VI-17-59 (J. H. Linam) Skull Valley, IV-19-58 (H. Collins), II-20-59, III-5-59, III-16-59, IV-6-59, IV-21-59 (J. H. Linam).

WYOMING:

Sublette: Lower Green River Lake, VI-3-56.

Uinta: Evanston, V-29-59, V-31-59 (G. Eddy).

The localities from which *A. schizopinax* have been collected are shown in Fig. 1. At the present time this species has been found in eight western states, twenty-five counties and thirty-four different localities. All collections, with two exceptions, were of larvae or pupae. The only adult collections were made by light trap, one female each, at Logan and Dugway, Utah. The earliest larval collection was February 20 at Skull Valley, Utah, the latest, July 1 at South Lake, California. Larval collections by month have been as follows: February, two; March, three; April, eleven; May, seventeen; June, nine; and July, one.

DISTINGUISHING CHARACTERISTICS

Aedes schizopinax is a distinctive species belonging to the *punctor* group. A few comments on some of the useful taxonomic features, some previously unreported, are made below. In general the characters reported by Carpenter and LaCasse (1955) are reliable in distinguishing this species.

Adult Female

The following combination of characters will separate *A. schizopinax* from all western *Aedes* species: Scale patch on sternopleuron extending to anterior angle; scale patch on mesepimeron reaching ventral margin; lower mesepimeral bristles present; postcoxal scale patch present; hypostigmal scale patch absent; proboscis grayish scaled on ventral surface. All of these characters are reported by Carpenter and La Casse. In addition, the author has found three additional characters to be reliable. Numerous pale scales cover the probasisternum (region under head and between fore coxae). A conspicuous patch of white scales is generally found at both the base of the costa and vein 1 on both wing surfaces. Pale scales also are usually present along the subcostal area on both upper and lower surfaces of the wing. The tarsal claw is distinctive (Fig. 3); the lateral tooth is very small and

[1]The author is indebted to the University of Utah Research Fund for granting financial assistance during the course of this study.

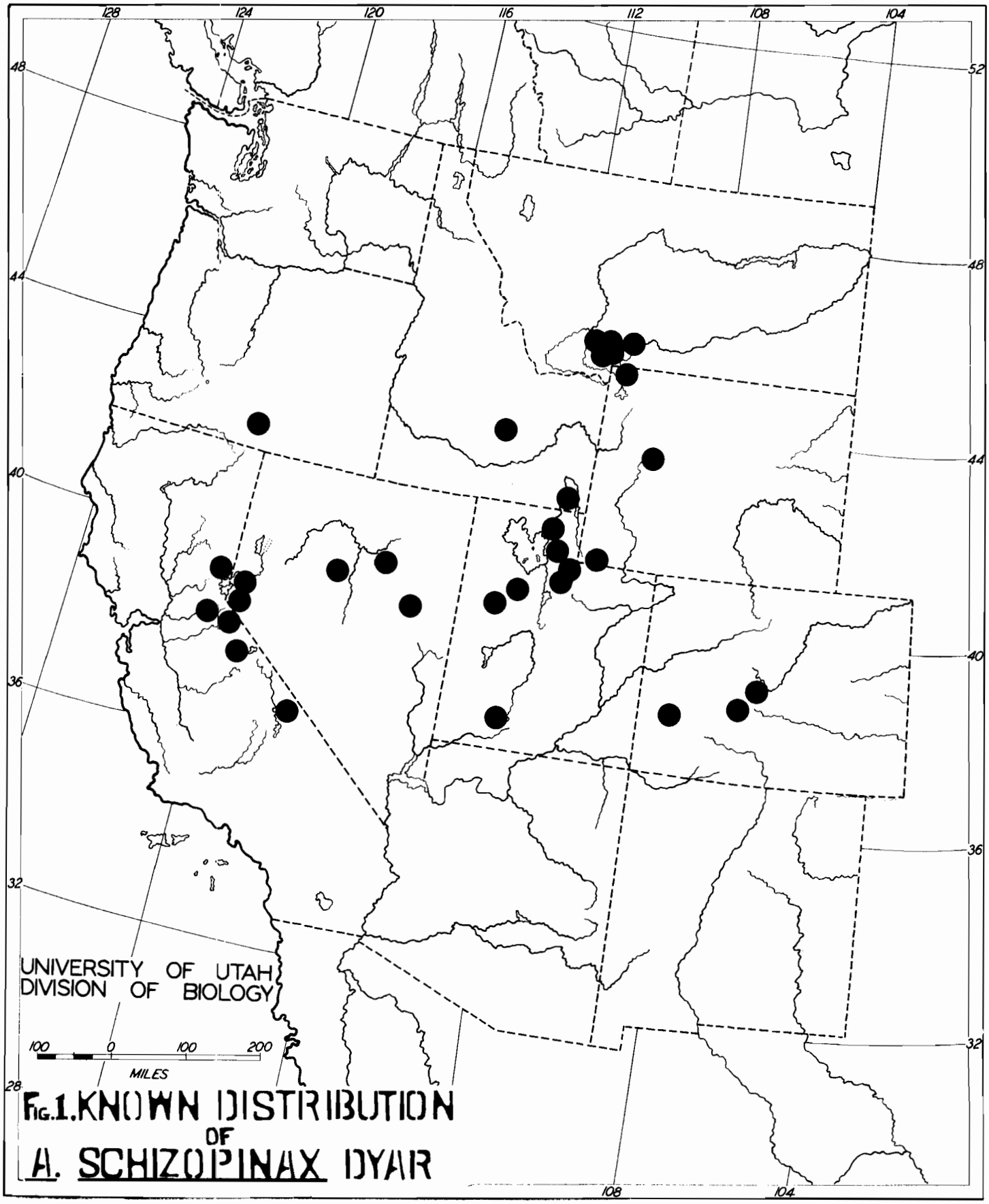


FIG. 1. KNOWN DISTRIBUTION OF *A. SCHIZOPINAX* DYAR

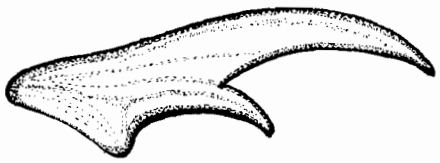


FIG. 3. TARSAL CLAW

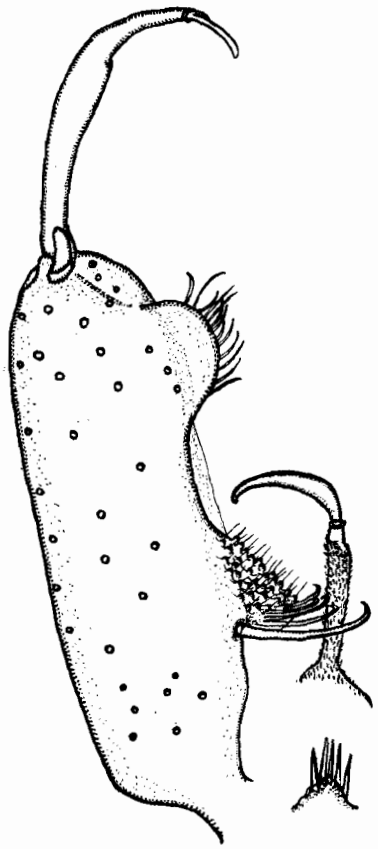


FIG. 2. MALE GENITALIA

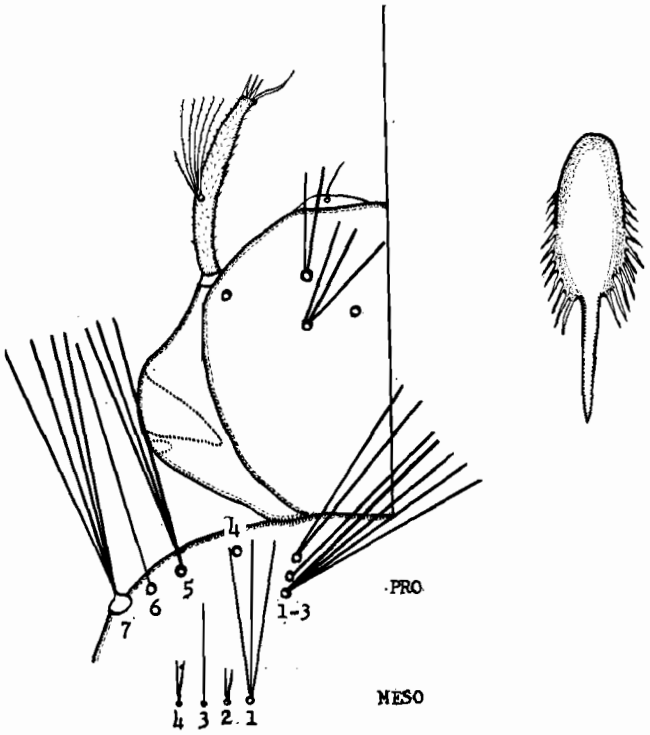
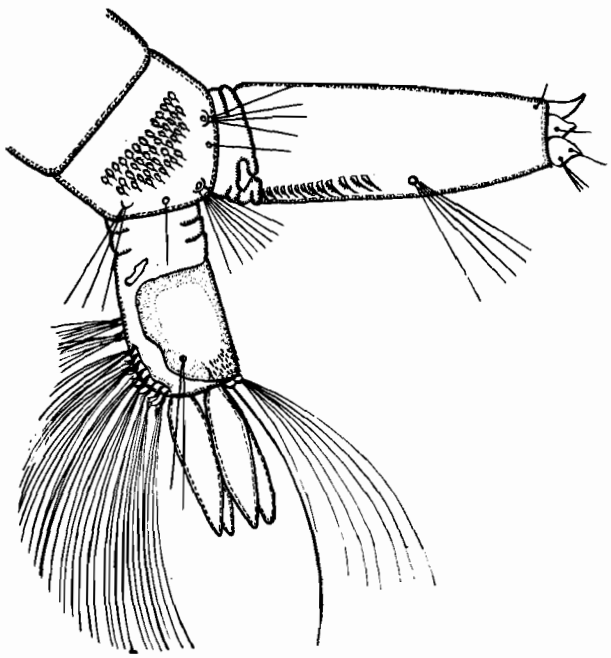


FIG. 4. FOURTH INSTAR LARVA



bluntly pointed, being only about one-sixth or less the length of the entire tarsal claw.

Male Genitalia: Fig. 2.

The male genitalia is typically like that of other members of the *punctor* group. As reported by Carpenter and LaCasse the claspette stem is pilose to near the apex, the small setae extending to within about the width of the claspette stem from the attachment of the claspette filament. This character appears reliable in separating the male of *schizopinax* from that of other males of the *punctor* complex. In addition, the tarsal claws of the hind tarsi in *schizopinax* are like those of the female and also are useful in separating the males.

Fourth Instar Larva: Fig. 4.

The larva of *A. schizopinax* is perhaps the most distinctive stage. The head hairs as reported by Dyar (1929) are especially coarse in appearance, with the upper frontal head hairs 3-5 branched and the lower frontal head hairs double or triple. The thoracic setae are conspicuously developed; prothoracic hair No. 1, long, 3-5 branched, No. 2, long, single; No. 3, long, 2-3 branched; mesothoracic hair No. 1, long, 3-4 branched. The siphonal index is about 3.0; pecten of evenly spaced teeth followed by a conspicuously long siphon tuft of several setae. The comb contains about 40 scales; individual scale with a thorn-like terminal spine.

BIOLOGY

Aedes schizopinax is a single brooded species. Very little is known of the biology. Larvae have been found most frequently in mountain valleys at elevations below 7000 ft. Chapman, however, has found the species in snow melt pools at higher elevations. Larvae appear to prefer small to moderately sized pools containing considerable vegetation and organic matter and often covered with a scum. Dyar (Op. Cif.) reported larvae in cattle and game tracks. The author has also found larvae in cattle tracks or comparable sized depressions. On occasions the species has been taken in relatively large fresh water meadow pools. Larvae have been found in association with the following species: *Aedes cataphylla* Dyar, *A. cinereus* Meigen, *A. communis* (De Geer), *A. dorsalis* (Meigen), *A. fitchii* (Felt and Young). *A. hexodontus* Dyar, *A. increpitus* Dyar and *A. implicatus* Vockeroth.

The habits of the adults are particularly in need of clarification. Repeated visits by the author in areas where larvae have been present have failed to reveal biting females. Chapman (1959b) has reported the same experience. At the present time the only adult records in nature were taken in light trap collections.

ACKNOWLEDGMENTS

I am grateful to the following individuals for permission to use in this paper previously unpublished data or collection records: Dr. Harold C. Chapman and Mr. Gaines W. Eddy of the Entomology Research Division, U.S.D.A. at Reno, Nevada, and Corvallis, Oregon, respectively; Mr. Fred C. Harmston, U.S. Public Health Service, Greeley, Colorado; and George R. Roemhild, Assistant State Entomologist, Bozeman, Montana.

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CHROMOSOME STUDIES WITH FIRST INSTAR MOSQUITO LARVAE

PART I. TECHNIQUE[1]

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Introduction

Considerable interest is now had in the use of cytological studies as an implement of mosquito research. The value of such studies has been clearly indicated by a number of investigators concerned with problems associated with mosquito speciation (Rozeboom and Kitzmiller, 1958; Kitzmiller and Laven, 1959; and Breland, 1960). Recently, Dr. O. P. Breland (1959) has shown that the so-called squash technique for the study of chromosomes can be used with a variety of mosquito tissues. Dr. Breland's technique holds great promise in that it gives a relatively simple but useful procedure to facilitate these studies.

During the past few months, the writer has been engaged in a survey problem requiring the collection of mosquito egg-rafts and the rearing of larvae from the rafts collected for identification purpose. With larvae available within the laboratory from this source, a series of experiments has been instigated in an attempt to locate tissues of early stadia which might be suitable for squashing. Although the results of these experiments are incomplete at this date, certain tissues of the first instar larvae have been found to be appropriate for chromosome preparations. A somewhat altered procedure has been developed, however, to accommodate for the small size of specimens used. The purpose of this paper is to report on the exact

[1] Supported by Sam Houston State Teachers College, Huntsville, Texas.

[2] The writer wishes to express his appreciation to Dr. O. P. Breland for his helpful suggestions during the course of this investigation and to Mr. Bill R. Brinkley for the valuable contribution he has made to the current study.

procedure employed at the present time for preparation of first stadium tissues.

Procedure

As indicated, the technique used in the present investigation is adapted from that proposed by Breland. The fixative, a modified Carnoy's fluid, and the stain, a 1% solution of aceto-orcein, are also those Dr. Breland suggests. No attempt is made with the procedure used in the current study to dissect specific tissues of the first instar. The head region of the larvae is stained and later squashed in its entirety. The steps given below are those being presently followed.

1. With a pipette, a living larvae is transferred to a clear slide along with a small drop of water.
2. The larvae is covered with three or four drops of Carnoy's fixative and the head is cut free from the body as quickly as possible. The thorax and abdomen are removed and discarded and the head is retained in the fixative for a period of at least one minute.
3. Excess fixative is removed with filter paper and several drops of aceto-orcein stain are added. Additional stain is added as needed, the tissue being kept covered with the solution for a period of 30 to 45 minutes.
4. Excess stain is removed with filter paper and the head is rinsed with a solution of 50% acetic acid.
5. Several drops of 50% acetic acid are again placed on the stainless tissue, a cover slip is applied and the tissue is squashed in the usual manner.

Although the above procedure is easily followed and yields good results, certain difficulties encountered should be mentioned. As seen, the preparation involves the squashing of the entire head and, with the exception of skeletal elements, no specific tissues of the head can be later identified. Certain large nuclei are seen which undoubtedly are those contained within the nerve cells of the brain, the principal tissue of the prepupa used by Breland. It is impossible, however, to recognize which nuclei are from this specific tissue. The usefulness of the procedure is hampered to some extent by this handicap.

Another factor which has proved to be of significance in the application of the procedure has been that of the age of the first instar larvae used. If the procedure is applied to newly hatched larvae, few if any nuclei are found with mitotic figures. The tissue of older larvae, however, often contains numerous nuclei in some stage of mitosis. Larvae best suited for squash preparations appear to be those whose age is around 24 to 30 hours. At this time in the larval growth the cells are apparently rapidly dividing, possibly preparing for the first larval molt. Older larvae, as a rule yield poor results with the procedure as outlined. It is also possible that environmental features may alter the metabolism of the larva in such a way as to effect the cell's activities and exert an influence on this factor. Temperature variations have not been found to effect first instar in this regard to any great extent.

Results

At the present time, the chromosomes of several species prepared from first instar tissues have been observed. The first experiments were conducted and the outlined procedures were developed with larval *Culiseta inornata* (Williston). Later, larval *Culex restuans* Theobald and *Culex quinquefasciatus* Say were also used with success. Additional species are currently being investigated and a detail comparison is being made of the chromosome seen in the tissues of the first instar with those of the prepupae of the same species. The findings of this study will be the subject of a later report. The chromosomes of the first instars which have been studied as of this date compare favorably both in size and shape with those found in the brain tissue of the prepupae. The six chromosomes which appear to be typical for the somatic cells of the mosquito can be clearly seen and are paired during prophase. The chromosome compliment in each instance consists of two pairs of "long chromosomes" and a third, somewhat shorter pair. No further observations of significance have been made.

Summary

A technique has been developed for the study of the chromosome of first instar mosquito larvae. Although the present report is based on preliminary observations, the technique developed appears to be a suitable one for the preparation of mosquito tissues for chromosome studies.

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FLUCTUATIONS IN ABUNDANCE OF COMMON SPECIES OF MOSQUITOES IN SALT LAKE COUNTY, UTAH*

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DON M. REES
University of Utah

Changes in mosquito populations in Salt Lake County, Utah have been observed over a period of several years. Some of these changes are relatively permanent increases or decreases in the yearly abundance of various species. These changes were reported in 1958 by Graham, Rees and Nielsen. The conclusions reached at that time are still valid but further study

* This study was supported by a grant from the National Institutes of Health.

of *Aedes nigromaculis* populations has been necessary. Graham (1959) reported some of these studies and recent populations changes in this species are to be presented at this meeting by Collett and Rees.

Other observed changes in mosquito populations are seasonal cycles of populations and temporary increases or decreases in the numbers of mosquitoes of each species produced in a year. Changes in populations were determined primarily by means of careful and complete larval surveys in which a sample of mosquito larvae was taken from each body of water where larvae were found. Biting counts and light trap collections were used as additional sources of information and in general are in agreement with the larval collections. Light trap catches were not used as the primary source of data regarding changes in mosquito populations because generally only a few mosquitoes are taken and a small source near the trap can and has produced biased results so far as total populations of certain species are concerned. The traps are placed to determine mosquito nuisance in populated areas and the sample of adult mosquito populations obtained by this method is neither random nor broad and inclusive as the larval samples. Biting counts taken were insufficient to be a reliable index of changes in mosquito populations. Field observations were used to substantiate data from other sources.

The four most common species of mosquitoes in Salt Lake County in order of abundance are *Aedes dorsalis, Culex tarsalis, Culiseta inornata* and *Culex pipiens.* Changes in abundance of *Aedes dorsalis* and the factors responsible for them have previously been reported in detail by Graham and Collett.

Following are three graphs showing the seasonal distribution of the number of pools with larvae of *Culex tarsalis, Culex pipiens* and *Culiseta inornata* for the years 1957, 1958, 1959 and 1960.

Figure I—Seasonal distribution of pools with larvae of *Culex tarsalis* for the years 1957, 1958, 1959 and 1960.

Figure II—Seasonal distribution of pools with larvae of *Culex pipiens* for the years 1957, 1958, 1959 and 1960.

Figure III—Seasonal distribution of pools with larvae of *Culiseta inornata* for the years 1957, 1958, 1959 and 1960.

Culex tarsalis and *C. pipiens* have consistent and similar patterns of seasonal abundances as determined by the pools with larvae. In these two species the number of pools containing larvae increases slowly the first part of the season and then more rapidly until a peak is reached, usually in the first half of August. Although both species reach a peak at approximately the same time, *C. tarsalis* begins increasing in the number of pools in which larvae are found about a month before *C. pipiens.* Because *C. pipiens* has a shorter period in which to increase in abundance, it is not able to utilize as many larval habitats as *C. tarsalis* even if the habitats are available. This shorter period of increase in the cycle of seasonal abundance of *C. pipiens* is a probable factor in keeping populations of this species below that of *C. tarsalis.*

Populations of both species begin to decline in August and decrease rapidly in September even though there are still a large number of habitats present.

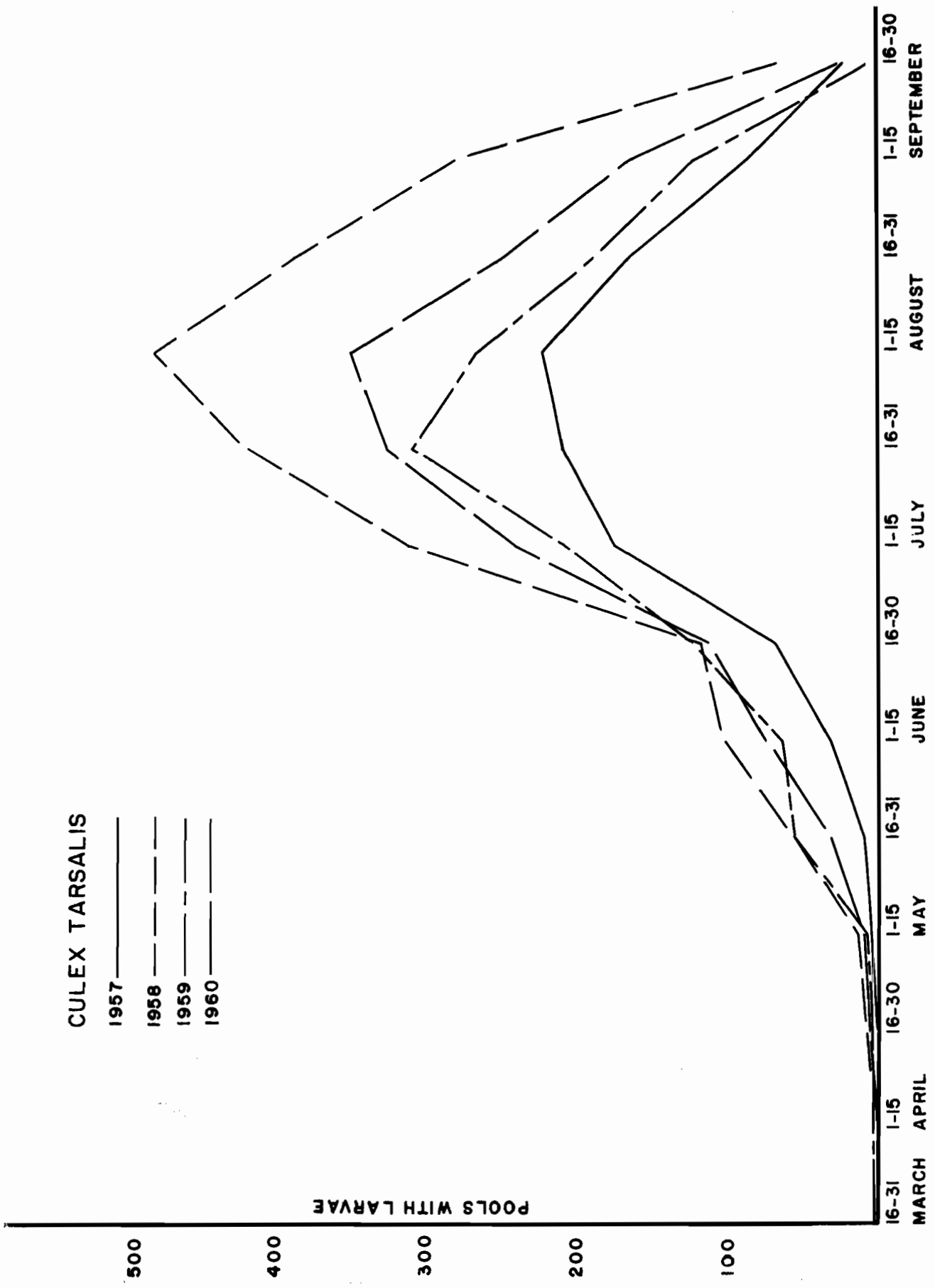
Culiseta inornata does not show a consistent or regular pattern of seasonal abundance of larval populations. Peaks of abundance may occur from the first half of June until the last half of August. The factors responsible for the seasonal fluctuations in the abundance of *C. inornata* are not known, but the species occupies larval habitats with *Aedes* and *Culex* mosquitoes and this wide variety of larval habitats used by *C. inornata* may account for the lack of a consistent seasonal pattern in larval abundance of this species. Since a variety of larval habitats would probably be influenced by more factors than a uniform larval habitat.

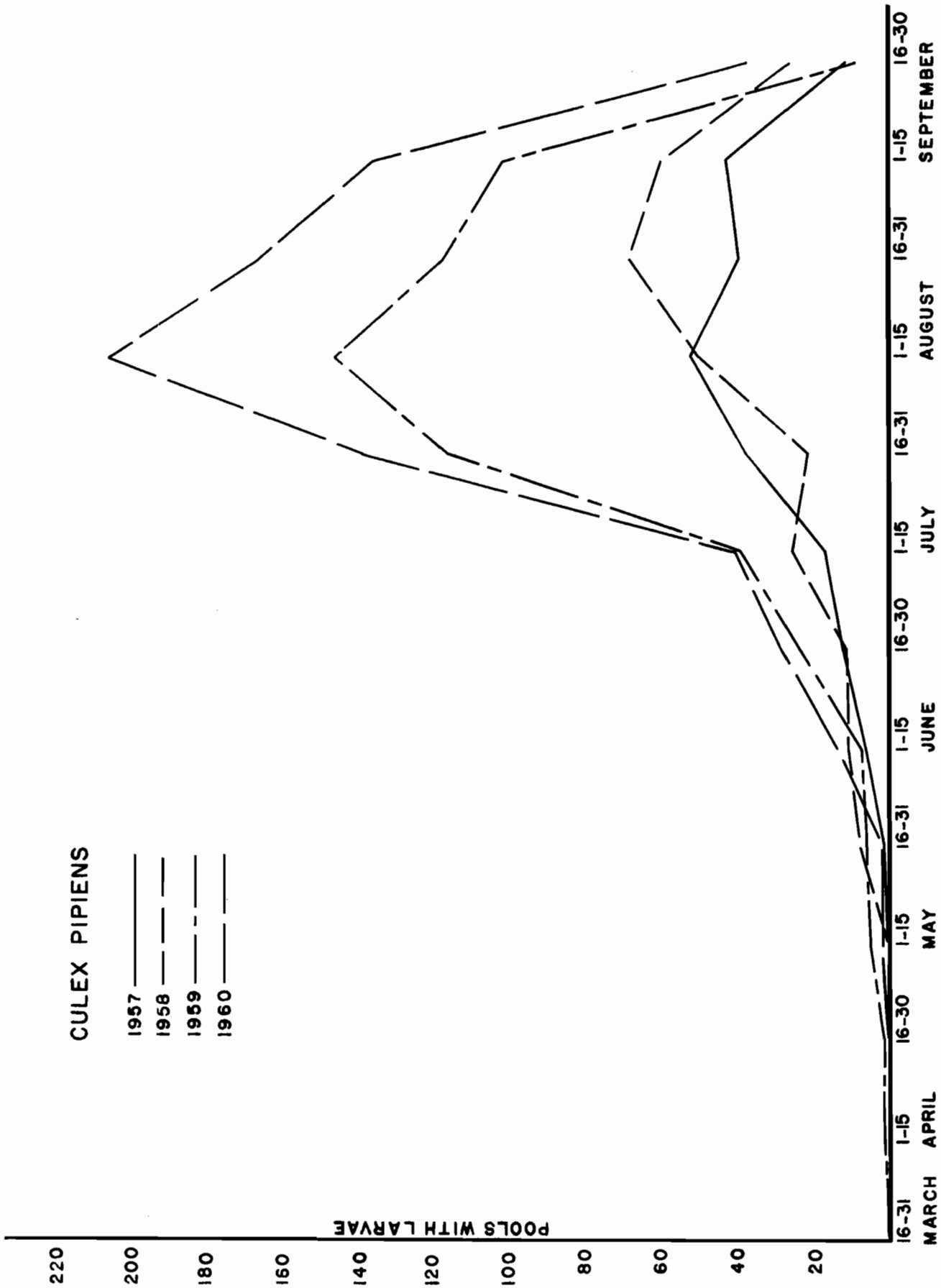
Fluctuations have been large in the total number of mosquitoes produced by a species in a year. The most important of these changes was the increase of *Culex tarsalis* that occurred in 1958. (Rees et. al 1959.) Light trap collections and larval collections indicate that this increase actually began in 1957. Some factors responsible for increases in *C. tarsalis* populations in Utah are believed to be known (Graham, Bradley and Collett, 1960). These factors are above normal precipitation early in the year either as excessive snowfall in the winter or above normal rainfall in late May or June followed by a long, hot dry period in July and August. Additional evidence to support this was obtained in both 1959 and 1960. In 1959 larval populations of this species reached a peak in the last half of July rather than in August. The decline in larval populations in August coincided with above normal rainfall in the first week of August. Rainfall at this period may directly affect larval populations of this species adversely but it is more likely that the effect is indirect resulting from a decrease in the amount of irrigation water used. In 1960 the Salt Lake Valley experienced the hottest summer on record with practically no rainfall. During this hot dry period larval populations of *Culex tarsalis* increased considerably but remained below 1958 because precipitation early in the year did not provide as much stored water for irrigation purposes and fewer larval habitats were available from waste irrigation water.

Both *Culiseta inornata* and *Culex pipiens* larvae increased in numbers in 1959 and again in 1960. The increases were great enough to cause considerable additional work for the mosquito abatement district. The factors responsible for the increase are not known. The larvae of the two species are frequently found together and are influenced, at least in part, by the same factors. All of the increases in number that have been observed have occurred over a period of at least two years. This indicates that changes in the population of mosquitoes produced by these species in one year is limited, in part, by the level of the previous year's population.

SUMMARY AND CONCLUSIONS

Careful and detailed mosquito larval surveys in Salt Lake County, Utah have shown that distinct


CULEX TARSALIS
1957
1958
1959
1960
POOLS WITH LARVAE
500
400
300
200
100
16-31 MARCH
1-15
16-30 APRIL
1-15
16-31 MAY
1-15
16-30 JUNE
1-15
16-31 JULY
1-15
16-31 AUGUST
1-15
16-30 SEPTEMBER


CULEX PIPIENS
1957
1958
1959
1960
POOLS WITH LARVAE
220
200
180
160
140
120
100
80
60
40
20
16-31
1-15
16-30
1-15
16-31
1-15
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MARCH
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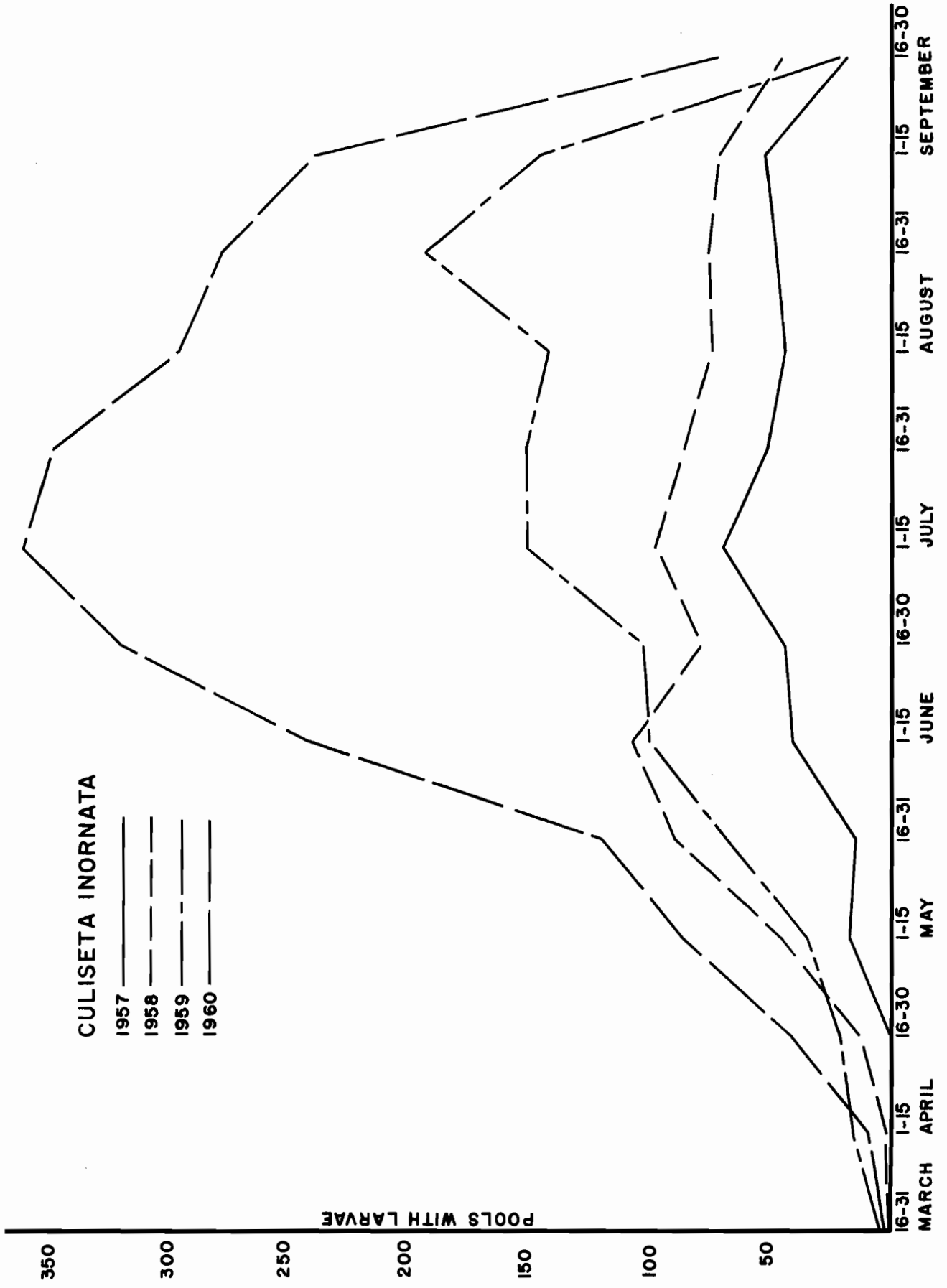
CULISETA INORNATA
1957
1958
1959
1960
POOLS WITH LARVAE
350
300
250
200
150
100
50
16-31
MARCH
1-15
16-30
APRIL
1-15
16-31
MAY
1-15
16-30
JUNE
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JULY
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16-31
AUGUST
1-15
16-30
SEPTEMBER

fluctuations in populations of *Aedes dorsalis, Culex tarsalis, Culiseta inornata* and *Culex pipiens* have occurred. Evidence obtained from larval surveys was substantiated by light trap collections, biting counts and field observations.

Culex tarsalis and *C. pipiens* larval populations show definite and similar patterns of change consisting of an increase in numbers from the first part of the season until a peak is reached, usually in the first half of August, followed by a sharp decline. *C. pipiens* lags in this pattern about a month behind *C. tarsalis* during the period of increase but reaches a peak at approximately the same time.

Populations of *Culiseta inornata* do not show a consistent seasonal pattern of change in number from year to year possibly because the larvae occupy a wide variety of habitats and are influenced by a greater number of factors than *Culex tarsalis* and *C. pipiens*.

C. tarsalis showed an increase in numbers in 1957 and a greater increase in 1958. Some factors responsible for this are above normal precipitation early in the year followed by a long dry period and the subsequent affect of these weather factors on irrigation practices.

C. pipiens and *C. inornata* increased in number in 1959 and 1960. The factors responsible for these increases are not known but since the increases for these species as well as *C. tarsalis* developed over a period of at least two years, the increase of one year's population appears to be limited in part by the populations level of the preceding year.

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IMPROVED TECHNIQUES FOR THE LABORATORY REARING OF *AEDES AEGYPTI*

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Abstract: Three techniques are described which have proved useful in rearing *Aedes aegypti* at the Miami Beach, Florida Quarantine Station. These are: (1) Preparation of an adult feeding solution consisting of 1 part of a 2% propyl and methyl paraben to 3 parts of a honey-water solution to prevent fermentation and molding and a preliminary report on the effects of paraben solutions for mold prevention on egg deposition papers; (2) a honey-water solution feeder which is impervious to egg deposition and rapid evaporation; and (3) an easily constructed and inexpensive sleeve-type cage for establishing colonies of mosquitoes from small larval collections.

MOSQUITO LARVAE RECOVERED FROM CISTERNS AND CEMETERY URNS IN SEAPORT CITIES IN LOUISIANA, MISSISSIPPI AND ALABAMA

BURTON R. EVANS[1] AND EDWARD J. FINK[2]

The Public Health Service has carried on an active program for the control of *Aedes aegypti* (Linn.), the urban yellow fever mosquito, in international traffic areas of the United States, particularly since 1957 (Hughes and Porter, 1958). It has been observed during the conduct of the program that areas favorable for *aegypti* breeding sometimes occur near airports and docks and serve as points for reinfestation of the traffic centers. Other more-distant, potential breeding sites are also inspected when time permits. In this report, information based on inspections made of cisterns and cemetery urns in various seaport cities of Louisiana, Mississippi, and Alabama from January through September of 1959 and 1960 is summarized.

The importance of cisterns and cemetery urns in the production of *aegypti* was well-recognized during the last yellow fever epidemic in the United States, which occurred in New Orleans in 1905 (Augustin, 1909). A United States Public Health Service survey and control unit in New Orleans in 1943 reported that in 45 cemeteries there were an estimated 100,000 flower vases. This presented a very difficult inspectional and control problem with a limited staff. One solution was found to be the "installation of automatic phenothiazine larvicide dispensers on cemetery hydrants." Vases were thus filled with "mosquito-proof water." Another Public Health Service survey was conducted in 1956 and 1957 for the presence of *aegypti* in cemetery urns, but only one vase was found breeding this mosquito (Tinker, 1960; and Herms and Gray, 1946).

Many of these cemetery urns are of a permanent type and afford potential breeding sources of a continuing nature. Many urns are permanently fixed in place with cement and cannot be over-turned, others contain natural or artificial flowers which make mosquito control a rather delicate public relations problem. Rain water keeps even neglected urns periodically filled. A wide variety of insecticides have been used in the treatment of cemetery urns. However, applica-

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tion of these insecticides by hand is very expensive, particularly in a high cost labor area as the United States. Hence, the use by the Public Health Service of automatic larvicide dispensers on cemetery hydrants is one answer to this problem.

In a survey by the United States Public Health Service from May 1 to November 30, 1944 a total of 245 cisterns with water were inspected in New Orleans. Forty positive cisterns, or an *aegypti* index of 16.3 was found (Tinker, 1960).

Cisterns are not commonplace structures in New Orleans today. However, they do occur more commonly in communities along the lower Mississippi River where the local ground water is too brackish for drinking purposes. Although piped fresh water is presently brought to these localities, many of the old cisterns are still in use. Control of mosquito breeding in these cisterns by screening, a light oil, or the use of minnows *(Gambusia)* are reported to be effective (Herms and Gray, 1946).

In Table 1 it may be noted that eight species of mosquito larvae are reported recovered from cemetery urns inspected in cities in Louisiana, Mississippi, and Alabama. *Culex quinquefasciatus* Say and *Aedes triseriatus* (Say) were the most common species, with *Culex salinarius* Coq. and *C. restuans* Theob. to a lesser degree. *Anopheles punctipennis* (Say), *An. crucians* Wied., *Culiseta inornata* (Will.) and *Aedes aegypti* were rarely recovered. Among the cities listed in Table I, *aegypti* have been found breeding in the international dock areas only in New Orleans and Mobile, and here only in small numbers (during the last

TABLE 1

MOSQUITO LARVAE RECOVERED FROM CEMETERY URNS IN VARIOUS SEAPORT CITIES IN LOUISIANA, MISSISSIPPI, AND ALABAMA DURING JAN.-SEPT., 1959-60

Cities surveyed during Jan.-Sept., 1959-60	*Total No. of urns inspected*	Total number of cemetery urns positive for each mosquito larval species								*Total No. Coll.*
		Ae. aegypti	*Ae. triseriatus*	*C. quinquefasciatus*	*C. salinarius*	*C. restuans*	*An. punctipennis*	*An. crucians*	*Cul. inornata*	
New Orleans, La.	7,866	1	17	45	7	7	3	1		81
Venice, La.	240		35	10	1	1		1		48
Buras, La.	277		9	11						20
Destrehan, La.	400		22	22		1				45
Gramercy, La.	123		1			1			1	3
Baton Rouge, La.	169			17						17
Gulfport, Miss.	590		1	23						24
Biloxi, Miss.	324		62	50	12					124
Mobile, Ala.	1,140		4	7						11
TOTALS	11,129	1	151	185	20	10	3	2	1	373

TABLE 2

MOSQUITO LARVAE RECOVERED FROM CISTERNS IN VARIOUS CITIES ALONG THE LOWER MISSISSIPPI RIVER IN LOUISIANA DURING JAN.-SEPT. 1959-60

Cities surveyed during Jan.-Sept., 1959-60	*Total No. of cisterns inspected*	Total number of cisterns positive for each mosquito larval species			*Total No. Collected*
		Ae. triseriatus	*C. quinquefasciatus*	*C. restuans*	
Venice, La.	93		3		3
Empire, La.	66	2	3		5
Buras, La.	87		4		4
Port Sulphur, La.	66		8	1	9
TOTALS	312	2	18	1	21

1960 survey there was an *aegypti* index of .46 in the New Orleans dock area, and an index of 1.9 in the Mobile dock area).

In Table 2, three species of mosquitoes were recovered from the cisterns inspected. *C. quinquefasciatus* was again the most common species found with *A. triseriatus* and *C. restuans* more rarely recovered. No *aegypti* have been found in the international dock areas of Venice, Empire, Buras, or Port Sulphur, Louisiana during the 1959-60 *aegypti* surveys.

On the basis of these surveys, it would appear that *aegypti* are not breeding to an important degree in cemetery urns or cisterns in the areas inspected at this time.

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TECHNIQUES USED TO DETERMINE THE PHYSIOLOGICAL AGE OF MOSQUITOES

(Illustrated with slides)

BETTINA ROSAY

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ABSTRACT

Studies of mosquitoes in the laboratory show that the teneral adult can be recognized by the presence of muscle remnants carried over from the immature stages. Ovarian development from the earliest follicular state to the mature egg is classified according to Christophers' categories (Paludism, 2: 73-88, 1911). Subsequent to ovulation, a dilatation remains on the follicular pedicel to mark the site of the previously developed egg. The number of dilatations per pedicel is an index of the number of ovarian cycles completed by the female.

The conversion of physiological age to chronological age based on laboratory studies shows that at 21°C. the teneral stage lasts about one day and each ovarian cycle requires five or six days in several mosquito species. The duration of each phase is directly related to temperature. The finding of mosquitoes near Fresno with two follicular dilatations was unusual, and the finding of individuals with three such dilations was rare.

Age determination techniques have been used in cooperation with mosquito abatement agencies to help define breeding sources, to detect movements of populations, and to compare separate populations by age composition. Use of the techniques is continuing in field studies of adult mosquito behavior.

STUDIES OF THE BIOLOGY AND CONTROL OF *LEPTOCONOPS TORRENS* TOWNSEND[1]

R. H. WHITSEL, T. H. LAURET, C. A. VICKERY, JR., AND H. E. MUNSTERMAN

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Recent studies on the biting black gnat *(L. torrens)* within San Mateo, Santa Clara, and Solano Counties, California indicate that specific locations within classified soil series may account for a large proportion of the adult gnat population. Since actual control work necessarily requires delimiting positive source areas within many thousands of acres of cracked clay soils, one of the main objectives has been to determine the specific soil characteristics and recognition factors pertinent to actual positive black gnat sites.

The long range studies of larval habitat, life history, experimental control and environmental modification have received continued study.

The advice and cooperation of a considerable number of people were required in this investigation. The suggestions of C. Donald Grant were of great value in planning the study and preparing the manuscript. The workers are particularly grateful for the continued cooperative efforts of Dr. Austin Morrill in relation to experiments conducted at the U. S. Naval Radio Station near Dixon, California. Special appreciation is extended to Mr. Ralph E. Nelson, Assistant State Soil Scientist; Mr. Glen E. Brown, Work Unit Conservationist; Mr. Wesley Lindsey, Soil Scientist; Mr. Herman C. Cohen, Soil Conservationist; and Mr. Leland Bates, Soil Scientist, for their helpful information and field assistance. Seasonal weather data was obtained from the U. S. Weather Bureau, San Francisco, California.

Materials and Methods

Since a considerable amount of this work has been concerned with establishing specific facts relating to the soils in which the black gnat is confined, equipment which reduces errors and facilitates handling has been acquired.

To this end a Roper post-hole digger capable of digging a hole 42 inches deep and 6 inches in diameter was purchased and attached to a jeep in order to obtain soil samples more readily.

A Weston 24 inch stainless steel industrial thermometer (Model 2211) was utilized in acquiring soil temperatures at specified sites. These temperatures were taken in the soil by digging a hole 6 inches in diameter by 30 inches deep and back-filling with the original soil and sand to facilitate the insertion of the thermometer. It was arbitrarily decided that the 28 inch depth would give the workers an idea of the temperature variation within the middle to lower portions of the A soil horizon where larval specimens have frequently been extracted.

Soil-moisture content was derived by the standard

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[1] Studies conducted under a matching research grant from the California State Department of Public Health.

[2] Studies under the direction of C. Donald Grant, Manager-Entomologist.

method prescribed by the U. S. Department of Agriculture (1954), and was also acquired from the soil 28 inches below the surface. Five permanent soil temperature and soil moisture stations were established on positive soils in April, 1960. Additional recordings were obtained from the environmental study plots at Dixon.

Soil pH recordings were obtained by using the Beckman glass-electrode pH meter. The pH readings were taken from soils prepared at a 1:1 soil-water ratio or at the sticky point.

Trapping of adult gnats was completed in San Mateo, Santa Clara, and Solano Counties, California, with a total of 130 modified Dow traps being employed (Lauret, 1958). Many of these traps were placed over soils suspected of being positive or soils previously established as being positive with continued results desired. Six chemical control and two environmental control study plots required the use of 70 emergence traps.

The experimental chemical control plots established at the U.S. Naval Radio Station near Dixon, California, were designed to test the effectiveness of Dieldrin when applied at the rate of 2 and 4 pounds of active material per acre using 300 gallons of water to provide the desired physical coverage. Three control and three test traps were placed on both the three-sixteenth and three-eighth acre plots.

An experiment designed to examine the effect of environmental modifications on gnat emergence was established on Capay clay at the U. S. Naval Radio Station. Four three-sixteenth acre plots with 5 traps each which included a native pasture (control), an irrigated pasture, an irrigated-disked field, and a dry-disked field were created to test the affect of different agricultural practices on the emergence pattern. A "rain bird" sprinkler system was utilized on the irrigated plots to soak the soil over some time. Water was not allowed to accumulate on the surface of the plots, but was added slowly at frequent intervals until the cracking evidenced on the native pasture was entirely eliminated.

Chemical control plots were established on a Cropley clay soil in San Mateo County, California, to further examine the effectiveness of Dieldrin and in addition test the possibilities of Diazinon dust as an effective chemical in control of adult black gnats. Dieldrin was applied on two one-eighth acre plots at the rate of 1 and 2 pounds of active material per acre (with the addition of 1 percent kerosene and 0.25 percent Colloidal X-77) in 10 gallons of water. At the U. S. Naval Radio Station near Dixon, Dieldrin was also applied to a 3/16 acre and a 3/8 acre plot at the rate of 2 and 4 pounds of active material per acre, respectively, in 300 gallons of water. Diazinon dust was applied on two one-eighth acre plots at the rate of 1 and 2 pounds active material per acre. A Kiekens Deker (Whirlwind) mist-blower was employed in the dispersal of both chemicals. Three control and three test traps were set on each plot.

The susceptibility of *L. torrens* to known concentrations of dieldrin and DDT was carried out in the laboratory using impregnated papers from the World Health Organization kit for mosquitoes. Difficulties in the handling of specimens secured from dense swarms in Santa Clara County, and transfer of the gnats into individual containers during the tests often led to debilitating affects to many individual gnats. Three tests were made on separate days wit hthe first one on June 26th serving as a trial. Specimens used in the tests were made on separate days with the first one on stored in an ice cooled container during transport.

Specific Soils and Adult Emergence

It has been noticed by another worker (Smith, 1948) that adult gnats may infest a particular locality for as long as 6 weeks, but the actual emergence period experienced from any single trap is normally three weeks. It has been demonstrated that more than one type of soil may support larvae. Apparently the physiographic position of these soils control to some extent the factors which ultimately trigger emergence. Reference to Table I clearly illustrates that two different soils capable of gnat production in the same locality may have dissimilar emergence periods even though the climatic conditions are very similar.

There seems to be some correlation between early drying and cracking of a soil and an advanced emergence period, while the converse seems equally true. Other factors involving characteristics of the soils may complicate this picture. The cracking potential of a soil may be an important key as to where the greater or lesser larval densities may be expected. It is of interest to note that only the smaller cracking, ½"-1" wide,

TABLE I
SPECIFIC POSITIVE SOILS AND THEIR EMERGENCE PERIODS

Location	*Topography*	*Soil Series*	*1960 Emergence Period*
Palo Alto Santa Clara County	Hilly	Altamont	June 3—June 24
Menlo Park San Mateo County	Alluvial fan	Cropley	May 25—June 27
Hillsborough San Mateo County	Hilly	Montara-Climax	June 8—July 6
Dixon Solano County	Alluvial fan or Basin-like	Undetermined	May 31—June 26
Dixon Solano County	Alluvial fan or Basin-like	Capay	May 16—June 13

TABLE II

CHARACTERISTICS OF FOUR POSITIVE BLACK GNAT SOILS IN THE NORMAL LARVAL ZONE[1]

Characteristics	Soil Series			
	Altamont	Capay	Cropley	Diablo
Color[2]	dark gray to dark gray brown	dark gray brown to light olive brown	gray to pale yellow	dark gray to gray-brown brown
Texture	clay	clay	clay to sandy clay	clay
Structure	strong coarse angular blocky to massive	strong coarse angular blocky to massive	strong coarse angular blocky to massive	strong coarse angular blocky to massive
Pores	tubular	tubular	tubular to none	tubular
pH[3]	6.6–8.0	6.7–8.0	6.4–8.0	7.0–8.0
CO_3[4]	none to slight effervescence	none to slight effervescence	none	none to slight effervescence

surface soils (generally correlated with fewer cracks per unit surface area) demonstrated high numbers of gnats per trap during the 1960 emergence period. Traps placed on soils where 2 to 3 inch surface-cracks were common yielded little or no emergence. Further testing and evaluation of the trapping methods on wide cracking soil surfaces is to be accomplished in the future.

The feasibility of a control program will be largely dependent upon the care in delimiting those soils capable of producing great numbers of gnats within a given area. If specific established soil series are found to be responsible for heavy gnat production in widely scattered areas of the state, then a more concentrated effort could be expended within these limits.

The emergence of *L. torrens* from two specific soil series may be seen in Figure I. The greater number of adults collected in Solano County is probably due to the higher densities of gnats experienced in the field during the emergence period in comparison with the lighter populations generally noticed in San Mateo County.

To date a complex of certain characteristics are evident in our positive soils yet no single measurable common denominator can be distinguished. Many of our soils are "Chernozemic" soils and frequently have characteristics of a Grumusol.[3] The following characters normally are present:

1. Dark colored surface soils with a moderately high organic matter content. This character is somewhat variable.

2. The surface soils have a slightly acid to neutral reaction becoming more alkaline with depth. A pH range of 6.0 to 8.0 or slightly higher is typical.

3. Normally the darker surface soils grade into lighter colored soils which contain a moderate to high accumulation of lime. The carbonate horizon may or may not be visible.

4. The surface and upper subsoils have a definite structure with moderate cracking evident during the dry season but the lower subsoils (C horizon) generally lack structure and may be termed massive.

5. The surface and upper subsoils have a clay or clay loam texture while the lower subsoils frequently have a sandy clay loam texture. These characters are slightly variable.

Larval Habitat

An increased understanding of the bionomics of the larvae and adults before large scale control is initiated has obvious advantages.

It has been observed that considerable variability in relation to the number of emerging individuals under any given productive soil is frequently experienced even though the density of adults is very great. This apparent aggregation of larvae has not yet been explained but may very likely denote specific habits not yet known of the adult female relating to oviposition. The determination of the factors which induce oviposition is an apparent prerequisite to our understanding of larval distribution in a specific soil.

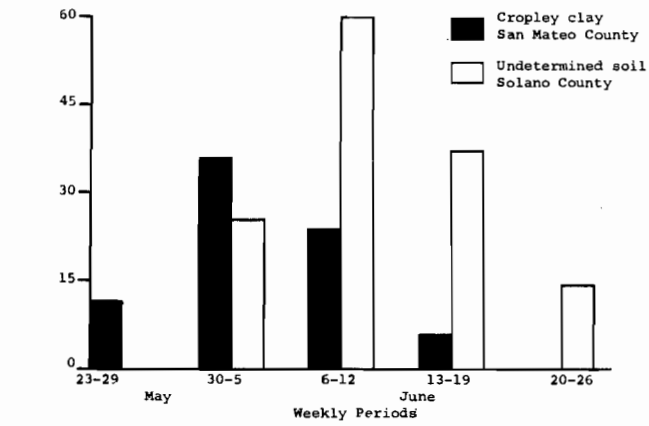
In order to study the habits of the larvae in the laboratory, a method to speed their isolation from the soil must be provided. During the 1961 emergence period increased numbers of larvae will be created under selected sites by the employment of a procedure reported by Smith (1948) where adult gnats were induced to feed on caged animals and oviposit within the

[1] Known and suspected larval zones
[2] The word "to" refers to a changing condition with depth
[3] Colorimetric; field moist
[4] All above soils display effervescence with depth

[3] Great Soil Groups.

FIGURE I

EMERGENCE PATTERN ON TWO POSITIVE SOILS(1)



(1) Data from five traps on each soil

cage confines. In addition, various attempts will be made to survey large quantities of specific soils for the presence of larvae utilizing various isolation techniques.

Attempts will be made to induce oviposition and rear larvae in the laboratory.

During the 1959-60 season examination in the larval zone of positive soils has revealed certain facts which may be an aid in predicting the distribution of larvae in any potentially positive soil (Table II). Smith (1948) received 85 larvae in 99 pounds of Capay clay soil at a depth of 15 to 25 inches below the surface and reported the maximum number in the vicinity of 18 inches below the surface. Table II shows that the majority of the larvae extracted occur in a dark gray brown clay with a neutral to moderately alkaline reaction. The positive soils at this depth normally have higher moisture equivalent values (USDA, 1958) than in the subsoils (C horizon), a characteristic that is generally true of our positive soils listed in Table II. The degree to which a soil cracks may be a factor which allows the moisture content within the larval zone to remain sufficiently high during the developmental period of the larvae.

The range of soil moisture percentages and temperatures at 28 inches below the surface within five positive soils may be seen in Figure II. The temperature range for all of these soils is similar while the moisture content may not only vary with the soil type but may vary considerably within the same soil. Variations of as much as 8 per cent moisture content have been recorded within a foot of each other over a period of a week. Since so great a variation has been recorded at various times during this eight month period, resistance blocks will be permanently placed at two different levels within the larval zone to obtain accurate temperature and moisture percentage records at a fixed point in a soil block adjacent to subsurface cracks.

Adult Observations

Confirmation of adult habits previously described by Lauret (unpublished report, 1957) were obtained at various times during the emergence period. One additional observation is worthy of mention. On June 15, 1960 two separate mating pairs were observed within a period of 5 minutes (11:25-11:30 a.m.) at the U. S. Naval Radio Station near Dixon, California. These two mating pairs were not contiguous with a swarm.

Chemical Control Tests and Environmental Modifications

Chemical control plots were established at the U. S. Naval Radio Station, Solano County, California, and in Menlo Park, San Mateo County, California.

The problems involved in receiving adequate insecticide coverage were described by Lauret (1958).

Results of the experimental chemical control plots are given in Table III. Negative results were obtained from all traps on a chemical control plot at the U. S. Naval Radio Station where dieldrin was used on a 3/16 acre test plot.

TABLE III
EXPERIMENTAL CONTROL PLOTS

Insecticide	Insecticide and Rate of Application	Total Subsequent Gnat Emergence Test	Control
Dieldrin	1 lb/acre	1	2
	2 lbs/acre	0	2
	4 lbs/acre	9	120
Diazinon	1 lb/acre	5	14
	2 lbs/acre	2	11

Since the emergence on any specific plot may be highly variable it is imperative that studies in the future regarding chemical control include a greater number of traps. In our most productive area at the U. S. Naval Radio Station where dieldrin (4 lbs/ acre) was applied on a ⅜ acre plot we received an average of 40 gnats in the control traps and an average of three gnats in the test traps. A greater number of experimental traps will be set during the 1961 emergence period on the basis of this year's results.

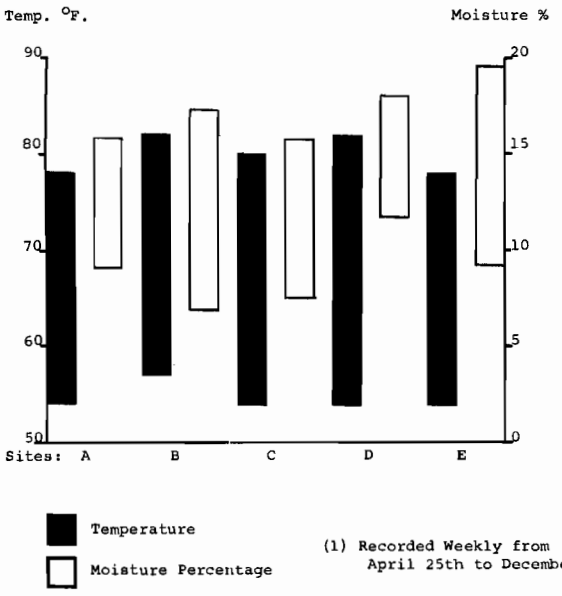
Fortunately, the adult gnats spend considerable time on the grasses and forbs immediately after emergence, prior to flight in the morning, and at various times during the day depending largely on the meteriological conditions. In all probability, temporary relief may be received through the application of chemical insecticides to the surface of the soils in such a manner that adequate coverage of the vegetation is obtained.

A more permanent type of control has promise in areas suitable for its application. This type of control involves the modification of certain agricultural practices in the vicinity of gnat producing soils.

It has been noticed by inhabitants in heavily infested areas that when permanent pasture lands were converted to irrigated pastures there seemed to have been a correspondingly lesser number of *L. torrens* thereafter. With this possibility in mind four ⅛ acre plots employing different agricultural practices were

FIGURE II

MAXIMUM-MINIMUM SOIL TEMPERATURES AND SOIL MOISTURE PERCENTAGES FOR FIVE POSITIVE BLACK GNAT SITES OVER AN EIGHT MONTH PERIOD, 1960(1)



established at the U. S. Naval Radio Station previous to the 1960 emergence period. Five traps were placed on each of the plots which included a native pasture (control), an irrigated pasture, an irrigated disked field, and a dry disked field. The traps on the modified plots were negative from May 5th through October 12th, while the control plot received positive results from two traps during the week of June 11-17th. The traps were purposely allowed to remain on the plots after the water was withdrawn on July 6th in order to observe a retarded emergence period. Examination of soil moisture retention at 30 inches below the surface from July 6th through October 12th in the soils of the four plots provides us with an index as to the relative effectiveness of the various modifications employed (Figure III). A soil which is disked and then irrigated (or visa versa) may be the most important agricultural practice to recommend since the cracking is greatly reduced as a result of the increased moisture content. A delayed emergence failed to materialize and it was apparently entirely eliminated within these experimental plots.

Susceptibility of L. torrens to Chlorinated Hydrocarbons

In order to gather an initial index of susceptibility by *L. torrens* to common chlorinated hydrocarbons a testing set was devised using containers made from plastic pill vials and fashioned after the testing kits of the WHO for mosquitoes. The standard papers in various concentrations of dieldrin and DDT were cut to size for use in the small containers. The analysis of results from such exposures, directly or indirectly, are not statistically comparable with methods utilized for mosquitoes; however, an initial index of laboratory susceptibility of adult gnats to known concentrations and exposure periods could be obtained. Handling and exposure procedures were not fully determined for best results initially, hence the data gained shows some variability. (Table IV).

In all cases the exposure time to the chemically treated papers in the cages was one hour, and Table 4 on susceptibility shows the gnat reactions to the insecticides were readily manifested in their behavior within short periods after exposure, and whereas the short natural life span of the gnats could have a considerable effect in the results, it was deemed best to rate the affects on the four obvious conditions that were demonstrated.

In all cases it was apparent that the adult gnats showed a high susceptibility to these insecticides and that they were rather quickly affected after exposure to the test papers, considerably more so than the usual case with mosquitoes at similar exposures. No statistical evaluation or comparative index may be afforded on the basis of these initial tests; however, the susceptibility was so obvious that a rough guide was readily afforded for field testing of insecticide applications.

Discussion

Our major objective is eventual control which may be more effectively accomplished when the soils which produce *L. torrens* are delimited and further information concerning the life history of the gnat is available so that control methods, when provided, will be more effectual.

The emergence period normally extends over a 3 to 4 week period, but adult gnats may continue to fly in a restricted locality for 6 to 7 weeks or more. This is due to the presence of dissimilar soils in the immediate vicinity which have different internal character

FIGURE III

MOISTURE CONTENT IN CAPAY CLAY UNDER DIFFERENT AGRICULTURAL PRACTICES

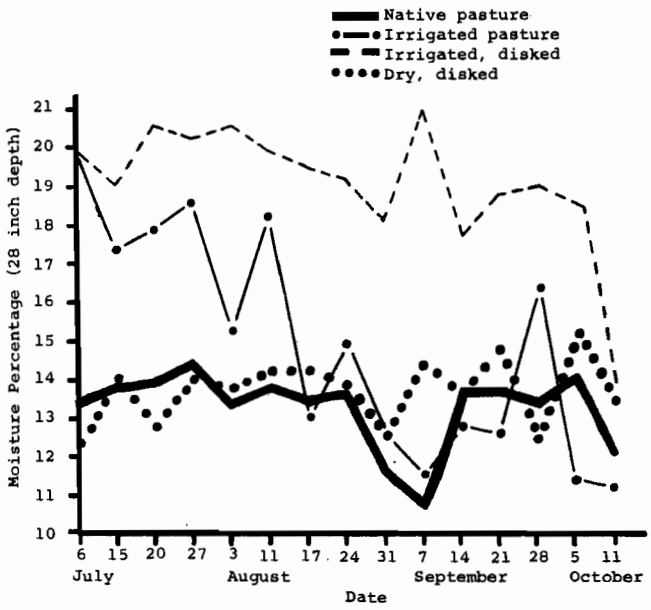


TABLE IV

SUSCEPTIBILITY

		Dieldrin				DDT				
Test II (1) June 27, 1960 Post-exposure time in hours	Control	0.1%	0.2%	0.4%	0.8%	Control	0.5%	1.0%	2.0%	Condition
	17			1		17				Active
½		13					19			Crawling
		2	8	8	4			14		Kicking
		1	10	10	12		4	3		Dead
Number of adults 2	16					17				Active
	1	5					14			Crawling
		8	4	3	4			3		Kicking
		3	14	16	12		9	14		Dead
	15					17				Active
3	2	1					2			Crawling
		7	2	1			4	3		Kicking
		8	16	18	16		17	14		Dead
Test III (2) July 1, 1960 Post-exposure time in hours	11					10				Active
		12	10	11	4	2	6	3		Crawling
0			1	5	5		3	8	4	Kicking
									12	Dead
Number of adults 1	11					10				Active
		11	7			2		1		Crawling
			4	6	3		6	2	1	Kicking
		1		10	6		3	8	15	Dead
	10					10				Active
2	1					2				Crawling
		8	3				1	1	1	Kicking
		4	8	16	9		8	10	15	Dead

(1) 76°F
(2) 78°F

istics and physiographic positions that ultimately effect the factor or factors which trigger emergence.

Although we receive varying numbers of adult gnats from traps in different areas, usually a certain proportion of the traps for any one site are strongly positive.

All of the soils that are positive to date may be termed "Chernozemic" soils, or soils that possess many of their characteristics such as the Grumusols. Soils maps are available for nearly all areas infested with this black gnat which could be used to locate potentially positive soils.

There is a high indication that soil moisture content is an important factor either directly or indirectly stimulating pupation. Soil moisture percentages vary greatly within the soil after cracking is initiated during dry periods. A variation of as much as 8 per cent moisture content has been recorded within a week in the same immediate location. Such wide variations may also accur within a positive clay soil on any given day during the emergence period.

A temporary control can be achieved by applying a properly formulated insecticide to the surface of the soil and vegetation. The adult gnats spend a considerable amount of time on the vegetation both after they emerge and in the morning before flight. On windy days the gnats frequently seek cover on the grasses and forbs. The reduced number of gnats reaching the collection containers in the traps placed over vegetation treated with insecticides demonstrates the effectiveness of such a temporary control measure.

It would appear probable that a more permanent type of control may be achieved if the soil is irrigated to a point where cracking is reduced and emergence is retarded or eliminated. Three experimental test plots utilizing different agricultural practices were trapped with negative results in gnat recovery while the control plot proved positive.

Summary

1. A study of specific soils that produce the biting black gnat (*Leptoconops torrens*) reveals certain characteristics that are common to all.

2. Emergence of adult gnats from any positive soil is not uniform. It is not unlikely that high larval incidence is a result of ovipositional habits.

3. Soil moisture adjacent to subsurface soil cracks appears to be a critical factor in the microhabitat of the larvae that determines the emergence period.

4. Temporary control may be achieved by applying insecticides to the surface of the soil and vegetation on which the black gnat rests.

5. Permanent control may be realized through the application of different agricultural practices (environmental modifications) on known black gnat producing soils.

6. Susceptibility tests in the laboratory indicate dieldrin to be an efficient insecticide for temporarily reducing black gnat populations in the field.

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SECOND GENERAL SESSION

TUESDAY, JANUARY 31, 1961, 1:30 P.M.

AMCA President Dan Jobbins presiding.

Dr. Jobbins: This afternoon we have a particular treat in store for us in the standpoint of the number of experts we have to discuss a most important subject in the light of the present day knowledge, problems and experience. I think all of us appreciate that the center of gravity of malaria control from a practical standpoint has long since passed from the interests of the United States territory; but at the same time we appreciate that, from the standpoint of our world-wide obligations and moral responsibilities, that this is one of the real problems and one of the great areas in which the know how and the experience of the past several decades (and even beyond) in this country by our specialists can be of tremendous help.

Practically all of the international programs on malaria control, malaria eradication, have been in effect in various parts of the world for long enough, at the present time, as many of the early high hopes have been either accomplished or they have been altered by the forces of nature that have been revealed or set in motion in combating man's sacred effort. Some of the information in this regard is the subject of the distinguished speakers that we have this afternoon, who will be led by our good friend, Louis Williams, whom you all know, and who will contribute to the various subjects that we have on the program. Mr. Roy Fritz, Dr. Rene Rachou, Dr. Robert Coatney are the speakers participating in this session, and at this time, Dr. Williams, I will turn the session over to you to have it progress as the situation best indicates.

THE GLOBAL PICTURE OF MALARIA ERADICATION

LOUIS L. WILLIAMS, *Consultant*
Pan American Sanitary Bureau, WHO,
Washington, D.C.

Dr. Jobbins and ladies and gentlemen, I have the task of indicating the magnitude of the program and how it got underway.

In the world there are about two hundred and fifteen nations, territories and semi-autonomous unions. The population of which is about 2,800,000,000. There never was malaria at all, or else it disappeared through natural occurrences, from 880,000,000 million of them. The original malarious countries, thus, are found to be populated by 1,300,000,000[1] people. Of these malaria has been eradicated from 280,000,000 with eradication programs now under way covering 840,000,000 people, and there are no programs at all for only 180 million of the original 1,300,000,000 people, which, on the face of it, looks highly satisfactory. But this is only to show the magnitude of the task and to emphasize what remains to be done, because in the nations where malaria eradication programs are under way, 840,000,000 people, some of them are not going as planned. We have ceased boasting of what has been done and are now concentrating on the most important project, i.e. not what has been done, but what remains to be done. That, I think, is the first difference between malaria control and malaria eradication.

The control artist, one of whom I was, used to assume a high level of malaria and then show the "tremendous" drop that had resulted from the work. It took a little while to get the eradicationist's point of view that there is no interest in what has been done. As one officer in the World Health Organization has put it, ". . . this shift from the platform of sublime confidence to the more difficult sphere of critical assessment is a very promising sign of enlightenment in the evaluation of this world-wide public health operation."

As the situation stands today 22% of the malarious population lives in cleared areas, where eradication work is 45% under way and where success seems about to be obtained, pre-eradication and pilot projects cover another 12.7%, and only 19.1% live where no malaria eradication plans or programs are under immediate contemplation. Unfortunately, programs are not going according to schedule. When the program first commenced, the immediate need was promotion. Get more and more countries committed to eradication programs. Then in each succeeding year as malaria became less and less, the first resistance was not the resistance of the mosquito, it was the resistance of the budgetary people. We met some technical problems; we found some resistance to insecticide of various mosquitoes in different parts of the world, and we had some operational-administrative difficulties; but success has always been achieved whenever a program was thoroughly planned, operations well administered, evaluation critical, and the government has supported the program fully. Whenever total coverage with insecticide has been achieved, transmission has been halted—and that is true even in Africa.

Success seems to be brightest at the present time in the Americas. There is a plan in every country in this hemisphere and operations are under way in all countries but one. Cuba is in the pre-eradication year, and only one country has had a halt temporarily because of lack of government finances.

But this hasn't all come about in one day. The program was urged on a hemispheric basis in the Americas in 1950 when DDT became available everywhere. Everyone expected a large and successful program in the next four years, and four years later we found that nothing had been done. In 1954, the program was re-urged and for the first time a little money was put into it. It became a global program in 1955, and the real program started under way in 1956 and '57.

[1] Populations of mainland China, North Vietnam and North Korea are not included because no information can be secured concerning extent of malaria problem.

As I said before, money was not too difficult to get for the initial attack. One should understand a little of the practical difficulties of initiating and operating even such an enthusiastic program. The first year is a preparatory phase, geographical reconnaissance, malariometry and training. The second to the fifth constitutes the attack phase. The sixth to eighth years are the consolidation period and if there is no recrudescense of malaria, then enters the maintenance phase. The surveillance period is what might be called the watchful waiting period. And here is where the failure of complete early planning is first likely to be noticed. Remember that first there is a reconnaissance survey, to know how much malaria there is and where it is. Second, there must be a geographic survey. Every house must be spotted and numbered, and the average square meterage of walls determined. Then comes the financial estimate—the amount and the cost of the insecticide, of the equipment, pumps, spray-nozzles, etc. Next is estimated the number of jeeps and trucks that are required. Maintenance of equipment and transportation must be carefully computed. It is one thing to turn loose a large number of trucks, cars, and jeeps in the United States where the average youngster, by the age of ten, has become a full-fledged mechanic; but if you take them into the middle of China where they look at a pair of pliers with suspicion and wonder what in the deuce this instrument is used for, you will find that the cost of repair of equipment has been woefully underestimated. It is essential to estimate needed spare parts and stock them before hand. Then comes the problem of logistics and storage of material *within reach of the tiniest localities.* To all of this must be added the cost of training. Then one is ready to compute the total cost.

The international organizations have given much help to countries in each phase of this program. The Pan American and World Health Organizations and the International Cooperation Administration have loaned experienced men to aid in program development and training.

Even professional men must be trained in the special techniques of malaria eradication. As I indicated before, the viewpoint of a "control" operator is quite different from the viewpoint of the *eradicationist.* The control director is quite satisfied when he brings the malaria rate down to tolerable limits—what people will stand for—but when the eradicationist is after the last cases, the toughness of the administration and the carefulness of the supervision is quite surprising; it is rigorous; it is difficult to teach. Special schools have been set up for the purpose of training international advisors and technicians.

Eradication depends on the fact that if the transmission of malaria is halted, untreated malaria drains out of the population within three years.

The first year of spraying is designed to interrupt transmission and must cover every house in the nation. Spraying is continued for the second, third, and fourth year, thus assuring three full years of no transmission of the disease. Malaria should be practically gone at the end of the fourth year. Practically speaking, it isn't; because while spraying progressed, a great many new houses were built; the people were away from many homes leaving them locked; and many laborers were living in temporary huts thus making the spray coverage faulty and permitting outdoor transmission to take place. In the fifth to eighth year, there must be a well trained organization of epidemiologists to find those few cases of residual malaria that are still among the population and stamp out the disease. Eradication has been achieved in the United States. Although a considerable number of cases are reported each year, the bulk of them are in the military who have served overseas or in returnees from long visits in the tropics. There are usually only between four and six cases that could be indigenous.

Dr. Fritz: May I break in? In 1959, there were 71 cases of malaria reported in the United States. Fifty-four of these were confirmed, but only six were indigenous to United States. Two of those were from blood transfusions; so that we have a total of four cases which apparently were transmitted within the United States. In 1960, the number of cases were even lower, but I don't have those figures.

Dr. Williams: Thank you, Dr. Fritz. Until recent days we did receive some infection from Mexico. The transient labor that follows the crops, here on the West Coast, were bringing 60, 70, or more cases each year. In 1959,I think, there were one or two cases. Last year, no cases have appeared. This is not strange, Mexico is nearing the end of her eradication program and has very little malaria left. The same thing is happening in other countries. Puerto Rico is free of malaria; so are the Islands of Barbados and Tobago. Northern Chile has eradicated malaria. The bulk of Venezuela is now free. Part of Argentina, all the Coast of British Guiana, of Surinam, and most of French Guiana have succeeded in eradicating malaria. Already some of Mexico, and by mid-year all of Mexico, the Canal Zone, Jamaica, the islands of Dominica, St. Lucia, Grenada and Trinidad will have finished the attack and be in the consolidation and surveillance stage.

The global eradication program has progressed well. Most of Spain is now free of the disease and much of Portugal, Holland is free as is most of USSR. Italy is now clean as is Sardinia, Corsica, and Sicily. In most of Greece malaria has been eradicated. Singapore is free, and one of the nicest eradication programs so far has been on Formosa, where the last count among ten million people showed only 44 cases in 1960.

Within the consolidation period in Europe is Albania, Jugoslavia, Bulgaria, some of Iraq and some of Iran, and the rest of Greece where they haven't yet eradicated the disease. In the United Arab Republics the program is in fair shape. Lebanon is in the consolidation period and so is Israel, as are some of the Philippine Islands, part of Borneo, and some areas in Japan.

In Europe the claim is made that all countries will be in the consolidation phase—that means the watchful waiting surveillance period by 1962. In Asia, India is doing an extraordinarily good job. Africa I am going to leave to Mr. Roy Fritz.

Sound planning is the first essential for a successful program. It has to be complete and thorough. I very much appreciate the remarks of Dr. Malcolm Merrill this morning as he bore down on the necessity for planning through to the end. Some of the early malaria eradication programs became somewhat occult because

they were only planned to get started; they had not planned through to the finish.

While the reconnaissance is going on, public health education should commence. The populace should be prepared for the advent of the spray squad lest refusal meet it. Who opens the door to a stranger who suddenly appears with a pump to spray an unknown substance for some mysterious reason on all the walls? Preparation of the public is an essential to success.

Decisions must be made on what insecticide, what dose, and what cycle is to be used, DDT or dieldrin. With DDT, spray twice a year; with dieldrin, traditionally, only once a year. As all local costs are paid by the government, they are very willing to spray only once a year. It was not until they found out that one spraying a year was insufficient—that too many new houses were built, that too many of the walls of the houses that have been sprayed have been altered by painting or white wash or half a dozen calendars, or pictures hung on them—two sprayings a year has become a necessity. Also, anophelines become resistant to dieldrin more easily than to DDT. A national malaria board on which sit high members of each of the cooperative agencies is needed to assure full inter-agency cooperation. Special legislation for the malaria service is required to give that service authority to hire, to fire, and to set salaries. That can be quite difficult in a country that has a civil service system scaled to the expectation that four-fifths of the employees will do an inefficient job; and so pay is at a low level, and consequently the hours are short to allow time in which to work somewhere else to assure a living wage. Such a civil service system cannot operate a malaria eradication job. Legislation must create a separate organization given autonomy and a free hand.

The World Health Organization will send a team to help a country make the pre-eradication reconnaissance and plan for the job. They will assess the malaria; they will also train the personnel in the country; and they will recommend its administration. This may not be easy in a country where no one was especially trained in the administration of government schools. For teaching the administration of malaria eradication, programs had to be organized. WHO and PAHO have done this at strategic areas throughout the world. The World Health Organization will help in malaria eradication with technical advice to countries with the premalaria eradication services and it will assist in building up a technical administrative force. It has set up schools and field training and it does a certain amount of research.

In planning, it is essential to make arrangements for financing throughout the entire period of the program —that means for eight years. It must cover not only the preparatory phase but the attack and surveillance phases. Although the epidemiological service is not urgently needed until surveillance commences, it must be foreseen and personnel must be trained for it during the attack phase.

In surveillance there are two methods: the active and the passive and combinations of both. The advantage of active surveillance is its ease of supervision because it is done by the malaria eradication service. It is the dividing up of a country and putting enough people into each section so that in a three month period they can actually visit every house. That costs money. It may cost as great as seventy-five percent of the most expensive year of attack. The passive method is different. In the passive, one hunts out intelligent people in each locality; teaches them the simple method of taking a blood slide and mailing it. They are given an antimalaria drug to induce the people to come and give up a blood slide. They are residents, there all the time, and the people can find them easily. But it does have a big disadvantage, for it is always incomplete. No matter how well we seem to run it, it is incomplete. A combination of both methods is ideal.

The World Health Organization has six regional offices, of which the Pan-American Sanitary Bureau is the Regional Office for the Americas. The regional offices provide advisory services, educational services, parasitologists, administrators, epidemiologists and evaluators. The technical staff at present at headquarters is comprised of eleven people. In the regional offices there are thirty-three, and on the projects there are three hundred and eighty. Of these, ninety-seven are medical people and fifty-five are entomologists. There are seven training centers, with an allowance for fellowships, so that people can be sent to be trained in English in Jamaica, in Spanish in Maraquay and in Mexico, in Portuguese at Sao Paulo, and in English in the Philippines, Jamaica, and Cairo, and in French in Jugoslavia.

In general eradication programs are carried out by governments which bear sixty percent of the cost. UNICEF is putting in about ten million dollars a year. Between them they have supplied the major foreign currency needs of this vast program. Now I think I have given you enough statistics and we will go on to the next phase.

Mr. Fritz: No questions, but I would like to say a few words in summary.

You know, we who are involved in these problems have to talk from both sides of our mouth at the same time. Frankly, we are very pleased with the progress that has been made on a world-wide basis. When we talk to congressmen that are going to provide money for the program we must emphasize this particular aspect; but on the other hand, when we sit behind our desk piled with papers of problems, we have to talk to our administrators in terms of the problems that are facing us in order to make this world-wide problem a true success. So, we have to look at it from both sides and sometimes we are talking optimistically, sometimes we are talking pessimistically. Oftentimes it disturbs me no end when some of my friends come to me and say, "Well, now, I hear the program is a flop in such-and-such a country." This is not so. It is not so until we give up and say that we cannot do the job. There are many problems, but one by one those problems are being surmounted and we are making tremendous progress.

For example, during the past year two and a half million blood smears were taken from people that were ill, had fever, in the western hemisphere. The rate of positivity of those blood smears was less than one percent. Well, if any of you have traveled in Latin America prior to 1958, or even know about the situa-

tion, you know that this is a tremendous sign of progress.

Dr. Williams: Thank you, Dr. Fritz. In answer to the question from the floor, "Why is the U.S. interested in fighting malaria abroad"?, we have had malaria fever imported by visitors from other parts of the world. It is not only the travel of the United States citizens abroad, who, on returning, bring malaria, but facilities for traveling to the United States are so much greater than they have ever been before that we get a large number of visitors. But, to me, the big reason why the United States is interested in malaria control abroad is because we pay such a high malaria tax on all of our imports from malaria-ridden countries. We probably pay better than fifteen percent higher rates for the imports that we make than if the countries which are exporting those goods didn't have malaria.

Question: What effect have all of these airplanes flying all over the world with so many of them stopping here? Are they spreading insects in our country at a rapid rate?

Mr. Fritz: May I answer that question? Dr. John Hughes is probably in the audience. One of his responsibilities is that of disinfecting the planes as they arrive in the United States. I think that if you want some first hand information, he could give you this.... Every plane that comes into the United States is sprayed, I think I am right, but John would have to confirm that statement.

Dr. Williams: Dr. Fritz, would you now present the viewpoint of ICA? The ICA is the overseas agency of the United States government that aids foreign nations. Malaria eradication, we think, is rather prominent in those operations.

THE ROLE OF THE UNITED STATES IN MALARIA ERADICATION

ROY F. FRITZ, *Chief*
Malaria Eradication Branch, ICA, Washington, D.C.

You just took my first sentence. The ICA are three initials that represent the International Cooperative Administration, which has gone by many different names in the past. It is known overseas more frequently as the Point Four Program of one of our former presidents. As has been indicated here previously, malaria is no longer an endemic disease in the United States. Many of you present in this room know the details of our fight against the disease here. Many of you, also, know of the pioneering work that has been done by Americans all over the world in the control of the disease. Today, many Americans are continuing this pioneering work in the malaria eradication program.

Some of these pioneers are well known to all of you. Some of them come from California. I hate to see Dick Peters, because I am afraid always that he is going to say, "When are you going to quit robbing us of our best District Managers and our best people from out here?" I have passed him in the hall two or three times, but I have not stopped to talk to him yet.

The United States is a full-fledged member in this world-wide fight against malaria with the World Health Organization and its regional office the Pan-American Health Organization in this hemisphere and with ninety other nations or entities scattered all over the world. The World Health Organization plays a very important role in this undertaking because it is the only organization that can truly coordinate the efforts of all these nations, so that there is a concrete, well-executed program.

The U.S. has an important role because of its industrial and technical know-how. Where else could sixty million pounds of insecticide be mobilized in one single year for this fight overseas? Where else could we obtain the numbers of vehicles and the spray equipment which can withstand eight hours or ten hours a day's use day in and day out, year in and year out? Where else could that be produced? It isn't produced, anywhere else.

Of course, I think that the most important contribution which is being made is the financial backing of this program. To be a little bit more specific, with so many partners in this undertaking there has to be some ground rules to assure that there is coordination. The ground rules that have been accepted are those policies and procedures which have been adopted by the World Health Assemblies and by the WHO expert committees on insecticides and malaria. Now this does not mean that the technicians in the various countries cannot have a difference of opinion; but when the technicians of ICA do have a difference of opinion with our colleagues in WHO, we have learned to talk these out until we come to the proper solution of the particular problem that we are working with.

This coordination effort is quite a big one, and every year we have several meetings to assure that there is coordination between the WHO and the ICA, not only between the headquarters office represented by WHO, Geneva, but by the regional offices and by the personnel who are stationed in the various countries. So far the need for utilizing all of the available resources has been so great that there has been little opportunity for any of the partners to go off on a tangent and set up their own way of doing things.

The U.S. plays an important role in supplying the commodities to these programs: insecticides, vehicles, sprayers, microscopes and so forth. We play an important role in the training of personnel by supporting training centers in Jamaica, in the Philippines and elsewhere for training of the international personnel. We support a segment of the research that is necessary in this world-wide program by a project with the Communicable Disease Center in Savannah, Georgia. They are working on a number of projects in insecticides, in packaging, standardizing our equipment, insecticides, and so forth.

The ICA also plays a role in the evaluation of various programs. The India program, which is the greatest in the number of people being protected at the present time—there being some three hundred and ninety-four million people in India now being protected from malaria—has just had an evaluation team from ICA. This team went into all of the areas of India and very critically pointed out the problems that were slowing up the progress of eradication. In these efforts we tend to overlap in function with WHO and UNICEF, a United Nations organization that provides a good deal of the commodities, but in no instance do we duplicate efforts country by country. The ICA and the WHO are

working jointly in twenty-one countries. The ICA-UNICEF are working jointly in eleven countries. To carry out its role, the role of the United States, the U.S. will have spent, from 1958 to June, 1961, about 120 million dollars in support of both bilateral and the multilateral aspects of the program. This is in addition to regular contributions being made to the UNICEF and the regular budgets of WHO. In all there has been about one hundred and thirty-five million dollars spent in this endeavor by the United States. Additionally, the United States in partnership with these nations own certain sums of local currency. About forty-three million dollars equivalent of these currencies have been invested in the program. I think there is no question but that the U.S. will continue to support this program. I think that if you had listened to our new president the other day that you would have gathered this from his talk about bettering the health of people throughout the world.

Although the program is limited in time in any one area, the magnitude of the problem is going to necessitate a considerable amount of time before the world is free of this disease. If you have any doubts on this, just mentally picture a country such as Indonesia, where there are some eighty million people at risk to malaria and where there are few people who are trained to undertake this job.

As Dr. Louis Williams said, we do have problems of training technical people to assist these governments with their programs, and again if you have any interest in this sort of thing, I happen to have a few blank applications up here that we could arrange to issue if you will just see us a little bit later. Dr. Louis—I have no more than that to contribute.

Dr. Williams: I am very grateful to you for your informative discussion, Dr. Fritz. You have emphasized the large role that the United States government plays in this program. Now why does the government spend so much money on malaria eradication overseas?

Mr. Fritz: Well, I think you have given some points on that already. There is another one, however. It is in the interests of the United States to keep many segments of the world free. We are spending a considerable amount of money in trying to develop countries economically, and how in the world can you develop the economy of a country if fifty, sixty, seventy-five percent of the people annually have malaria? Even if only thirty percent or ten percent have malaria, you just can't do it. It seems to me that this is an important factor.

Dr. Williams: This might be stated as a question of hemoglobin. Hemoglobin carries oxygen. It carries it to the brain as well as to all other parts of the body, and if the whole population of a nation has only forty-five or fifty percent of the hemoglobin that the number of people ought to have, you can't expect that population to think as well as it is going to think after the malaria is gone and hemoglobin rises to normal. It is a very anaemia producing disease. We think that our democratic way of life is far superior to anybody else's. If we wish others to understand our view, and appreciate our way of life, and be friends with us, then they must be able to think properly. I think it comes down to a question of hemoglobin. Do you agree with me, Bob?

Dr. Coatney: Yes, I think that you have got something there. I'm going to try to keep mine high.

Dr. Williams: Well, we now come to the viewpoint of an entomological researcher on malaria eradication. Dr. Rachou is an eminent epidemiologist who started out being an entomologist. Dr. Rachou, would you please give us your viewpoint?

ENTOMOLOGICAL RESEARCH ON MALARIA ERADICATION

RENE RACHOU, *Ph.D., Entomologist, P.A.H.O. Guatamala City, Guatamala*

Thank you. Ladies and gentlemen: The present malaria eradication campaign based on the intradomiciliary spraying with residual insecticides was planned on three major and fundamental facts: the first was the host-specificity of human plasmodia. Man was considered the only known vector and reservoir of this malaria parasite, or at least, the only one of true immunilogical importance. The second factor was the longevity of the parasite or the natural exhaustion of sources of infection. Human plasmodia spontaneously disappear from their vertebrate host in a shorter time than was formerly admitted: *Plasmodium falciparum*, within one year or a little longer; *Plasmodium vivax* in no more than three years; *Plasmodium malariae*, which may last somewhat longer than *vivax*, loses its infectiveness after its third year of life. As a third factor, the indoor transmission. Human malaria is usually and predominantly transmitted indoors. Therefore, the application of insecticides of residual action on the internal surfaces of human dwellings should interrupt the transmission of malaria. This interruption for a period of a little longer than the longevity of the human plasmodium determines the natural disappearance of the plasmodium from the population. This natural disappearance, considering the absence of other reservoirs, accomplishes malaria eradication.

This, in very broad lines, is the philosophy and the strategy of the present malaria eradication campaign which is not vector eradication but the natural exhaustion of the sources of infection by the ending of transmission, even without killing all *Anopheles*. These general and fundamental principles of malaria eradication are today as firm as when they were stated. The achievements of several countries in several parts of the world, as Dr. Williams told us, are definite proof that the possibilities of malaria eradication as they originally planned it was not unfounded.

Nevertheless, the same success has not been obtained everywhere. Some programs, mostly for financial, administrative, or operational difficulties, failed to develop as fast as they should, or in accordance with the proposed original schedule. Some others had to face the real problem of persistent malaria. Indeed, many factors may interfere in the successful action of the intradomiciliary residual insecticide in cutting down and interrupting the transmission of malaria, even in programs with adequate house spraying operations; but even in these programs with a total complete, efficient and regular coverage of all the various acts,

one or several of the following factors, which I shall mention, may play a role in the persistence of malaria transmission in these programs.

We have to consider, first, cases of subtotal coverage. Some houses of the malarious area are not sprayed, or because they were left without being sprayed at the moment of the spraying operation; and in this case we have two main causes: the houses were closed when the spraying squad arrived in the locality, or by refusal of occupants or owner. Then we have also the problem of the new houses constructed between the spraying cycles. These new houses may be a consequence of the growth of the population or maybe a consequence of the custom of the population. For instance, in the first case, we have in the north of Belize—the program in Belize is well developed and in 1960 they had only 163 cases in all the country. Of these, fifty percent of the cases occurred in the north of the country in the rural area called Sheepyard, which received workers from Mexico. In 1957, these workers, called menonites, 12 of them from Mexico, came and settled there. In 1958 there were 25 or 26 and there were six houses. In 1959 they had 24 houses and 100 inhabitants. In 1960, January, they had 109 houses and 400 inhabitants. Six months later, in July, they had 1,200 inhabitants and more than 200 houses. Fifty percent of the cases in Belize came from this area and almost the total number of cases from this area occurred in houses that were constructed after the year's spraying cycle.

As an example of the second problem, houses that are built or constructed after the spraying cycles as a custom of the people occur in the Pacific coast of Costa Rica. In this place they have a problem of persistent malaria. We worked there last year, suspecting that we had to face some entomological problem as extradomiciliary transmission or resistance or other factor; but visiting house by house and making a thorough survey of each house, we found that in the three last cycles about thirty-five percent of the houses in this area were being sprayer for the first time. The total number of houses in this area, however, did not increase. That is a custom of the population. They have a very primitive type of house of thatch, cane and so forth. They build their ranch, this little house, and four, five, or six months after, they pull the house down and construct another nearby and bring with them the same number of occupants and the same spraying target. So, it is quite a problem to prevent the persistence of malaria in this area.

Then we have the problem of incomplete coverage. New sources constructed at sprayed houses, or by addition, or by the intermittent or step by step house construction. That is most common in the rural area or rural countries in Central America. They first construct their shelter or ranch of four poles and the roof. When the spraymen arrive they have only about one meter of roof on which to put DDT because they spraying operation covers up to about three meters high from the ground. The houses have no walls. Well, fifteen days to one month after the spraying, they put up the external walls of the houses and they await the next cycle of the spraying that is coming five months later. So, these houses are practically unprotected. You have another cycle; you think that the house is protected; then the owners divide up the house with internal surface walls into several compartments. That constitutes one of the problems of persistent malaria because in the houses there are constantly unsprayed surfaces that are good resting places for the mosquitoes inside the houses.

Another problem is the substitution of sprayed surfaces by new ones, mainly in the houses of varied primitive types. Since the houses of cane and thatch are not able to afford good protection from the rain and weather, the owners are always substituting new surfaces for sprayed surfaces. Then there is the question of new and unsprayed furniture. These can offer, even in sprayed houses, good resting places for the anophelines within the houses. This is a factor that has not yet been measured. This can be, insofar as we know, a real cause of persistence of transmission, but we have some suspicions in this regard. For instance, I was in a place in Nicaragua last month, at a place called El Cajon, where I tried to catch several mosquitoes that tried to rest on furnitures that were not sprayed.

Another group of factors is related to the alteration fo sprayed surfaces: wall washing, wall-papering, wall painting, calcimining, and wall preparing or the action of smoke, dust, grease, friction and other mechanical factors. In some parts of Belize it is the usual habit of the population to wash the internal walls of the houses three times a year. The first time is on the occasion of the anniversary of the Queen of England. The other two occasions I do not exactly remember, but they are fiesta days on which they wash all the houses. The question of papering is another important factor. The houses have their walls in various conditions with openings and so forth, so it is a habit to protect themselves against weather conditions by papering. As an action of the smoke, dust, wind, friction, and other mechanical factors, we really don't know if the smoke can be considered as a factor in alteration of the sprayed surfaces. Personally, I do not remember catching any anophelines on smoked surfaces. So, I do not know if smoke on a sprayed surface will really alter the sprayed surface, because it seems to me that they are not normal or good resting places for the anophelines. The question of the dust must yet be proven and needs study. There is a place in Nicaragua that is called El Porvon and they have a serious problem of persisting malaria transmitted by *albimanus*. The local *albimanus* is highly resistant to DDT. He rests quietly and calmly in the houses, even on the sprayed surfaces. But the name "El Porvon" in Spanish means dust in English. It is a very dusty and windy place. We have clouds of dust that are deposited inside the houses and over the sprayed surfaces. But in this place we have, as a first cause of persistence of transmission, the resistance of *albimanus* to DDT, so this second possible factor has not yet been really studied or measured.

Then we have the group of factors related to the type of house construction: houses without walls, partially walled, or with walls highly fenestrated. In the Amazon region, for instance, it is very common to find the type of house without walls but with three floors on four poles. Each floor is occupied in a certain season of the year, depending on the level of the water above the Amazon River, and then you have the roof. So, you don't have any wall surface to insecticide. Houses

partially walled are common in Paraguay. You have a roof, four poles and one or two walls, only to protect against wind and nothing more. Then there is the highly fenestrated type of wall which is very common in the rural areas of Central and South American countries.

When we went to study the problem of persistent malaria on the Pacific coast of Costa Rica, one of the aspects which we tried to develop was what we call in Spanish "en cuesta de roseado", which means survey about the spraying operations intimately related to the house. We measured it house by house and we tried to establish several relations among the surface areas that we obtained. One of these relations was called the relation between the ideal perimetrical surface of the house and the real perimetrical surface of the house. This was a tentative attempt to translate in numbers the subjective impression that we have in saying that the houses do not have enough walls to be sprayed and give adequate protection to their occupants. We imagine, as the ideal perimetrical surface of the house, the surface of the external walls and the roof if they hadn't any opening. The real one is this surface less the open area that we found. For this area we found an average of twenty-five percent of open surface area on the perimetrical surfaces of the houses there. That is a quarter of the perimetrical surface that could be an obstacle to the entrance of anophelines was open. To get an idea of this twenty-five percent of the surface, let us imagine a house formed of only one room, a square house, with four walls and the roof. If we consider only the walls, each house would have only three walls; but when we consider the roof area, it means that the average house has only about two walls.

Then we have the other problem of the houses with verandas. It is very common; seventy, eighty, ninety percent of the houses of rural areas of certain zones in Central and South America have a veranda. This is a place covered only by the wall of the house and open on the other three under the roof, and is usually occupied by the entire family during the early hours of the night. You find that everybody will sit there between the hours of six and nine at night and they are bitten by mosquitoes which do not have to go inside the houses. The mosquitoes come, they bite, and they go away without resting on any of the sprayed surfaces.

Then we have certain houses with very high roofs. Preliminary studies demonstrated that the spraying operation should reach to three meters from the floor, since the anophelines, with the exception of certain species, normally rest at levels less than three meters from the ground. Houses with these very high roofs offered a large area of unsprayed surface as resting places for the anophelines. In one of the surveys, wherein we made captures of mosquitoes resting at levels above three meters, in houses sprayed with pyrethrum, we captured twelve anophelines resting under this high roof which had not been treated.

Another problem is the nature of the material used in the walls. Walls with softer material seem to act quicker in inactivating the insecticides deposits. This is a problem which we know exists, but we do not know exactly the extent of inactivation. Thus far we do not have a reliable and easy technique to evaluate this problem.

Then there are several problems related to human habits: movements of human population, migrations of nomads of certain tribes as well as certain types of workers. In my country, for instance, in Brazil, it is very difficult to protect the men that work in the rubber trees and those that pick brazil nuts. It is most difficult to protect those men; they live here today and at night are sleeping in another place, and so on. Another habit of the population that is a cause of persistent malaria is the presence of people outdoors around the houses in the early hours of the night, mainly in those houses which have a veranda. There is also the question of people sleeping in temporary shelters which is very common in parts of the world where we work. In El Salvador the people have gregarious tendencies and live in villages where they have their permanent home, but they work about twelve to fifteen kilometers from the village. Each week they stay three or four days at work, spending the night in temporary shelters that are unsprayed because they are constructed at the moment that they arrive at the place of work.

Then we have the vector habits. We have to consider as factors of persistent malaria in some areas vectors having endophagic activity without, or with, a very short indoor resting period, and the exorphagic activity, considering the peridomiciliary and extradomiciliary transmission. There are several cases well studied and well known here in America. Probably the best known case is the problem of the anophelines of the subgenus *Kertesia*. They are extradomiciliary biting anophelines and we have the problem of extradomiciliary transmission by *bellator* and *homunculus* in the Trinidad Islands, by *cruzi* and *bellator* in the south of Brazil, and just now it seems that the problem exists on the Pacific Coast of Colombia with malaria transmitted by *neivai, nuneztovari,* and other anophelines are transmitting malaria extradomiciliarly in Venezuela and certain parts of Colombia. Even *darlingi,* which probably is the most endophagic and the most endophyllic of the neotropical anophelines in the center of Brazil—probably in the center of the dispersion of species—in the jungle, is a mosquito with exophagic activities. So this problem exists in certain parts of the Americas.

Then the question of the endophagic activity without, or with very short, indoor resting exists. We do not exactly know the real problem, but the problem exists and has already been seen. I had the opportunity of being bitten as a human bait in a house during the night. I caught the mosquitoes and wanted to determine the hours of *albimanus* indoors, so I stayed as a human bait for the twelve hours of the night catching the mosquitoes that were biting my leg. In this house at the same time I had an auxiliary helper who was reviewing the walls; and during this twelve hours time I captured one hundred and twenty-two *albimanus* biting me and he didn't find any mosquitoes resting on the walls.

We also had the opportunity of being bitten at dinner time upon the occasion of my first experience as an international worker. It was at a dinner given at the first house I entered in Costa Rica, during which I felt something on my leg under the table, and when I looked it was an *albimanus*. Everybody stopped to see

what was going to happen to this *albimanus*. He fed himself and then left directly through the door without resting upon the walls. So we tried to make several visual observations. To observe the flight of *Anopheles albimanus* within the house is a very, very difficult thing to do, but we did manage to observe twenty specimens. From these twenty specimens whose flight we could follow inside the houses, twenty-five percent came in, bit, and left through the doors and windows; twenty-five percent after biting flew directly to the ceiling, whereas we know that in general the mosquitoes after feeding go to the lower parts of the walls. Thus we have the endophagic activity without resting period. It is a very important factor in maintaining the transmission of malaria.

Finally, the vector's response to insecticides. We have the question of irritability by exciting repellents as happens, for instance with *gambiae* in regions of Africa, and the question of insecticide resistance. This is considered in two different generally accepted types, the physiological and the behavioristic. There are twenty-one different species of anophelines that are resistant to insecticides—to one of the two groups of insecticides employed, or to both groups. Naturally the same species might be resistant in one area and perhaps susceptible in another. Generally, this problem of resistance occurs in areas where there are agricultural spraying operations. The behavioristic resistance may be a consequence of the increase of the original degree of excitor-repellence as in the problem of *albimanus* in Panama in the Chagres area where the mosquito continues to go inside the houses but does not rest. He tries to rest but he is easily irritated and he goes away from the house without receiving a lethal dosage of insecticide, and the problem of a real change of habits of the mosquitoes as a consequence of selection. The only known cases which I have experienced are in the *Kertesia* problem in the south of Brazil, where it seems that one place *Kertesia* change their habits. There it used to go inside the houses in very high numbers and DDT was sprayed inside the houses to control malaria. After two or three years of such control for malaria, transmission was again high. We looked for anophelines inside the houses and we could not find them. We measured the susceptibility of the anophelines to the insecticides and it was the same as in areas that were not sprayed. We found the anophelines not in the houses but around the outsides of the houses on the bushes. We could even find two or three specimens with sporozoites. Two or three years later we couldn't find any *Kertesia* in the bushes around the houses. They didn't arrive anymore. They were totally and exclusively extradomiciliary. We think that this is one of the cases that may be considered a change of habit by a vector population of certain importance.

I think that that is all I have to offer, thank you.

Dr. Williams: Thank you, Dr. Rachou. Well, Dr. Rachou has carried us pretty much over the epidemiological problems. He has touched on pretty much everything from nomadism to extradomiciliary biting, and now I see we have a question from the audience.

Question: It seems as though in many cases you have had but very little success in spraying, and I would like to know what results you have had from source reduction.

Mr. Fritz: May I aswer that Dr. Williams? The question is that in these cases where there have been problems of reducing malaria transmission by means of insecticides, what success has been achieved by source reduction. I was anxious to say something here before that question was posed. Both Dr. Williams and Dr. Rachou have stressed this matter of the use of insecticides in this world-wide program. Actually, this is the most economical means that we have at our disposal for this program, but it does not mean that where we run into problems wherein the insecticides are not handling the malaria that we do not go to other measures.

Now in Nicaragua, where we have run into this particular problem, we have turned immediately to larvicides as the first step. The draining, filling and so forth will come on as soon as we catch our breath from the larviciding, but in the face of outbreaks of malaria from three localities in Nicaragua the turning to larvicides immediately stopped the transmission and the malaria cases began to be down to nothing again.

Dr. Williams: Then, of course, we have the whole question of the use of drugs, but I have purposely left that alone since Dr. Coatney is going to speak of that after the break.

I think we can dispose of the next question rather rapidly and that is the question of administration. It has been mentioned by almost everyone here as a tough nut to crack. Before we ask Dr. Fritz to open that question, I would just like to read the description of the Director of a Malaria Eradication Campaign as visualized by a panel composed of a number of distinguished American malariologists, and they each had their own viewpoint to throw in. It says:

"The Director of a National Malaria Eradication Program has the prime responsibility for seeing that malaria is eradicated in his country. To do that he should have full administrative authority, that is nationally budgeted malaria eradication funds and the resources made available to the program, also, control of personnel including hiring and firing. Care must be taken in the selection of a director competent to exercise this authority and competent to delegate this authority to the lowest supervisory echelon."

Now Dr. Fritz, will you speak a few words of the troubles you have had with administration?

ADMINISTRATIVE PROBLEMS IN MALARIA ERADICATION

ROY F. FRITZ, *Chief*
Malaria Eradication Branch, ICA, Washington, D.C.

You know when I first got involved in this malaria eradication, I had just come from a program in the United States where we had a great many technical and administrative problems, but where we had people who could readily meet those problems and surmount them. In the face of a number of successful attempts to eradicate or, let me say to bring malaria down to nothing in pilot projects throughout the world, malaria eradication appeared technically possible throughout the world. I was just a little bit naive to believe

that this could be done, that we could get on with the chore and that was it, until we began to run into administrative problems of a magnitude of which I had no idea.

Dr. Williams, you have touched on many of these things briefly, or hinted at them, as you have gone through your discussion; but I think that I might take just a few examples to bring home just exactly the magnitude of these things. I can't begin to describe all of them. I think that one of the major administrative problems is that in many of these countries there is just no administrative structure with the flexibility to carry on the military type of campaign that the malaria eradication campaign has to be to be successful. Let me give you some examples.

In one country, all personnel, even spraymen, must have the recommendation of a member of congress before he can be appointed to a job. The president in this country makes all appointments. With no more required qualifications than this, there is no wonder that many of these spraymen turn out to be inadequate for the hard work or even detrimental to the program.

We have met problems such as this in some countries by establishing the malaria program as a semi-autonomous organization in government with a Directing Council responsible for establishing rigid qualifications for all jobs and with the full authority to hire and fire personnel, in accordance with the Council policies, in the hands of the Director of the malaria program. Under such circumstances, when a Minister of Health is asked to employ a person through political pressure he can refer the person to the Director of the Program. The Director can reply, "Dear Doctor . . . you know that we have an agreement that we will only hire people that are competent to do this job. We would be glad to give this man a chance, but if he does not carry out the job he is assigned to, he cannot stay on the program." This relieves the minister of this political pressure and keeps the program free of these political hangers-on.

There are many other important aspects, the matter of funding, for instance. To maintain petty cash at a field headquarters to replace a bolt that holds a radiator to the motor block is difficult. The method of accounting is sometimes such that a year is required for repayment. Well, you can't operate on that basis. Pretty soon you are out of petty cash so the radiator falls off, the fender falls off and the spray cans aren't repaired and you are in bad shape.

Another example: in one small country arrangements were made to provide gasoline to the whole fleet of vehicles from one single filling station. If one group of spraymen went out to spray villages many kilometers from the headquarters, they had to carry gasoline in the back of their vehicle so that they could do their job. When those barrels of gasoline ran out, they had to come back and fill up and go back out again if they hadn't finished their job. This problem with the gasoline went on month after month after month until somebody from the outside came in and investigated that situation and said, "Look, we can make arrangements with filling stations in every one of these places where there is a filling station, and you can get your gasoline that way." No one had thought about it.

Supervision is one of the greatest administrative problems. It is awfully easy for a sprayman, unless there is someone right on his neck, to go off and sit down under a tree someplace. You've got to have competent and devoted supervisors inspecting all of the houses that these spraymen are spraying. This generally is the leader of the spray brigade, but you have to have somebody checking on him, and you have to have somebody checking on the fellow that is checking on him. This just has to be done. You can't do it any other way in these places.

Maintenance of equipment. This is a major problem. It is human nature, I guess, for people to get in a car and drive it until it stops, or to use a spray can until it won't spray anymore. But in order to maintain this equipment so that it will last over the number of years that it has to last, you have to have planned maintenance of those vehicles and sprayers and so forth. This has to be taught to the people. They cannot do it as just a function of normal reasoning.

There has to be a complete planning of these programs. If you go into Latin America now at the beginning of the spray cycle, sit down with a zone chief, you will find that he has on his desk an itinerary for every spray crew in his zone. This itinerary shows, week by week, what villages they will be spraying, how many houses in that village, when they can complete that job and go on to the next village. They have an itinerary for every one of the surveillance aids, the evaluators, so that at any time he knows where they should be. If at any time he finds out that a spray crew is not where it should be, then he has to find out why they are not there. If it is a matter that more houses have been built, and they have had to do more spraying, then he may have to supplement that spray crew with additional men to get that job done on time. But that has to be done on a constant basis, and you cannot do that unless you have planned in advance and know how many houses are in these areas, these villages, and set up an itinerary on the basis of this.

The matter of human resistance is a big problem. Dr. Williams mentioned a spray crew going out and piling out to spray a house. The people have to know why they are coming in to spray a house, or why someone comes and tacks a number on the house. If he is going to tack that number on the house, the people are going to immediately start to wonder: am I going to be taxed? or is my oldest son going to go into the army? or what have you. You have to inform these people.

I am just more or less hitting or missing some of these things. I think Dr. Rachou has many more examples. I know you do, Dr. Williams.

Dr. Williams: In other words, it is a question of supervision and checking, double-checking, and rechecking.

Mr. Fritz: It is certain that an international consultant or advisor can't say look, this is the way it ought to be done, and then turn his back and go away. He has got to stay and get the same sort of devotion or fanaticism in the people down the line that he himself has in order to be successful in this program.

Dr. Williams: Exactly so, Dr. Fritz. We are very much obliged to you for this illuminating discussion, but I think that at the present moment we had better take a little recess.

RECESS.

Dr. Williams: The subject that now comes up is malaria and zoonosis. For those of you who don't know what a zoonosis is, it means a disease of an animal that can be transmitted to a human being. Dr. Coatney will present this subject.

MALARIA AS A ZOONOSIS

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Thank you very much, Dr. Williams. This story begins rather far back. Because we had always considered that when we got to talking about malaria eradication we would not have to take any time to think about malaria in lower animals as ever being infectious to man. So, it was with a good deal of surprise that on the fifth of last May, when Dr. Eyles called me from our laboratory in Memphis, Tennessee and said, "I have malaria." I said, "Okay, we have had our joke for today, now what's on your mind?" I thought he wanted some more money for some pet project of his. "No, I'm serious. I have malaria." I knew he wasn't working with any of the human malaria at that time and I said, "Is there any possibility that that monkey malaria that you have been working with has somehow gotten into you?" He said, "Well, that is my guess." The point is that we immediately took the blood from him and put it into a Rhesus monkey and it grew. Human malaria, so far, grows very poorly, any of the simian malarias, grow very poorly in man. *Plasmodium cynomolqi* as we know will grow in man, but it will only produce about four paroxysms, maybe five, and then it burns itself out. When this malaria from this infected blood was put into monkeys, it produced typical *cynomolqi* infection in the monkeys.

This was the first evidence we had that monkey malaria was infectious to man. You can imagine the consternation on our part because we had—we, meaning those of us in malaria eradication—because we had a bill before the Congress to give thirty-eight million dollars to malaria eradication. Now the Congressmen are rather smart folks and we knew that right away they might say, "For heaven's sakes. You want thirty-eight million dollars for malaria eradication; but how in the world do you propose to spread this to eradicate malaria from monkeys too?" Well, this is simplifying the situation a little, as you well can see; but the point is that this was a question which had to be dealt with immediately.

I am going to ask our operator to show you the first slide to demonstrate what happened. Here you see what happened on the 28th of April when Dr. Eyles got sick. On the 5th of May we knew he had malaria, but we didn't know for sure which malaria he had because *Plasmodium cynomolqi* looks like *vivax*. He was quite ill and had been sick from the 8th of April. He had been treated for bad colds and things, and no one suspected that he might have malaria. However, his assistant came down on the 8th of May following this; in other words his technician took sick and when her blood was examined on the 11th of May, she also had malaria. What had been happening was this: these people had been dissecting large numbers of mosquitoes in order to get a large number of sporozoites into a single monkey in order to be able to study the exo-erythrocytic stages of *Plasmodium cynomolgi* in the monkey. We were doing this because if we could produce good infections in the monkey and then section the livers of the monkeys and find these parasites in the livers, then we could start giving drugs to find out whether these drugs which were being used would actually kill the parasites in the liver—and these are the parasites which are responsible for the relapses. So, when these two people became sick and we found parasites in their blood, the blood was taken from these two people, put in the monkeys, and each of the blood samples produced infection in the monkeys. For the second stage, we took blood to the prison in Atlanta, where we have an installation for studying malaria in prisoner volunteers, and when that blood was put into two volunteers at the Atlanta prison they came down with malaria and ran a very stiff course—if I might call it that.

Well, the interesting thing about this is that on the 8th of May in Cincinnati a man got sick. That man was also working with monkey malaria in Dr. Schmidt's laboratory. This went undiagnosed until the 13th of May. They knew this man had malaria all right, and they put his blood sample into a monkey and it produced a typical infection in that monkey. But, because Dr. Schmidt was so interested in studying TB, he forgot to look in the blood of the monkey for 12-18 days; and when he did, he thought he had the wrong monkey because he found *vivax*-like parasites in that monkey. He felt that this could hardly be; this man couldn't possibly have malaria, it looks like *vivax* but he hasn't been any place where he would get it. So, on the night of July the 7th, if I remember correctly, he called up Dr. Eyles and said, "By any chance when my boy was over at your place finding out how to raise mosquitoes, did you have any human malaria over there?" Dr. Eyles said, "No, but we've got it now." "What are you talking about?" Dr. Schmidt said. Dr. Eyles replied, "We've got four cases in the laboratory right now of monkey malaria."

Not to be outdone, Bethesda had to get in the act, too. One of Dr. Huff's assistants who had been working with malaria for many years got it. Dr. Huff was getting infected mosquitoes from Dr. Schmidt; Dr. Schmidt had gotten the parasite from us; we had gotten the parasite from Garnham; Garnham had gotten it from Hocking; Hocking had got it from Kuala Lampur a year and a half before then. The point is that this lady had taken sick on the 4th of July. She had gotten 17 infected mosquitoes from Dr. Schmidt and could account for everyone of the 17 infected mosquitoes—they were dissected and the spores used in tissue culture for some work that they were doing in Dr. Huff's laboratory at the Navy. But, evidently, in the packaging, one of these mosquitoes had got loose or one of them had just nicked her through the gauze of the tube—we don't know. But anyway, she was taken to the hospital, went through four paroxysms, and finally —and this is rather amusing in a way—at the third

paroxysm while they had her at the hospital she said to the physician that was attending her, "You know, Doctor, I might have monkey malaria," because she knew about this thing happening in Memphis. The doctor immediately went out and told the nurse, "You know, this lady is worse off than I thought. Take all precautions with this lady. There is no telling what might happen." But, on the other hand, she was smarter than the doctor at that particular moment; but, of course, she had more information than the doctor. Within a day and a half it was diagnosed. The point is that her blood when put into monkeys also produced infection. We then had a simian malaria infectious to man. By the time this fourth case was known, we had already had two more cases in Memphis which were purposefully induced.

One of our boys went into the insectary and allowed thirty of our infected mosquitoes to bite him without telling Dr. Eyles anything about this. Afterwards he did come back and tell Dr. Eyles what he had done; but it is pretty hard to take the spores out of him. Of course, had Dr. Eyles known his intention, he would have said, "You can't do this." Anyway, of these two fellows, one of them came down—two men actually did this—with a frank attack shortly thereafter, on the fourteenth day, if I remember correctly. The other fellow had a slight malaise and didn't look quite right. Although his blood did not show parasites, when his blood was put into monkeys, it did show infection—using Rhesus monkeys all the way through.

We determined then that we must study this carefully in order to know whether this might really be a problem in malaria eradication, because we knew that there was *Plasmodium simiam* from Brazil, *Plasmodium brazilianum* in Central America, *Plasmodium schwetzi* in South Africa, and I could go on and on with these things. If these simian malarias are infectious to man we must know this right away, because we have to plan for that if it is true.

(Slides were then shown with pertinent narration.)

Here is the parasite on a thick smear, and for those of you who are familiar with thick smears of malaria parasites, the parasitemia in these people is low. The highest parasitemia that we have had is around five hundred per cubic millimeter, and that is pretty low. These people get very sick, nevertheless.

The next slide shows what happened in terms of time. We used *Anopheles freeborni* and we used *quadrimaculatus* in some cases, but here is what happened. Here we are down on the forty-ninth case—forty-nine people that have been infected by mosquito bites. We are using two strains of *Plasmodium* in the monkeys, *Plasmodium cynomolgi bastianellii*, which was named by Garnham while he had the parasite, and the old *Plasmodium cynomolgi* which we worked with in this country for a long, long time. It shows that some had frank infections while others were not well indicated.

In our Memphis laboratory Dr. Eyles was trying to get large numbers of sporozoites into the monkeys in order to be able to find these stages in the liver. The liver is a large organ, and in order to find these things you have to introduce large numbers, so he was putting sporozoites from as many as two hundred mosquitoes—in other words, dissecting the glands from two thousand mosquitoes in one eight hour day—and injecting these every two hours (they keep them cold). If a mosquito or two, or three, escaped they let him go; they didn't stop and try to catch that mosquito, because at that time there wasn't any point to it, since from their knowledge monkey malaria doesn't infect man anyway. That is evidently how they got infected.

Here is what happened purposefully, after that. These are all human volunteers that had been purposefully inoculated by bites of infected mosquitoes in the Atlanta penitentiary, that is the cases from ten on down. These are volunteers who agreed to go through this. The next twenty cases are shown in this slide. They were not at all infected at the same time, but this shows the fever pattern. You notice that those marked with an N are all Negroes. We needed to know this right off the bat, because if this malaria is infectious to Negroes and produces a good infection in Negroes, the planning would have to be different than if they were resistant. We had no reason to suspect that they were resistant at all, but the people that had so far been infected at the time we started this were all white. As it turned out, we did not produce an infection recognizable to the extent of finding parasites in any of the Negroes. Three of the Negroes, however, did have a slight fever response, their liver had a slight hypertrophy, their spleen came down, and this all happened at the time that you would expect to find parasites, that is in the first two, but not the third. Later we had one in which we did find parasites.

So, where are we when we have gotten this far? Here was an infection—a monkey parasite that looks like *vivax*, and if those of you who are familiar with parasites on smears will look at this, you would say that it is *vivax*. There are a few differences, but you don't see them right off. When we set this thing up, the idea was not to treat anybody if we could avoid it, but for administrative reasons, we had to treat one or two. One fellow got paroled, if I remember, and another fellow was one that we just couldn't get along with and we had to get him off the project—things like this happen all the time, so this was nothing new. One man had almost a continuous fever for six solid days. He was pretty well knocked out so he was given ten grains of quinine, it was knocked down for a little while and then came back again. In general, however, this is the fever pattern of *Plasmodium cynomolqi bastianellii*, monkey *vivax*, in man, that is as far as his temperature response and so on occurs. Now then, there are two or three things that are very distinctive about this malaria. One is a very pronounced bitemporal headache—this is pronounced, terrific. They all complained of this. In every case the spleen comes down almost as soon as you find parasites, sometimes before; and this is not typical of *vivax* either. The liver is very tender and has a slight hypertrophy, and parasitemia is low and does not increase. In fact it disappears off and on for some eighty days.

The next slide shows what an oocyst looks like—in other words, one of these infected prisoners produced gametocytes. We allowed mosquitoes to feed on that inmate volunteer; they became infected, and this is an oocyst on the gut of one of those mosquitoes. The next slide shows you the sporozoites from that oocyst. It was burst and the sporozoites stained. As you know, this is what the mosquito puts in to start the infection

all over again. So, we had found out up to this point two things: one, that we could infect man by allowing mosquitoes that had fed on monkeys to bite man and the man became infected. We then allowed mosquitoes to feed on the infected man and we had it this far. Then the question was, could we get it the rest of the way? Could we get the mosquitoes that had fed on man to infect man? So far we have been able to do that once; but the man did not show parasites until one hundred and four days after he had been bitten. He was bitten by one hundred and twelve mosquitoes, but only four of them were found to be infected when they were dissected and we found the sporozoites with difficulty in the four. I don't know how to explain this—why it took so long for the parasites to appear. The man had fever and all of the clinical signs or symptoms by the fourteenth or fifteenth day, but we couldn't find the parasites.

Then we have been able to transmit it first from monkeys to man, and then from man to man. Now this is the new strain of *Plasmodium cynomolqi bastianellii.* Dr. Schmidt, not being satisfied with this, since he had not believed what he saw—and I don't mean this critically at all. He was incredulous. He just couldn't believe that monkey malaria could infect man; and none of us believed it, you might say. He had the old strain of *Plasmodium cynomolgi,* that Dr. Coggeshall had isolated from a monkey that he had found in the zoo in New York, if I remember correctly, in 1940. That old *cyomolgi* has been used by all of us during the war years and up till now, until we got this new *bastianellii* strain. No one believed that it would infect man up until now. Dr. Schmidt allowed heavily infected mosquitoes, from this old *cynomolgi* strain, to bit three members of his staff. One man showed parasites after some days, but blood taken from two of the three produced the infection in *Rhesus* monkeys. We then decided that the thing to do was to take heavily infected mosquitoes fed on monkeys with this old strain and try them on our prisoner volunteers. We did this, allowing forty-two infected mosquitoes to bite each of two Negroes; and I think it was twenty-five or twenty-six mosquitoes to bite each of nine white people. None of the Negroes came down with parasites; but one of the white men did. This blood, a blood taken from him, and put into another man produced the infection in him, and blood taken at the same time and put into monkeys produced the infection. Then blood taken from this first man has produced an excellent infection in the second blood recipient, and we even have mosquitoes that are infected because I have already seen the oocysts on the gut. The day after tomorrow, if everything goes well, we will put those mosquitoes on fresh, clean volunteers to see if we can transmit that one.

So, here we are at this stage. In August, Dr. Eyles was sent to Malaya where *Plasmodium cynomolgi* came from. Within three weeks he had found the vector for *Plasmodium knowlsei.* It turned out to be *Anopheles hackeri.* A vector, any vector, for this parasite of monkeys which will grow in man very poorly, had been sought for a quarter of a century. He was very lucky to find this vector. Since then he has come home. They have Dr. Garibaldi out there and they have turned up *vivax*-like malaria in three different new species of monkeys—new from the standpoint of parasites—and just recently we have a report that came to Roy Fritz saying that Lee Howard had found malaria in monkeys in the Philippines, which is really the first report; although it had been isolated some years ago, in 1940 I think, from a Philippine monkey. So they now have a laboratory in Malaya, which I hope will be permanent to the extent of two or three years, to study these malarias in man to see if these monkey-malarias in Malaya, for example, are infectious to the people there, and if the malarias in the people are infectious to clean monkeys which we are bringing in from India.

So far we have not been able to transfer any of the human malarias to monkeys; but this doesn't worry us too much because we haven't had too many monkeys, for one thing. We have made thirty trials, however; thirty different bloods from thirty different people have been transferred to thirty different monkeys and so far have not produced an infection—not by the time that I left Washington. However, many trials had been made with *Plasmodium cynomolgi* over the years before this accidental infection on the 5th of May last. Why they didn't take, no one will ever know; but I don't know what the story is.

In a few words, this is the story of what appears to be a zoonosis because it satisfies the definition; but more important really, in terms of malaria eradication, we haven't got the answer for Dr. Williams as to whether this really takes place to produce an infection in man. We are going right ahead with this, infecting new people all the time and studying this disease in order to get the life pattern and so on. But there is the story of a simian malaria in man which may be a problem in malaria eradication. Thank you.

Dr. Williams: Thank you, Dr. Coatney. That is a fascinating story. Are there any questions that anyone would like to ask Dr. Coatney. Being as he is the only one that knows anything about it, I am not surprised that there is nobody popping up with a question.

Mr. Fritz: I would like to ask Dr. Louie a question. What do you think the epidemiological significance might be on this?

Dr. Williams: Well, you have heard Dr. Coatney say that he didn't know.

Mr. Fritz: It seems to me that there are some facts though that we must consider, and that is that in many places where there is malaria and where we are trying to eradicate it we won't be faced by this problem because there are no monkeys.

Dr. Williams: Exactly so. That is very true, and that covers a large part of the world. The second point is that the Negroes were hardly infected, and that we can hope will eliminate Africa. Whether this is going to be one of these cumulative things; whether a monkey parasite has adapted itself to human beings and will go through repeated transmissions from one human being to another, to another, to build up its ability to be transmitted to humans, nobody knows. It is a possibility. Just at the moment, I have the feeling that this is an interesting accidental discovery which at the moment does not assume large proportions. If it should assume large proportions, all that it means is that we will have a forest reservoir with infected people in the forest and we will simply have to go after them with drugs, and go after them hard. There may have to be

a barrier zone between the jungle and the densely populated area. But these are questions that only time will tell, and as time is running out on us now, the next subject was slightly miscast in the program—it is really intended to be the WHO Research Program, and I have quite a bit of material on it, but I am going to literally skip most of it. We have two interesting subjects still to come and I would rather save the time for them.

The World Health Organization is making a study of administrative and socio-economic troubles that have risen in one place or another. Particularly the problem of nomadism which in the old world in some places assumes considerable proportions. On the operative side, we do get a number of problems. For instance, there is collaborative international work which was stimulated and organized by WHO in the domain of the study of behavior of vectors of malaria for the investigation of feeding preferences by means of the precipitin test. I won't go too far into that. Then there is the critical appraisal of data on results of insecticide susceptibility tests carried on throughout the world. This boils down to the fact that they have found resistance in thirty-two *Anopheles* species, of which fifteen are important malaria vectors in the countries concerned. I would like to say that the resistance among mosquitoes is not the tremendous resistance that agricultural pests so often exhibit. When a mosquito is resistant, it is usually two, four, or six times as resistant as normal mosquitoes; and even in El Salvador, where the local *Anopheles albimanus* is resistant to both DDT and Dieldrin, that when DDT is freshly applied, it still kills them for about three months. That is about as well as Malathion does on those mud walls, so Mathalion is no particular advantage in that place.

They are carrying on research on the epidemiology of disappearing malaria and on the determination of the best practical and economic surveillance procedures—research on the practical methods best suited to deal with continuing transmission due to nomadism, on the more economic dosages of insecticides, on the behavior of vectors in sprayed areas, and on the best and most economical methods of drug administration in malaria eradication projects.

We have also commenced at least one biological approach and there are those playing around with the fungus, *Coelomyces*, which they have found in the South Pacific parasites against tree-hole breeders, where they have *albopictus* which transmits filariasis. They have found that seeding down tree holes with this fungus that it completely removes this mosquito. They are studying in a number of places, and trying to develop, anti-malaria drugs in the hope of finding the perfect drug. The entomological work, I am going to pass over. They are evaluating spraying equipment; and finally, they give assistance to a good deal of research. They give grants in cash to research on the mechanism of dynamics of induced resistance of malaria parasites to drugs. It was recently found in the Magdalena Valley of Colombia that *falciparum* has, in a few places, become resistant to chloroquin. A study of the bionomics of the mosquitoes of Israel which are giving them a good deal of trouble; research on invasion of erythrocytes by exo-erythrocytic stages of *Plasmodium* as a model for studying the effect of anti-malaria drugs. Assessment in the field of bio-assay methods and their application for determining the activity of residual insecticides is under way.

Entomological problems, particularly the genetics of resistance, are coming under a good deal of study. Research on the use of flourescent antibody techniques for parasitological studies of malaria, and the study of an electronic scanning machine to make diagnosis more rapid. There are others, but that will indicate that the World Health Organization is keenly aware of the problems that are facing them. They have commenced research on them. They have about four teams in the field at the present time and doubtless there will be more.

I am going to close this part of the discussion at this time, because, as I say, our time is getting short and we have two very interesting final papers. Dr. Coatney is going to tell us something about "Chemotherapy in Malaria Eradication."

CHEMOTHERAPY IN MALARIA ERADICATION

G. ROBERT COATNEY, Ph.D., *Chief*
Laboratory of Parasite Chemotherapy
National Institute of Allergy and Infectious Diseases
Bethesda, Maryland

Thank you, Dr. Williams. Ladies and gentlemen: I am being inflicted upon you in a real strong dose today. It is hard to get me to talk about malaria, and it is still more difficult to get me to talk about the chemotherapy of it. Dr. Williams has succeeded; he has broken down my resistance.

What has happened in the chemotherapy of the disease is a far cry from what we had at the beginning of the war in 1940 up 'till now. The whole subject revolves around two things to my mind. One is in the different philosophy that must be adopted if we are going to use drugs for malaria eradication. The physician is interested in treating his case and he has but one idea in view, and that is to get that person back to health so that he can go back to work and carry on his normal duties. Those of us that are interested in applying drugs for malaria eradication have a sick community to deal with, so that it is entirely different. Those of us that are interested in chemotherapy for malaria eradication are not one bit interested in the person who is sick; except that we expect that the public health facilities will take care of the sick individual, naturally. We are interested in stopping transmission; bue we are also interested only in using drugs for stopping transmission when the other methods fail. For example, it is much cheaper, and much easier, to stop transmission by the use of residual insecticides. Though spray personnel do not need to be highly trained, except in one sense, the point is that you don't have to do a perfect job, merely a good job is adequate in spraying. But in the use of drugs, you must get the drug to everybody, and this is difficult—extremely difficult and very expensive. The result is—if I might read one paragraph from the expert committee on malaria in its eighth report of August, 1960, where it is said:

"It is now recognized that in some parts of the world the chemotherapy of malaria has its place, also in the attack phase, either in conjunction with residual insecticides if their action is too slow, or without residual insecticides if these cannot be used effectively."

The report also gives the reminder: "There is yet no proof that eradication of malaria from any sizable area can be accomplished by the exclusive use of existing drugs." And this is true.

If we are going to use drugs then, and in certain areas we have to use drugs, for any number of reasons —Dr. Rachou told us about the houses without walls, and I have been in this area too, where there is no wall to spray; the morés of the people sometimes prevent spraying, the business of nomadism, and I could go on with all sorts of things that make it very difficult in some areas, in some places, with some peoples to use residual insecticides—therefore some other way must be found. And the only way at the present time that we can think of is to use drugs. Now these drugs are effective, highly effective, but no one drug will do all the different things that we want them to do.

Let us take, for example, chloroquin—and I take it that all of you know that quinine has disappeared as far as having any real place, or no place, in malaria eradication, although there are still some places where they use it for treating a particular case where they raise quinine—but in chloroquin we have an excellent drug. It persists for quite a long time in the body of the person who receives it. In other words, if six hundred milligrams is given in a single dose, the person's blood will maintain a blood-level of about ten micrograms per liter for twenty days; the parasites will be taken out of the blood stream and kept out for twenty days. If you give a gram and a half in three days, which is the accepted dosage now for the treatment of a case, this will hold for forty days. But imagine trying to go to an area with twenty thousand people, more or less, and try to get every person there to swallow two pills. You can't even get people who are sick to take pills every day even for a short time. The doctor tells them to go to the drug store and get this and they take it; but he knows very well that sometimes some won't do it. Here you have people that are more or less well; they don't even know that they are sick until you tell them—then you try to get them to take pills. You can do this once or twice, you can take candy along for the children, or balloons, and you can tell the mother what a wonderful thing this will be, her child will be rosy cheeked and so forth, and for a while she will go along with you, but this gets old. People are not going to walk five or six kilometers to come to a place where you are dispensing drugs. They will come the first day because it is a kind of circus day and they want to see what this all looks like—what are you going to do, what are you going to sell, so to speak. This is hard to do; so something must be found to get these drugs into people and so that they will stay for a long time.

One approach is to try to find a way which will extend the action of a drug like chloroquin, which is an excellent drug, but if you give four times as much as you try to give now, you will make people sick, so that won't work. If we could get a drug that would keep this drug from being absorbed—in other words, to prevent the metabolism of this drug for a while, we might get someplace. Dr. Russell was one of the first people who thought about this and he tried to get us to work on it a long time ago.

In this first slide now I am going to show you a slight beginning in this regard—it hasn't been accomplished by any means. When you put in one hundred milligrams of chloroquin, as it shows here, into a rat, it is degraded as shown. But if you take that same amount of drug and at the same time the same amount by weight of SKF 525A, which is a French compound that has no action at all as far as malaria is concerned, you can see what happens. It carries the degradation curve on out. It prevents the metabolism of the chloroquin for awhile and can carry this on. So the principle is sound. This chemical is SKF 525A, and if any of you want the chemistry of it, I'll give it to you—it's about three yards long. But the point is that this particular compound can't be used because if you give it for a long time it produces fatty degeneration in the liver. Still, the principle is here in this compound. It can be done; if we could just find the right way to do it.

So far this has not been tried in man. We can do this in mice, rats and rabbits—it does work. Now if we could find some way to prevent this damage so that we could give this drug only once every six months, and you may give it with a hydraulic gun, then all you would have to do is just walk along the people as they lined up with your gun filled up and treat them as fast as you could touch the skin to the nozzle of the gun. It doesn't prick the skin; they don't even know that it is being given. That is one aspect of this thing.

Another aspect is that you have the situation which I think Dr. Rachou mentioned, in Venezuela, in which you've got outside biters and outside resters—*Anopheles nuneztovari.* In the area you have the old reliable that yields to DDT. In this slide I will show you what happened in Venezuela. Here is what was happening up until 1956 in the State of Trujillo under the best system that could be devised. There is no system for the use of DDT any place in the world, to my mind, that could compare with the organization that Dr. Gabbledon had in Venezuela. This was an army; not only an army that was willing to do what they were told, but this was an army that believed in what they were doing. But you see the two things are separate and to illustrate this, I asked one of the fellows who was dispensing drugs down there, "How are things going?" He said, "Look, we are going to eradicate malaria." He didn't say Dr. Gabbledon was going to eradicate it; he didn't say Venezuela was going to do it; he said *we* are going to do it; which to me is very significant. And they will do it; but—in this particular area you can see the dwindling number of cases down to 1956, and they could not get it any lower. Every single house was mapped, every house was visited and was sprayed—but why? Because *nuneztovari* was biting and resting out side. It isn't a very good vector, but just enough so that malaria was being transmitted. So Dr. Gabbledon decided to use drugs, and in 1957 he started chloroquin, giving everybody chloroquin, using the same kind of army precision to see that everyone got the drug. But chloroquin is bitter and the children didn't like it so they would run off into the woods when the man came—you couldn't blame them. He changed to pyrimethamine three months later, July 1

of 1957. Pyrimethamine is tasteless; the children would take it; and he put on a big campaign. Another reason that this worked was that the boys who were actually dispensing the drugs came from the areas in which they were working. In other words they would recruit them, train them, and then take them back to the same areas. So that here is a boy who comes and gives a youngster a drug and he is known to that family and he knows them. It isn't some city slicker coming in to do it. In the beginning of July this started off and in the first three months the malaria down there dropped to nothing so that in September, October, and November there was not a single case in one hundred and ten thousand people. Every person had a card and they knew exactly where he was—or where he could be found.

Then came the revolution. Everything broke down, as you can well imagine, and malaria began to appear in May and June. We knew that four of these cases were new cases because they appeared in children that had been born in October and November. Then what to do? Well, there was only one thing to do, and that was to start the program all over again. In other words, pyrimethamine, a very excellent drug, could be given to a hundred and ten thousand people every single week at fifty milligrams per dose. But very few countries are like Venezuela—few have as much money per capital as Venezuela for this kind of a project—who have a man like Dr. Gabbledon who instilled an esprit de corps that I have never seen anywhere else in the world—and as a consequence it worked. I don't mean that they do not have good people elsewhere too; they have good people in Brazil, too; but the point is that it was a model program that they had set up here. But this began to break down because they left out two things. One is to put the incentive back in whereby the man who saw to it that every man under his jurisdiction got the drug over a certain period of time would receive a bonus. And the mother who saw to it that all of her six children who took the drug over a certain period got a lottery chance on a sewing machine or some other household appliance; so she saw to it that all of her children got the drug, naturally, since she might get a sewing machine. But this was left out, it didn't work so well apparently. But the point is that the use of drugs can be successfully done, which was why I wanted to show you this. But it is too expensive to be practical as a primary method.

Now the next slide gives the data from January to June of 1957, and shows clearly the results of which we have been speaking. This shows zero cases in October, November and December for one hundred and ten thousand people, just by using pyrimethamine once a week in a single dose. Now we'll show what can be done by putting chloroquin or pyrimethamine in salt. This is a way of getting it into the people without having to go around and visit every one of them. The only thing you have to have is an area where no salt can get into the area except medicated salt. This was a test; a pilot project with prisoner volunteers to show whether it could be done or not if all the salt which was used in the preparation of their food was medicated at the dosage for each of these drugs: one of them got three hundred milligrams of chloroquin per patient per week, the other one at the rate of twenty-five milligrams of pyrimethamine per patient per week. It worked, as you can see. They all came down with malaria, eventually, after cessation of the drug. We knew this—we knew that these drugs were not curative. But we also found out that although they were bitten on three separate occasions one week apart, they did not come down during the life of the experiment. So it can be done. This is being done in Brazil right now, in the whole Amazon Valley, where twenty-five tons of chloroquin was delivered in one shipment, if I remember correctly. And this cost about a million and a quarter dollars. This is really a big project. This is a pilot project and the bouquets should go to the inmates who allowed us to do these experiments.

The last slide shows what recently happened when Dr. Donald Moore, over in Dallas, found a case that would not yield to chloroquin from the Magdalena Valley in Colombia. These are Dr. Young's data. He later took the parasite over to Columbia, South Carolina, and this shows what happened. In other words, here is a drug, chloroquin, where we have never been able to get any parasite resistant to this drug. We have tried everything we knew and we could not do it. But we could do it with pyrimethamine and some other things, but we couldn't do it with chloroquin. Then all of a sudden resistance shows up in Colombia. Another slide here shows what happens in a patient when the parasite fails to respond. So, here we have something on our hands now. This area, we don't know how large it is, finds the best drug for the treatment of malaria or suppression of malaria, to keep malaria from being transmitted, subject to a true resistance to this drug. I found the same thing in South Africa on March of last year, which we have proved by putting it into prisoner volunteers, and I think it will prove to be the same thing. We are in trouble with drugs. Thank you.

Dr. Williams: Thank you, Dr. Coatney. We will now take up the last one, Malaria Eradication in Africa, which is a tremendous task but I think it can be done. Dr. Fritz, will you summarize malaria eradication in Africa, please?

MALARIA ERADICATION IN AFRICA

ROY F. FRITZ, *Chief*
Malaria Eradication Branch, ICA, Washington, D.C.

Africa has been known as "the dark continent" for a good many years, but the reason for this has not been the color of the skin of a good many of the inhabitants. The reason for this has been the fact that Africa is mysterious and unknown. And the malaria situation in Africa was unknown back in 1955 when the nations in the World Health Assembly advocated that malaria eradication should be undertaken on a world-wide basis. They excluded, at that time, Africa from consideration simply because they did not know what the situation was. This was the situation a year later when the President's International Development Advisory Board studied this problem. They too excluded Africa from their consideration. We are just now beginning to understand what the problem may be in Africa. It is true that early control projects, which were fre-

quently affiliated with military operations, were highly successful in controlling malaria. It was easy to reduce the infection rate of eighty to one hundred percent in a village down to five or ten percent. This was outstanding. But, nevertheless, the problem is in getting that last five or ten percent.

We didn't know, and we don't even know today, the total population of Africa. Since that time, 1955-56, there have been a large number of pilot projects in Africa to find out what the situation really is. Many of these were not very successful in the beginning. I know very well the situation in the interior of Liberia, where Dr. Avery Jones was trying to spray all the houses of quite a large area. He just could not get rid of that last residual malaria. But since then we have found some very interesting things in that same Liberia area. It was found that the population lived for a part of the year in what they call "rice kitchens." These are shelters that are built out in the rice fields where they live while they keep people from poaching on the rice, while they keep birds out of the rice. These were not sprayed during that original trial in Liberia. When Dr. Guttoso took over the project, he faced that problem and followed the boys up when they were spraying and insisted that they walk out, find every one of those rice kitchens, and spray it. As soon as this was done, the malaria rates dropped precipitously—down to nothing. No parasites in infants whatsoever, and very, very low rates in all of the other persons.

Dr. Coatney: A contrast to that, Roy, was in Zanzibar where I tried to get them to do this same thing and they wouldn't do it. And malaria is right where it was then.

Mr. Fritz: That is right. It came right back. At the same time a pilot project in Cameroon had the same experience. At first the results were not adequate; but when they went out and found and treated everyone of these shelters that were being inhabited they got rid of the malaria.

Now to appraise this situation in Africa, the World Health Organization called a meeting of experts at Geneva in August of last year. The consensus of that group is quite optimistic. All of the failures to stop transmission in Africa have been found to be due to problems which can be surmounted.

One of the problems has been that of resistance to insecticides. There is an area in the central western part of Africa where dieldrin has been used and where the *gambiae* are highly resistant to this insecticide. They quickly developed resistance to dieldrin. But investigations have shown that this area of resistance is quite limited, and there are areas in other parts of Africa where dieldrin has been used for a number of years and no resistance whatsoever has developed. Very obviously there is a difference in the *gambiae* population in those two areas with respect to their ability to develop resistance to this insecticide. *A. gambiae* is susceptible to DDT. The greatest problem in Africa has been the lack of complete coverage of the areas in the pilot projects. In the August meeting they found that successes were being achieved in a number of areas. When the results were examined it was found that in some areas the two vectors, *Anopheles gambiae* and *Anopheles funestus*, had virtually disappeared. It happened in the Liberia area. It happened in the South Cameroon area. It happened in areas that were forested principally; but it is practically impossible to find *Anopheles gambiae* in those places where the job of spraying has been thorough. They also found that in other areas of Africa there has been a change of biting habits, or they have eliminated the portion of the vector population which was biting humans. The remaining population is zoophilic and exophilic. In fact in Southern Rhodesia in some quite extensive tests run they found that about one-tenth of one percent of the *gambiae* mosquitoes were found to have bitten man. In other areas they found that it was very easy to reduce the vector population to a point where transmission of malaria was completely stopped. There is a possible fourth category of conditions which could not be proven by the data available, and that is one that Dr. Rachou mentioned, this matter of outdoor transmission. It has been claimed in a number of areas in Africa; however, careful appraisal of these projects has shown that there are other reasons for failure in each one of these areas. Principle of these reasons is lack of thoroughness in insecticide coverage. On the other hand, in several areas where such extradomiciliary transmission would be expected because people rest and sleep out of doors or live in shelters which consist of four poles and a roof, in all of these areas where spray operations have been thorough, transmission has been stopped. This is much more optimistic than the view which Dr. Rachou had to bring us from the area of Central America.

The conclusion of this work was that malaria eradication was technically possible in Africa. Still, there are some major problems to be surmounted. One of the major problems is the lack of money. Most of these nations are so low in their economic status that they cannot bring forth the two and a half to six dollars per person which will be necessary to eradicate malaria. There is a shortage of trained, or even trainable, personnel. You can't take a boy from the village who in the past has only been concerned with scratching a little patch of soil to grow enough rice to keep himself alive and then take him into a program of this nature where he has to do a thorough job for eight hours a day or more and expect to get very far. You can't readily train him to do that. It takes a great deal of effort.

There is certainly a lack of administrative structure on which we can mount a program of this nature. I am not going to go into detail. Poor communications is an obstacle that is going to be difficult to surmount. People walk in Africa, and our spraymen are going to have to walk. They are going to have to walk and find trails back to villages and back to huts. This is not an easy thing to do. I think that one of the major problems is that there is a lack of desire on the part of the villager to have people come in and treat them with drugs or spray or anything else. They may be sick at times, but this is their way of life. They haven't known anything different from that.

Logically, even though eradication is possible in Africa, we certainly should await successful conclusions of our programs in other parts of the world before taking on the large burden. Right at the present time the international organizations are extended to their maximum capacity in resources of money and trained

personnel. However, the leaders of these new African countries are not going to wait until other parts of the world are freed of malaria. These new leaders recognize malaria as the major deterrent to the economic and social development of their country and they are demanding that malaria eradication be started in their country. At the present time there are three centers of malaria activity in Africa. One in the southern part where the Union of South Africa has eradicated malaria from an area containing about two and one half million people and as actively engaged in a program in the rest of the country. Adjacent to that, Southern Rhodesia and Mozambique are carrying out programs in part of their territory. In the central western part of Africa, just below the hump, Liberia has a program, and there are scattered pilot projects all the way over to South Cameroons. These projects could be coalesced into one large area of activity. In the northeastern part of Africa, French Somaliland has eradicated malaria—it's a very small area, very much of a desert, but malaria no longer exists there. Somalia has a program over the whole area. They have a real problem of nomadism. Of about a million and a half people in that country, a half million of them move back and forth throughout the country, into Ethiopia and elsewhere. Ethiopia has a program for eradication that is just now getting started. Egypt has completed the pilot work. They have completed their pre-eradication survey and this year are starting their coverage in one part of the whole malarious area. Libya has reduced their malaria problem to one small area now of ten thousand people and there is no transmission, apparently, going on in that area. These three blocs have solid activities going on, and if we must get into this, and I am sure we must, these are the areas where we must start to build—to extend these areas outward until we can make them coalesce into a final program for all of Africa.

I have gone over it pretty hurriedly, but that is the story I think as far as Africa is concerned, except that I might say that our new president, President Kennedy, is very much interested in the future of Africa and that I have spent this whole week-end, Saturday and Sunday, drawing up some plans on what might be accomplished *if* the resources were available, and if the countries of Africa were really serious about going into this problem of removing malaria.

Dr. Williams: Thank you, Dr. Fritz. I think that covers the situation fairly well. In conclusion, I will draw your attention to the fact that what the panel has done has been to try to give you a broad picture of the malaria eradication program on a global basis. We have then taken up problems that have faced various people in various countries and what we are trying to do about it. Dr. Coatney has told you of the drug program; although it has its problems too, in the main these problems don't halt the campaign. In some areas they have not yet been solved. When all of the eradicable part of the world has eradicated malaria, then these few small places where there are problems that have not been resolved yet by the use of the cheap modern methods, then these places shall commence to assume an importance to the rest of the world which they do not visualize at the present moment. When almost all of the world is free of malaria, those few foci remaining where the problem is technical and is tremendously difficult will then have the total resources of the areas of the world where malaria has been eradicated in removing these last foci of infection which can reinfect them. At that time they will begin to realize the great importance of these residual foci to them, and we will get the resources of the world pouring out to remove these foci, even if we have to go back to the days of digging ditches and spraying larvicides. So the future really looks bright and I am confident that, although I may not live to see it, our children will live to see malaria as an historic event of the past.

Thank you.

Dr. Jobbins: Ladies and gentlemen, for this afternoon's session, I certainly want to express the thanks of our entire group for the very wonderful coverage on this heroic problem. I certainly hope that all of the aspirations of you and your group and others who expressed the needs realize these in the not too distant future. Thank you, very much, again.

(End of session)

THIRD SESSION

WEDNESDAY, FEBRUARY 1, 8:30 A.M.

ANNUAL BUSINESS MEETING OF THE CALIFORNIA MOSQUITO CONTROL ASSOCIATION

Presiding: GARDNER C. MCFARLAND, *President*

CMCA BUSINESS MEETING

Pres. McFarland: Again it is my pleasure to preside over a business meeting of this august body. I only wish I had time to give a Presidential address worthy of the group, but suffice it to say that it is my firm opinion that the California Mosquito Control Association has continued to make progress and in no small measure has contributed to improved mosquito, gnat, and fly control in 1960 throughout the land.

This progress would not have been possible without the support and contributions of all of the members of the California Mosquito Control Association, its friends, and in particular its officers and committees.

We only have an hour to complete all our business, so I now declare the Annual Business Meeting of the California Mosquito Control Association to order and ask the Secretary to call the role to see if we have a quorum.

(Sec. Murray called the role of Districts and established that a quorum was present, 27 of 51 districts.)

Pres. McFarland: First I would like to call on our Secretary-Treasurer for the Budget Report.

Dr. Murray: I would like to point out that in developing our CMCA bookkeeping records, we have made some advances over past procedures, in that we now have a bona fide journal for journal entries, and we have a bona fide ledger for ledger entries, plus a number of sheets for balances so that we know where we stand. The auditors who have audited our books in past years have stated that they just couldn't guarantee certain records because they couldn't get balances. I believe that we now have improved things so that these problems should not occur in the future.

We have an audit report that is submitted at this meeting, put out by the CPA who audited the books as they exist in Visalia. This report will be presented in the Proceedings. The budget of the Association was formally established on December 2nd of 1960. That budget was approved by the Board of Directors and was circulated to the membership with no repercussions. The accepted figures were entered into the books and they are shown therein at the present time. Both the expenditure budget and the anticipated receipts are shown so that we can compare how we stand as we go along throughout the year.

One thing I would like to point out on the budget is this: There is apparently some confusion among the membership as to just what a budget is. I have been working on this for some time under John Brawley, who headed the Committee a year ago, trying to find out who should make the budget and when it should be made. It seems that we should consider this budget as a guide or a plan. It has to be made out before the Conference, because that is when most of the money is spent. To do that, it should be done early enough and before we get too far involved, that is, early in December. As far as I am concerned, that is the budget, and that is what is in the books.

Now, you have an incoming Board of Directors—and maybe they don't like something in the budget. All right. It is up to the new Board of Directors to make a change. This change can be entered into the books.

One thing that has been commented upon by past auditors has been the matter of an inventory. It isn't too big a job, so for the past two years I have taken an inventory of our CMCA supplies. This will again be put in the Proceedings so that you will know what is available. One of the things that I would like to see removed for physical reasons alone is the supply of Proceedings. We have many copies—300, 325, 270 copies of different years. These are in the past. It hurts me just to throw them in the wastebasket and burn them. They don't burn well anyway. I wish that we could move them to libraries, and Don Grant and I, of the Publications Committee, are going to do as much of that as possible. If you know of anyone, of any student, of any school who could use some of these, let us know. It would be an official use and would be a very proper use.

One other thing involves membership. For 1960 we had 51 active agencies at the beginning of the year, but only 44 paid members in 1960. Seven agencies were not members of the Association. Of these seven, only four are really of significant size. Carpenteria, Oroville and Pine Grove are small Districts with modest programs. There were four large districts that did not contribute, but even that is not bad if you look at fourty-four agencies. Some of them we have to give a pat on the back because they have not been too involved in our total program, but they are still sharing with us.

In 1961, right now, we have 55 active mosquito control agencies. As of today, we have thirty-one who have already paid their Corporate membership fees, and we have several from whom we have received the agreement but they haven't paid.

One point that I would like to bring up, although there is no rule and nothing we can enforce on this and it is strictly up to your honor—but contractual payments are based on budget; it seems the fairest way. We start at ten dollars payment for a budget of ten thousand up to twenty thousand, and is scaled up. When your budget reaches a hundred thousand,

we hope that you will give a hundred dollars, and then it levels off; there is no more payment beyond that. Our financial record has gone very well; in fact, we gained about two hundred dollars during the last year over expenditures. This is perhaps pretty tight, but we still were on top. I have noticed this year that a couple of agencies haven't paid according to their budget. Maybe their budget that they turned in to the salary committee isn't what they are using—I don't know. We can only hope that you will be fair and considerate, because it isn't fair to the others that must pay more than their share.

SECRETARY-TREASURER'S REPORT

Miscellaneous information of membership and exhibitors.

1. Corporate membership

In 1960

51 active agencies at beginning of year.
44 paid members in 1960.
Only seven agencies did not participate in 1960. Of these only four have programs of significant size.

1. Fresno	125,000+
2. Kern	300,000
3. L.A. City Health Dept.	34,000
4. San Diego Co. Health Dept.	50,000

The three lesser are:
1. Carpinteria
2. Oroville
3. Pine Grove

In 1961

55 active agencies at beginning of year.
32 paid
3 agreements in, money coming
22 potential

Several districts have not paid according to the budget. This creates unfairness.

2. Associate members

In 1960
19 paid
In 1961
1 paid in advance

3. Sustaining members

In 1960
14 paid $280.00
In 1961
23 paid $575.00

4. Exhibitors

In 1959
11 paid $550.00
In 1960
10 paid $350.00
In 1961
24 paid $2,410.00

INVENTORY OF C.M.C.A. SUPPLIES

JANUARY 1, 1961

Proceedings, Year	No.	No. of Copies
1930-35	1st-6th	8
1948	16th	44
1949	17th	160
1950	18th	25
1951	19th	220
1952	20th	59
1953	21st	225
1954	22nd	300
1955	23rd	300
1956	24th	325
1957	25th	300
1958	26th	270
1959	27th	200
1960	28th	90
Proceedings-author title index		200
Reprint Malaria in California		200
Guide to Common Mosquitoes of Calif. (charge $1.00 per copy)		167
Mosquitoes About the Home (charge $35.00 per 1000)		5000
Insecticide Bulletin		550
Yearbook 1960		20
Yearbook 1959		120

FINANCIAL STATISTICS OF 29th CONFERENCE AT DISNEYLAND

1. INTRODUCTION

The basic figures have been taken from the exceptionally clear and detailed records of Jack Kimball, plus additional precise records from Norman Hauret, Gardner McFarland, and the C.M.C.A. Secretary-Treasurer. While there may be slight variations in interpretations of the category of some of the figures, it is believed that the records represent outstanding accuracy, made possible by the fact that written records are available for essentially every transaction that occurred.

It should be noted, however, that all expenses are not included in the accompanying records. For example, in the development of the program, the program chairman sent out many letters and made numerous phone calls, the cost of which was absorbed by his district. Other districts, agencies and individuals also contributed in various ways without reimbursement. Finally, some conference expenses are included in the administration accounts of the association, too varied and miscellaneous to justify separation into the conference account.

Sustaining Membership is considered as an administrative, not as a conference account. Exhibitors paid a total of $150, of which $25 was set aside for Sustaining Membership. Also, the $25 supplied by agencies for a Sustaining Membership was placed in this separate account. This bookkeeping procedure resulted in 17 agencies participating both as exhibitors and as Sustaining Members, while 12 agencies participated as Sustaining Members only.

2. FISCAL RECORDS

		Receipts	*Expenditures*	*Balance*
I. Meals—sub-total		$2,846.70	$2,644.55	$ 202.15
Monday luncheon		179.55	165.30	14.25
Banquet		1,974.00	1,700.00	274.00
Wednesday luncheon		481.65	570.00	(88.35)
Thursday breakfast		211.50	209.25	2.25
II. Tours and Ladies' Activities—sub-total		433.00	838.44	(405.44)
Bus—Hollywood tour		99.00	99.00	
Bus—Marineland tour		100.00	44.00	56.00
Bus—Ladies' tour			123.20	(123.20)
Victor Hugo luncheon		234.00	234.12	(.12)
Mission San Juan Capistrano			38.00	(38.00)
Ladies' favors			105.12	(105.12)
Wyco oil bath	$86.40			
Postage	12.12			
Phone	6.60			
Orchestra			195.00	(195.00)
III. Hospitality—sub-total			233.75	(233.75)
Trustees' reception			233.75	(233.75)
Conference hospitality (paid by Willys)				
IV. Registration—sub-total		1,755.00	69.69	1,705.31
Printing cards, tickets, etc.	25.65			
Ribbons	14.04			
Name and address list	30.00			
V. Exhibit expenses—sub-total		2,535.00	530.03	2,004.97
Commercial exhibit, 17 at $125		2,125.00		
Educational exhibit, 4 at $50 and 1 at $150		350.00		
Donations, 1 at $50 and 1 at $.10		60.00		
Decorator			441.00	
Ballona Creek M.A.D.			89.03	
Printing	15.50			
Postage	8.52			
Coupon tickets	23.40			
Prizes	29.61			
Banquet tickets	12.00			
VI. Program—sub-total			107.15	(107.15)
Speaker's expenses			92.55	
Phone calls			14.60	
VII. Conference general—sub-total		12.00	828.36	(816.36)
Room rent		12.00		
Announcement printing			75.91	
Announcement mailing			65.20	
Miscellaneous postage			9.28	
Meals for speakers			12.44	
Hotel room for secretary			60.00	
Hotel room for Harold Gray			48.00	
Program printing			308.68	
Publicity			100.00	
Publicity engraving			54.75	
Miscellaneous local arrangements			94.09	
TOTALS		$7,601.70	$5,251.97	$2,349.73

3. FUTURE ITEMS

All basic conference receipts and expenditures are completed, and the totals presented in the preceding page represents a fair picture of the financial record. However, the profit shown is gross, not net. The C.M.C.A., when it invited the A.M.C.A. to join in this conference, agreed to supply a copy of the Proceedings to every A.M.C.A. member. The C.M.C.A. included the costs of the Proceedings for the A.M.C.A. mailing list in its budget. Also, the recording and stenographic services for preparing the Proceedings are a basic part of the conference budget. These expenses are still to be incurred. The following projection indicates the estimated expenses still before us, and the estimated final "net" income.

		Receipts	*Expenditures*	*Balance*
Totals of completed fiscal activities		$7,601.70	$5,251.97	$2,349.73
Budgeted items—sub-total		-------	1,575.00	-------
Recording expenses	$ 175.00			
Stenographic costs	200.00			
Printing proceedings for A.M.C.A.	1,200.00			
Unbudgeted items—sub-total		-------	300.00	-------
Additional estimated costs of printing	100.00			
Mailing costs	200.00			
GRAND TOTAL		$7,601.70	$7,126.97	$ 474.73

($474.73 is estimated net profit.)

M. FREEDOM MEEKER
CERTIFIED PUBLIC ACCOUNTANT
Post Office Box 411
Exeter, California
January 9, 1961

Board of Directors
California Mosquito Control Association, Inc.
1737 West Houston Avenue
Visalia, California

Gentlemen:

We have examined the balance sheet of the California Mosquito Control Association, Inc., as of December 31, 1960, and the related statement of surplus for the year then ended. Our examination was made in accordance with generally accepted auditing standards, and accordingly included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

Our report includes the following financial statements:

Exhibit A—Balance Sheet, December 31, 1960

Exhibit B—Statement of Surplus, Year Ended December 31, 1960

Schedule 1—Schedule of Expenditures with Budget Comparison, Year Ended December 31, 1960

COMMENTS

Balance Sheet. We made no direct confirmation of accounts payable, since none were recorded. However, we found no evidence of the existence of any liabilities as of December 31, 1960. The deferred revenue consisted of the following prepayments:

Corporate Members' Contractual Dues	$ 100.00
Associate Members' Dues	3.00
Sustaining Members' Dues	350.00
29th Conference Exhibit Fees	1,825.00
Total	$2,278.00

Statement of Surplus. "Other Revenues" consisted of:

Cash fund on hand 12-31-59 not recorded in the prior audit (used through Petty Cash)	$31.94
Stockton Insurance Exchange payment	2.50
Registration Fees, Managers' Seminar	53.00
Total	$87.44

Schedule of Expenditures with Budget Comparison. With the exception of the budget over-expenditure of $60.00 for the fidelity bond, all such over-expenditures were accompanied by substantial under-expenditures in related classifications. The minutes of the Board meeting of October 28, 1960, indicate an intention to transfer funds at the December meeting to cover all over-expenditures. This apparently was not accomplished. We recommend that this action be on the agenda for each December meeting of the Board. The $50.00 spent in the "Contingencies" classification was a payment to Richard S. Lazarus, the speaker at the Managers' Seminar.

Inventory of Publications. The value of publications on hand has not been reflected in the financial statements, as they are largely of an expendable nature. The only one which is held for sale is the "Field Guide to the Common Mosquito," of which 167 were counted by your Secretary, representing a recoverable cost of $167.00. We observed the physical presence of these publications but did not verify the count.

Bookkeeping System. Your Secretary-Treasurer has inaugurated a revision of the bookkeeping system, and has requested our assistance in this accomplishment. We have heard the draft of a report he is preparing in this regard which is, in our opinion, quite comprehensive and appropriate, so that we need add only a notation of our approval. We will endeavor to advise on the establishment of the new system to the extent necessary to obtain satisfactory results.

Conference Funds. One advantage of the new bookkeeping system will be the segregation of the portion of Available Surplus which has been derived from conference activities since January 1, 1960. At December 31, 1960, this amount was $169.64.

OPINION

In our opinion, the accompanying balance sheet and statement of surplus present fairly the financial position of the California Mosquito Control Association, Inc., at December 31, 1960, and the results of its operations for the year then ended in conformity with generally accepted governmental accounting principles applied on a basis consistent with that of the preceding year.

Respectfully submitted,
M. Freedom Meeker
Certified Public Accountant

MFM:mm

CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC.
BALANCE SHEET
DECEMBER 31, 1960
EXHIBIT A

ASSETS	
Cash on Hand	$ 377.50
Petty Cash Fund	86.05
Cash in Security-First National Bank, Visalia	6,801.06
Total Assets	$7,264.61
LIABILITIES AND SURPLUS	
Liabilities	$
Deferred Revenue (1961 Surplus)	2,278.00
Available Surplus	4,986.61
Total Liabilities and Surplus	$7,264.61

CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC.
STATEMENT OF SURPLUS
YEAR ENDED DECEMBER 31, 1960
EXHIBIT B

Balance Available, January 1, 1960		$4,660.31
Add Revenues:		
28th Annual Conference		
Registration and Dinner Tickets	$1,308.00	
Exhibits	350.00	
Total	$1,658.00	
Corporate Members' Contractual Dues	2,710.00	
Associate Members' Dues	57.00	
Sustaining Members' Dues	280.00	
Sale of Publications	474.53	
Other Revenues	87.44	
Total Revenues		$5,266.97
Total Surplus Available		$9,927.28
Deduct Expenditures (Schedule 1)		4,940.67
Balance Available, December 31, 1960		$4,986.61

Note: Deferred revenue of $2,278.00, representing prepaid dues for 1961, became available surplus as of January 1, 1961, making a total of $7,264.61 available at that time, subject to a general reserve of $3,000.00.

SCHEDULE 1
CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC.
YEAR ENDED DECEMBER 31, 1960

Classifications	Budget Appropriations	Actual Expenditures	Under-(Over-) Expended
Administration			
Advertising and Exhibits	$ 150.00	$ 108.00	$ 42.00
Communication	300.00	334.34	(34.34)
Office of Secretary	600.00	300.00	300.00
Office Supplies	200.00	142.11	57.89
Publication, Proceedings	1,600.00	1,833.52	(233.52)
Publication, Other	1,500.00	279.39	1,220.61
Audit (Independent Accountant)	100.00	100.00	----------
Fidelity Bond	65.00	125.00	(60.00)
Travel Expense	500.00	179.95	320.05
Contingencies	150.00	50.00	100.00
Total Administration	$5,165.00	$3,452.31	$1,712.69
Conference (28th Annual)			
Conference Expenses	$1,800.00	$1,112.25	$ 687.75
Proceedings, Recording	200.00	200.00	----------
Proceedings, Steno Service	200.00	176.11	23.89
Total Conference	$2,200.00	$1,488.36	$ 711.64
Total Budget and Expenditures	$7,365.00	$4,940.67	$2,424.33

Pres. McFarland: Are there any comments on the budget from anyone in the group? The procedure will be that if there are no questions or discussions from the floor, we will accept the reports. We do not need action here to approve the reports; we will merely accept them. Any discussion on the report?

Mr. Grant: I think Don Murray deserves a vote of thanks for the great amount of work he has done in bringing these books up to proper order.

Pres. McFarland: We will make it a matter of record that he gets a vote of thanks from the group. We all appreciate it, I know that—not only for work on the budget, but everything else.

If there is no discussion on the budget, we will accept the Budget Committee's Report. Next, I would like to call on Bill Rusconi to give the Fish and Wildlife Committee Report.

DUCK CLUB COMMITTEE REPORT

The Duck Club Committee has considered and recommended to the CMCA Board of Directors that the name "Duck Club Committee" be changed to read "Fish and Wildlife Committee."

The reason for this, being that Duck Clubs Committee is too limited and the Fish and Wildlife is more closely associated with other State and Federal agencies who are related to Mosquito Control.

The Committee also feels that the mailing address should be the office of CMCA Secretary, 1737 West Houston Avenue, Visalia, California, so that in changing of Committee Chairmen there will be no break in communications with other interested agencies.

The Committee received very good response on a questionnaire sent out to obtain information on general control methods of Duck Clubs throughout the State.

These results show 812 Duck Clubs covering 215,055 acres of land.

The general trend shows that source reduction is the practical approach to the problems wherever possible.

This will require close knit cooperation with all agencies, State and Federal, to coordinate all of their research and knowledge.

This phase, the committee feels, has hardly been touched upon and will need a long range cooperation so that we can understand one another's problems better and result in better Mosquito Control.

COMMITTEE
Bill Rusconi, Chairman
Pete Pangborn
Chet Robinson
Oscar Lopp
Gus Auguston

Pres. McFarland: Any comments on the Report of the Fish and Wildlife Committee? If not, this report is accepted.

Now I would like to call on the Chairman of the Education and Publicity Committee, Gordon Smith.

(No Report.)

I would like to say that part of the responsibility of this Committee was the publicity for this Conference, and as you can see, the publicity has been very good. I would like to call on Dick Frolli, Chairman of the Entomology Committee. We will call on him later, then. Is Jack Kimball back? As you know, the Chairman of the Insecticides and Herbicides Committee was Leon Hall and we had a memorium yesterday for him, but his report will be given by Don.

Dr. Murray: I was called by the Fresno-Westside District, the day after Lee passed away, and was asked to pick up certain of the records of this Committee since I had been working very closely on it. This is what I have put together, and if somebody else has something on it, why that's fine, but I have prepared this for presentation in the Proceedings.

REPORT OF THE INSECTICIDE COMMITTEE

Leon Hall, Chairman of the Insecticide Committee for the past two years, passed away suddenly from an acute coronary attack on January 15, 1961.

Most of the development work on a revised bulletin on insecticides and weddicides used by California mosquito abatement agencies has been completed.

A complete draft of the proposed bulletin has been prepared and is now in the process of being reviewed by a number of selected specialists. Following this review, the final draft will be prepared for publication.

The association owes much to Leon Hall for the accomplishments of this committee. His energy and ability proved to be very important in keeping the program of this committee moving forward towards its goal.

Respectfully submitted,
Leon Hall, Chairman (Deceased)
Robert Dolphin
Oscar Lopp
Gordon Smith
David Reed
W. Donald Murray

Pres. McFarland: Any discussion on the Report of the Insecticides and Herbicides Committee? If not, the report is accepted.

Before we go to the next report, we will have a roll call of the Districts to determine which ones are now represented. (Secretary Murray again took the roll call.)

Now I would like to call on Les Brumbaugh to give the Legislative Committee Report.

1960 LEGISLATIVE COMMITTEE REPORT

Gentlemen:

During 1960, the Legislative Committee submitted the following recommendations:

#1—Amendment of the Vehicle Code, Section 25251, permitting mosquito abatement agencies or pest abatement districts to use flashing lights on their vehicles.

(Amendment of the Vehicle Code pertaining to flashing lights on vehicles during daylight hours is being submitted by Senator Short.)

#2—Request that the California State Department of

Public Health review any new bills that might affect mosquito abatement districts, and send copies of such proposed legislature bills to the President and Secretary of the California Mosquito Control Association, and the Chairman of the C.M.C.A. Legislative Committee.

(At their October meeting, the C.M.C.A. Board of Directors passed a resolution requesting that the State Department of Public Health review any new bills affecting mosquito abatement agencies, and notify the President and Secretary of the C.M.C.A. of any proposed new legislation.)

#3—The Legislative Committee unanimously passed a Resolution recommending that the word "gnats" be inserted after the word "flies" in the phrase, "mosquitoes, flies or other insects," in Section 2270 (a), (b) and (f), 2274, Article 4, of the Health and Safety Code.

L. R. Brumbaugh, Chairman
William Bollerud
Hugh W. Carpenter
Robert Dolphin
E. Chester Robinson
John H. Brawley
Arthur Cavanaugh
Edwin Jacobsen
T. M. Sperbeck

Pres. McFarland: Are there any comments on the Legislative Committee Report. At this time I would like to urge any of you that have any recommendations for legislative action that you submit these to the Committee at your very earliest opportunity. The new Chairman of the Legislative Committee will be known after the meeting fo the Board of Directors at the end of the Conference.

Mr. Gray: I might make one remark, and this goes back a little way into the history, you see there the recommendation concerning review of new bills relating to mosquito control; but unfortunately you will find that there are bills presented in Legislature each year that affect us, but they, apparently from the title, bear no relation to mosquito control. Over the past thirty years or so we have had a number of those bills which would have seriously affected us if we had not had some astute people watching all of the legislation that comes up, examining it to see if there were some bugs or sleepers in it which could damage us. Pretty generally, we have been able to find them; but two years ago one slipped by. I don't know how. Our guard was down I guess; and it was buried in one of those bills which was apparently innocuous elsewhere. That is this law which permits part of these districts to secede. You have to watch all over the place—don't trust any legislator.

Pres. McFarland: This is good advice and a policy which we try to follow up on. We instruct the Legislative Committee to do everything that they can so that the State Department of Public Health is watching it. All of you normally see some of the bills, and if you know about anything that they might hear of—through the league of California Cities meetings, or the League of County Supervisors, or any such places, ask them to let you know about it. No matter how innocuous some of these may appear, tell them you would appreciate it, so that the Legislative Committee may then look into it and make recommendations, etc.

Mr. Brumbaugh: That was one of the reasons for this motion of recommendation, because of the many bills presented to the Legislature each year. There is such a service that the Association may request, however, you will have to pay for it. This would cost about $250.00 a year, but you would get every bill introduced into the Legislature sent to one officer. I understand that the stack of bills would stand about so high. Who, in our Association, would take the responsibility to scrutinize each one of those bills to determine if something was affecting mosquito abatement agencies. So it was the hope embodied in this recommendation that it would be the responsibility of the State Health Department to try to scrutinize all of those bills. We also hope that all of the members, if they have any contacts, can keep their ears and eyes alerted in the event that they might find something, in which case we could then go to work and see if we could remedy that situation. That is the only reason for this recommendation.

Pres. McFarland: Thank you, Les. Now I see that our hard worker and friend has just come in, Chairman of the Forms, Records and Statistics Committee, so we would like to call on Jack Kimball for his report.

Pres. McFarland: If there is no discussion on these two reports they will be accepted as submitted. I would like to call on Ted Raley, Chairman of the Operational Equipment and Procedures Committee for his report.

REPORT OF FORMS RECORDS AND STATISTICS COMMITTEE

President Gardner C. McFarland has requested this Committee's recommendation on the amount of funds required for next year. He would like this information by November 16 so that the Budget Committee can prepare and submit the proposed 1961 Budget to the Board of Directors at their next meeting at Disneyland Hotel on December 2.

During this year our Committee has accomplished the following:

(1) *1960 Year Book:* A total of 671 copies were distributed last April at a total cost of $233.78. The unit cost was $0.35. A copy of my report dated April 19, 1960 to Secretary Don Murray was mailed to you at that time.

(2) *Mosquitoes About The Home:* During 1960, 8,000 copies of this leaflet were sold from our remaining stock of 13,000 to the following:
5,000 Copies—Northern Salinas Valley M.A.D.
1,000 Copies—Vandenberg Air Force Base
1,000 Copies—Delaware State Highway Dept.
1,000 Copies—Northeast (Riverside Co) M.A.D.
At the present time the Association has realized a net profit of $40.00 from its original investment in the printing of the 50,000 copies of this leaflet. When we sell the remaining 5,000 copies in stock at $35.00 per thousand, the Association will have netted a total of $215.00.

(3) *Personal and Working Conditions Schedule—1960:* During the past six years, Don Murray has been a one-man sub-committee who has compiled, summarized, printed and distributed this invaluable statistical report covering some 45 Districts. This year, however, Don requested

that he be relieved of this assignment. During the summer months I procrastinated to the extent of not even contacting *you*, the members of this Committee, to see if one of you would like to take on this assignment as a one-man-job. At the last meeting of the Board of Directors in Oakland on October 28, Steve Silveira, Manager of the Turlock District offered to take on this project. At my request, the Board approved his appointment to our Committee and authorized the canvassing of all Districts for the information.

The following week Steve mailed out his November 2 memo and questionnaire on salaries and working conditions. My personal thanks and appreciation to Steve for his interest and action. We can now count on this information being available before budget time.

My purpose of submitting the above summary at this time is to get your individual suggestions and recommendations on what this committee should try to accomplish and how the committee should function during 1961. What additions or deletions should be made to the Year Book and to the Salary Survey? Are there other statistical data, forms or records that would be of value to the Association as a whole? What funds should be budgeted to this committee?

With your comments, I will prepare a committee report with recommendations for submittal to the Board of Directors at their next meeting scheduled for December 2 at Disneyland Hotel.

Sincerely yours,
Jack H. Kimball, Chairman
Forms, Records and
Statistical Committee

OPERATIONAL EQUIPMENT AND PROCEDURES COMMITTEE

TED G. RALEY, *Chairman*

The activities of the Committee have been pretty well covered in the minutes of the various Board meetings, which have already been sent out to the districts. The two recommendations made by the Committee have been considered by the Directors and the Officers anticipated for 1961. I will not touch upon those recommendations at this time, because that, seemingly, would be appropriate for a little later discussion; but the material will be published as it has already appeared in the minutes of the various Board meetings.

Pres McFarland: Has anyone any questions of Ted, as Chairman of this Committee? If not, the report is accepted. I would like now to call on George Whitten to give the Source Reduction Committee Report.

Recommendations suggested by the Source Reduction Committee are:

1. That the Dairy Drain sub-committee become an integral part of the Source Reduction Committee because all source reduction people are vitally interested in these problems, making it useless to hold special meetings which are costly and time consuming.
2. That the 1961 committee continue publication of the source reduction papers.

REPORT OF THE SOURCE REDUCTION COMMITTEE FOR 1960

The Source Reduction Committee met four times as a group and had one special meeting of the dairy drain sub-committee.

A new publication entitled "Source Reduction Papers 1960," sponsored by the Source Reduction Committee, consisting of papers published by committee members was sent to all member districts and a copy is included in this report.

A two-day seminar held at the University of California at Davis was sponsored by this committee for all those interested in source reduction. Thirty people were in attendance. A copy of the schedule is included with this report.

This committee had originally intended to contribute to the program of the conference but due to the over burdened schedule another concurrent session would only detract from the splendid program already scheduled.

The chairman of the Dairy Drain sub-committee, Steven Silveira, requested that his sub-committee report be included as part of the general report. The results of the dairy drain questionnaire are included in the "Source Reduction Papers 1960." An additional publication on the dairy drain problem is "The Economic Value of Liquid Manure." Both of these publications are available by writing to the secretary of the California Mosquito Control Association.

3. The Source Reduction Committee took under consideration the possibility of changing some items on the Source Reduction Summary section of the Yearbook in an attempt to clarify some of the statistics. However, the committee found that to do this would be necessary to complicate the summary further. At this time we can recommend no changes.
4. Rental equipment—the Source Reduction Committee would like the Board of Directors to consider the feasibility of the California Mosquito Control Association taking on an additional function. There has been a need by various districts for certain specialized equipment which as a district they have neither the capital to purchase nor the total need to justify this capital expenditure. Specifically, a small dredge is an example. Many districts could make use of a small dredge in their source reduction program. River overflow and seepage areas and salt marshes could be eliminated as mosquito sources if this equipment were available at a nominal fee or at cost.

Source Reduction Committee:
George W. Whitten, Chairman, Delta M.A.D.
Maurice V. Brown, Kings M.A.D.
F. A. Campiano, San Joaquin M.A.D.
Don A. Merritt, Consolidated M.A.D.
Vaughn J. Miller, Butte Co. M.A.D.
Harold Townsend, Merced Co. M.A.D.
A. L. Paden, Consolidated M.A.D.
Dennis Ramke, Tulare M.A.D.
William Reilly, Colusa Co. M.A.D.
Calvin Rourke, Sacramento Co.-Yolo Co. M.A.D.
M. A. Wood, No. Salinas Valley M.A.D.

Source Reduction Sub-Committee:
Steven Silveira, Turlock M.A.D., Chairman
G. Paul Jones, Marin Co. M.A.D.
Ray McCart, Eastside M.A.D.

Pres. McFarland: Is there any action that anyone would like to take at this time on this report? If not, the report is accepted; and I might say that as to those recommendations, they will be turned over to the new Board of Directors who will refer them to the appropriate Committees who will keep you informed and give you an opportunity to make your own recommendations and suggestions.

I would like now to call on the Chairman of the Ways and Means Committee, Howard Greenfield, to give his report.

REPORT OF THE 1960-1961 WAYS AND MEANS COMMITTEE

The Ways and Means Committee Report will be brief, because the Minutes of the Committee Meetings have been filed in their entirety with the office of the C.M.C.A. Secretary. Inasmuch as the Minutes have been filed, it is felt that the purpose of this report is only to briefly mention those recommendations and actions which have been taken by the Committee.

No. 1. *Administrators' and Managers' Meeting*
Under the guidance of the Ways and Means Committee, an Administrators' and Managers' Meeting was held on October 26 and 27, 1960, in Berkeley at the State Department of Public Health.

No. 2. *Code of Ethics*
It is the recommendation of the Ways and Means Committee that a Code of Ethics be developed by the 1961-1962 Committee for presentation to the C.M.C.A. Board of Directors.

No. 3. *Boundary Problems*
After lengthy consideration, it is the recommendation of the Committee that the California Mosquito Control Association refrain from interfering in strictly local jurisdictional boundary problems, and that such problems be left to the discretion of the local Boards that presumably would be involved.

No. 4. *Association Lapel Pins*
It is the recommendation that a membership pin, a past-president's pin, and a president's pin are needed for the Association. It has also been recommended that the costs be underwritten by the C.M.C.A.

No. 5. *Certificates of Merit or Appreciation*
It is recommended that an appropriate certificate be awarded to the immediate past-president and, at the discretion of the C.M.C.A. Board of Directors or by petition, to any other members of the Association deserving such an honor. Said presentations to be made at the annual conference of abatement agencies. It is also suggested that an Honorary Member Certificate be presented to those individuals that have obtained this high honor.

No. 6. *Certification of Administrators*
To the Incoming Ways and Means Committee, it is recommended that the need for Certification of Administrators be explored jointly with the State Health Department and the Board of Directors of the C.M.C.A.

No. 7. *Arm and Cap Patches*
It is recommended that the 1961-1962 Ways and Means Committee study the possibility of developing and standardizing an arm and cap patch for district usage.

No. 8. *Corporate and Sustaining Membership Certificates*
And finally, it is the recommendation of this Committee that a definite need exists for the re-establishment of Corporate Membership Certificates and Sustaining Membership Certificates.

As Chairman of this Committee, I wish to take this opportunity to express my gratitude to the members of the 1960-1961 Ways and Means Committee for their excellent cooperation and willingness to perform their assigned duties.

Respectfully submitted,
Howard R. Greenfield, Chairman
Members:
John H. Brawley
Jack H. Kimball
Sidney H. Ryall
Lester R. Brumbaugh
Joe D. Willis
James St. Germaine
Robert H. Peters
E. L. Smith

REPORT OF THE C.M.C.A. PUBLICATIONS COMMITTEE

The only Committee assignment this past year was publication of the Proceedings and Papers of the 28th Annual Conference of this Association, which was completed and distributed last July. Recording and transcription was performed by the San Mateo County M.A.D. personnel at a cost of just under $400.00 to the Association, with a printing cost of about $1,550.00 for 800 copies.

Since the amount of taped material has led to an excessively lengthy period of transcription, it was recommended that the Association purchase a tape recorder for the ensuing conference. With authorization for such from the board, a Wollensak 4-track stereo recorder has been procured at a cost of $173.00 and should prove to be a good investment.

It has been frequently suggested that a subject index be provided for the past issues of the Proceedings; and although the Publications Committee concurs with the suggestion, the problem of available time by capable workers for such a project is a significant one. An index of authors and titles has been previously planned for publication at five-year intervals and would be scheduled for the 30th Proceedings in the form provided by Jack Walker for the first 25 Conference Proceedings. If only the major references were included in a subject index for the past 10 or 15 years, it is possible that such a project would be feasible in the ensuing year. An expression by the Association

would be appreciated by Publications Committee for guidance in this matter.

Appreciation is expressed to the Committee's other member, our Secretary-Treasurer, Don Murray, for his services during the past year, and to the District personnel for their work in recording and transcribing the Conference proceedings.

Respectfully submitted,
C. Donald Grant, Chairman
W. Donald Murray

REPORT OF THE RESEARCH COMMITTEE

During a year of considerable discussion on potential vector control and insecticide research needs by the State Universities, State Departments and a Special Committee of the Governor, the C.M.C.A. Research Committee has taken a minimum of action and no formal meetings. This has been primarily due to the fact that considerations and proposals drawn up by this Committee last year have been an integral part of such discussions for adaptation and incorporation in interests broader than the field of mosquito control.

Several Committee members did meet with staff members at the University of California at Riverside, reviewed research objectives and toured the facilities at the Campus.

Several contributions pertaining to research developments by other sources have been received from Committee members with appreciation, but are not incorporated in this report.

The Chairman delayed action by the Committee pending submission of a report by the Governor's Special Committee on Public Policy Regarding Agricultural Chemicals. This report was finished and sent to the Governor at the first of January, 1961, and was only recently available to the Committee Chairman. However, the summary and conclusions from such report, together with the section proposing establishment of an Ecology Research Center at the University of California under the direction of the State Department of Public Health is included as a part of this report.

A request had been made of the Committee to submit a report on the research needs in mosquito control affecting the member agencies of the California Mosquito Control Association. As indicated in the accompanying report, this is a most difficult assignment; first, because an adequate treatment may be too long and include too many detailed considerations for easy review, or may be too short and restricted to generalities; and second, difficult because of the several possible approaches in such a presentation that could be chosen to meet the many different objectives and interests within the Association, as has been demonstrated in the requests and suggestions received by the Chairman. The deficiencies of the submitted report prepared by the Chairman, are recognized and regrets are expressed that time has not permitted an earlier distribution for review and revision prior to this Conference.

The determination of a course of action and specific policy regarding research objectives is still an open subject following the action this year; however, a basic resolution endorsing a research center has been prepared for your consideration and modification at this Conference or a later date.

Respectfully submitted,
C.M.C.A. Research Committee
C. Donald Grant, Chairman

THE NEED FOR RESEARCH IN MOSQUITO AND RELATED VECTOR CONTROL BY CALIFORNIA ABATEMENT AGENCIES

The presentation of needs for research in mosquito or vector control may be pursued by many different approaches depending upon the agency or interests to be served and the persons to whom such justification may be directed. In any event it is necessary to portray both the generalities and scope entailed in the proposed research as well as the specific examples to bear out such generalities.

Certain basic postulates pertaining to all abatement agencies and their operations are widely recognized and logically serve as criteria in evaluation of research needs. Some of these may be mentioned for reference in further considerations.

1. Public agencies have an obligation to perform their services with the greatest degree of *efficiency* available—as governed by funds, personnel and desired level of abatement prevailing locally.
2. In fulfillment of their services such agencies have a responsibility to avoid the creation of secondary public nuisances in the correction of another.
3. The application of insecticides and many other chemical materials employed in abatement operations may be potentially hazardous to public health and many other interests where improper procedures result from carelessness or inadequate knowledge.
4. Almost all portions of our State are facing increases in development and population which shall grow even more significantly in the next few decades.
5. Pressure resulting from the need for public protection, wildlife conservation, pollution safeguards and other factors are increasing the statutory restrictions affecting abatement procedures in a variety of ways.
6. The types of aquatic sources needing abatement are significantly varied in type and quantity in various areas of the State as are the resulting problems and abatement methods.
7. In several areas a public need for abatement of other aquatic insects or biting gnats has placed a strong demand on the local abatement agency for control of such public nuisance insects which are beyond the realm of private pest control agencies.
8. The high potential of many mosquitoes and other insects to develop resistance and other adaptations for their survival often render new insecticides and efficient procedures useless within a short time.
9. Thus far we have no prevention for encephalitis other than adequate control of the vector mosquito.

To meet the objectives and needs pointed up by the sum of these postulates, there are strong demands for good management, well-trained personnel, and especially the qualities of awareness and adaptiveness within the technical and skilled personnel. Yet even maximum efficiency within the district falls short of meeting the current challenges on an efficiency level commensurate with either the rate of problem development or with the potential level of effectiveness that could be made available through adequate programs of research and development. What constitutes adequacy of programs must be determined by cost practicalities, comprehensive evaluation of needs and projects, and evaluated in terms of time and efficiency of returns, which is beyond the scope of this paper.

In spite of the many studies, papers, proposals and modified programs treating with research in mosquito control in this State, the most difficult aspect to resolve and adequately present is that of the need or justification for research which is representative of the many objectives and agencies in mosquito control. The reason is obvious to most abatement personnel as well as to academic and professional people working in this field. It is simply that the problems and our limitations of knowledge and technical development are of such magnitude and diversity as to defy a simplified condensation and still satisfy the many interests involved.

As control agencies charged with the public responsibility of providing abatement services with public funds from our local residents, our research needs may be initially judged on a basis of aid to our local problems as of now and the foreseeable future. It is recognized, however that State and local public health agencies, fish and wildlife agencies, the department of Agriculture, etc., also have major interests in such research work and have different as well as many parallel needs in potential research subjects.

Observations From Previous Polls On Research

One of the Committee's most difficult problems in defining the need for such research studies has been the analysis and reduction to conformity of the numerous suggested topics for specific or general studies which have been submitted both to this committee and to other compendiums in the past years. However some things did show up.

1. Every field of endeavor was felt essential to someone.
2. The majority of opinions expressed needs on all fronts.
3. *Insecticide* and *ecological* studies were most often felt needed, followed by biological control and equipment technology.

Some conclusions which might be drawn from these polls are:

We recognize deficiencies and needed improvements in all areas.

There is a great lack in means of disseminating technical information (already obtained) in a manner to be understood and used by district personnel in guiding application techniques, as has been indicated frequently in listing specific needs or suggested studies.

A great obstacle to problem evaluation and solution lies with our inadequacies of measurement, not only calibration of materials or equipment, but more significantly in evaluation of our mosquito sources and the contained factors affecting abatement operations.

There is a universally recognized need for studies directed toward disease vectors and encephalitis and basic research in all fields; however an urgent need is more often expressed for knowledge and assistance in technical development pertinent to direct control operations.

Needed Study On Insecticides

It has been most often mentioned that our knowledge of insecticides, their relative toxicities and formulations for mosquito control purposes, is one of our most essential research needs. Perhaps this is so; although substitute methods of larval destruction would undoubtedly be preferred if feasibly attainable.

However, insecticides studies must be considered highly desirable, even on this restricted aspect of larviciding. But there are many complexities to be encountered in every direction for such apparently simple studies. The effectiveness of any specific insecticide, of any physical form, or any specific formulation thereof is highly dependent on many other factors about which we yet need extensive knowledge if we are to select such insecticides for efficient application at their greatest potential.

These include knowledge of larvae: their relative susceptibilities, resistance, feeding habits and location in the water—top or bottom, etc.

Knowledge of the aquatic environment; water contents, substrate, emergent vegetation, predator effectiveness, its permanence, and numerous potentials of flow, wind exposure, contour, hazards, etc.

Knowledge of injurious effects to other plants or animals, or even the corrosive or staining potentials, or of ultimate effects on the soil ecology and agricultural potentials of any insecticidal ingredients.

A large portion of these factors may be readily estimated or determined from our current knowledge or minimal testing, but other factors are not yet predictable by known or feasible means, and any one factor under specific conditions may be critical. With the large variety of situations being treated, with the public awareness of insecticide hazards and the tightening regulations, as well as our own need for better efficiency, knowledge of these many modifying factors are essential in the determination of the effectiveness of any given insecticide and its formulation for use in mosquito control. And any number of examples could be cited to demonstrate this.

This merely points up that studies in one field of control interest are dependent upon advances in other fields and further demonstrates the need for an integrated program capable of providing such knowledge and research in the many different aspects involved. The problem of public exposure to the hazards in the total use of pesticides and agricultural chemicals is a major field and will receive study and action on its own merit—as indicated further on.

Other Types Of Larval Control

Outside of such insecticide applications only minimal choices of eliminating existent mosquito larvae

remain at present. The use of mosquito fish and other predators and the occasionally feasible cases of environmental modification with plants, flushing, salinity changes, and so forth have been our only alternatives to actual source elimination. With the apparent possibilities in development of effective pathogens, increased effectiveness of other means of biological control, and the significant aid that improved knowledge of mosquito habitats and biology can add to our methodology and program efficiency, rests a major promise of reducing the critical insecticide problem.

A very promising development lies in the findings of Dr. Kellen on the lethal action of certain Microsporidia and viruses, especially for *Culex tarsalis*. Should these pathogenic organisms and related forms, found to destroy mosquito larvae with a high degree of host specificity, prove adaptable for control operations a new era of mosquito control through such biological methods might be initiated. The desirability of this approach and the possibilities apparent should justify a very significant effort in this direction.

The determination of bio-chemical stimulants serving to govern the selection of oviposition sites may contribute to several practical control objectives. An adequate understanding of the stimuli could lead to determination of the causative factors in suitability of the water sources for different mosquito species and provide a key for more practical methods of source prevention—or the prevention of oviposition. It might well provide a key to the living organisms and their metabolites which may in turn provide additional control approaches through use or inhibition of such organisms. And of course there is the direct possibility employing the actual stimulating substances as attractants or repellents in varied operations.

The study and determination of the possible effectiveness of such approaches is essential to many objectives embodied in the basic postulates of mosquito control and, if found practical, could be of direct aid in many of our needs.

Needs Ellicited By Fish And Wildlife Considerations

A recent policy statement by the U. S. Fish and Wildlife Service pretty well points up the need for careful, efficient control procedures that emphasizes our needs for increased levels of operations and technical knowledge at higher levels in our personnel.

In our desire to cooperate with this policy statement (below) it is apparent that we have need for improved methods of measurement and predictability as to the mosquito potentials in a given source—a knowledge of the precise factors governing mosquito production to afford a reliable statement on the potential as an index to establishing need for control.

It is also essential that we be able to effect control with precision of insecticidal applications and an improved knowledge regarding the hazards of various insecticides, including the considerably safer forms potentially available at a higher cost.

It is obviously desirable to develop a high level of knowledge on the ecology and management of these wildlife sources in order to minimize the need for chemical control. To a great extent such land and water management practices may curtail mosquito production therein, but reliable evaluation and recommendations are essential to elliciting the cooperation and costs involved. A significant portion of this report lies with the conditions of acceptability of mosquito control programs which demonstrate the above mentioned needs and are included here as follows:

"Thus, necessary mosquito control programs are most acceptable to the U. S. Fish and Wildlife Service if they:

(1) Are based on facts determined by field surveys which establish the need for control, and delimit the species and source of mosquitoes creating a problem.
(2) Have been reviewed and found satisfactory by responsible local, State and Federal conservation agencies having an interest in the area involved and a responsibility for the control procedures that are used.
(3) Employ land and water management practices that are favorable, and kinds and concentrations of insecticides that are least damaging to fish and wildlife.
(4) Are applied selectively in areas of known and potential mosquito production rather than by a general broadcasting of chemicals or widespread drainage.
(5) Are carefully accomplished by fully instructed trained, personnel under responsible supervision, using adequate equipment and following prescribed regulations.
(6) Are to be maintained satisfactorily.

The development and use of preventive methods of mosquito control, such as certain types of water manipulation and land use which preserve or improve fish and wildlife habitat, are favored over control by chemical applications, drainage, or other measures which are usually inimical to living natural resources."

NOTES FROM THE REPORT OF THE GOVERNOR'S SPECIAL COMMITTEE ON PUBLIC POLICY REGARDING AGRICULTURAL CHEMICALS

In June, 1960, Governor Brown appointed a 15-member special Committee on Public Policy Regarding Agricultural Chemicals to study and review the problem and recommend a sound public policy. After six months of study the Committee prepared a report embodying a Statement of Public Policy, Review and Analysis of the subject, a proposal for establishment of an Ecological Research Center, and recommendations for action by the State of California; which report was submitted to the Governor on December 30, 1960. Some extracts from this report which may be of special interest to the California Mosquito Control Association are submitted as follows:

Ecology Research Center

The need for research in environmental sanitation was brought to the attention of the Chairman who appointed a sub-committee to study an approach to the matter.

A proposal for a joint research program in those aspects of ecology affecting vector control operations and other aspects of agricultural chemical usage was drawn up and submitted.

The Subcommittee recommended the establishment of an Ecology Research Center on the campus of the University of California at Davis. The function of the center would be to provide for systematic pursuit of research principally in the area of vector control, with subordinate effort on chemical residues in food, air and water and other phases of ecological concern relating to pesticide usage including fish and wildlife problems.

Mosquitoes, flies, gnats, and other vector and noxious animals which threaten the public health and comfort, and the direct and indirect effects of pesticide and other agricultural chemical usage lend themselves to joint study and evaluation on a basis involving cooperation between the State Departments of Public Health, Agriculture, and Fish and Game, in collaboration with the University of California.

It is proposed that the Department of Public Health should assume the planning, coordination, conduct, and contracting of vector research necessary to assure progress toward the control of mosquitoes, gnats, domestic flies, rodents, field mammals, ticks, fleas, lice, mites, miscellaneous noxious animals, vector-borne diseases, and the management of solid organic wastes. At present, great voids of knowledge exist with respect to all these problems. It is evident that much cooperative research is needed relating to agriculture, community planning, industry and recreation. A primary need exists for a public health research staff to stimulate, motivate, and collaborate on various kinds of research pertaining to vector control and associated with these segments of endeavor in California.

The Committee received information that federal funds may be available from the Division of Research Grants, National Institutes of Health, to aid in the establishment of an Ecology Research Center in the University of California.

Conclusions And Recommendations

The great preponderance of evidence presented convinced the Committee that at this time our food supply is safe. No evidence is presently available that there is any danger of anyone being poisoned by pesticide residues in food.

Regulatory programs that can give the public confidence in the food supply and strict enforcement of the laws that protect the food supply are primary requirements.

Analytical procedures for detecting residues are being improved, but simplicity of analyses is needed. This important field of research needs greater emphasis in order that regulatory and investigational programs may be pursued effectively. It is necessary and desirable that regulatory agencies, industry, and other interested people be kept informed with regard to methodology in the determination of pesticide residues.

The public should be provided continuous, full, factual, authoritative information concerning the laws and regulations, their enforcement, the safeguards which are in effect to protect the consumer, as well as the occasional difficulties in the use and control of pesticides. This should be done because a fully informed public can evaluate facts and will not be panicked by "scare" stories.

There are several courses of action that can contribute greatly to resolving uncertainties, provide additional protection to public health and facilitate administration of laws.

The Committee recommends:

1. Research in all areas pertaining to agricultural chemicals should be continued by government, universities and industry in order to increase understanding as to how pests may be controlled more successfully, and to establish ever more clearly how pesticides may be used without injury to public health. The search for better pest control measures, safer pesticides, and alternative measures including biological control and development of pest resistant varieties of crops should be pursued.
2. The proposed Ecology Research Center be established at the University of California under the direction of the California State Department of Public Health. It will be to provide needed scientific information on vector control, and other related problems involving pesticides, and will be able to make available facilities and information to the Departments of Agriculture and Fish and Game and other agencies, for needed use. Furthermore, funds should be provided for grants-in-aid to private research laboratories where competent investigators are located.
3. Authority should be provided in the Agricultural Code to limit the amount of pesticidal chemicals, additives, and drugs in all livestock feeding materials. At present, processed livestock feeds are exempt from the provisions of the spray residue law and there is lacking the full control that should prevail to assure that there is no contamination of milk and meat from chemicals in harmful amounts.
6. Encouragement and necessary financial aid should be provided for further development of biological control of pests and the development of pest resistant varieties of crops.
8. Funds should be made available to the State Department of Agriculture and Public Health for full staffing to carry out the regulatory programs needed to enforce requirements on residues for public protection.
10. Where recommendations for control of pests are made by a State or local agency consideration should always be given to suggesting the least toxic material with which adequate control can be achieved. Special attention should be given to urge safe storage and careful use of pesticides in homes and on premises.

COMMITTEE MEMBERSHIP

Dr. Emil M. Mrak, Chairman
Chancellor, Davis Campus
University of California

Dr. Charles E. Hine
Professor of Toxicology
University of California
School of Medicine, San Francisco

Louis A. Rozzoni, President
California Farm Bureau Federation
Berkeley, California

George A. Gooding, Vice President
California Packing Corporation
San Francisco

Dr. Elwyn Turner
Santa Clara County Health Officer
San Jose, California

Dr. Clinton Thienes
Professor of Toxicology
University of Southern California
School of Medicine
San Marino, California

Dr. Daniel Aldrich
Dean, College of Agriculture
University of California
and
Member, State Board of Agriculture

Dr. Ralph C. Teall, Vice Chairman
Council, California Medical Association
Sacramento

Dr. Wendell Griffith, Chairman
Dept. of Physiological Chemistry
School of Medicine
University of California, Los Angeles

John Watson, President
State Board of Agriculture
Petaluma, California

Dr. Agnes Fay Morgan
Emeritus Professor of Nutrition
University of California, Berkeley

Dr. Rosemarie Ostwald
Associate in Nutrition
Department of Nutrition
University of California
Agriculture Experiment Station

Mrs. Helen E. Nelson
State of California Consumer Counsel
Governor's Office
Sacramento, California

Dr. Malcolmn H. Merrill
Director of Public Health
2151 Berkeley Way
Berkeley 4, California

William E. Warne, Director
Department of Agriculture
Sacramento (Secretary of Committee)

PROPOSED RESOLUTION ON VECTOR CONTROL RESEARCH

WHEREAS the member agencies of the California Mosquito Control Association have long been faced with the need for further specific knowledge pertaining to the biology and control technology of vector and pest mosquitoes, and

WHEREAS the existing sources of such knowledge, research and investigations in California or elsewhere have been inadequate or inappropriate to meet the challenges and divers problems facing mosquito control agencies in this State in providing freedom from mosquito borne disease and annoyance for the public welfare, and

WHEREAS population increase and the unprecedented water and land development in California have brought about a corresponding growth in the scope and complexity of mosquito abatement responsibilities, and

WHEREAS even the most conservative estimates indicate tremendous increases of population and land and water use in California within the next few decades which shall foreseeably be accompanied by extensive problems of water pollution, drainage, and the accumulation of organic wastes with the resulting high potentials for noxious insect production, and

WHEREAS California is currently being exposed to approximately 20% of this nation's insecticide application with its attendant potential hazards to public health, conservation and agricultural interests, and

WHEREAS the Governor of California, many of the Departments and the Universities within this State are cognizant of the serious problems facing vector and pest control operations through the report submitted by the Governor's Special Committee on Public Policy Regarding Agricultural Chemicals, and

WHEREAS the Governor's Special Committee has submitted a primary recommendation for the establishment of an "Ecology Research Center at the University of California under the direction of California State Department of Public Health to provide needed scientific information on vector control, and other related problems involving pesticides, and will be able to make available facilities and information to the Departments of Agriculture and Fish and Game and other agencies, for needed use. Furthermore, funds should be provided for grants-in-aid to private research laboratories where competent investigators are located.

THEREFORE, BE IT RESOLVED that the California Mosquito Control Association does herewith endorse and substantiate the need for the establishment of the proposed Ecology Research Center with its attendant functions under such direction as may be resolved between the State Department of Public Health and the University of California, and respectfully urge that appropriate steps be taken by the Governor, the Legislature, the State Department of Public Health and the University of California to implement this vital recommendation.

Mr. Grant: Do you wish to take action on this Resolution on Vector Research?

Pres. McFarland: I think maybe we had better take the time to do it, because if we need action, this is the time that it has to come.

Pres. McFarland: This is the resolution presented by the Research Committee. Is there a second to this Resolution?

Mr. Greenfield: I second it.

Pres. McFarland: Everyone should have a chance to consider and possibly review it. Maybe someone didn't understand it.

Dr. Furman: This wording given in the report is not exactly the same as I saw in the original report. I would like to ask whether this has been changed officially, or whether it is the actual wording used in the proposal for the establishment of the Vector Research Unit.

Mr. Grant: This has been quoted from the report to the Governor.

Dr. Furman: In the report which I saw, which also was of this nature, the wording was sufficiently different that it has aroused, rather than any cooperative effort which I think that this proposal should engender, a considerable amount of antagonism. This is presumably a cooperative arrangement which is to be worked out between the State Health Department and the University. As it was originally established, I think that the wording was extremely unfortunate. I believe that a number of the concerned persons involved were not consulted on it, and that before it is put into final effect, some changes should be made in the wording of the statement as I have originally seen it, so as to do away with the antagonisisms which are bound to result from within the University, if nowhere else, to a program which could otherwise be of great mutual benefit.

I don't know just what changes have been made officially in this report. Perhaps this is now the official report which was submitted to the Governor by the Committee; but it is not the wording which I initially saw.

Pres. McFarland: Is there anyone present with a copy of the Committee Report to the Governor? Dick Peters, perhaps you could help.

Is there any further comment on this discussion?

Mr. Gray: I would back Deane up on that rather strongly, although I have no voice; nevertheless I would enter *a caveat,* in any wording which would seem to give resentment among some of the people whom we would most want to have cordially cooperating in this project. If there is anything in the wording there that would do so, I strongly suggest that you try to couch it in such terms that would be acceptable.

Mr. Grant: I feel that if there remains a question on the precise wording of the Governor's Special Committee Proposal, pending its clarification, the action might still be endorsed in general principle.

Dr. Furman: I would go along with endorsing the general principle of the resolution.

Pres. McFarland: Could we have someone move such suggestion for revision of the resolution, if needed?

Mr. Grant: I am not quite sure which words Dr. Furman is referring to, but I believe it is in regard to the relationships in direction of the Ecology Research Center and I believe this could be amended to be under such relationships as may prove appropriate.

Mr. Greenfield: Frankly, I am a little concerned and confused at the moment as to the intent and the purpose of this resolution. I understand that this is a resolution coming from the California Mosquito Control Association in support of the Report of the Governor's Committee. Apparently there is some question being raised about the content of the resolution.

Pres. McFarland: Apparently, as to the phraseology as to who will be the cooperative agencies in this program; that they feel some part of the University has been left out in it. That is my understanding.

Mr. Grant: This merely states that it be established at the University of California. It does not say what Campus, or anything else about it. I think there may be a question as to the statement that it be under the State Department of Public Health's direction.

Dr. Furman: May I quote a part of this report? I think perhaps that this may clarify the issue. Under the title "Ecology Research Center," the statement is made, following "flies, gnats, mosquitoes, other vectors and noxious animals which threaten the public health and comfort, etc., *it is proposed that the Department of Public Health should assume the prime coordination, conduct and contracting of vector research necessary to assure progress toward the control of mosquitoes, gnats, domestic flies, rodents, field mammals, ticks, flies, lice, mites, miscellaneous noxious animals, vector-borne disease and the management of solid organic wastes."*

I think we all have to recognize that there are a great number of persons within the University who are already concerned with various aspects covered by this broad list of organisms. In my knowledge, a good many of these had not prior information that this thing was coming about. Looking at it on the surface, to suddenly find that the Department of Public Health should assume the planning, coordination, conduct and contracting of vector research necessary to assure this progress within the University, seems a strange thing to me— for an outside organization to come in and plan to assume the conduct and planning for all this research within the University. That does not quite appear to me to be a function of the Department of Public Health. Within their domain, yes. Within the University, no.

Mr. Grant: It would not be my position, of course, to argue with the relationships between the University of California and the State Department of Public Health and so forth. This resolution was essentially in agreement with what the Special Committee had in its report in their Summary and Recommendations. I think undoubtedly there will be quite a number of revisions in responsibilities and so forth in the final conclusion of any such a proposal. This has merely been the report to the Governor. I am sure it will undergo alterations. Now whether this Association wishes to endorse it or not on that basis or whether they wish to refrain until further clarification comes, I can't say. However, I think that the establishment of such a center for the research program is the essential purpose of the resolution. Mr. Peters, would you care to make a comment upon that.

Mr. Peters: Probably the error which is identified here is moreso derived from a taking out of context one inference which is in no way intended to be unilateral with respect to the function of any one department.

I think the intent of the entire proposal is rather one to amalgamate the function of planning and the development of all possible resources available within the State of California. I am certain that under no circumstances was it the intent of the Committee that was working on this to suggest—in fact I am astonished to find—this inference given, that the Department of Public Health would presume to accept the role of the University of California in this function. I personally believe that the error which exists is an error of lack of opportunity to discuss the problem in its full perspective, all its ramifications, and I can only assure the California Mosquito Control Association that, from the standpoint of the Department's intent in this matter, it is strictly to perform a complimentary relationship on these activities, and in no way suggests a substitution of the very vital and important part of the University of California's role in this function.

Mr. Gray: Mr. Chairman, may I suggest that Dr. Furman confer with the Chairman of this Committee and without the need of any further argument either delete or modify the wording so as to remove any possible cause of offense.

Pres. McFarland: We have already had this accepted as part of the motion, so I will ask if there is any other discussion. If not, I will ask for a vote. All those in favor? (Voice vote.) All those opposed? Motion to adopt this resolution as amended is carried.

It is getting late, so we will let the last Committee report speak for itself. John Brawley, will you stand and take a bow for the marvelous job you have done and are doing as Chairman:

Mr. Brawley: As Gardner says, the Report speaks for itself. You have already seen some portions of the program. But I would like to say that if you approve, then the Committee should have the credit; if there are those portions that do not meet with your approval, please blame me for it.

Pres. McFarland: And now we come to one of the most important parts of the program, and that is the report of the Nominating Committee, Howard Greenfield, Chairman.

Mr. Greenfield: The report has already been given to the Secretary and I will call upon him to read it.

Sec. Murray: I wonder if I might insert, very briefly, one additional item. We have a new Honorary Member to our Association, Dr. Lewis Hackett. He is not here, so Chet Robinson would you say a word about Dr. Hackett?

Mr. Robinson: Dr. Hackett is now in Rome, and I anticipate that he will be there for another three or four months and then return to the Bay Area. I suggest that then, at one of the Regional or CMCA meetings that we will probably have in the Bay Area, we call in Dr. Hackett and present this certificate to him. I will advise you when he returns.

Mr. Gray: I might say, in passing, that I just had a postcard from Lewis in which he says that he is very comfortably settled in Rome and that he has a full time cook.

Sec. Murray: I might add one final word as Secretary of the Association, you have heard certain comments about items on deposit with the Secretary. The Committees have been superb this year, and the President, the various officers, in keeping a unification of action by channeling copies to the Secretary. It has kept things together better than I have ever seen it before.

REPORT OF THE NOMINATING COMMITTEE

The following candidates have been selected by the Nominating Committee as nominees for offices in this Association as follows:

For PRESIDENT: Lester Brumbaugh

For PESIDENT-ELECT: John Brawley

For VICE-PRESIDENT: David Reed

For SECRETARY-TREASURER: W. Donald Murray

For TRUSTEE MEMBER: Marion Bew of Sutter-Yuba MAD

The Past-President Office is of course filled by Gardner McFarland.

Pres. McFarland: These names are submitted by the Nominating Committee for your consideration; however the nominations are now open for the Office of President-Elect. Vice-President? Secretary-Treasurer? Trustee Member?

If there are no further nominations, I will entertain a motion for unanimous election by acclaim.

Mr. Robinson: Mr. President, I would like to move that the candidates listed be unanimously elected to their respective offices.

Pres. McFarland: The motion is seconded by Bob Peters. All those in favor of this motion signify by the usual sign. Carried.

I had a long speech prepared for delivery at this time but in that we are so late, I will only say thanks to the Officers that have been so helpful; we couldn't have had such a good year without their help—the Officers and all the Directors. We will get a chance to compliment them all individually, later. Without further ado, I would like to turn this meeting over to your new President, Lester Brumbaugh.

MOSQUITO CONTROL IN CALIFORNIA IN 1960

OUTGOING C.M.C.A. PRESIDENT'S MESSAGE

GARDNER C. MCFARLAND, *Manager*
Southeast Mosquito Abatement District
South Gate, California

The control of mosquitoes and related insects such as flies and gnats progressed on a broad front throughout California during 1960. There were a number of new developments in knowledge and control and improvement in technological and practical control. New insecticides were tested and improved formulations were perfected for use on a routine basis. Information was exchanged in many ways in regards to new equipment, new devices, and adaptation of a number of pieces of equipment used in mosquito control. Interesting highlights of mosquito and related insect control include:

Sacramento Valley Region

The Lake County Mosquito Abatement District continued its major emphasis on the control of the clear lake gnat. Their problems become more difficult as

time goes by because of problems of contamination of fish by insecticides which precludes the use of some effective materials. This District, as a number of others, continues preventive control of tree-hole mosquitoes by elimination of these holes with sand. The Sutter Yuba District reports increased use of Parathion and Malathion and report that their light trap records as well as complaints of residents are much less than in previous years. Because of their concern of bank erosion, the Del Norte County Flood Control District found it necessary to concentrate on the use of propane burners for weed control measures, as a source reduction Program for control of mosquitoes.

Districts in the *Coastal Region* report considerable interest in fly control, with the public and official agencies actively soliciting aid from the Alameda County Mosquito Abatement District and Northern Salinas Valley Mosquito Abatement District. Mosquito control activities in this area have become so well organized that they report normal control, if anything can be called normal. These Districts have been very active in improvement of equipment to fascilitate urban control of mosquitoes in gutters, catch basins, and in similar structures. Alameda County indicates satisfaction with installation of an insecticide pump drive directly off the fan belt pulley.

Northern San Joaquin Region

Districts in this Region report a reduced number of service requests, which means, of course, better mosquito control throughout the Region. The San Joaquin Mosquito Abatement District reports several activities including: adoption of a Civil Service System, Radiologcial Civil Defense, adaptation of jeeps with a dual drive for spraying of catch basins and similar structures. Merced County Program featured increased use of air spraying by airplane, with large-scale use of Parathion and Malathion, with no major difficulties from FDA restrictions. Eastside and Turlock Mosquito Abatement District's report that the aircraft meeting held at the Eastside Mosquito Abatement District was completely successful with clarification of mutual problems and discussion of administrative aspects.

Southern San Joaquin Region

This region, also, reports greatly improved mosquito control, with very few complaints from the public. The Consolidated Mosquito Abatement District experienced great success with the use of granular materials (New Hard Core Parathion Granules) applied with a modified (horn) Seeder. In their opinion, the use of this material promises to revise their entire control Program. They, also, report that an all plastic horn, reinforced with nylon braid shows wear properties second to none. Fresno Mosquito Abatement District experienced excellent success with Parathion granular materials, as well as with Bayer 29493 emulsions. Kern Mosquito Abatement District reported no cases of Encephalitis, one of the few such years in the past 15 and successful mosquito control, perhaps the best in the history of the District. Parathion emulsions, together with granular Parathion formulations are being used with great success, both on the ground and by plane. Corcoran Mosquito Abatement District reports successful operational use of Bayer #29493 as a replacement for Malathion. They, also, report successful use of 1 per cent Parathion granules as a pretreat for irrigated pastures. Of interest is their report that they have expanded their entomological surveys to include Bettina Rosay's age determination techniques for better entomological control correlation. The Kings Mosquito Abatement District indicated successful use of Methyl Parathion at the rate of one-tenth pound of technical material per acre. They solved the public relations problem in relation to potential contamination of milk by insecticides, by banning District purchase and use of chlorinated hydrocarbon insecticides and use of an intensive public education campaign and cooperation of milk processors, milk inspectors, and various agricultural organizations.

Southern California Region

Mosquito and gnat control in Southern California was carried on successfully by the various agencies with the programs increasing because of increase in population, with consequent greater demands for service. The Borrego Valley Mosquito Abatement District reports progress in their *Hippelates* Gnat Program with a program to start with soil larviciding by means of Dieldrin granules. In the interim, they are making attempts at localized gnat control with the use of a Seeburg See-Fog Aerosol generator and, also, with the use of a small gnat trap for issue to homes and places of business. Each dwelling receives one trap free of charge and any extra ones at cost. The new Northwest Mosquito Abatement District in Riverside reports success with a source reduction program in relation to sewage treatment, oxidation ponds, gun clubs, dairies and chicken ranches. Another new District, Isla Vista Mosquito Abatement District reports great reduction in the emergence of salt marsh mosquitoes by the use of channeling and ditching. They have received great co-operation from the University of California at Santa Barbara and feel that considerable progress is being made.

Ballona Creek Mosquito Abatement District reports several annexations to their District and successful use of carp in various ponds for the control of Chironomids. The City of San Diego has a general program for the control of salt marsh mosquitoes, brackish water, and mosquitoes arising from the industrial and domestic wastes. Materials used by the Health Department include Malathion, DDT, and large quantities of Diesel Oil. Their source reduction program included use of weedicides, burning, use of Gambusia, and construction and maintenance of many thousands of feet of ditches. The City of Los Angeles reports on their generalized program of urban mosquito control ranging from mosquito problems from Forest Lawn Cemetery to the usual urban sources such as gutters, storm drains, and subdivision problems. The new Antelope Valley Mosquito Abatement District reports continued success on an overall program. They report interesting possibilities in the use of amino triazol in weed control. They, also, report the successful use of carp in control of Chironomids in a series of oxidation ponds of the sewage treatment system for the Lancaster area. The Southeast Mosquito Abatement District reports successful use of carp for the control of Chironomids in golf course ponds and some success in the use of granular Malathion formulations. This District reports

a new annexation, which increased the assessed valuation of the District by 8 per cent. The Los Angeles County Flood Control District and the University of California at Riverside report that the joint research project for the study of Chironomids show promise with the use of various insecticides and the biological control of Chironomids, with the use of carp and other fish.

Much detail has been eliminated from this report, since many papers covering specific subjects have been given at this meeting. In general, it can be stated that mosquito and gnat control is progressing satisfactorily in California. Public relations continued to improve, source reduction programs continue to become more effective, and research by mosquito control agencies, the University at all its branches, as well as the State Health Department, show promise in all aspects of the field to the end that the public who pays the bill is getting more service with greater efficiency and effectiveness.

Pres. Brumbaugh: Thank you, Gardner McFarland. I would like to have the Officers and the 1960 Board of Directors please stand. I think they deserve a nice hand for the job they have done.

I would also like to take the opportunity to have the new Officers stand so that you will all know them. Will you please stand up. Thank you. And now I would like to have the Regional Representative of each Region tell me if they have appointed their new representative.

For the Sacramento Valley Region—Joe Willis

For the Coastal Area—Howard Greenfield

For the Northern San Joaquin Valley Region—Bob Peters

For the Southern San Joaquin Valley Region—Richard Frolli

For the Southern California Region—Henry L. Messier

This CMCA Board of Directors wishes to thank the Association for the confidence in electing all of the members. We will also try as our goal and aim to improve the Association as you set in your by-laws. We will try to follow those at all times.

Mr. Bob Peters: May I make one final motion at this time in that it is customary that the membership go on record as accepting all of the action of the previous Board's actions in order that they may have clean sheets for the rest of their lives?

Pres. Brumbaugh: You have heard the motion, is there a second? Seconded. No question? All those in favor signify by saying aye. Carried.

Our good Secretary made one mistake. We have a Trustee Member, Marion Bew; will you stand up. Thank you.

If I may open this meeting again, we are now on new business. Is there any new business? Dick Peters.

(Mr. Peters made an announcement concerning proposed by-law changes in the constitution of the AMCA.)

If there is no further new business, I will call upon Harold Gray, Chairman of the Resolutions Committee.

RESOLUTIONS COMMITTEE

RESOLUTION NO. 1

BE IT RESOLVED, that we extend to Malcolm H. Merrill, M.D., M.P.H., State Director of Public Health, our special commendation for his masterful address at the opening session of this joint meeting of the American and California Mosquito Control Associations on January 31, 1961, at Disneyland, California, in which he so ably indicated to us the increasingly complex problems confronting us under changing conditions of great population growth; the wider opportunities in public service being presented to us; and the need and value of close cooperation of our agencies with many other public agencies for the benefit of the health, comfort and prosperity of the public.

RESOLUTION NO. 2

BE IT RESOLVED, that we the members at the California Mosquito Control Association, in annual meeting at Disneyland, California in 1961, do hereby extend our particular thanks to the Honorable Carley V. Porter, State Assemblyman from the Sixty-ninth District, for his statesmanlike and stimulating address of welcome on January 31, 1961, and we request that his paper be reproduced and sent by the secretary of our association to each Assemblyman and State Senator in this State, to the heads of appropriate state departments, and to all trustees of all mosquito abatement districts in California.

Respectfully submitted,
Harold F. Gray, Chairman

Pres. Brumbaugh: Thank you, Harold Gray. The floor is still open for new business. If there is no further new business, it is time to adjourn, since we are ten minutes overtime. Before doing so, I would like to have the new Officers meet outside and to announce that there will be a Board meeting this afternoon at five o'clock in the press room. We will now adjourn for a slight intermission before the AMCA general meeting.

RECESS.

The General Business Meeting of the American Mosquito Control Association was held at 10:20 a.m., following adjournment of the CMCA Business Meeting. The minutes and recorded action of the AMCA Meeting will be published in the June, 1961 issue of MOSQUITO NEWS.

FOURTH SESSION

WEDNESDAY, FEBRUARY 1, 1:30 P.M.

Gourmet Mezzanine

W. E. BICKLEY *Presiding*

Pres. Bickley: The panel for this afternoon on "Mosquito Control and the Public Well-Being," was to have been moderated by Cdr. John M. Hirst, but, unfortunately, he was not able to attend these meetings. I will now turn this session over to Dr. W. Donald Murray of California.

Dr. Murray: Thank you, Dr. Bickley. This panel was first conceived almost a year ago, with the thought that we would discuss the relationship of mosquito control and public welfare. It was decided to change to the word well-being. Many words in the English language have double meanings, as, for instance, in the case of the pregnant bed-bug—it's going to have a baby in the spring.

Commander "Mo" Hirst was urged to moderate this panel. He tried to get clearance to come here, but at the last minute found he could not make it, so he sent me a very complete discussion of the background of the relationship of mosquito control to the public. I will not read it, however it will appear in the Proceedings.

SYMPOSIUM—RELATIONSHIP OF MOSQUITO CONTROL TO PUBLIC WELL-BEING

DR. J. M. HIRST, CDR.
U. S. Naval Medical School, Moderator

The assignment of this vital subject to this panel is another example of the excellent programming which we expect from the California Mosquito Control Association. If there is no relationship between mosquito control and public well-being, then C.M.C.A. and A.M.C.A. and other similar organizations exist for purely social reasons. Dr. Harry H. Stage, the first Life Member of A.M.C.A., wrote in the National Geographic that "no insect appears more often in entomological literature than the mosquito. More than 400 different papers, large and small, throughout the world, devoted to mosquitoes, are listed annually." But how many of these papers are written for or by Mr. Public? And how many of them are written to improve the knowledge of Mr. Public so he can help himself in the control of mosquitoes? Bulletin No. 44 of the State of California, Department of Public Health Mosquito Control stated, "Few people realize the tremendous damage to community life and prosperity or to individual health and comfort, that can be caused by uncontrolled mosquito breeding. Even severely affected communities may fail or refuse to recognize the damage done. The toll of malaria is not only in excessive cost of medical services, but also in lessened labor efficiency, lost time from work, depreciation of real estate values, and community retardation and stagnation. Even if disease does not accompany a severe mosquito pest, this depreciation in real estate values, losses to live-stock industry, especially dairying and even poultry raising, reduction in labor efficiency, and interference with outdoor recreation, make the mosquito a formidable foe to community life."

In 1958, an estimated fifty million dollars was spent in the United States and the United States spent another eighty million dollars in the rest of the world to wage the war against the bloodthirsty mosquito. Many thousands of people are employed in this fight to control this insect "Public Enemy Number One." A research organization reports "Besides their notoriety as pests, mosquitoes in considerable numbers constitute a definite health problem—In addition, they cause inestimable economic losses. The dairy farmer loses in reduced milk production. Incalculable pounds of beef are lost each year due to mosquito activity. In some areas thick mosquito broods make it impossible to carry on outdoor work. Where mosquito populations go unchecked, real estate values are reduced, industrial expansion is prevented and in the cause of resort communities, patronage is irretrievably lost."

Even in the reports of research organizations, we find only general statements. Where and what are the specifics we need to know. Our correspondent writes "Regarding your request for information on the subject of 'Relationship of Mosquito Control of Public Well-being' I have gathered up a few brochures that may contain some information that you may be able to use on this subject. This topic has been hashed over and talked about a great deal but actually there is very little in print. It is about time that someone should assemble data on the subject for discussion and publication. Sorry that I could not be of more assistance."

We do write and publish many words on mosquitoes —and mosquito control—but the limited number of publications under titles related to the subject before this panel proves that we have failed the Public from whom we obtain substance for our work. This panel has been assembled to provide firm evidence that mosquito control is closely related to the well-being of the Public which is anxious for improved Public Health, Public Economy and Public Morale. We hope our deliberations will be of value to the Public whom we serve. But this is not an easy task!

In 1910 Sir Rupert W. Boyce wrote his revised Second Edition of his book "Mosquito or Man?" He states, "The campaigns show that the three great insect-borne scourges of the tropics—the greatest enemies that mankind has ever had to contend with, namely malaria, yellow fever and sleeping sickness—are now fully in hand and giving way, and with their conquest disappears the awful grinding depression which seems to have gripped our forefathers.

Now the situation is full of hope. *The mosquito is no longer a nightmare, it can be got rid of.*" Even though Sir Rupert Boyce wrote this in Liverpool in 1909, we doubt his complete optimism since the title page of his book carries the quote "Stagnation, the great enemy of life." And yet, at the very time this book was being written mosquito control is reported to have become active in California, New Jersey and a few other areas of the United States.

Fifty years later, at the recent meetings of the Entomological Society of America, Atlantic City, 1960, Dr. E. F. Knipling jolted the membership by his frankness. "Suffice to say that, in general, as late as 1920, methods of controlling insects were inadequate to deal with the diseases which they carried. *I regard this slow progress in dealing with important insect vector problems up to that time to be a discredit to mankind, especially in regard to his sense of values.* Peoples of leading nations had harnessed electricity, developed motor vehicles, steamships and aircraft, and invented and manufactured many intricate and deadly weapons for man's destruction at costs aggregating millions of dollars. Yet, they had not invested more than a few million dollars for the development of means whereby the worst scourges of mankind could be adequately controlled." But in 1961, we note the hope of light in Dr. Knipling's words "There is every reason to be optimistic for the future. The very concept of dealing with entomological problems from a national and international standpoint, such as the world-wide malaria eradication program, is evidence of the world recognition of the importance of insects in relation to human welfare—a concept that had not prevailed before."

References to Mosquito Control in Relation to Disease are plentiful. But the real focus on our specific subject is more adequately established by Professor Edward S. Hathaway, Emeritus Professor of Zoology at Tulane University and an acknowledged authority in entomology. In Miscellaneous Publications No. 3 of the Louisiana Mosquito Control Association, October 1959, Professor Hathaway wrote "What Louisianians need to know about mosquitoes." In a State which makes the most of the more than 50% of the swamplands of the United States, he believes, "Most people are familiar with the havoc wrought in past years by malaria, yellow fever, and dengue (all transmitted by mosquitoes); and many are aware of other mosquito-borne disease that we still have with us, notably encephalitis, though fortunately, human cases are not numerous." This is only a part of his answer to the self-imposed question, "How much harm do mosquitoes do in the life of Louisianians?"

"*In cattle raising*, cattlemen in some coastal parishes lost half of their 1955 calf crops due to insect bites. So these men know in dollars and cents something about what mosquitoes are costing them.

"*In industry:* Many highly trained workers have left jobs and moved to other States because of continued torture by mosquitoes."

In family life: Parents describe vividly the family outings that were ruined by mosquitoes; also, the festering sores caused by the scratching of innumerable bites."

"*In outdoor sports:* Enthusiastic hunters, fishermen, and campers remember all too well the days when mosquitoes took all the joy out of their favorite sport."

"Beyond doubt, and in many ways, mosquitoes are a problem in Louisiana." It is interesting to note the contribution of one of my correspondents who wrote: "First, I emphasize that all insects, even mosquitoes, are things of beauty to be studied and cherished by us humans." But, as you suspected, my friend states also, "as I have probably already revealed, I am extremely ignorant of mosquito problems."

Mr. Arthur H. Woody, Insect Abatement Supervisor, Bureau of Insect Control wrote on Mosquito Control Work in Portland, Oregon and vicinity in 1950. "The first serious attempt at mosquito control in the Portland vicinity came in the middle thirties. In 1934, a study was made by the U.S. Department of Agriculture and Plant Quarantine, with entomologist H. H. Stage in charge. Results showed that the *Aedes*, or floodwater mosquitoes, were much more than a nuisance. Their presence caused losses running into thousands of dollars through decrease in milk production in dairy herds, inability to hire or keep labor in the truck crop area, and loss of tourist trade." Attempts to check this report failed when correspondence was returned marked "unclaimed." Has this Bureau been lost in Oregon?

The rapid development of amusement for the urbanites by drive-in theaters was brought to our attention by W. C. Baker and H. F. Schoof, Communicable Disease Center, U.S.P.H.S., Savannah, Georgia. "Temporary control of Adult Mosquitoes at Outdoor Places of Public Assembly" in 1955. Ballparks, drive-in theaters and golf courses were being treated for adult mosquito control as early as 1946 with available DDT and certain types of misting and fogging equipment. It was not unusual in 1947 to see the DDT equipment appear at ball parks during the seventh inning stretch. In many localities this situation has been remedied by area control or improved by permanent mosquito control techniques.

Mr. W. Harris Bell, Legal Consultant, Texas State Department of Health, Austin, Texas justifies "Texas Methods of Organizing and Financing Mosquito Control Work" by writing that "Industrial progress has brought expanding populations to a point where all sections of Texas are growing faster each year, and we have outgrown the lines that guided our progress in early days. Today we find cities extending far into our rural areas. We find modern homes in last year's cotton patch. Where we formerly had one rustic outhouse to take care of the needs of the family today we find modern homes with two or three bathrooms . . . The increasing trend of our population toward rural areas where tremendous investments are being made in housing, make it a matter of critical importance that our statutes be amended to more adequately control mosquito breeding in these areas" to which modern man returns at the end of his day's work to relax and enjoy the "wide open spaces" where his family spends the day away from crowded city life.

Although dengue was the disease which brought the need for mosquito control into focus in Hawaii in 1943, it has continued with increasing attention as justified in (1) the prevention of human disease transmission (2) prevention of other public health nuisance (3) prevention of the introduction of new mosquito spe-

cies; and (4) prevention of interference with tourist trade and other economic developments. Mr. Patrick Y. Nakagawa reported this to the AMCA in 1958. At that time a survey of the veterinarians provided an estimate that more than 90% of the dogs in Hawaii were infested with heart worms (Filarioidea). This may occur early in the life of native dogs and most certainly has opportunities to develop during the 120 days quarantine period imposed on all animals which enter the 50th State.

Mr. A. J. Boulahanis wrote of "Mosquito Control in Illinois" that "Pestilential Marshes gave way to prosperous agricultural land and urban development. The byproduct of this activity was the sharp downtrend in malaria and other mosquito-borne disease. However, the increased drainage activity, and especially the lowering of the water tables by drainage without regard to all phases of mosquito biology created new mosquito problems. Thus the permanent water breeder problem was replaced with the floodwater type. This new twentieth century problem was largely man-made. Flooded situations of a temporary nature developed at a fast pace, mainly due to poor engineering practices such as construction of highways, railroads, drainage systems, and sub-divisions of urban areas without provisions for residual drainage. Likewise, polluted streams and ditches developed rapidly as the problem of economical disposal of raw sewage and industrial wastes increased.

"Under these conditions the mosquito problem drew metropolitan attention. . . . In 1925 at the request of the Gorgas Memorial Institute of Tropical and Preventive Medicine, Mr. Joseph H. Le Prince, the dean of mosquito fighters, came to Chicago and surveyed the entire metropolitan area. His conclusions were summed up in one statement: "The prevailing problem is mostly man-made." Mr. Boulahanis summarized "The bulk of the recent growth of mosquito control activities has been centered in the Chicago metropolitan area, where a great exodus of populations into the suburbs has occurred and leisure time expressed in outdoor recreational activities has increased steadily. Since suburban living and outdoor recreational activities are most enjoyable during the spring, summer and fall seasons, they are dependent to a great extent upon a mosquito-free environment. To obtain such an environment, there is a clear need for additional control measures. In view of the many different sources involved outside the areas affected, changes in the abatement laws may also be required." (1959)

The approach to this development discussion may take several routes. In 1901, Dr. L. O. Howard published his excellent book on "Mosquitoes—How they live; how they carry disease; how they are classified; how they may be destroyed." He tells of many personal experiences and related the observations of other experts to prove that "In many places infested with mosquitoes nothing could be easier than to put a stop to the whole tormenting plague. In many other cases the problem is a more difficult one, but in even the worst cases, by a judicious effort, which should be a community effort, and by the expenditures of a greater or smaller amount of money, much relief can be gained. In fact, Mr. W. J. Matheson, of New York, was quite right when, in the summer of 1900, just before commencing a successful crusade against the mosquitoes on the north shore of Long Island he wrote that there seemed to him to be no more reason for enduring the mosquito scourge than in allowing small-pox to ravage communities, as it used to do before the days of Jenner. Work against mosquitoes is being undertaken everywhere by individuals and by communities."

In sixty years, we have made outstanding progress in some areas,a little less in other places, and we have not started in many mosquito ruled lands. Mosquito Control is like Preventive Medicine—a must for Public Well-being. When a mosquito-borne disease burst forth in the bloom of an epidemic, Dr. J. C. Geiger stated, "This is another example of doing too little, too late." Our panel should force us through this dismal situation and carry us up to a more optimistic plane. We can't overlook the importance of this attitude, however, as we move forward. Sixty years ago, in that age of optimism, Dr. Howard wrote, "Some years ago I was visiting a family in the mountains. It was during a dry season, and water was scarce. There were no swamps, no lakes or pools, and the drinking water was taken from springs; yet mosquitoes were so plentiful that it was necessary to screen the porches that sitting out of an evening might be possible. I asked where the water came from in which they washed their clothes, and they replied, as expected, 'from a rain-water tank,' which, as it happened, was situated under the porch. I investigated this tank and found it literally alive with mosquito larvae. A pint of kerosene stopped the breeding, and as the water was drawn from a faucet near the bottom of the tank the kerosene did not injure it.

"The indifference of this family as to the source of their local mosquito pest, or rather their combined ignorance of and indifference to this subject of the breeding places, was at that time—and it was not so very long ago—characteristic of people in general."

The only purpose for preparing these background testimonies is to evaluate the "Relationship of Public Well-being to Mosquito Control." Do people, in general, want to be well? Education is the building program on which our Public Well-being advances. Education is the means by which our goals can be reached. Our Public Well-being is often the cause of our Mosquito problems. The water for washing clothes was the source of mosquitoes in 1895. In 1960, the bucket of rainwater under the porch was saved for the housewife to wash her hair. It was a source of mosquitoes, too.

Settlement of the lowlands with the resulting improvement of the land for agricultural purposes, and the institution of flood control measures which have reduced the size of the overflow areas have certainly shrunk the breeding grounds of some of our pest mosquitoes in Arkansas. But the development of home spaces and the establishment of villages and towns has always been accompanied by water pollution and the increase in the number of artificial containers. One observer estimated 70 times as many breeding sites after the development of a Florida real estate project. These conditions were favorable to *Culex quinquefasciatus* and related species, and *Aedes aegypti.*

Dr. Stanley J. Carpenter observed that the agricultural development of the country seems to have brought about very little reduction in the production

of *Anopheles quadrimaculatus*, the chief vector of malaria in the South. Mass production of *Culex tarsalis*, one recognized vector of encephalitis, has been related to changing conditions which resulted from agricultural practices.

The development of the oil industry in many parts of the world created ideal breeding conditions for salt marsh mosquitoes as the dumping of salt water into small streams became a common practice. Similar conditions have been found in coal mining areas.

Dr. Carroll N. Smith, Entomology Research Service, U.S. Department of Agriculture, Orlando, Florida responded in his most respected manner. "Like so many other entomologists most of my comments must consist of impressions rather than statistics or other positive data. I have heard all kinds of claims about mosquitoes, sand flies, and stable flies affecting the tourist trade along various parts of the east coast, and I am willing to believe most of them. Although hunters and fishermen will put up with an enormous amount of discomfort to pursue their hobbies, most tourists are out for pleasure and they will not stay in an area where such pests take all the pleasure from swimming, boating, hiking, photography, or just plain loafing. Many of them will not even stay if they have to use repellents to obtain relief. I believe that at least moderately good mosquito control is an absolute essential for a healthy economy depending on tourism or outdoor recreation.

"Reliable figures on the effect of mosquitoes on milk production are also fairly hard to come by. However, the dairy owners tell us that so many things can bring about decreases in milk production, that if one-half of them are true, mosquitoes must certainly be of importance. We sprayed a barn with a fly repellent and for two days the cows were skitterish in the barn. The dairy owner gave us statistics showing a substantial loss in milk production which he attributed to the disruption of the equanimity of the usually placid dairy cows. On the other hand we sprayed the entire area around a dairy farm from the air for house fly control, and incidentally achieved complete eradication of barn flies for a few days. During these few days milk production increased sharply. For all we know other factors could have caused the decrease and the increase I mentioned, but all dairy men agree that any disturbing influence will decrease milk production, whereas anything that contributes to the comfort of the dairy cow is apt to be reflected in better production. It seems impossible that the annoyance which must be caused by thousands of mosquitoes feeding on dairy cattle at a single time would not have some effect.

"I am most dubious about the effect of mosquitoes on labor. In some places there is a labor pool which must work or starve, and I believe they would work no matter how hard the conditions are. In other places, and I believe Oregon in 1950 was one of these, there was much competition for labor, and under these conditions I am certain that laborers would not work where mosquitoes were bad.

"I would like to make one comment on the positive side, but here again this is simply an impression which I cannot support with definite statistics. Immediately after World War II we had a boom in Florida, which was particularly marked along the east coast. Many people who had been stationed at Air Bases or Army Camps (where mosquito control had generally been carried out) wanted to return to Florida to live, and industries were looking for places for expansion. At this time, mosquito control in Florida, and particularly along the east coast, was excellent, and when individuals and businesses surveyed the area for places to locate it was not too difficult to find favorable places free from mosquito annoyance. I am personally convinced that the excellent mosquito control operations played a part in Florida's growth at that time, and that development would have come much more slowly if salt-marsh mosquitoes had been uncontrolled.

"In 'The Mosquitoes of New Jersey and Their Control,' Dr. Thomas J. Headlee points out that 'probably the most important economic effect of mosquito reduction has been in the increased value of vacation lands along the seashore. It was no matter of chance that the Asbury Park region on the Monmouth County shore and Absecon Island in Altantic County were developed before other vacation spots. There were no salt marshes closely adjacent to Asbury Park, and Absecon Island is swept by prevailing sea breezes, hence neither had a serious mosquito problem.'

"On the other hand there is a record of the Berkeley Arms Hotel built around 1880 at which is now Seaside Park, said to be the finest hotel on the coast, but killed its first summer because a huge flight of mosquitoes drove the guests home. It was located at the terminal of the railroad both to New Jersey and Philadelphia, was financed by the Pennsylvania Railroad and had all the prestige of that road behind it, but it never recovered from the reputation given by that first flight of mosquitoes and was finally abandoned, and later burned down.

"Today the thriving resorts of Seaside Park and Seaside Heights with an assessed value of almost four million dollars (1945) adjoin the location of that ill-fated hotel and bear testimony to the economic value of mosquito control for shore resorts."

Dr. Headlee ends his interesting treatise by showing how malaria is controlled by breeding of *Anopheles quadrimaculatus*. His concluding statement is emphasized in italics: "This experience leaves no doubt in our minds that malaria can be readily eliminated by the Anopheles mosquito which serves as a vector for this disease, but the control of such things as fowlpox of chickens, encephalitis of horses and heart worm of dogs by elimination of the mosquito carrying the infection has not yet been worked out."

In a recent discussion with medical personnel who had been in the Belgian Congo for many years, it was revealed that the problems of Public Well-being were controlled by an excellent medical organization. Filariasis, for example, was eradicated from Leopoldville by the use of aerial dispersal of insecticides. With a well-dispersed population, 12.7 per square mile, and less than one-tenth living in cities, localized control programs are not practical. Mobile sanitation groups assume this important responsibility and visit the villages once a year but in some districts more frequent visits are made depending on the population and rate of disease. These sanitation groups are directed by at least one medical assistant who has one native clerk and several highly trained native aides. Unless the recent re-

organization of their government causes any drastic changes in this operational program or the problems which it is geared to meet, we are optimistic about the future of Mosquito Control and its Relationship to the Public Well-being of the Congo people.

Dr. William Y. Chen of the National Institutes of Health, summarized many scientific publications from Communist China at the meetings of the AAAS in New York. Dr. Chen reported great progress in preventive medicine and sanitation. Their clean-up campaign in the once crowded and dirty capital city, Peking, has "resulted in the decline of the general death rate . . . from 14.1 to 7.4 per thousand during the past ten years." "It may be of interest to examine how the Communists did this job," Dr. Chen said. "The first step was to start a campaign to eliminate the four major pests—mosquitoes, flies, rats and grain-eating sparrows.

"They integrated public health work with mass action by the so-called 'patriotic health movement.' Millions of people were mobilized to kill these four pests throughout the country with all available anti-vermin chemicals and devices, including manual swatting of mosquitoes and flies and manual combat of rats and sparrows with sticks and stones. They not only mobilized adults, but also utilized the aged and the very young.

"Under such all-out war launched by millions of human beings against vermin and birds, the humans finally won the battle and were eventually able to prevent and control many communicable diseases spread by these vectors. "It has been reported in 1959 over a billion sparrows, 1.5 billion rats, 100 million kilograms (110,000 tons) of flies and 11 million kilograms (12,500 tons) of mosquitoes were eliminated.

"It was humorously reported that many sparrows which were actually not killed by shooting or striking, but were constantly chased by the people hour after hour, finally died of sheer exhaustion."

Most of our members who have been in this business of Mosquito Control for many years are acquainted with the biological control program which employed bats. Although it is reported that several towers—bat towers—were built in Texas about 1920, the literature available at this time does not include scientific results of the technique. I mention it only to bring another example of man's attempt to control mosquitoes to improve his own well-being. This 70 foot high tower on one of the Florida Keys was constructed of cypress and has withstood the elements for more than 30 years. Although bats were brought to the tower on several occasions they failed to remain and inhabit the area. In good faith the builders hoped that this effort would make it possible for them and others to live on this island and enjoy life. It was "Dedicated to good health" but failed its purpose. And yet, these people *did* something about the problem. They can't be accused of "doing too little too late."

To live together in towns and cities, to have successful agriculture, and to have industries for employment are necessary to our standard of living. Mosquitoes have limited man's habitation of many regions of the world and are claimed to be among the worst insect pests affecting man and his domesticated animals. The optimist explains that sanitary conditions do improve slowly and mosquitoes of certain species will diminish and may disappear completely. We submit that this may be noted in very small sectors while other areas wait for the discovery of "how man is to live with the insects, not how to eliminate them 100% which last is rarely practicable anyway." Can we wait longer. Most of us are convinced that Public Well-being must improve continuously and this cannot be accomplished where mosquito control is always delayed "until next year's budget" or unnecessary "where natives of this area have become immune to them" or "let the alligators repopulate the area under our new protective laws and our mosquito populations will drop" or 1000 and 1 other excuses. Mosquito Control will come this year or when we have an enlightened Public. This is our challenge.

Murray: The first speaker will be Mr. Roy McLain, a farmer. He has seen mosquito control in action for many years. In 1952 the Delta Mosquito Abatement District, of which I am manager, faced a dilemma. Because of resistance, we could no longer use DDT, Toxaphene, Dieldrin, etc., and because of weather conditions, we had unusually large populations of mosquitoes. What were we going to do? We decided to go to the public and find out what they wished us to do. The president of our Board and I went to a highly respected and civic minded leader in our area, Roy McLain, and asked him for his guidance. He suggested that we call a meeting of members and leaders of civic groups and public offices to discuss the problem. At this meeting we found out what the public wanted, and we received many valuable suggestions which have guided our program ever since.

Roy McLain is a citrus, olive, grape and livestock producer. He is president of Lindsay Ripe Olive Company and vice-president of Sunkist Growers. He has been in the California Farm Bureau for seventeen years, was first vice-president for four years and second vice-president for four years. He and the next panelist, Jack Chrisman, are currently working on a project to develop a hospital district in the area about Visalia. We have here persons who are very civic minded and who are doing what they can to help their community. They are in an excellent position to guide us, as mosquito people, in our program with the public. Roy McLain.

MOSQUITO CONTROL AND AGRICULTURE

ROY R. MCLAIN
Visalia

Mr. McLain: Thank you, Don. I have wondered in the past few days just why a farmer was invited here to tell you people who are administrators or directors of this particular work what to do; but I want to get the record straight on one thing. The story still fits about the school-boy who wrote the essay about Socrates. It was one of those very short and very simple compositions—as school boy essays usually are—in which the boy wrote "Socrates was a Greek. Socrates was a wise man. Socrates told people what to do. Socrates was murdered."

I'm not here to tell you what to do. I am here merely to discuss with you, from an agriculturist's viewpoint, a little bit of this matter of mosquito control. Certainly,

when our district was formed, people expected results. Time went by and results were not quite all that were expected, so certain other steps and changes in procedures had to be made.

Now farmers are people too, and I sometimes thought that maybe this was Don's objective in inviting me here, although I didn't know whether or not I could prove it to you. They have the same needs and desires as other people. They want to see mosquitoes controlled, although usually, and this is the first item of proof I submit that they are people, it is the other people's mosquitoes that they want to see controlled. This is a common practice, and I think you will find it true among urban as well as rural populations. I am not fully acquainted with all of the frustrations that I know you must receive in your daily task of carrying out your control program, but I just want you to know that your adversary sometimes becomes frustrated too. You must never forget this. Don mentioned the meeting of the public that we held when he and his staff became a little bit frustrated. You know mosquitoes can become frustrated too, because the story is told about the mosquito that was flying by the high board fence one day and he heard human voices on the other side of that fence. Naturally he was interested in humans, so up he goes and flies down on the other side. Pretty soon a second mosquito flying along on the outside of that fence saw this first mosquito setting on the limb of a tree just inside the fence looking very downcast. As the second mosquito flew over and sat down beside him he saw that the first mosquito was just shaking all over, really trembling and looking bad all over. He asked "Well, what's the matter?" The first mosquito explained the situation of how he had heard voices of people on the other side of the fence and flown over to find that it was a nudists' camp. He said "You know, the field of opportunity was so large, I just didn't know where to begin."

This I understand can happen to men in mosquito control work; sometimes the field is so large that they hardly know where to begin. This matter of control or eradication is of interest to all people. Your most difficult job, however, is not with the mosquitoes themselves, but with people—people who are breeding the mosquitoes or providing the water where mosquitoes breed. Education to bring about cooperation with people should be your main objective. You should avoid telling people what to do. Sure, you have certain laws behind you; you have certain opportunities in which you can bring about, by legal means, the forcing of people to do certain things; but you will get much, much further if you do it by cooperation. This is not always an easy job. Let me assure you that I am well aware of this. Patience is a virtue that you must possess if you are going to do this job right.

I have had a good deal of experience over quite a number of years with farmers, and I believe it is true that they are not much different from urban people in many respects. Yet the problems that farmers have are somewhat different, and you must view them from this different viewpoint if you are going to be successful.

Another story is told about farmers. We have farm advisors, as you know, that bring knowledge that is developed by the experiment stations to the rural areas. This one farmer was being urged by his neighbor to let the farm advisor come out and show him how to do certain things which he just knew could be done better. The farmer replied "No. I don't want that man on my place at all. I already know how to farm better than I'm doing." This is absolutely true—there are many things that we already know how to do better than we are doing, but for some reason or other we just don't quite get to them.

In dealing with farmers, you have to consider the different areas and conditions. For instance, the area where we are meeting today here in Southern California has become a metropolitan area, and the program of the abatement district here might be completely different than it would be in Don's district up in Tulare County which is more predominantly a rural or farming area with only small country towns or relatively few urban people in the area. So, you have to work with farmers on the basis of where you are and the conditions within the district where you are located.

All people, rural and urban alike, use water. I think we would all agree that where water is—I am talking particularly about stagnant water—this is the potential breeding place for mosquitoes and constitutes the first problem that must be dealt with in any control or abatement procedures that you try to bring about. I live in an area where there have been water shortages. We have heard about water shortages in the San Joaquin Valley and in Southern California for many, many years and at times they have become acute. Don happened to mention that I was in citrus, along with the production of other farm commodities. Because of the lack of water, it was said that citrus was going to go out of production. But I have said before and I will repeat again, that in my opinion there have been more citrus trees killed by the use of too much water, even in an area of water shortage, than there have been by the actual shortage of water itself. This has been brought about by poor irrigation practices, sometimes complete laziness, a lack of planning, by not properly levelling the land itself, the composition of the soils, and by one reason and then another. This is something you will have to understand if you are going to talk about the agricultural part of your program and the agricultural people that you have to deal with.

The soils itself may be of a composition which does not take the water, and whether it is in an orchard, a pasture or an alfalfa field you may need gypsum, sulfur, or these types of materials which will flocculate and loosen the soil so that water can penetrate down in and not stand on the surface as an actual or potential breeding place for mosquitoes. You must approach all these matters with care, because when you talk about relevelling land, the use of gypsum or sulfur, or proper irrigation practices, the first thing you may be talking about is what is this going to cost the farmer. You are talking about money out of his pocket. You just don't go out and say "Do these things tomorrow," but you actually work on an educational program which stresses the values to be received from the control program itself. You first have to convince him and make him believe in your program. Let me assure you that most people, in rural areas as well as urban, already believe in the necessity for control of mosquitoes. But I come back to the statement I already made—sure, they want the other fellow's mosquitoes controlled—but if it is going

to cost them some money, then this is the first big hurdle that you have to get over. It can be done, however, and it has been done in many districts and areas where an educational and cooperative type program has been carried on.

We are very proud in our area of the Delta Mosquito Abatement District under Don's management, because the district has used this approach. I think we can say that what spells the success of the district itself is in working with people. One of the areas of cooperation has been with dairies. Wherever you go in the United States there are dairies, you have them right here in Orange County in a metropolitan area. The rural area in Tulare County where I come from is quite a dairying area, and these dairies potentially create some of the greatest sources of mosquito breeding we have. Work has been done. I happen to have done a little. I operated, during the war years, a small dairy on my own. I put in a drainage system wherein I utilized gravity to drain the washings from the dairy barns, the holding corral and the milking barn through a mere few feet of extension of the cement drain line into the irrigation pipeline. This fertilizer then was taken out onto the pastures and the alfalfa fields with the irrigation. The Delta District has developed a booklet on this; maybe some of you have already seen it, I have a copy here in my pocket. If you haven't, pick one up. They are available here. This shows the actual value which one dairy, a rather large one, puts forth in fertilizer content of the refuse from the dairy holding barn and milking barn. Put on the ground by this dairyman it amounted to $7,500 in one year. This is of economic interest, the dollars out of his pocket that I have been talking about. If you can prove to him where he is going to get money or save money, or make money by the use of this fertilizer in this way, then you eliminate the problem of the stagnant holding ponds which become breeding places for mosquitoes.

There also are examples given here of three smaller dairies, each one of them with monetary value shown in the tables in this booklet to prove the point. If you establish the proof first, most farmers today, if they are successful or going to remain as a farmer very long, have to take a look at the economic side of this thing because they are practical people.

In the field of agriculture itself we know some of the frustrations that you have been up against. Don mentioned in his opening remarks the need to change materials in the control program due to resistance--this can be understood most readily by farmers. The question of safety of the materials you use, is as important to farmers as to people in cities. One of the greatest losses we have had in agriculture is from insects and pests. We have had to change materials just as you have. For example, we started out in the old days about forty years ago, with lime sulfur. Then we went to DDT which you first used after the war. But we have gone from there to tartar emetic to dieldrin; then we have gone from the bait sprays to the phosphates; we have gone from fumigation to parathion and methyl parathion. We have used all of these types of materials in our production methods; and all of these things that have to be used, in the mixes that we use, to protect our crops from the insects when formerly we worked with very simple materials, today are something we have to live with. We even use them in areas such as we are now in, in Southern California, where there are many millions of people, and under proper methods they can be used with comparative safety. The changes, and the use of these newer materials, have come about through the cooperation of people, first in the research field, in the manufacturing fiield, in the sales field, and then in the user field in agriculture. These are things you have dealt with; you should know that the farmer is well acquainted with your problem in this particular regard.

Why are we interested in the mosquito control program? To be sure—from the everyday welfare of being able to sit on the lawn and enjoy an evening, to have a barbeque at your outside pit, and all of these things. This is important to rural people as well, because rural people are living today in that manner which in former times we'll say was restricted to urban people. We are also interested in what happens to humans and to livestock. Mosquitoes are important in livestock. I can recall having visited other areas of the nation—I will give just one bad example. Let us take the delta area of New Orleans. The delta runs about a hundred miles or so south of New Orleans and is a heavily mosquito populated area in which it was almost impossible in former times even to work there, for the workmen themselves, to say nothing of the horses which were formerly used. There are more tractors today, although there are still places where they have to use horses.

There is the matter of encephalitis in horses, which also spreads to man. This comes home to me, because right out of a clear sky I had a son that was put in the hospital. What did this develop from? A mosquito carrying encephalitis actually put the son in the hospital for a period of time. He came out of it all right. But this is of interest to rural people just as it is to people anywhere in this world. This points out the importance of your job. When these things come home to you, you recognized the importance of the work that you people are engaged in.

One other thing that I would like to talk about here. In this area right here, if you will drive around among some of these orange groves, you will see some dead trees. You will see groves right in this area where fifty per cent of the trees on a ten or twenty acre block, or a forty acre block, are dead. What are they dead from? They are dead from a virus disease, a virus which was discovered back in 1946 by the experiment station at the University of California. This virus is spread from tree to tree by a vector. A mosquito is a blood animal —he's after blood and is not a vegetarian as such. The quick decline virus of oranges is spread by a vector that is a vegetarian, yet the control principles and the materials that you use against mosquitoes and those that we use against our vector in many ways tie together. Here we are talking about the investment of hundreds of thousands of dollars in an orange grove, and the question of whether you are going to lose it or save it is involved. I don't know where the breeding places for all these vectors are; I don't know all the types of vectors that can possibly spread this disease: but when you start talking about the program on pears, in which they in the last two years have had a serious new virus problem, and cherries, peaches, strawberries, etc. are now being attacked by virus diseases; and when you start talking about the changes of materials which you have made, the safety of the

population involved where you use these materials, you do have the understanding of the farmers in this regard. The monetary factors can be proven, and there are ways and means if you will study them, as has been done in the Delta Mosquito Abatement District, where you can go out to the farmer and prove to him, by facts and figures, that economically it is in his interest to do this thing to prevent the spread of mosquitoes. It is mainly a matter of public information, education, following a research program, assuring that your facts and figures are correct, then you will get the cooperation you need.

Thank you, gentlemen:

Dr. Murray: Thank you very much, Roy.

The next speaker is Jack Chrisman. Jack is currently Mayor of Visalia, serving his third term in this capacity. He has been on the City Council for ten or eleven years. He was a trustee of the Delta Mosquito Abatement District for eight years. In 1960 he was president of the League of California Cities, an organization that includes all of the cities, big and small in the State of California. Not only has he been extremely involved in city problems, but he is also one of the biggest cattlemen in our county, also a general farmer. He has proved himself to be so effective in things of community interest that he was given a very specific job of going to Washington, D.C. to assist in the planning and building of several dams in our area for flood control purposes. Jack will talk on "The Relationship of Mosquito Control to the Cities." Jack.

MOSQUITO CONTROL AND URBAN INTERESTS

JACK CHRISMAN
Mayor of Visalia, California

Mr. Chrisman: Don, distinguished guests, ladies and gentlemen: A few honors that Don didn't mention, for example, and I think it is rather significant, that not too long ago I was made an honorary member of the California whale watching society. I had always thought that you could just watch whales, but I understand that there are certain rights and privileges that go with an organization like that.

First permit me to express my very sincere feeling of appreciation for having been extended the opportunity to meet with you today and to some degree participate with you in your program. In the presence of all of these experts and distinguished guests that we have here, if I appear to be somewhat nervous, I am reminded of the story of the bridegroom who was asked if he was nervous on his wedding night and he indicated that he was, but he was awfully glad to be there. Certainly, I am very happy to be here.

My job, as I understand it, is to talk to you. And your job, as I understand it, is to listen. But, if you finish before I do, just raise your hand. Reviewing the subject matter of the very fine program that has been arranged for you during this conference, I can not help but be somewhat intrigued with the idea that I was going to participate in a symposium. My dictionary defines symposium as "a convivial fete characterized by the drinking of wine mixed with water, by intellectual and enlightening conversation, and by music, dancing and other amusements." After that definition, I think I am rather inclined to want to make my remarks brief in order that we can get on with the symposium.

I think, certainly, that when we consider the matter of mosquito control and urban interests, we invade of necessity a broad area of facts, problems and speculations. Roy indicated that the scope is indeed broad. I am somewhat reminded of the story of the far eastern potentate who gave his son one hundred concubines on his son's twenty-first birthday. His son was heard to make the observation that it was not a question of not knowing what to do with them, but rather a question of knowing where to begin. I think that perhaps, when we consider this overall program, that is the position which all of us are in. I think that if we are going to be objective in our thinking, we must recognize that those of you who are actively engaged in the field of mosquito control, indeed deserve credit for the effectiveness with which you have done and are doing your job. I think also though that we must be cognizant of the fact that a coin has two sides. Generally speaking, though control in most areas has been very effective, the overall problem, while reduced, still exists.

I could give you a few statistics, and they will be very few, because I think you will agree with me, that you can use statistics to support almost anything, and particularly statisticians. Here in California for example, our experts tell us that this decade promises an even greater population expansion than we witnessed during the past ten years, that by the middle of this decade California will become the most populous state in the union with a total in excess of nineteen million people. By the end of this decade, we will have approximately twenty-five million people, and by 1980 there will be upwards of thirty-five million people. I think it is rather interesting to note that more than two-thirds of the people in our state live within cities which encompass less than two per cent of our total land area. By 1980, if our experts are correct, there will be approximately twenty-five million people residing on less than four per cent of the land, and our other ten million will require an even smaller fraction of the total. I think that this vast concentration of people in so small an area is a forceful reminder of the tremendous problems of urban growth that are facing us. Certainly, if the effectiveness of our mosquito control does not at the very least keep pace with our population growth, then we will not have done the full job for which you, ladies and gentlemen, have been trained, by your education and experience, to do; and your problems instead of diminishing, will in reality grow.

How then can we best deal with this problem? It occurs to me that we can actually reduce our approaches to the ultimate solution we wish to achieve to three in number. 1) We can adopt a so-called laissez-faire program, do nothing—certainly I would not insult your intelligence by elaborating upon this method. 2) We can approach this problem through a purely legal point of view: you know, the law is on your side and you're going to shove it down their throat whether they like it or not. But I am sure that you would agree

with me that even a Callicak or a Jukes could see the folly of this type of an approach. 3) Or we can undertake the cooperative approach, and certainly if we are the least bit intelligent, the least bit objective in our thinking, we will recognize the full value of cooperative undertaking. During the eight years that I was privileged to serve on the Board of Trustees of the Delta Mosquito Abatement District, I watched with a great deal of interest and no small amount of pride as our program of mosquito abatement was undertaken and projected by professionally qualified and competent administrators and technicians, by dedicated staff workers aided and abetted by a board of trustees that had the interest. I think the knowledge and sincerity of purpose to develop a policy sufficiently flexible in nature has enabled our trained personnel to achieve their official function in a highly successful and effective manner.

I watched with consuming interest, as first both those in our urban as well as in our rural areas apprehensively, and with a certain amount of urging, explored the area of cooperative undertaking much as one would test the water in a swimming pool, first by sticking his toe in and then his foot, and then finally, finding that the temperature was not too painful, he immersed his whole body. Cooperation is like that. I don't think it can too often be achieved in one big supreme effort; but in small doses it can become a vital living tool through which effective achievement can be realized. Through cooperative effort I have watched many problems, which at the outset appeared almost insurmountable, but I watched those problems surmount themselves almost effortlessly. And through cooperative effort, I have seen many so-called problems that might have ballooned themselves all out of proportion, become troublesome little incidents that were successfully handled in a routine manner. Through cooperation and cooperative effort, I have watched as I am sure you have within your own district, the birth and development to a very high plane of urban-rural relations that has made for effective mosquito control and a measurably easier and much more effective reality.

I feel certain, that you would agree with me when I say that the case for cooperative undertaking has been very well established, and certainly throughout this entire fabric of accomplishment one very important, one very significant, thread has been utilized time after time to complete the final woven product—education. Education in not necessarily an academic sense alone, but education in a practical sense as well. And here again, I think the coin has two sides. The educational process has to be just as effective for the worker in mosquito control as for the citizen who pays the bill and gains the benefit. Each, certainly, must understand the wishes, attitudes, the resentments and the problems of the other if the desired results are going to be obtained. Patience, courtesy, consideration, understanding are all vitally important watchwords in the educational process. Let me say with all the sincerity of which I am capable, that in some quarters you will hear the cry that education is expensive. Certainly, education is expensive, but ignorance is even more expensive. But I would hope that you would agree with me that ignorance in action is a frightful thing to behold.

Thank you.

Dr. Murray: Thank you, very much, Jack. This has been extremely interesting to me.

We have gone from the country to the city. Now, for the interest of both country and city we have a phase of our program that plays a very important part: conservation, the conserving of natural resources for everybody. There is a question whether there is or not a real conflict of interest between or among different groups. Certainly, where you have the use of water, you may has such conflicts. Considering what has been said up to now, cooperation, education and understanding, this is what we need to get in a field such as this. We in mosquito control don't want water; but those who like to shoot ducks or go fishing want water. There is a question of how we can pool our knowledge, our resources, to achieve something that will fit all desires.

Dr. Paul Springer, Chief of the Section of Wetland Ecology at the U.S. Fish and Wildlife Service Center, Laurel, Maryland.

Mr. Chairman, ladies and gentlemen: I appreciate this opportunity to speak to you on the subject of mosquito control in relation to conservation. Also, I am looking forward to the trip that I will take after this meeting in which I, along with others, will view some of the areas in the State of California on which there are mosquito-wildlife problems. Before proceeding with my assigned topic I should like to modify one of your remarks, Mr. Chairman. I hope that when I finish my talk I shall have shown that we can have water for wildlife and still accomplish good mosquito control.

When asked to speak on the subject of the relationship of mosquito control to conservation, I assumed that this meant wildlife conservation. I will restrict my topic primarily to that because it is the only field of conservation in which I feel at all well informed. The term "conservation" means different things to different people. I like to think of it as the preservation and wise use of our resources. This doesn't mean the locking up of our resources, but rather their active maintenance and even their promotion in the face of competing land use.

RELATIONSHIP OF MOSQUITO CONTROL TO CONSERVATION

PAUL F. SPRINGER

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There are few people who would deny that as far as man is concerned, mosquitoes are pests. Mosquitoes have few recognizable virtues or values, and certainly few supporters, unless it be the taxonomists or the

insect morphologists or physiologists. In a sense then, we can liken mosquito control to motherhood. I believe that practically everyone is in favor of both. In motherhood, the ideal is that the mother bear a child without defects and at the same time remain healthy. In mosquito control, the ideal is to obtain effective control with no undesirable side effects. To the extent that we can achieve this goal, there should be no complaint.

Now, let us look into the pros and cons of mosquito control in relation to conservation. First let us consider this subject from the point of view of elimination of mosquitoes without regard to the methods used and any side effects they may have.

It might be argued that mosquito control is beneficial to wildlife, since it eliminates vectors of wildlife diseases. There are a number of wildlife diseases and parasites that are transmitted by mosquitoes; for example, bird malaria, bird pox, encephalitis, and heart worm. We know almost nothing, however, of the benefit of wildlife from the control of these diseases and parasites. We do know that animals of many species are inured to afflictions by these organisms and seem to survive despite their attacks. Even if the disease or parasite is a limiting factor, there may be compensating mechanisms. For example, control of one limiting factor can result in another one exerting a correspondingly greater influence. There is the possibility, also, that elimination of the first limiting factor could cause members of a particular species of wildlife to attain a higher population level. If the species is desirable, this would be a benefit.

We know very little about the harassment of wildlife by biting mosquitoes. There is some evidence, probably associated more with biting flies than with mosquitoes, that animals disturbed by biting may move to less infested areas. There is no question, though, that mosquito biting is a cause for agitation among humans. This has a relationship to wildlife since it is difficult for one to enjoy wildlife if he is constantly swatting mosquitoes.

Another theoretical benefit of mosquito control to wildlife could be a reduction in secondary infection resulting from mechanical breaks in the skin caused by mosquito bites. We do know that most birds and mammals have a more protective external covering than do humans, and that they also may be able to resist infection better than humans. Hence, the benefit of mosquito control here, at least as far as our present knowledge is concerned, would seem to be minor.

A possible disadvantage of eliminating mosquitoes is that their reduction might affect fish, birds, and other wildlife that feed upon them. Although elimination of mosquitoes could change some food-chain relationships, there is no evidence that these insects are an essential item in the diet of any animal.

Now, let us examine the pros and cons of the principal methods used to achieve control of mosquitoes. First, let us consider environmental control through open ditching and drainage. The critical factor here is the degree to which the water table is lowered. If this is not too great, there may not be any harm to wildlife, and this method actually may benefit wildlife by providing better interspersion of surface water within a marsh. Sufficient lowering of the water table, however, destroys the wetland and changes it to a drier environment. Then the wildlife that utilizes this habitat is reduced or is eliminated within the area.

Earthen or hydraulic filling, if it is carried out effectively, is completely destructive to wetland wildlife. In addition, it may create new problems. In many areas phragmites (sometimes called reed, cane, foxtail grass, or feather grass), invades filled areas. Stands of this plant are very attractive as roosts for blackbirds, which are one of our less desirable groups of wildlife.

Impounding for mosquito control ordinarily provides favorable habitat for fish, shellfish, waterfowl, and other aquatic wildlife. Also, the erection of dikes provides better opportunities for people to observe wildlife. Like any other method of control, however, impounding can affect certain species of wildlife detrimentally. For example, we still don't know what flooding does to certain species of fish. The dikes may interfere with their movements in the marsh or change habitat conditions. Also, flooding may drown out the habitat of certain songbirds.

Among biological controls, the use of fish is generally considered to be a safe procedure. These fish also provide food for other kinds of wildlife. Other types of biological control include the use of diseases and parasites of mosquitoes. A biological control method that has been studied in California is the use of bluegreen algae. The presence of these plants in ponds, ricefields, and other water areas may provide a suitable condition for fish and other aquatic life. It should be recognized, however, that some of the same species of algae that restrict the production of mosquitoes are toxic to warm-blooded animals.

Chemical control ordinarily has no beneficial effect on wildlife. There are exceptions, however. For example, barnacles, which are crustaceans, are very susceptible to DDT. Application of this chemical controls barnacles but has a lesser effect, or no effect, on oysters with which the barnacles compete. Thus, destruction of the barnacles results in greater production of oysters. We must recognize, however, that chemicals are poison, and we must be careful that they do not kill sensitive fish and other aquatic wildlife.

What, then, is the over-all effect of present mosquito control programs on wildlife? To the extent that these programs result in control of mosquitoes but not wildlife and its food, or do not destroy wildlife habitat, they can be considered good. In some mosquito control programs, harm to wildlife can be tolerated if it is not too great. The amount of damage that can be sustained is difficult to determine. Generally, this question is resolved by speaking of developing the the best program as measured by the over-all public good. It follows then that a well-balanced program can be achieved by giving proper consideration to the various effects. In this regard we should never overlook minority interests, since one of the basic tenets upon which our country is founded is that we always try to consider the other man's viewpoint.

We should be realistic, too, and recognize that almost all control programs will have some undesirable aspects. The problem, then, is to give proper emphasis

to the use of procedures that are effective and at the same time as safe as possible. Generally, programs that stress biological control or compatible methods of environmental control are the most acceptable to wildlife workers. This agrees with the basic principle of good mosquito control: manipulation of the environment so that mosquitoes are not produced, or, so that if they are produced, they do not reach the flying stage. This is sometimes called source reduction. Besides impoundment, other types of environmental control that can be beneficial to aquatic wildlife are controlled ditching, and dewatering followed by flooding during the fall, winter, and spring.

Some chemicals can be used to control mosquitoes with comparative safety to wildlife if recommendations are followed closely. Other materials are more toxic and there is little or no margin of safety in their use. To the extent that chemicals do not harm wildlife to a significant degree, their use can be considered compatible with wildlife programs. There is an increasingly prevalent view among mosquito control workers that toxic materials should be restricted for emergency or high level control, or as a supplement to environmental or biological control. The studies of Llewellyn, Mulla, and others in California have shown that it is possible to integrate the use of chemicals with other types of mosquito control.

Although the foregoing discussion analysis has been very general, it shows that there is a considerable area of agreement between mosquito control and wildlife conservation. In the future, we should expand this middle ground rather than emphasize the differences. This means that we should join ranks and work actively together on programs to develop better and safer methods of mosquito control. We can do this by (1) learning more about the biology of mosquitoes and the weak links in their life history, and (2) appraising, to the extent needed, the effects of control measures on the whole environment, including the effects on fish and wildlife.

Dr. Murray: Thank you, Dr. Springer. I guess that fits right in with the pattern we have been discussing so far. There was rather a peculiar thing—I was back in Ohio a couple of months ago to see my parents. My father is rather old, but peculiarly, he has far more hair on his head than I. Now, peculiarly, we have two John Mulrennans here, and one has more hair on his head than the other, and the younger one has the least.

But to get back to this subject of mosquito control and the public, we have two major states in the union which specialize to a considerable extent in recreation. There is a lot more in these states than that, of course, for California and Florida tend to vie with each other in many ways. As for mosquito control, I have seen more of the situation in Florida, I know what can be involved if the public comes to an area such as occurs there, where people intend to move to the area, live in the community, get out on the beaches, but then run into a severe mosquito problem. I think Mr. Mulrennan can explain the reaction of those people and the philosophy of the mosquito control program in that area as they attempt to solve the problems of the people. Mr. Mulrennan.

RELATIONSHIP OF MOSQUITO CONTROL TO RECREATION

JOHN A. MULRENNAN, *Director of Entomology*
Florida State Board of Health, Jacksonville

Members of the Association, I am at a loss to know exactly why I was chosen to discuss this particular subject, since this will be the first time I have had a vacation and visited any recreational areas to speak of in about twenty years. I would imagine that the reason for it is the fact that, as the chairman has stated, I have a bald-headed son out here, and I am planning to visit with him for a couple of weeks. It is unfortunate that he is bald-headed, but maybe it is good in some respects. I have always heard that it is a poor bull that can not mark his calf. But I have also heard that a bald-headed man is the most virile, so maybe we both have something to look forward to.

I will try to discuss something about the crown jewel of the North American continent, which, as you probably know, the entire State of Florida, is one big recreation area, especially around the coastal area of the State.

There are two things which are not compatible: one is recreation, and the other is obnoxious arthropods. To develop and maintain recreational facilities under obnoxious conditions, it is mandatory that biting and other pestiferous animals be suppressed to an acceptable level. There can never be developed a satisfactory environment for comfort and relaxation, with its many supporting facilities, until there is in operation a successful mosquito abatement program, expertly staffed and efficiently administered.

The State of Florida, in the early days of her development, experienced the bitter with the sweet. The devastating havoc that was brought by arthropod-borne diseases and persecution inflicted by the bite of the mosquitoes made development almost impossible. As recently as 1845, when the State was being considered for statehood by the National Congress, John Randolph of Virginia rose and stated that "Florida would never amount to anything, that it was a land of quagmires, swamps, alligators, and mosquitoes." It is absolutely true that people are not going into an area where they are going to be annoyed by houseflies, bitten by mosquitoes, or be plagued by blind mosquitoes, midges, and other pestiferous animals.

In the State of Florida, I might say that when I got into this work, we had four organized mosquito control districts in the State. In 1949 the State, in order to expand and develop the recreational facilities and bring and keep more tourists for a longer period of time, got into the program with State Aid; and today, out of sixty-seven counties in Florida, we have fifty counties that carry on active mosquito control programs.

In coming across the United States, from the Atlantic Coast to the Pacific Coast, I have enjoyed the trip for the simple reason that time was taken off to visit some of the real recreational and show places of this country, and I hope to see more before I leave this State. Today the people of this nation need and are seeking recreation. I think that we all realize and know that the medical profession has stated that more people are dying from lack of recreation and lack of exercise than from any other cause. I think it behooves this organization

to do everything in their power to bring about better and more comfortable recreation for the good of the citizens of this country, which means, if we are to accomplish this, it will mean working with all of the different, interested groups and coordinating our efforts.

In Florida I am not only in charge of all the mosquito control work in the State, but also as Director of the Bureau of Entomology I have the responsibility for the enforcement of the Structural Pest Control Act and the enforcement of the use of highly toxic pesticides in residential areas. We have a Council, which is made up of people from agriculture and related fields, with whom we are endeavoring to work out regulations to protect the public. Having been brought up on a farm and having come from one of the oldest citrus-growing families in Florida, I am cognizant of their many problems. I also understand the problems of the cattlemen. In Florida we are working with these groups. It means that all mosquito control workers must work with these various groups, since all of these activities are inter-related.

We have found that in some of our cattle-producing areas, where tremendous acreage was put into permanent, improved pastures, that in the clearing of the pastures by the bulldozing of the stumps, that terrific mosquito breeding areas were created in the stump holes. The specific species of mosquito has been known to kill over three hundred cows in one night. Our Research Center was able to work with the cattlemen and demonstrate to them how to prepare the pastures before the planting of the improved pastures.

We also have mosquito problems in the citrus groves in some areas, especially along the coastal areas, where citrus groves are planted in areas of high water tables.

Therefore, I say to this group that the one thing that we must all learn to do is to live together and work together. In many areas of Florida, the population is growing out into the agricultural areas, and we will have to think about more and better planning, especially in certain types of agriculture, because these people have got to live and progress to produce the food needed. It has been estimated by some of the best authorities in this country that by the year 2000, if we are not able to bring more land into production in this country, we may be in the same position in this country that many of the far eastern countries are in at this time.

So, in conclusion, I would say that we all have a big job to do—in working with the many different groups as well as the municipalities in bringing about better arthropod control. Careful planning is in order to minimize creating problems, which are now being created through pollution. It all means closer cooperation with agriculture, wildlife, and other agencies, if these aims are to be accomplished. There are many things to be seen and preserved in nature, and I think we need to work and plan more carefully in the preservation of nature's handiwork and creatures than has been demonstrated by many of us in the past. We have big problems with toxic pesticides, and we must be more careful in their use, although we must be always mindful of agriculture's need for these pesticides, since they are needed, in order to produce the food and fiber that this country is going to need in the future.

Dr. Murray: Thank you, very much, John. Are there any questions or discussion from the audience?

Mr. Steiner: I don't have a question, but I would like to make a comment if I may to enlighten some of the audience. I agree with Mr. Mulrennan in that some of the finest grapefruit, citrus fruit, come from Florida. I have eaten a good deal of it. But I would like to also say this to Mr. McLain as an explanation: I have been a resident here and a real estate broker for sixteen years. If you look outside and see these little fruit trees here, these orange groves, they are—and this whole area was—a low type of orange grove area, called a juice orange. Now, immediately before the Disneyland Corporation purchased this land here that we are on, this acreage was selling for eight to twelve hundred dollars per acre, including houses, barns, etc. The year afterwards, it was selling from twenty thousand dollars up to the present cost of forty thousand dollars per acre. So, we have orange groves in Orange County that are beautiful, well kept, sprayed and so forth. Even these were once nice clean groves, but the reason you find these groves in the immediate area from fifty to sixty per cent dead is that they were bought up by speculators for depreciation and they don't bother to do anything with them. Because as I said, the cheapest orange grove you can buy anywhere in Orange County is probably around twelve thousand, and in this area, up to forty thousand dollars an acre. That is why they are dying out.

Mr. Mulrennan: My statement was just made in fun. I drove up Victoria Drive the other day, and I will say this: there is no question but that some of the prettiest orange groves I have ever seen are in that section.

Dr. Murray: We are running a little bit short of time and Jack Chrisman has to catch an airplane in a little over an hour; so, are there any other questions? Discussion?

I certainly want to thank the panelists here for participating, for taking their time, developing this subject. There certainly was strong unanimity of discussion here—very intriguing to me. Commander Hirst had sent me a poem, since he is quite a poet, to summarize this discussion. I have just time to read it.

"Relationship of Mosquito Control to Public Well-being."

Malaria strikes the young and old
Where mosquitoes are prolific.
And encephalitis can be found
From Pacific to Pacific.
We've lost 40 head of cattle
From 2000 in the herd;
Yellow fever took 400 from 1000
So we heard.
Once dengue hit 6000 folks,
Just 97 dead.
This is part of what we paid,
So we could get ahead.
A Florida doctor pleads aloud,
"Mosquito Control is silly,
Since my house is air conditioned
I don't need DDT!"

I don't agree with him a bit
But he must be retired;
When I can't play around at night
I'll have to get rewired.
Now I can't quite understand
A man who underrates
This glorious North America
We call United States.
We have a constitution here,
Our freedom's guaranteed,
Only if we do our part
Whenever there's a need.
My grandfather left his country
Where he had lived in fear
And when I asked him, "Why?" He said,
"Cause it can't happen here."
He said, "If anything goes wrong,
We people have the right,
That when mosquitoes bother us
We won't stay home at night.
We form a Mosquito District;
Let everyone belong.
We eradicate those "flying fleas"
Before they do us wrong.
We'll make that public servant eat
His words of recent date,
'Our problems are quite simple, but
We do too little, too late.' "
First things first, in distribution
There is no known substitution
For Prevention. That is a must
To save the Peace at any cost.
Mosquitoes don't make resolutions.
They plan their bloody revolutions
To happen almost any date.
Since some of them will work quite late
And early, too, where folks have hated
To release funds, they've appropriated.
Each night before I go to sleep
I pray for all of those who keep
The world free in democracy
And opposing strong autocracy.
I pray that in our strategy,
There'll be no false economy;
And wisely, we'll include the line
That states, "A stitch in time saves nine!"
Then all our budgeteers will note
With pride, the comptroller who wrote,
"Our Mosquito Control must stay
So our economy will pay.'"

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1 February 1961

JOHN M. HIRST
CDR MSC USN

RECESS.

ORGANIZED MOSQUITO CONTROL IN MINNESOTA

A. W. BUZICKY, *Director*
Metropolitan Mosquito Control District
St. Paul, Minnesota

Thank you, Dr. Bickley. Ladies and gentlemen: At the time of the last joint meeting of the AMCA and CMCA here in Los Angeles, about 1955 I believe, I had the pleasure of speaking to you briefly on the possibilities for establishing organized mosquito control in the State of Minnesota. Since that time, a District, the one which I represent now, has been organized in the State. When I spoke to Dick Peters about the content of this presentation, he suggested that it would be of some interest to see how our District was established, how we are getting along, and how our experiences during the past two years might help other new or potential mosquito control districts in the upper midwest area. I am prepared to give you some information that might be useful from that standpoint.

For orientation purposes, the State of Minnesota is divided into three major plant and associated animal communities. The western third of the State was typically long grass, great plains, rolling prairie. The northeast third of the State was, and still largely is, coniferous forest, and the southeast one-third is largely elm, oak, maple, hardwood forest—at least originally. The precipitation in the State ranges from approximately thirty inches in the southeast to about eighteen inches in the extreme northwest. This occurs mainly as rainstorms of varying intensity during the months of May through September.

More specifically, our Metropolitan Mosquito Control District occupies six counties in the southeast sector of the State at the confluence of three major rivers, the Mississippi River, the St. Croix River and the Minnesota River. Virtually, the entire State was glaciated at one time, and the six counties lie in a terminal moraine area which is generally characterized by a rolling terrain and literally thousands of pot holes —depression in the till which were dropped by the glaciers. Drainage is rather poorly developed, and one of the rivers, the Minnesota, has very extensive semiswampy flood plains which are subject to periodic inundation.

The District encompasses six counties and takes in twenty-eight hundred and fifty square miles in the Minneapolis-St. Paul area. One of the vital prerequisites to the establishment of any district or successful mosquito control effort, of course, is the mapping of all known mosquito breeding sites. This, our District has been doing for three years, utilizing first aerial photographs, topographic maps, and very intensive on-the-ground surveys. Although we have been engaged in this work intensively for three years, there are still many mosquito breeding sites which at the present time are still not on our maps. We have recorded from this survey over 39,000 separate and distinct sites, comprising 290,000 acres with an average of approximately 7.6 acres per breeding sites. The average number of sites per square mile in the District is fourteen, with several townships averaging over

thirty sites per square mile. We have very many sections where the entire section is one large mosquito breeding site.

This density of mosquito breeding sites is not unusual, in fact, it is rather typical of what we find over a large portion of the eastern half of the State. Minnesota is known as the Land of Ten Thousand Lakes, and that certainly is true. And if that statement is true, there are tens and tens of thousands of small swamps and other low areas which impound water during a heavy rainfall. In over two-thirds of these 39,000 sites, we have actually found *Aedes* larvae or eggs present. Approximately one-fourth of the known *Aedes* sites are in pastures and about one-eighth of the sites in wildlife-sensitive areas. This creates problems from the control standpoint because we have to take, of course, intensive efforts to avoid any injury to fish or to wildlife, and we can't have any contamination by any type of insecticide on our pastures.

In the three years, we have collected approximately thirty thousand six hundred samples of soil from suspected *Aedes* oviposition sites and these were processed in the District's egg-separator machine. We found that sixty-five percent of these thirty thousand odd samples were positive for either *Aedes* eggs or egg shells. We found this machine to be an invaluable tool in distinguishing between a potential mosquito breeding site and an actual breeding site by finding eggs present. At first we used this technique on a qualitative basis. We took samples from suspected sites and ran them through our egg-separator machine just to determine whether eggs or shell were present or not. During 1960 we used this technique to count the actual number of eggs found in sites throughout the six counties of our District. We will follow this year after year to determine how much we are reducing the potentials of our *Aedes* mosquitoes. We found that we have been able to process one hundred samples, utilizing a five man crew, in an eight hour day.

As for our mosquitoes in Minnesota—there have been various research workers who have done work on the mosquito fauna of the State. The first definitive work on the mosquitoes of Minnesota was a University of Minnesota Technical Bulletin published in 1937 by Dr. William Owen. More recently, Dr. A. Ralph Barr, who presently is in California, published a very comprehensive bulletin on the mosquitoes of Minnesota in 1958. Additional, but less comprehensive contributions to the knowledge of Minnesota mosquito fauna have been made by Riley and Chalgren, Peters, Daggy, and Rueger.

For the past three years the Metropolitan Mosquito Control District has been making very extensive light trap, larval, and bite collections within and adjacent to the District. Of the forty-nine known species of mosquitoes found in the State, thirty-eight have been recovered in the District. We have also recovered and added two species to the known mosquitoes of this State from our District.

In 1960 86.2% of all the female mosquitoes caught in our light traps were *Aedes vexans*, and in 1959 the comparable figure was 84.3% for this species. Second in importance was *Aedes trivittatus*, representing 5.6% of the female mosquitoes caught in light traps in 1960, 2.15% in 1959. In human bite collections, taken at dusk, *vexans* accounted for from 70-80% of all the mosquitoes caught during the past two years, and *Aedes trivittatus* was second with 11-13% of all the mosquitoes caught.

Presently, 13 species of *Aedes*, 5 species of *Anopheles*, 5 of *Culex*, 3 of *Culiseta*, and one each of *Mansonia* and *Uranotaenia* normally are very small components of the human-biting mosquito population. *Aedes* species, particularly *vexans*, are the dominant human-biters throughout our District and throughout the State of Minesota. We consider it essential in our District to maintain an entomological laboratory where adults and larvae can be accurately and rapidly identified and species and population trend recognized in order to determine that control funds are expended against the primary human biters. For example, on our large breeding sites that require airplane treatment and considerable expenditure of funds, a sample of the larvae which are present in the water is taken and run through our laboratory to determine in fact whether they are *Aedes* larvae. If they are *Aedes* larvae, the site is set up for appropriate insecticidal application. If they are not *Aedes* larvae, the treatment is not made. Perhaps in the future as we progress and have more success in control of our *Aedes*, we will follow the history of many other control districts in the United States where various species of *Culex* have assumed more importance as the District get older. Presently, we do not have enough money, and *Culex* are not important enough to justify expenditure of funds to control them.

The major part of the District's control program consists of the application of DDT or fuel oil larvicide to sites where *Aedes* larvae are present. I mentioned that aircraft applications are made only on sites where *Aedes* larvae are found. All of the known *Aedes* sites in the District, excluding pastures and wildlife sensitive areas, are prehatch treated with DDT dust or granules in March and April. We have adulticided 16,500 acres, approximately, of public recreation areas with DDT-malathion mixture in our District's mist blowers. During 1960 we treated 267,000 acres of confirmed mosquito breeding sites. This figure in 1959 was 237,000 acres of confirmed sites. We normally use one helicopter and from two to four fixed-wing aircraft to make our aerial applications. These aircraft are not owned by the District, but are leased following a bid procedure. We require that a very adequate amount of insurance is made available, we require a performance bond, and the successful bidder has to agree to provide us with those aircraft and us only, so that we have him at our call whenever his services are required. We will probably treat about 180,000 acres from the air this coming season, and it is profitable enough for the contractor to make his aircraft available to us exclusively.

During 1959 our basic field crew consisted of two men in a vehicle, and on the average each crew was able to inspect and treat if necessary (that is if larvae were present) twenty-six sites per crew per day. During 1960 our crew size was cut to an average of one and a half men per crew and the seasonal average was twenty-three sites inspected and treated where necessary per crew per day. Although this shows a decline of three sites per crew per day, the additional number of crews which we were able to put into the field

increased the total sites treated to almost a third. We were able to put fifty-four crews into the field last year.

For any new or contemplated district with similar field conditions, and planning to use similar control methods, it will be possible in the preparation of preliminary plans to calculate the approximate numbers of crews required if the total number of mosquito breeding sites were known. Our initial survey of mosquito breeding sites was done with stereoscopic aerial photographs and a planimeter to measure the acreage. This was done early in the winter of 1958.

Our experience in the following two years has indicated that this technique accounted for eighty percent of the breeding acres now on our maps. Aerial photographs are very generally available now, so that this type of a survey could be done in the winter months to give an approximation of the cost of conducting control using similar techniques employed by this District. We are also making cost analyses to determine just what it is costing us to keep a crew in the field throughout a season. It may, or may not, come as a surprise to you that we found that the best aerial photographs were in the hands of the county tax assessors. We were fortunate in being able to utilize their maps to start off with.

As for other organized mosquito control in the State, there are eighty-five communities in the State of Minnesota who are doing some type of adult control. There is a State Enabling Act which permits the village and municipalities to expend monies to control certain insects under the direction of the Commissioner of Agriculture. It is a rather simple statute and easy to use, but it has one serious drawback in that the maximum which can be levied for mosquito control is only fifty cents per capita. Our State Enabling Act pertaining to our own District also has this limitation of fifty cents per capita. Our preliminary cost analysis figures indicate that it may cost two to three times our present budget to do the job in the way that the public expects. At the time that we established our District, no one had any idea as to the extent of the problem to be met, and it was only after we had been in operation for some time that we accumulated figures that would enable us to provide a reasonable cost analysis. Presently, the State law would have to be changed in order to get an increase. There will, however, be a moderate increase available to us for next year's budget based on the fact that the fifty cents per capita tax is based on the last federal census. The 1960 census figures were not available to us last fall at the time that the tax assessments for this coming year were made, so we will have approximately $750,000 available to us a year from now if our commission taxes their constituents at the rate of fifty cents per capita.

The fact that eighty-five other communities in the State have interest enough in mosquito control to be expending funds indicates that there is very intensive interest in mosquito control, not only in our District, but elsewhere throughout the State. In the resort area in the northern part of the State, many of the resort owners are doing their own mosquito control, utilizing either aerial application of insecticides of their own ground machines—usually foggers or mist blowers. However, I do not believe—and certainly the figures that we have generated so far in our own District bear this out—that a mosquito control program based on larviciding primarily, with some source reduction along with it, is going to succeed at fifty cents per capita in the State. The reason that we are able to approach it in our District is that we have a large population center with a million and a half people in Minneapolis and St. Paul. I believe that in the future we are going to have to have more money in order to do the job that the people in our District demand.

I would be glad to answer any questions on any aspect of what I have covered so far or perhaps on some features that I have missed.

Dr. Hedeen: One thing that I would like to ask you is do you have your 1960 light trap figures for *Culex*? We are down in South Cook County, Illinois, and for many years *vexans* way outnumbered *Culex*. In 1960, for the first time, *pipiens* went over *vexans*.

Mr. Buzicky: Yes, I have those figures here, Bob. Our 1960 light trap figures indicate that *Culex* are low. To give you an example, for *Culex pipiens* we collected 87 females, for *Culex restuans*, 986; *Culex salinarius*, 1417; *Culex territans*, 205 out of a total of 200,000 odd female mosquitoes caught, whereas *vexans*, for emample, numbered 172,700.

Dr. Hedeen: It was just the reverse down our way. We had sixty percent *Culex* of all our mosquitoes.

Mr. Buzicky: That is amazing. You can see that our *Aedes* are by far our most important human biters. Our *Culex* are presently of no practical concern to us. Thank you very much.

Dr. Bickley: Thank you, Dr. Buzicky. The next paper is by our friend, Mr. Mulrennan from Jacksonville. We are going to have some pictures, I believe.

Mr. Mulrennan: In driving across the United States from Florida to California I was impressed with one sign along the way. "Research is the key to Progress." In my judgment, that certainly is a true statement. I have been invited to tell you something of Florida's research program in which we are trying to learn and develop better ways and means of controlling arthropods that affect the health and comfort of man. In the State of Florida, as you heard yesterday from Dr. Merrill, in which he said that he took his hat off to Florida, we do have a very outstanding research program and are very proud of the program. We are very proud of the men that have worked in this program, and also of the support that we get from the mosquito control workers of Florida because this program is their program. We are also proud of the support that we get from our State Legislature, because it is with that type of support that we find it possible to have a research center where you can find the answers that need to be found in this world of ours.

We have about $150,000 a year in funds that are appropriated by the State for research on arthropods that affect the health and comfort of man. In addition to that, we have around $100,000 in research grants from the National Institute of Health. I would like to show you the facilities at Vero Beach where this research is going on. (Slide presentation.)

APPLICATION OF THE DIFFUSION PROCESS IN MOTIVATING FARMERS TO UNDERTAKE MOSQUITO SOURCE REDUCTION

H. C. PANGBURN,[1] HOWARD DUNPHY,[2] AND EMBREE G. MEZGER[3]

Since its very first day of operation, in 1930, the Solano County Mosquito Abatement District has been engaged in a program of mosquito source reduction. Being situated on the northern edge of the San Francisco Bay, a major portion of the district's energies have been devoted to the control of two species of salt marsh mosquitoes, *Aedes dorsalis* and *Aedes squamiger* on roughly 118,000 acres of marsh. Gradually, however, over the past decade, a major program shift has taken place to the point where, now, at least an equal amount of energy and resources are being devoted to the control of mosquitoes produced in the agricultural areas of the county.

Solano County is predominantly an agricultural area. The major farm products are cereals, seeds, forage, truck crops, fruit and nut crops and livestock production. The county contains 576,640 acres, of which 423,123 are devoted to farming. Of special concern to the district is the fact that 90,000 acres, or approximately 20 per cent of the agricultural land in the county is under irrigation.

The shift in program emphasis which has characterized the Solano district is similar to that experienced by most of the Bay Area districts, and came about as a result of a comparable pattern of evolutionary development throughout the area. Possibly, one of the more important reasons for the change in program emphasis has been the relative success of the district in controlling salt marsh mosquitoes. Within a ten-year period, from 1930 to 1940, drainage channels were dug, dikes were built, low areas were filled to destroy mosquito sources, and insecticides were used to destroy the insects themselves. The Civil Works Administration played a large part in helping to bring about this program success by their contributions of men, money and materials. In 1933 and 1934, 150 men labored at these important tasks. Having largely accomplished this original program objective, it was possible to devote a larger effort to other mosquito problems within the physical boundaries of the district.

In 1930, the year the district was formed, the population of Solano County was 40,834. As of the 1960 census, it is 134,597—an increase of better than 300 per cent. A major portion of this population increase has been urban and industrial in character. It naturally followed that, with more people working in non-agricultural pursuits and living in non-agricultural areas, increased control emphasis needed to be focused on urban, suburban and surrounding agricultural mosquito breeding sources.

As it has been true of many parts of California, while Solano County's population has been increasing at a faster rate than has the rural population, the number of acres under irrigation has been steadily increasing. With more water being used by farmers to irrigate their crops, there has been a gradual but significant increase in the mosquito production potential throughout much of the county.

Mosquito production in the salt marsh areas of the district was and still is principally the result of the recreational use of land and water, whereas the mosquitoes produced in agricultural areas are the result of the planned utilitarian use of land and water. This is an important distinction. The district board of trustees felt that, in the case of the former, direct legal intervention was the proper approach: however, in the case of the latter, where a farmer's livelihood could be jeopardized, nonlegal methods were deemed more appropriate.

With the program shift in effect the district soon became dissatisfied with the progress it was making in getting farmers to adopt more efficient land and water management practices that would significantly reduce mosquito production on irrigated lands. To speed up farmer adoption of these practices, a decision was made to undertake a research project designed to judge the applicability of certain educational methods in a source reduction program.

The Diffusion Process

By and large, the traditional concerns of mosquito control agencies in their approaches to source reduction have been with the technology of moving earth, grading fields, and related practices. It goes without saying that improving operational methods, equipment, and techniques used in mosquito source reduction programs are major considerations. It must also be acknowledged, however, that we have not always been as resourceful and energetic as we might have been in applying the newer knowledge being made available through the social sciences, which, if properly applied, can increase public understanding, support and participation in our abatement programs.

Actually, the specific educational method we are employing, is perhaps best described as a combination of the common sense approach and the scientific approach to solving problems of human affairs. The basic elements of the common sense and scientific approaches are essentially the same: the objective of both is to solve problems, one intuitively, the other by design. In its own way, each approach calls for a definition of the problem, formulation of a hypothesis, a procedure to test the hypothesis, collection of data, analysis and interpretation of data, generalization of results, and a plan of action to solve the problem.

We have alluded to the problem previously, namely, the educational processes by which farmers learn of new ideas in agricultural science and, more specifically, how farmer adoption of improved land and water management practices could be accelerated. Rural sociologists have been especially concerned with this particular area of research, and have come to refer to it as the "Diffusion Process."

The basic premises of the diffusion process model we are employing are:

(1) That people accept new ideas after they have have gone through a series of mental steps,

[1] H. C. Pangburn, Superintendent, Solano County Mosquito Abatement District.
[2] Howard Dunphy, Health Education Consultant, Bureau of Vector Control, California State Department of Public Health.
[3] Embree G. Mezger, Entomologist, Solano County Mosquito Abatement District.

or stages. These stage have been described as: *Awareness, Interest Evaluation, Trial* and *Adoption.*

(2) That people do not adopt new ideas at the same point in time, but, rather, a few will adopt new ideas when they are first exposed to them, some will adopt them only after a period of time has elapsed, and some will be very slow to adopt them, or will never adopt them.

At each stage of this mental process leading to adoption, certain communication channels are relatively more influential than others: for example, at the *Awareness* stage mass media are more important as sources of information than are neighbors and friends.

To refine the model further, when it comes to the adoption of ideas, farmers appear to fall into five categories. We have labeled these categories *Innovators, Early Adopters, Early Majority, Majority* and *Non-Adopters.* If we compare just two of these categories, we find important socio-economic differences between them. The *Innovator* is more likely to own a large farm, have high status, be active in community organization, get his information directly from colleges or agricultural agencies, and interestingly, is not named as a source of information by other farmers: on the other hand, the *Non-Adopter* is more likely to have less formal education, be older, be less active in community organizations, be less co-operative with governmental organizations and read fewer papers, magazines and bulletins.

Methods And Procedure

In this experiment an attempt has been made to borrow a scientific research model of diffusion and apply it to a given operations problem.

With our society becoming increasingly complex, any individual or group interested in planning for desirable technological and social change should have the best possible understanding of the processes by which people become aware of new agricultural, public health and other innovations, and the circumstances under which they tend to apply them to their own pursuits. This desire to gain a better understanding of the farming population was shared equally by the Solano County Mosquito Abatement District, Reclamation District, Health Department, Irrigation District, Road Department, Farm Advisor's Office, the University of California at Davis and Berkeley, the Soil Conservation Service, and the Bureau of Vector Control. These agencies therefore decided to undertake a co-operative study of ways and means by which to work more effectively with farmers. A major concern of the co-operating agencies has been to get more farmers to adopt land and water management practices that will conserve these valuable resources, and at the same time minimize mosquito production.

Another concern of the co-operating agencies has been to learn how they can develop an action program which would take into account the point of view, attitude, and agricultural knowledge of the farmer in a manner compatible with the program objectives of the agencies.

As a part of a joint plan, it was necessary to obtain certain facts about the human population, the mosquito population, the crops grown, and the physical environment in which farming is practiced in this area.

The area selected for special study is located in the northeastern section of Solano County. It includes all of Fremont township and portions of two other townships. One incorporated municipality, Dixon, is located within the study area. This community has a population of 2,960 and acts as a service center for the surrounding farming population.

Recapitulating the events which led up to this experiment, in 1958 the Solano County Mosquito Abatement District asked the Bureau of Vector Control for assistance in preparing news releases for the local Dixon paper. It was initially felt that if a series of carefully planned and well-written articles were to appear in the local paper, this would help motivate more farmers to adopt improved land and water practices. After several discussions, it became increasingly apparent that the objective of getting a large percentage of farmers to adopt source reduction methods was dependent on a number of inter-related factors, only one of which was a need by farmers for more information about these methods.

Also, it was obvious that the Mosquito Abatement District was only one of the governmental agencies concerned with agriculture: certain other agencies were, in fact, much more directly concerned than was the Mosquito Abatement District, and some were better identified with farmers in terms of guidance and leadership in agricultural matters.

Finally, it had to be acknowledged that the essential census and social data needed to plan the proposed program could only be obtained from the farmers themselves.

After a number of bilateral conferences between the Mosquito Abatement District and the agricultural agencies, a rough study plan was written and presented to all of the agencies at a joint meeting in October 1959.

The proposed plan included five phases. For the purposes of the study, these were called: (1)*Preparatory,* (2) *Planning,* (3) *Data Collection,* (4) *Action,* and (5) *Evaluation.*

The *Preparatory Phase* consisted of activities designed to bring together all of those agencies which had a direct responsibility for, or interest in, the conservation of land and water.

The *Planning Phase* included such things as deciding on the kinds of land and water management practices that would be recommended to farmers in the study area, and the design of research instruments necessary to collect essential data.

The *Data Collection Phase* included interviewing a representative sample of the resident population in the study area and conducting a section survey of the entire study area, the latter requiring representative larval sampling on each of the 60 study farms.

The *Action Phase* of the project will include tabulation, analysis, and interpretation of collected data and the use of educational methods and materials which will be effective in persuading farmers to adopt recommended land and water management practices.

One of the educational methods to be used will be that of working with those farmers known to be especially influential in their respective areas, and who might be more effective in persuading their neighbors to adopt recommended practices. Other educational approaches will be employed based on early analysis of collected data, as this phase of the project unfolds.

The *Evaluation Phase* will be concerned with the application of statistical methods to determine the effectiveness of the program in terms of how close we came to achieving our original objectives and the relative effectiveness of various educational methods.

The first three phases of the program have been concluded: only the *Action* and *Evaluation Phases* remain to be completed. The success of the project will, of course, depend to a large extent upon the energy and resourcefulness which can be applied to the *Action Phase.*

Discussion

The District is optimistically anticipating that a number of things will happen as a result of the study. Certain signs of progress are already in evidence. Of the several original objectives, we believe that one has already been satisfactorily fulfilled. The sponsoring agencies have agreed on the land and water management practices to be recommended to farmers in the study area. The other primary objectives all relate to the adoption of these recommendations and the elimination of mosquito sources.

We have succeeded for the first time in bringing together and pooling the resources of the several agencies which have conservational goals compatible with the primary objective of mosquito control. In discussing goals, we have tried to focus on new approaches and new ideas while at the same time emphasizing the basic technology necessary to the achievement of our objectives.

It can be said with some certainty that all of the co-operating agencies are now much better informed about mosquitoes and their control than ever before. It is hoped that this increased knowledge will be translated into a continuing support and understanding of the program objectives of the Mosquito Abatement District. On the other hand, the District is more appreciative of the problems and objectives of the other agencies.

If the success achieved during the first months of the study is predictive, then the future holds good for the remaining phases of the study. This is our hope.

VECTOR CONTROL IN THE NORTHWEST

LAVERNE S. MILLER
Program Supervisor, Vector Control,
Oregon State Board of Health, Portland

Vector control in the Northwest would be considered by many as in the Transitional Stage. By this I mean we are beginning to tie all phases of vector control in one area of endeavor. Granted, mosquitoes present over 60 per cent of our problems, but work in other phases of vector control can't be divorced from the study. A brief mention of some of the problems encountered and studies undertaken would be desirable at this time.

According to U.S. Department of Agriculture, Agriculture Handbook #46 entitled "Mosquitoes of the Northwestern States" by H. H. Stage, C. M. Gjullin and W. W. Yates we have 39 species or subspecies of mosquitoes in the Northwest. These vary from abundant populations to rare. I do not believe that this is the just a little general background on the Northwest would jut a little general background on the Northwest would be apropos. The Northwest has four distinct climatic belts in which each has its distinct species of mosquitoes. Starting in the west, there is a coastal area of heavy rainfall, dense underbrush, and extensive salt marshes. Moving inland over the coast range or mountains we encounter the inland valley which still has a considerable amount of rainfall, but is in the heart of the timbering and agricultural belt, where rainfall contributes to vector problems of both industry and agricultural origin. Vectors associated with snow waters in some western states are encountered in the high areas of the Cascades where a considerable number of our recreational areas are located. The high lakes are in some instances unharvested from the standpoint of game and fish due to mosquito annoyance. East of the mountains a semi-arid area is encountered, this encompassing nearly the entire Columbia Basin, where the predominant mosquitoes are those of the irrigation mosquitoes, a direct result of waste irrigation or over irrigating in the agricultural lands.

Studies are being undertaken by all states in the Northwest to determine the best possible biological, source reduction, or chemical means to control the mosquito problems.

In addition to mosquitoes, a number of biting flies occur in the Northwest which are of primary importance from the standpoint of annoyance. There are *Culicoides,* and *Simuliidae* that are quite pestiferous. Blue Tongue, the disease among sheep, of which *Culicoides* are indicated as being the vector, has been discovered in some parts of Oregon and Washington. *Culicoides,* also tend to minimize the recreational use of some lakes and streams due to the annoyance factors.

The Biting Snipe Flies are found in some localities.

Tabanidae found mostly in the semi-arid eastern parts of the states present a problem. Tularemia is a disease which is transmitted by these biting flies.

The discovery of several species of *Phlebotomus* flies in our Columbia Basin is a factor both of interest and of uncertain importance. These flies were discovered inhabiting rodent burrows in the Eastern section of the state.

Diseases considered endemic in the area are Sylvatic Plague, Tularemia, Rocky Mountain Spotted Fever, Colorado Tick Fever, Blue Tongue of sheep, and other diseases. The study of these require that the complete phases of vector control be considered rather than a single phase. Studies cannot be undertaken to

EDITOR'S NOTE: Mr. Peterson's paper was not submitted for publication and a large portion of his presentation was illustrated with slides on the subject of "Recent developments on the control of mosquitoes and other biting flies in Canada."

determine mosquito control or other insect control alone, but the entire ecological pattern of the disease and the vector associated with the disease have to be considered.

Projects undertaken or being completed by various agencies or control programs in the Northwest are as follows: the first project is a complete survey and evaluation of the Crooked River Project, an irrigation project of the Bureau of Reclamation located in Crook County, Oregon. This survey is a joint Federal and State effort. The survey will continue for a number of years to try to determine the effect that irrigated water has upon populations of mosquitoes and the effect that drainage will have on these populations.

The first year of the survey has been completed. During this survey the primary purpose was to determine the species of mosquitoes and other vectors present as well as the breeding areas involved. Breeding areas were outlined on aerial photos so that future surveys can be made to ascertain any change in breeding characteristics or habitat of the project. This project blends itself well into a survey of this type. The area involved is approximately ten square miles and is contained within a very large section of sagebrush.

The first year of the survey was made while the construction of the Prineville dam to supply adequate irrigation water for the Crooked River Project area was underway. The dam was completed in the fall of 1960 and the reservoir will be filled in the winter of 1961. Additional irrigation water will be supplied to a portion of the valley during the irrigation season of 1961. The Crooked River Project has included in the authorization drainage systems to eliminate and alleviate water residuals in the ends of the lateral canals and ends of the fields. It is contemplated that the survey will continue for a period of five years, the first year being devoted as it was, the general picture of vectors affiliated with irrigation, the relative abundance, and breeding characteristics. The second year a more complete survey to determine the effect of increased irrigation on vector populations; the third year devoted to determining the effect of total irrigation on vector populations. The fourth year will be devoted into determining the effect of drainage on populations of vectors and the fifth year will be to determine the agricultural and public health significance of the vectors associated with this irrigation.

The second project is the development of vector control and sanitation methods in recreational areas. This is being started this year at Wenatchee Lake, Washington. As has been stated before, this project deals with one of the big problems in the Northwest—that of vector control in recreational areas. We feel certain the recreational activities will increase in the future as additional roads are built into the mountain areas, thus, opening up a considerable greater area for recreational activities.

The third project is the log pond research sponsored by a NIH Grant, of which you will hear more about tomorrow.

We believe that our greatest overall unsolved problem is that which exists in large recreational areas where mosquitoes, other pestiferous flies, and domestic and wild rodents are a problem. Many of these recreational areas are situated in areas which are endemic for most of the above-mentioned diseases.

The Northwest Mosquito and Vector Control Association encompasses the states of Oregon, Washington, and Idaho. This organization was formed October, 1960. The officers in the association are:

President—Dr. Robert F. Harwood, Washington State University, —Pullman, Washington
Vice President—Jack Warren, Mosquito Control Supervisor, Lane County, Oregon
Secretary-Treasurer—Roy K. Welch, Sanitarian, Court House, Vancouver, Washington

The objectives and purposes of the association shall be to promote close cooperation with those directly or indirectly interesetd in the biology and control of insects and rodents, to provide for the advancement of members, and to extend and deevlop public interest in the control of disease transmitters and pestiferous insects detrimental to human comfort and animal comfort.

I realize that the objectives and purposes of this organization are rather broad and cover a great field but we feel a close cooperation between those interested either directly or indirectly with vector control can be worthwhile to an organization such as this. The researcher can benefit by having additional eyes and arms in the field to report and to field test research laboratory results. Exchange on control methods between the three states can be accomplished, thus, eliminating much time and work in working on problems that have been solved in other areas of the three states. Special problems in the field of vector control can be coped with by involvement of the association as a unit.

The association provides for three classes of membership: *Regular membership* which includes all persons who are specifically interested in the control or biology of insects or rodents who desire affiliation with this association. *Honorary Members* are those who render service to vector control as to entitle themselves to special recognition. This recognition and membership is given to them by the entire membership of the association. *Sustaining Members* are those of a corporation or company that have general interest in the Northwest Mosquito and Vector Control Association with objectives, purposes and desire to contribute to the association.

We are very enthusiastic in the Northwest about the formation of this association. Our problems in the three states are similar and it is felt that the cooperation of the members on problems can be best solved in an association of this type than in any other way. The pooling together of ideas, knowledge, work, and time to special vector control problems in the Northwest is better than one individual working alone on his own problems.

I have touched but briefly on the vector control problems in the Northwest. Each phase of vector control could be amplified if time allowed.

I wish to thank this organization for this opportunity of expresing myself and describing some of the problems that we encounter in the vector control field in the Northwest.

Thank you:

ALTERNATE SESSION

WEDNESDAY, FEBRUARY 1, 1:30 P.M.

HOTEL MEZZANINE

OPERATIONAL PAPERS

E. L. GEVESHAUSEN, *Presiding*

RADIO COMMUNICATIONS

A. W. BUZICKY, *Director*
Metropolitan Mosquito Control District
St. Paul, Minn.

The advantages of a two-way radio system to a large mosquito control district are great. Rapid communication between the field force and district headquarters enables management to know the status of field operations at all times and to provide the maximum support possible to control operations. In case of equipment breakdowns, vehicles getting stuck, or other emergencies, a radio call to headquarters will start remedial measures at once. Two-way radios cut vehicle mileage and save time by eliminating backtracking and searching for long distance 'phone booths. Saving of telephone toll charges will not pay for two-way radios for a long time, however. Radios assist in maintaining good public relations by enabling men already in the vicinity to service complaints and requests for assistance. All field work can be scheduled more effectively but especially that involving aircraft. Aircraft applications can be made more efficiently and misses observed from the ground can be corrected at once while the plane is still over the site. Aircraft can be diverted from a portion of the district where weather conditions are not suitable for applying insecticides to another where they are satisfactory. Art Geib in an article in the March 1960 issue of *Mosquito News* listed these and other advantages of a two-way radio system with which I heartily agree but will not repeat.

The Metropolitan Mosquito Control District radio setup in 1961 will consist of a base station, 19 mobile radios mounted in district trucks, and seven portable radios, which are used in aircraft and for short range ground to ground communication. The base station is a 250 watt unit located adjacent to but separate from our central county sheriff's radio setup. Our antenna is side arm mounted on the sheriffs' radio tower, thus saving us the cost of erecting our own tower. The base station is connected to a remote control console in District headquarters by a private 'phone line. A foot operated transmit switch frees the dispatchers or radio coordinators hand for writing. A separate Civil Defence Conelrad alert is always on receive while the two-way radio system is in use. The base station range is at least 70 miles. A soundproof room for the dispatcher is not necessary unless the noise level in the room is unusually high.

The mobile radios have an output of 60 watts and a range up to 40 miles. They employ a transistorized power supply for both transmitter and receiver and operate from the 12-volt truck electrical system. No heavy duty generators were found necessary and battery life was not jeopardized. The radio switches were hooked to the ignition switch of the truck so normally the motor was running while transmitting—which is the time of greater power drain. We have the Motorola T power model T53GKT-1100 B which is not the most expensive miniaturized transistor model but which is economical and gives completely satisfactory service. These units are simple to use with only a volume and squelch control on the receiver, and a transmit button on the hand held microphone.

The portable radios are 5 watt Motorola units, dry battery powered, weighing 17.5 lbs. Rechargeable wet cell batteries can also be used on the same unit in place of dry cells. It was anticipated that the dry batteries would require frequent replacement, but during the first season of use only three batteries in the seven units required replacement. The portable radio was securely strapped down behind the pilot in a Piper PA18A, with one lead to an external antenna and one to a lip mike and earphones in the pilot's hard hat. There was no connection with the aircraft electrical system so FAA recertification was not necessary nor was shielding required. All connectors were of a quick removable type so the unit could be removed from the aircraft and used for ground to ground communication. A hand microphone and whip antenna was attached for ground use. The five-watt portables so mounted in the aircraft performed with complete satisfaction. Transmission range depended on the altitude of the aircraft but was normally more than we required—up to 40 miles from aircraft to base station on one occasion. Instructions could be given the pilot while he was airborne, by the base station, a mobile radio in a truck, a portable radio hand carried at the site of the operation or aircraft to aircraft. This arrangement permits the greatest flexibility in the use of our radio equipment. The district leases aircraft annually so permanent installation of radios in the planes is not feasible.

All our radio equipment is under 24 hour maintenance contract so that repairs are made as soon as needed. Several types of maintenance plans are available depending on the needs, desires, and budget of the user. For about four and one-half months during the winter the District goes off the air to save money.

The Metropolitan Mosquito Control District applied for and was assigned its own frequency in what is known as the high band range at 158.760 Mc. Our license was applied for under FCC Rules and Regulations, Part 10, Public Safety Radio Services, Local

Government Radio Service. No other license can be granted within 75 miles and 30 KC of this frequency. It is best to be assigned your own frequency but where all bands have already been assigned it may be necessary to share a frequency with other users. Each operator who transmits from a base station is required to obtain a restricted radio telephone operators permit. No examination is required but the operator must certify that he is non-subversive. Users of mobile and portable transmitters do not require this operator's permit.

For a control district interested in radio communications I would first recommend talking to local users such as police, sheriffs, civil defense, fire chiefs, trucking firms, taxi companies, etc. for background information. These agencies are invariably helpful because everyone wants us to do a better job. Ask technical representatives of the larger, reputable radio firms to call on you. They will give you invaluable information on the best type of radio equipment for your local conditions and for your available money. We have found that their range and power tables are invariably conservative and we receive far better reception than we had anticipated. You are under no obligation to use their services. Applications to the FCC for an assigned frequency require three to four months for processing. Radio company representatives will offer assistance in helping to select an available channel and to make out the application.

Radio equipment can be rented directly from the major companies but such an arrangement is rarely the most economical from the District's standpoint. Such companies plan to amortize the equipment in about three years, must pay all taxes on the radios, and make a reasonable profit. Frequently radios can be purchased on a matching fund basis with local Civil Defense units, but these arrangements take a long time to consummate. One of the most economical arrangements for radio service would be a hookup into an existing county radio net if such is available.

The following suggestions will make for more efficient use of two-way radio equipment. It is very important to keep transmission time for each message as short as possible, particularly where a large number of units are in use. Personnel must be trained to compose their message with this in mind before beginning to speak. Coding the most frequently used messages is very helpful. The 10 series codes used by police and truckers are useful and other codes can be devised. All receivers should normally be in the on position. Each truck is assigned a number which is also its call letter. The dispatcher or radio coordinator is a key man who must be a quick thinker and be given full authority to make decisions and give orders. All transmissions to the base station from the field must proceed only after the dispatcher has given permission since another person not heard by the first may also be calling the base. It is useful to map out dead spots in the district where for some reason reception and transmission may be poor. Transmissions from such areas should be avoided and the dispatcher notified as to the time a vehicle will be in such an area. Where the mobiles are calling in from extreme range it would be desirable to transmit from a high spot rather than from the far side of a hill. Where transmissions from a distance are running into trouble, a radio at an intermediate point can act as a relay. The great value of a two-way radio system is to be able to communicate promptly with key people throughout the district so the dispatcher must know when a man is away from the truck. The man reports to the dispatcher his location and the estimated time he will be away from the radio. Similarly the man reports in when he returns to the truck.

The Metropolitan Mosquito Control District has found that its two-way radio system is an invaluable communications tool and encourages other Districts presently without radios to investigate the feasibility of installing a system suitable to their needs.

OBSERVATIONS OF THE USE OF FOGGING

BOYD LAFFERTY, *Superintendent*
Cape May County Mosquito Extermination Commission, New Jersey

In 1946 and in the best Hollywood tradition fogging burst upon us with great fanfare, and a flourish of publicity trumpets. A very severe polio epidemic broke out during that year in San Antonio. The Todd Fog Machine, Tifa, covered the city with fog. Magazines, newspapers and news reels certainly told the world about it. In 1947 when a freighter containing ammonium nitrate blew up in Texas City, Texas, causing widespread damage with attendant potential epidemic the newspapers again told of the Tifa's spectacular ability to control insects on the wing. Even Saudi Arabia hit the front pages. King Ibn Saud's faithful Moslems on their holy pilgrimage to Mecca had their staging camps fogged up to and including the Holy Khaaba itself. Year after year some happening took place that incited the newsgatherers to overflow with such favorite sunny California words as "stupendous," "fantastic," and "colossal."

During this same period and with no fanfare we in Cape May County quietly, or at least as quietly as we are capable of being, went about our own mosquito control business—dealing with the minor crises that often arise when irate citizens are annoyed by the *Culicidae* buzz-buzz and bite. In keeping with our tradition of searching for and using the newest and most efficient tools for controlling mosquitoes we purchased our first Tifa fog machine from the Todd Shipyards Corporation in 1946. This was a gear-driven job and on occasion the teeth on the gears would let go with an awesome rattle. This was but one of a number of growing pains inherent in new types of equipment. Constructive criticism given to the manufacturer by many workers throughout the country resulted in a modified unit that is Todd's present day largely satisfactory fogger.

It is not the purpose of this paper to present highly technical information. Data on the relative value of different sizes of fog droplets, the killing power of fog at various distances and other pertinent facts have been presented to you in papers by many able workers—to name a few—Norman MacDonald, F. Brescia, Dickinson, Merrit & Hough, R. D. Glasgow, Don Col-

lins, "Mo" Hirst, La Mer, Hochberg, J. Lyell Clark, A. W. A. Brown, D. L. Watson and H. M. Speechly—there are others; actually their names are legion. I think their findings are proof that fogging where the terrain permits is an effective method of adulticiding. With such a wealth of useful information it was eminently fitting that the compilers of the material in the AMCA Bulletin #2 "Ground Equipment and Insecticides for Mosquito Control" should on page 60 advise mosquito control personnel to "use large fog machines in community, residential or business areas where spotting is to be avoided."

Our first Tifa's were mounted on any trucks available but usually on "pick-ups." This of course, made this a two man operation with one man operating the unit and the other the truck. Many commissions still use this method. Others have resorted to many different types of controls operated from the cab—this to enable the driver to control the truck and the fog unit at the same time—a one man operation. We have achieved this by using jeeps where the driver can reach the essential controls with his right hand. These units are mounted on a CJ5-Jeep with special helper springs and heavy duty tires. A heavy duty tank is made and fitted next to the driver, this being equipped with baffle plates and necessary fittings for loading and unloading. These tanks are made so that the driver has a clear vision at all times and they hold from 125 gals. to 140 gals. which is enough material for one day's spraying of seven hours.

A few slides will be shown, showing these Jeeps at work stressing the one-man operation and areas we treat. Also 8 x 10 photographs of these mounted Jeeps can be viewed by anyone upon request.

We had our experiences too with the aptly named "Plumber's Nightmare." When using these we had them attached to a Ford truck or tractor. This venturi-type agglomeration of pipes, fittings, etc., often caused a back pressure on the engine resulting in a shortened life for the valves. Today there are refined examples of this equipment for use on many types of engine exhaust lines and even for lawn mowers.

Our mosquito control operations are carried to every portion of the county. Cape May County is largely a resort district and of necessity we have to spray or fog urban, suburban and rural areas.

We pay a great deal of attention to specialized regions such as parks, picnic grounds, playgrounds and the like. In many of these areas we do not find it convenient to use the vehicle-carried units. In spots that are hard to reach with convention methods we use a portable, hand-held pulse-jet fogger—The Swing Fog. Although this sturdy little unit is of all-steel construction, it is light and has performed quite satisfactorily.

During 1960 we used a relatively new piece of equipment—The See-Fog. We have this unit mounted on a truck with remote controls located in the cab. The See-Fog breaks up the insecticide liquid into fog-size droplets by the use of steam rather than by a high velocity stream of heated air used in the Tifas. This of course necessitates a water tank as well as a gas tank. The unit produces a very dense fog, possibly because of a large number of screening-size, ½-micron droplets. Our observations throughout the season led us to believe that the cost of operation and the percentage kill are approximately equal for both the Tifa and the See-Fog. These conclusions have not been reached through highly technical comparison testing. We did not have the time to run tests at many different periods to eliminate the many variables inherent in such work and we realize more such experimenting has to be done before positive statements can be made.

Each of these units has its special advantage. With the Tifa we can fog right up to an automobile parked at the curb, shut off the unit and commence fogging immedately at the other end of the car. A slight lag in such control is noticeable in the See-Fog.

The very density and volume of the fog produced by the See-Fog is more than we are used to and in streets adjoining the fogged area there is apt to be more obscuring fog than is safe for an unobserved driver. On the other hand, in more open areas where we do not have the possible traffic problem, the See-Fog appears to lay down a larger volume of fog that hugs the earth somewhat better than the Tifa. Here again there can be variables that we are not aware of. This type of Fogger will also be included in the slides as was previously mentioned.

How trouble-free have these units been? Relatively little trouble has been encountered in any of our units because of our maintenance policy. We insist on the manufacturer's recommendations being carried out to the letter. In most cases their manuals contain adequate information to keep the units running smoothly. I want an do have equipment that I can eat out of or off of. To keep our four large fogging units and their vehicles spotlessly clean costs us $42.50 a month for labor. That this cleanliness plus other proper maintenance procedures pays off can be attested to by referring to our parts replacements costs. We have three Tifas—a two-year-old, a three, and a six-year-old. For these our parts cost us less than $50.00 and our equipment almost never failed us. For this reason we have not felt the need to convert any of our Tifas from gasoline to L.P. gas as have so many other users. We realize of course that in hotter climates such a change might be advantageous.

There is one disadvantage to using L.P. gas in our territory. The gas suppliers in our state require that you use their fittings and gauges. Even though they are supplied free with the purchase of their gas you are confined to the use of that particular gas.

At this point it might be well to keep in mind another important item. Should you convert from gasoline to L.P. gas-fired equipment, be sure to notify your insurance company of the change. Although the rates are the same, they might not honor a claim on a piece of equipment that has been converted without their knowledge.

In our territory we have a number of communities and armed force posts that own foggers. For example, there are 21 Tifas being used by such groups. They frequently come to us for advice on how best to

maintain these units, how to follow the best technique of operation, and how better to correlate their efforts. We have found that the most efficient way to help these people is to hold a school meeting once a year. Manufacturers or suppliers of various pieces of equipment send men to this school to meet the operators and discuss with them the foregoing matters. This past season we had over 50 interested parties attend our school and it was pronounced quite successful. Our Commission garage maintains any repairs on these machines free of charge, of course, excluding the replacement of parts. We have found through experience that by requesting these 21 owners of foggers to bring in their equipment when it acts up, it eliminates a lot of headaches. Due to inexperienced operators, the machines can be very easily "fouled up" and it is much easier and cheaper for us to keep up the maintenance on them.

A word here about our own fogging methods—our units do not travel over seven miles per hour, usually about five. Our Tifas operate at a rate of 20 gallons an hour. We fog when we have an inversion condition—as a rule usually in the earl morning and in the evening. When we have the extra heavy influx of summer visitors we usually fog from 2:00 A.M. to 10:00 A.M.

Most of this last season we used an insecticide comprising 5% DDT and 3% of a 20—- strength pyrethrum in number two fuel oil. During the last ten days of our season we used 3% malathion in the same carrier oil. Both were effective—the latter very much so.

Now we come to the crux of the whole problem. How have our taxpayers, the mosquitoes' fodder, received our fogging? For some years we used a combination of foggers and mist blowers; the taxpayers couldn't see the mist too well; and they asked for fog instead. We had to replace the misters with fog machines. We now have three Tifas, three Swingfogs and one See-Fog. Last year these units travelled 20,423 miles emitting fog all the way. Our people were happy about it—they were provided with visible and speedy relief and their interest extended to other phases of our operation—they gave us their dollar vote. In 1946 they gave us $12,864 for our entire project. Last year they provided us with almost $115,000. We feel that fogging played a big part in this vote of confidence. Now, in conclusion, I will show the slides that I previously mentioned.

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MARSH CONTROL EQUIPMENT IN MARIN

G. PAUL JONES, *Manager*
Marin County Mosquito Abatement District
California

In Marin County, marsh spraying has varied from the horse and buggy sprinkling can technique to the use of the aeroplane. Around 1907 voluntary contributions were used to finance mosquito control and at that time diesel oil was transported to the marsh by horse and buggy and then applied by a sprinkling can to the infested areas. After this phase of larvaciding came the spray can and the organization of the District in the year 1915. The original spray cans used were carried by the operators in the same way you would carry a knap-sack. Usually a handle at the right side of the operator was connected by levers to a pump mounted inside the tank. The pump discharged spray material, diesel or kerosene, through a hose and nozzle onto the breeding waters. The nozzle was a petcock type valve which, when turned part way on, discharged the liquid into a spray, if turned all of the way on it discharged the liquid in a straight stream. These particular spray cans were hard to put on the operator's back when full, particularly if the operator had to remove the full can from his back when he was away from the loading vehicle. After the knap-sack sprayer came the pressure type spray can with which you are all familiar.

Two-wheel drive vehicles are of practically no use for reclaimed salt marsh mosquito control during the Spring and early Summer. Even during the Summer and Fall months, two-wheel drive vehicles are of no use in unreclaimed marsh areas. Before the jeep came into use in Marin and during the diesel oil era, trucks with tank capacities up to 500 gallons were used to haul diesel oil from the District Depot to the outlying marsh areas. The trucks would park on a hard road somewhere near the marshland that was to be larvicided. Operators would then carry the diesel oil into the marsh breeding areas where it was applied by hand sprayer. Full drums of diesel oil placed in the marshes during the summer months for use in the Spring were shot full of holes by hunters.

Use of DDT and the jeep vehicle came to Marin County about the same time. The first jeeps were equipped with dual wheels on the rear, and they carried a 50-gallon drum with power sprayer. Valves, pipe and hose permitted the operator to fill the jeep supply tank from field water sources with the spray pump. By mixing DDT emulsifiable concentrate with water from the source being treated, output of the operator increased enormously. The operator with the hand can carried emulsifiable concentrate into the breeding areas and mixed his insecticide as he needed it. In Marin County this newer method of operation at that time reduced operator personnel from a peak of 20 part-time men during the Spring months to five regular all-year-around employees. About the time that the jeeps and DDT came into the picture, the air-pressure type spray can also came into common use. This newer lighter type spray can made it easier on the operator.

Jeeps, when loaded, cannot operate in soft, wet marsh ground without the use of dual wheels, even then they get stuck quite often. The District's six jeeps have broken axles because of the dual wheels, probably three or four per year at the most. We feel that this is a cheap price to pay for being able to power spray a source as against hand spraying.

The District's Senior Operators are combination mechanics and heavy equipment operators and for this reason the only cash outlay to the District is the cost of the axle.

In 1960 the District purchased a set of Flotation tires and wheels from the Terra Engineering Company of Monterey, California, for one jeep, in the hope that these tires would replace the use of dual tires and wheels. These eight-ply 11.00 x 12 tires and wheels can be mounted on a jeep in the matter of minutes. When in actual marsh operation the tires are deflated to eight pounds pressure. The jeep handles normally at highway speeds when the tires are inflated to 24 pounds pressure. A spark plug adapter was purchased so that the tires can be inflated in the field, however, it is not used if the area being larvicided is within a mile or two from a service station. These tires have been put to use in our marshes and they have permitted the jeep to travel where we have been able to travel with our dual-wheel vehicles. There are miles of drain ditches in the marsh haylands of the County which need larviciding during the early spring months when the hay is short and the ground wet. In the past, some farmers have not wanted us to drive on this land with our regular dual-wheel equipment. It is hoped that Flotation tires will remedy this situation.

In Marin County and in parts of uncontrolled Sonoma County there are large open marsh areas which cannot be larvicided economically by either hand labor or by jeep power equipment, even when equipped with flotation tires. These areas have been controlled by helicopter in the past and by conventional aircraft at the present time. Larviciding by helicopter has been discontinued because of the additional cost as compared to the conventional plane. It is felt that better penetration of the insecticide through the pickleweed into the water is obtained by helicopter, however, this benefit is not worth the increased cost of application. The last acreage cost for three gallon application by helicopter was $1.00 as compared with present cost of $.25 per acre by conventional rented plane. These costs are based on large acreages and short runs. The conventional plane has also been used during the Spring months to spray rough marshes as small as 15 acres in size.

I will close by saying that source reduction is still pushed in our District. Since 1948 the District has been cooperating with the farmers, the Soil Conservation District, the Flood Control District, and the United States Department of Agriculture. Many sources have been eliminated and many prevented from coming into being. District cooperation has consisted of partial financing on some projects, but mostly we furnish District dragline time, labor and technical skill.

THE ECONOMIC ASPECTS OF SOURCE REDUCTION ON LIQUID AGRICULTURAL WASTES

GEORGE R. WHITTEN, *Agricultural Engineer*
Delta Mosquito Abatement District

There are two viewpoints to be considered in approaching the dairy drain problem. Because of the high potential for mosquito breeding and lack of accessibility which is characteristic of an average dairy drain, mosquito abatement districts have a vital interest in finding a solution to this aggravating problem.

The dairyman, because the problem is on his doorstep, cannot avoid considering the odor problem which annoys neighbors, and the unsightly mess in his backyard gives the milk-consuming public a poor impression of the sanitary methods he uses.

The key to the solution, of course, is the dairy farmer. He is the one who will pay for any improvements on his property and so he must be convinced that the money he expends will bring him some return.

We have proof that the liquid manure which, up until now, has been generally considered a waste product, is instead a by-product and the value in dollars and cents can not only defray the cost of the system necessary to handle the materials but, on dairies milking 100 cows or more, can actually be used as an additional source of income. The lever which we now have in this economic value can indeed move mountains—mountains of liquid manure from that weedy mosquito and fly breeding swamp 50 feet from the milking barn out onto the crop areas where it will increase productivity.

In the Delta Mosquito Abatement District we feel that an automatic system, such as the four described in the pamphlet recently published by this district, entitled "The Economic Value of Liquid Manure," is the most feasible method for handling this problem available for use at this time.

Because the physical facilities necessary to utilize this type of system are not present on many of our dairies, we have had to compromise by developing an intermediate type of system which could be used by dairies which were not yet ready to utilize a fully automatic system. This intermediate system consists of a collecting reservoir at least six feet deep with sharp banks and with a drive area around the outside wide enough to allow power equipment to treat the reservoir with insecticides or weedicides.

The Delta Mosquito Abatement District owns a large hydraulic pump mounted on a Jeep pickup which is rented to the dairymen at $4.00 per hour to pump out these reservoirs when they fill. The reservoir should be large enough so that pumping is not necessary more often than once a month. The liquid manure is dispersed along with irrigation water whenever possible. This operation will be demonstrated at the Delta M.A.D. Friday afternoon to those who will take the tour. While this does not solve the dairy drain problem completely, with these tools we have made considerable progress in the last two years in our district.

For the handling of other liquid agricultural wastes, I will refer you to a paper by Ralph L. Ricketts, Extension Agricultural Engineer, University of Missouri, Columbia, Missouri, entitled "Lagoons For Disposal of Wastes From Hog Feeding Floor." I understand this same type of system is used on chicken wastes.

CONCURRENT SESSION ON CHEMICALS

WEDNESDAY, FEBRUARY 1, 1:30 P.M.
Hotel Mezzanine

SUBMITTED PAPERS ON CHEMICALS
GORDON F. SMITH *presiding*

Mr. Smith: I am afraid that I don't recognize all of the faces here this afternoon. In case there is some confusion as to my identity, I am Gordon *F.* Smith, not to be confused with Tennessee Valley's Gordon *E.* Smith; and I belong to California, not the TVA. I don't know just why I was picked for this job, except that I gained somewhat of a reputation as a whip-cracker at another meeting; so gentlemen, please give your papers, be brief, and try to stay within your time limits if possible. We will try to allow fifteen minutes per paper, since one has been cancelled. Please leave your manuscripts with Mr. Lauret, who is recording this session.

We will then begin with the paper on "Carbamate Insecticides as Potential Mosquito Control Agents," to be presented by Mr. Georghiou.

Mr. Smith: Thank you, Dr. Georghiou. I am heartened to know that somebody is working on carbamates since we have already started knocking the phosphates off in California. The paper on Chemical Control Research on Chironomids has been cancelled, so I will call on John E. Porter to give the paper entitled "Further Comments on the Susceptibility of *Aedes aegypti* to DDT in the Miami, Florida Area."

FURTHER COMMENTS ON THE SUSCEPTIBILITY OF *AEDES AEGYPTI* TO DDT IN THE MIAMI, FLORIDA AREA

JOHN E. PORTER, BURTON R. EVANS AND GEORGE KOZUCHI
U. S. Quarantine Station, U. S. Public Health Service Miami Beach, Florida and New Orleans, Louisiana

Abstract: *Aedes aegypti* larvae of the F_1 generation reared from specimens taken at five different areas of Miami, Florida showed varying degrees of susceptibility or resistance to DDT in 1960 tests using the standard WHO DDT-test kit methods. They range from larvae in two areas with an LD-50 of 0.029 p.p.m. and 0.028 p.p.m. respectively to larvae from another area showing indications of resistance with an LD-50 of 0.22 p.p.m. Intermediate to these extremes were larval populations having an LD-50 of 0.138 p.p.m. It now takes up to three times as much DDT to obtain an LD-50 as was reported by Evans, *et al* (1960) for *aegypti* from Miami.

Mr. Smith: Thank you, Mr. Porter. I know some of you may have some questions to ask, but I would appreciate it if we didn't take time during the sessions to do so. Perhaps you can catch these gentlemen later and query them. The next paper will be "Inheritance of Insecticide Resistance in Corvallis Strains of *Culex tarsalis* Coq." given by Dr. Plapp.

(Printed elsewhere)

Mr. Smith: Some of this work that is being done on inheritance is most interesting to me. It helps to answer some of the questions that I have had on field results in going back and trying, say, DDT against mosquitoes in prior DDT resistant areas. Next we have the paper on "Laboratory Studies with Organic Compounds for the Control of Adults of *Aedes taeniorhynchus* Wied.," by A. N. Davis and J. B. Gahan. It will be presented by Dr. Davis.

(Printed in Mosquito News)

Mr. Smith: How toxic can they get? I have permitted some extra time for the next paper by Dr. Mulla. I think that what he has to say is going to be very interesting. We are running into this problem with insecticides more and more, and I feel that biological control has been too little investigated. Go ahead, Mir.

MOSQUITO CONTROL INVESTIGATIONS WITH EMPHASIS ON THE INTEGRATION OF CHEMICAL AND BIOLOGICAL CONTROL IN MOSQUITO ABATEMENT

MIR S. MULLA
University of California Citrus Experiment Station Riverside

Mosquito control technology in California is predominantly oriented toward abating pest and vector mosquito species in their breeding grounds. Residual or space spray aerosol treatments against adult mosquitoes are employed only occasionally. Dispersal of adults over large areas from their limited breeding grounds render such adulticiding practices unfeasible.

At the present time a variety of approaches are stressed in suppressing or abating mosquito larval populations. Source reduction measures are invariably instituted whenever such measures are economically feasible and practical. Clearing of vegetation and employing measures to alter the environment in such a way to make it unfit for mosquito breeding are also practiced whenever possible. Stimulations and preservation of biotic control agents in optimum environments may also aid in the reduction or elimination

of mosquito larvae. Due to the temporary nature of many breeding sources and unsuitable conditions for predation in others, the use of predators such as mosquito fish, aquatic insect predators and others have a limited but important place in the overall mosquito control technology in California. It has been observed that predators do not usually yield rapid and complete reduction of mosquito larvae.

The high standards formulated for mosquito control expected by the public in California can hardly be achieved alone by the manipulation of density-dependent biotic control agents. This is rather in contrast to the control of some agricultural pests where moderate to good control is considered satisfactory. The general lag between the poulation build-up of mosquitoes and their predators also contribute to the inadequancy of density-dependent biotic control agents. Notwithstanding these weaknesses, the integration and coordination of biological and chemical control may lead to improved mosquito control technology.

For maintaining mosquito populations below the tolerance threshhold level, it is imperative to resort to the routine use of chemical larvicides. Chemical larviciding programs constitute by far the greatest segment of mosquito control technology in California. Research toward the development of larvicides as substitutes for materials used now has been expanded. Problems such as bee poisoning by mosquito larvicides, residues on food and forage crops incurred due to mosquito larvicides have also been studied. The toxicity of several larvicides to the mosquito fish *Gambusia affinis* (Baird & Girard) was studied in the field.

The studies reported herein were supported by the Consolidated, Fresno, Kern and Westside Mosquito Abatement Districts in California. Field studies on the evaluation of larvicides and on the toxicity of larvicides to the mosquito fish were conducted in cooperation with the Kern Mosquito Abatement District.

Chemical Larvicides

Breeding sources treated for mosquito control in California are of many types. Irrigated agricultural land, duck clubs, sloughs, reservoirs and industrial waste water constitute some of the major breeding sources. Frequent treatments applied to permanent breeding sources resulted in higher operational expenses. Operational costs can be reduced by employing residual materials or granular formulations of less stable materials which will prolong the persistence of such materials. Currently, there is a great need for the development of stable larvicides which could be used for the treatment of large breeding sources where the residual effectiveness would cut down the number of treatments.

In urban and suburban areas the sources are usually small but numerous. Most of the sources are temporary in nature and require treatments which will yield quick and short term control. Unstable materials such as malathion, parathion, Bayer 29493, G-30494 and many others would produce the desired results. In these urban and suburban areas materials with low mammalian toxicity or granular formulations of other materials should be considered for application. Residual materials could also be used advantageously in such temporary niches.

TABLE 1

Relative biological activity of new insecticides against fourth instar larvae of a susceptible strain of *C. pipiens quinquefasciatus* as determined in the laboratory.[1]

Placement of Toxicants into Various Abritrary Categories of Activity[2]			
High Activity (LC_{90} 0.0053-0.026 PPM)	*Moderate Activity* (LC_{90} 0.031-0.07 PPM)	*Fair Activity* (LC_{90} 0.081-0.21 PPM)	*Low Activity* (LC_{90} 0.23-1.5 PPM)
Methyl Parathion	E.N. 18133	Methyl Trithion	Delnav
Bayer 38108	Endrin	Co-Ral	VC-13
Parathion	Bayer 29492	GC-4072	B-8999-S
SD-4402	Bayer 38156	DDVP	Dowco 139
G-30494	Ronnel	Malathion	Ethion
Bayer 29493	Ethyl Guthion	Trithion	Dekafos
Dieldrin	Bayer 22408	Bayer 38920	
Bayer 34042	Dow K-6951	Dow 22023	
Bayer 25198	DDT	GC-3583	
Aldrin	AC-5727	Dow K-7740	
Guthion	Dow K-6882		
	G-28029		
	Thimet		
	Bayer 30749		
	Bayer 25141		
	Dibrom		
	GC-3582		

[1] DDT, malathion and parathion are included for comparison.

[2] The materials are arranged in descending order of their activity at the LC90 level. A material at the top in any one category is the most active one, while that at the bottom of the category is the least active one.

Laboratory Studies—A large number of organochlorine, organophosphorus and carbamate insecticides were evaluated against fourth instar larvae of a susceptible strain of *Culex pipiens quinquefasciatus*. The relative effectiveness of the matrials as mosquito larvicides was ascertained and this information was utilized in arriving at the approximate dosages to be used in field treatments. Detailed information on the evaluation of these larvicides is presented elsewhere (Mulla *et al.* 1960, 1961).

For convenience, the materials evaluated in the laboratory are placed in various categories denoting their relative effectiveness in the laboratory (Table 1). Due to the development of resistance in mosquitoes to some of the organochlorine compounds, these materials cannot be used in many areas of the state. Also, the occurrence of persistent residues on food and forage crops due to larvicidal treatments with organochlorine insecticides discourages the use of these compounds. The information on their biological activity is merely presented for record purposes.

Materials with high activity were those which had activities similar to that of parathion. A great bulk of the materials evaluated in the laboratory manifested activities similar to that of DDT. Materials with a fair degree of activity against mosquitoes were those with activities similar to that of malathion. Materials categorized under 'low activity" would be required at relatively high rates for effective larvicidal treatments. For extensive field evaluation only some of the materials in the first three columns merit consideration.

Selection of a choice mosquito larvicide will be determined by the conditions under which the treatments will be carried. The desirability of short-term or long-term control, toxic residues problems on food and forage crops, safety considerations to applicators and beneficial life and economics of the treatments are some of the factors which will dictate the selection of an efficient larvicide. It should be pointed out that there is no single material which would meet all these requirements. Selection of three or four larvicides to be used for specific purposes under certain sets of conditions seems to be in order. In this manner it is possible to achieve an improved and sound mosquito control technology in California.

Field Studies—Seven insecticides were subjected to field trials during the past season. The trials were run against fourth instar larvae of *Culex tarsalis* in a duck club and artificial mosquito breeding ponds. The materials were evaluated at three to five dosages each and the range of biological activity determined.

Bayer 25198 proved very effective and yielded 100% kill of the larvae at the rate of 0.05 lb./acre in a duck club. At 0.025 lb./acre this material produced 98% mortality of the larvae. Bayer 38156 was slightly more effective than Bayer 25198. The former material produced 100% kill of the larvae at the rate of 0.025 lb./acre; however, this material when evaluated in olive vats and breeding ponds did not prove effective. Further tests with this material are needed.

Compound GC-4072 produced 100% kill of the larvae at 0.20 lb./acre. Compound K-6882 was evaluated in a duck club and also the artificial breeding ponds. In the duck club it killed 93 and 100% of the larvae at the rate of 0.10 and 0.20 lb./acre, respectively. In the breeding ponds it resulted in 99% kill of the larvae at 0.10 lb./acre.

Dowco 139 and Dkafos were relatively ineffective. At 0.4 lb./acre Dowco 139 resulted in approximately 80% control of the larvae both in the duck club and the breeding ponds trials. Dekafos when evaluated in the breeding ponds, produced 95 and 98% kill at the rates of 0.8 and 1.6 lb./acre, respectively.

Parathion was evaluated at six dosages (from 0.002 to 0.05 lb./acre) in the breeding ponds. Complete mortality of the larvae was obtained at all dosages. Such a high level of activity of parathion was not expected. Parathion at 0.1 lb./acre is widely used as a mosquito larvicide in California. It seems that this dosage provides too wide a margin of reliability in getting mosquito control. Whether this high susceptibility of larvae to parathion is general or merely a local phenomenon will be further investigated.

Granular Formulations—Research on the basic aspects of granular formulations of mosquito larvicides was continued in the field and laboratory. Several papers on this subject dealing with the fundamental factors influencing the effectiveness of granular parathion in mosquito control have been published (Mulla 1960a, b; Mulla and Axelrod 1960). Advantages of granular materials in mosquito control have also been included in these papers.

Studies on the role of carriers in granular parathion were completed in the past season. Various granular carriers having different particle sizes were evaluated. Celite, Volclay KWK, attapulgite, vermiculite, corn cob, calnite, and Emtal granules all proved very effective. There were some slight differences in the speed of release of parathion from these carriers but such differences were of lower magnitude. Bentonite did not prove as good as the others. Alfalfa granules released very small amounts of the toxicant into the water.

The various kinds of attapulgite granules such as A-LVM, A-RVM, AA-LVM and AA-RVM, and those containing various amounts of volatile material (0-10 VM, 10 VM and 20 VM) were found to be equally good. There were slight differences but these were considered to be in the order of experimental variations.

Toxicity of Parathion Spray and Granules to Honey Bees—An experiment was conducted in the southern San Joaquin Valley to determine the effect of parathion spray and granules on honey bees foraging in an alfalfa seed field. The materials were applied by air at the rate of 0.1 lb./acre actual parathion. Parathion spray resulted in appreciable kill of the bees, while the granular treatment caused no noticeable mortality of the bees. It can be said that loss of bees, pollinators and other beneficial life in agricultural fields can be avoided or greatly reduced by using granular materials for mosquito control.

Residues on Food and Forage Crops—The residue of toxicants on forage and food crops incurred during mosquito larvicidal treatments in agricultural fields or in the vicinity of such fields is causing concern among many mosquito abatement agencies. Information on this subject is not sufficient to provide guidance for mosquito control agencies to avoid unnecessary

toxic residues on agricultural crops. In providing such information, studies on the persistence of residues of parathion and Bayer 29493 on alfalfa hay were initiated.

Both materials were applied at 0.1 lb./acre actual toxicant. Both spray and granular treatments were employed. The residues were determined by the cholinesterase inhibition method and by bioassaying against mosquito larvae.

The initial residues for parathion spray were found to be over 20 p.p.m. (1 p.p.m. residue tolerance is established for parathion in or on many crops). Residues over 1 p.p.m. were maintained for about a week after treatment. Initial residues of about 20 p.p.m. were found in the hay treated with Bayer 29493 spray. The residues of this material declined and reached to about 0.7-0.75 p.p.m. one week after treatment.

No detectable residues were found on the crop treated with granular parathion and Bayer 29493. This information on granular materials again points out that many problems arising from residues on agricultural crops can be avoided by the application of granular materials. Due to lack of noticeable residues on plants in the granular-treated fields, toxic hazards of the larvicides to bees, pollinators and natural enemies of crop pests can be greatly diminished. It is therefore possible that a sound larvicidal program can be undertaken without disrupting the equilibrium level of agricultural pests and their natural enemies.

Toxicity of Insecticides to the Mosquito Fish

Sixteen insecticides were evaluated for their toxicity against the mosquito fish, *Gambusia affinis* (Baird and Girard). The trials were conducted in southern San Joaquin Valley in breeding ponds constructed by the Kern Mosquito Abatement District. The fish were caged in treated water for 24 hours or longer and the mortality recorded. Fifty fish were used per pond per interval of reading the mortality. Results of this study will be published elsewhere (Mulla and Isaak 1961) but they are summarized for convenience in Table 2.

The effectiveness of most of the new materials as mosquito larvicides has been studied in the field (Mulla *et al.* 1960, 1961). These materials were evaluated against the fish at a probable maximum larviciding dosage and also probable maximum dosage which may be used for the control of agricultural pests. These latter dosages were four times the larviciding dosages.

Certain materials such as Bayer 25198, AC-5727, Dowco 139, Dow K-6882 and Bayer 29493 were not toxic to the fish both at the larviciding and agricultural pest control dosages. These materials, even if applied repeatedly, would probably cause no noticeable reduction in fish population.

When applied at larvicidal dosages, malathion, parathion, DDT, Bayer 25141 and Methyl Trithion manifested moderate toxicity against the fish. At these dosages these materials would cause moderate-to-fair reduction in fish populations if they are used infre-

TABLE 2

Degree of safety of 16 insecticides at various dosages to the mosquito fish, *Gambusia affinis*, in the field.

Degree of Safety					
At Probable Maximum Mosquito Larviciding Dosages			At Probable Maximum Agricultural Pest Control Dosages		
Safe	Moderately Toxic	Highly Toxic	Safe	Moderately Toxic	Highly Toxic
Infrequent Applications[1]					
Bayer 25198 AC-5727 Dowco 139 Dow K-6882 Bayer 29493	malathion parathion DDT Bayer 25141 Methyl Trithion	E.N.18133 GC-3583 SD-4402 GC-4072 Dekafos Bayer 38156	Bayer 25198 AC-5727 Dowco 139 Dow K-6882 Bayer 29493	malathion	E.N. 18133 GC-3583 SD-4402 Bayer 38156 Bayer 25141 Methyl Trithion GC-4072 Dekafos parathion DDT
Repeated Applications[2]					
Bayer 25198 AC-5727 Dowco 139 Dow K-6882 Bayer 29493		All others in this category	Bayer 25198 AC-5727 Dowco 139 Dow K-6882 Bayer 29493		All others in this category

[1] Two or three applications (at least one month apart) made per person.

[2] Applications made at semi-monthly or monthly intervals.

quently. At the higher dosages all these materials, with the exception of malathion, caused high mortality of the fish. These materials having moderate toxicity at larvicidal dosages would probably reduce fish populations markedly if they are applied to the water frequently. Information on the effect of moderately toxic materials on fish populations in areas where repeated larvicidal treatments are made has not been ascertained.

Other materials such as E.N. 18133, GC-3583, SD-4402, GC-4072, Dekafos and Bayer 38156 manifested high toxicity against the fish even at the larvicidal rates. Infrequent or frequent applications of these materials would totally destroy the fish populations present at the time of the treatment.

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Mr. Smith: Mir, we can't let you get away without asking one question. Did you make any observations on predators other than mosquito fish in these studies?

Dr. Mulla: Yes. I forgot to mention that we did make observations on all relative conditions—mayfly and dragonfly larvae, tadpoles, and the like. Those six materials, which I indicated on the chart as safe against the fish, were also safe against these other predators. So that is a good note.

Mr. Smith: I think it is time to take a short break now. Let us take a five minute break and start again promptly at five after three.

RECESS

REVIEW OF INSECTICIDE RESISTANCE IN KERN MOSQUITO ABATEMENT DISTRICT

LEWIS W. ISAAK, *Entomologist*
Kern Mosquito Abatement District
Bakersfield, California

The purpose of this report is to discuss and review with you some of the work completed by the Kern Mosquito Abatement District in biologically evaluating three different insecticides on field collected mosquito larvae. The three insecticides chosen to determine tolerance level or resistance are DDT, Malathion and Parathion. For the sake of brevity, the report will deal principally with the use of Parathion.

Fifteen season have passed wherein the new organic insecticides have been used by this District. How much DDT and how many acres were sprayed with this compound before there was recognized indication of genetic resistance? Actually the number is surprisingly small; about 12 tons covering as near as can be determined, 70,000 acres during the years 1946, 1947, and 1948. Other Districts in the San Joaquin Valley as well as this one struggled through the next three years with a variety and combination of chlorinated hydrocarbons, but each of these fell quite rapidly by the way. A total of 68,000 pounds of the chlorinates covering nearly 200,000 acres over a six year period was used by the Kern District before this chemical group became useless as a larvicide to both *Culex tarsalis* and *Aedes nigromaculis.*

As we completed the change-over from the chlorinates to Malathion in urban control and EPN in rural control, there was little reason to doubt that we would not have a repeat performance of our past experience with DDT. With this past ordeal and the added possibility of cross resistance, our hope of even three years' use with the phosphate group was dim, to say the least. But as many of you know, we have now completed nine years of larviciding with the organo-phosphates, have sprayed in the neighborhood of 500,000 acres, which amounts to more than seven times the number sprayed with DDT before its way out, so what is our relative position now if there is a correlation between acres sprayed and the potential existence of a toxicant to mosquito larvae. There are, of course, too many variable factors to effect a direct relationship, but it is interesting speculation.

When Parathion was first tested in this District in 1951, the LC-90 by laboratory analyses on *Culex tarsalis* was one part Parathion to 200 million parts water or .005 ppm on a strain highly resistant to all chlorinated hydrocarbons tested. We do not have comparison LC-90 figures on a non-resistant strain for Parathion at that period, but we do have them for EPN, Malathion and Metacide, and it was found that it took three times as much of these materials on this strain on an LC-90 basis as it did on a non-resistant strain. As mentioned, these larvae had survived repeated treatments with a variety of chlorinated hydrocarbons and were resistant to Dieldrin 100 times, DDT 105 times and Heptachlor 1,300 times. Certainly if there was any weakness in the strain, it had been eliminated. Those remaining were large and generally heavy with fat body. It was not too surprising to find them moderately tolerant even to the phosphate group. However this tolerance cannot be directly identified with selective resistance but rather vigor tolerance.

MORTALITY RATE—*CULEX TARSALIS* TO PARATHION

Klipstein Duck Club Area

P.P.M.	1-100	1-167	1-200	1-250	1-500	1-333	1-1 BIL.
	.01	.0067	.005	.004	.003	.002	.001
1951		100	90	80	69		30
1953			100	95	77	38	
1955	99	99	94	87	82	62	
1958		100	97	79	58	30	
1959	100	77	57	58	23		
1960		100	96	68	75	30	

By 1953 this vigor was diluted by nearly 1/3 or about what it was on a non-resistant strain as tested with Malathion and EPN in 1951. The tolerance level remained relatively constant then for the next five years, or until 1958, when a record 106,000 acres were sprayed with Parathion. Seventy percent was for control of *Culex tarsalis*. As you see in table 1, we began to see some indication of resistance in the lower dosages. Even though we sprayed over double our past five-year average that season, the *Culex tarsalis* population was not subjected to intensive pressure because of the flooded condition throughout most of the District. In 1959, our operations were only half what they were in 1958, and we were able to exert a great deal more pressure on the *Culex* population. This fact is perhaps the reason for the sharp increase in tolerance to Parathion as is shown in table 1. This level of tolerance may well have continued except that by the beginning of the 1960 season we had experienced our second dry season; two consecutive years with less than three inches rainfall. Irrigation waste water was at a minimum and the river bottom was dry. As a result, the female *Culex tarsalis* in early early spring were really hard put to find enough suitable water for oviposition and the early crop of larvae were concentrated by reason of limited sources. The plight of the female *tarsalis* was further compounded that spring by an extended period of cool weather. Our spray operators were not pressed for time, and when they did find sources of larvae, the treatment was thorough to say the least. For lack of a better reason, it is my contention therefore, that larvae from over-wintering resistant stock was hit so severely at that time, that direct progeny were in the minority when these tests were made later that season. If someone else has a theory as to the reason for the sudden drop in the susceptibility that season, I am more than anxious to discuss it with him. I probably should also add that our District is surrounded by uncontrolled areas over half its borders, and we undoubtedly have an influx of non-exposed stock each season. The pattern and extent of this immigration is not fully understood but undoubtedly plays some part in our overall tolerance level.

The tolerance drop we experienced with laboratory evaluations in 1960 was strongly supported by field trials completed in our experimental plots two miles from where the larvae were collected for the date in table 1. Here we experienced 100% control of *Culex tarsalis* at .01 pounds per acre, or, said differently, 1 pound in 100 acres, 1 pound in 200 acres, 1 pound in 500 acres, 1 pound in 667 acres and at 1 pound in 1,000 acres, we obtained 100% control one time and 84% at another. In all trials we averaged better than 10 larvae per dip. At .0005 or 1 pound per 2,000 acres we did not experience any control, of course, but then we did not expect any at 1 pound in 100 acres. In these plots, there is no interference from vegetation, each plot is separate from the other so that there is no chance of contamination from another plot, nor any chance of dilution, and the drift is negligible. These results could never be duplicated on a field control basis because of the forementioned factors we encounter in field spraying, but it does give us an insight as to the potential toxicity of this material, if there were no mechanical interferences.

Judging from these results alone one might surmise that resistance is not an immediate problem, but there is always one fly in the ointment. One region in the District which is influenced neither by drought nor flood is our County and City sewer farm. Here, during the active breeding season, it is necessary to spray nearly every day either by ground equipment or the airplane. The *Culex* population, both *tarsalis* and *quinquefasciatus*, is under constant pressure. Although we appear to be getting 100% control and adult counts and service complaints are negligible from that area, our larval population remains relatively high week after week. What is worse, tolerance level has not gone down this year but actually took a rise. Both species of *Culex* are able to tolerate 2 to 3 times more Parathion than *Culex* taken from other parts of the District where pressure is a great deal less. Larvae from this area are a much heartier strain, though due to the nature of their food supply the difference in susceptibility is not great enough to ascertain specifically whether this is genetic resistance or merely vigor tolerance, but it does look like the beginning of resistance. In this respect Parathion resistance is more difficult to pinpoint than resistance in the chlorinated hydrocarbons. We do plan on pursuing this evidence with more vigor next season to ascertain our exact position in that region.

In concluding, I would like to mention that we do have resistance to Malathion in certain of the urban sections. In the rural areas where only Parathion has been used, except for hand applications, there is no evidence of Malathion resistance in either genus. DDT resistance has dropped quite noticeably in the rural areas the past five years, but its use is precluded by several unfavorable factors familiar to all of us.

STATUS OF SUSCEPTIBILITY OF ADULT EYE GNATS TO INSECTICIDES AND FACTORS CONTRIBUTING TO RESISTANCE IN THE COACHELLA VALLEY, CALIFORNIA[1]

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Toxicity data obtained on a colony of the eye gnat *Hippelates collusor* (Townsend) from the Coachella Valley, California, revealed a high level of susceptibility to several organophosphorus compounds, but surprisingly low susceptibility to dieldrin, lindane and DDT (Georghiou & Mulla, 1961). The colony employed in these tests had been established in 1957, i.e. more than 10 years after the introduction of synthetic organic insecticides in the area, and there were reasons to suspect that the insensitiveness of the test population to chlorinated hydrocarbon insecticides was due to selection pressure from these compounds rather than to natural tolerance in the species.

Practically every crop in the Coachella Valley is

[1] Paper presented at the Joint Meeting of the American Mosquito Control Association and the Calfiornia Mosquito Control Association, Anaheim, California, January 30-February 2, 1961.

treated with insecticides. Although most treatments are applied to foliage, a certain amount of the insecticide undoubtedly reaches the soil due to drift or runoff, or when the crop residues are plowed under. In addition to these treatments, which are aimed at agricultural pests, large areas of land have been treated since 1952 with aldrin or DDT by the Coachella Valley Mosquito Abatement District for direct eye gnat control. It was thus very likely that a continuous selection pressure was exercised by the insecticide residues on all stages of the eye gnat: the soil residue affecting the soil-inhabiting pre-imaginal stages, and the foliage residues suppressing the adults which spend a good part of the day in the shade afforded by the vegetation.

To verify the hypothesis concerning resistance, the susceptibility levels of the 1957 colony were determined vis-a-vis those of a colony established for this purpose from gnats collected in an untreated area near El Toro, Orange County, California. Comparative tests were also run on field gnats collected in the Coachella Valley and in Orange County. All tests were performed on adult insects by a contact method already described (Georghiou & Mulla, 1961).

The results obtained indicated that the Orange County population was very susceptible to dieldrin, lindane and DDT (LC_{50} values of 0.012, 0.017 and 0.23 μgs/cm^2 respectively), while the Coachella Valley population exhibited nearly complete immunity to dieldrin and resistance ratios of 50- and 11-fold to lindane and DDT respectively. Susceptibility to parathion in the Coachella and Orange field populations was almost identical (LC_{50} values of 0.014 and 0.0073 μgs/cm^2 respectively), indicating little or no cross-tolerance to this compound as a result of resistance to chlorinated hydrocarbon insecticides.

These results indicate that future research on eye gnat control should be resistance-conscious and must be oriented toward types of compounds which have been shown to induce only limited and short-term resistance in the treated population.

Detailed data on this work are given in a more extensive paper published elsewhere.

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STUDIES ON CHEMICAL ATTRACTANTS TO *HIPPELATES* EYE GNATS

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The study of insect attractants is an interesting one and the research man in this field has to cover a great number of phases ranging from insect physiology to analytical chemistry. We will attempt to cover a number of facets of the research on eye gnat attractants in which we have been engaged for the past few years.

Olfactometry

The olfactometer designed by Mulla *et al.* (1960a) for use in field evaluation of chemical attractants and fairly easy evaluation of a large number of samples. Nevertheless there is a four-months' period each year where the field population of eye gnats is not sufficiently active to allow testing. It is largely for this reason that we have spent a great deal of effort in designing laboratory olfactometers. In order to intelligently design an olfactometer the response of the eye gnat to a number of phyiscal factors had to be investigated.

The *response of eye gnats to light of different wavelengths* was investigated (Dorner and Mulla 1961) and it was found that eye gnats are attracted by light of a wide range of wavelengths. Blue and green light was most effective but the whole spectral range for *Hippelates* gnats is well known. It permits a rapid from ultraviolet to yellow was capable of attracting eye gnats. On the other hand gnats responded very poorly to orange and red light.

The *optimum temperature range* although known in a general fashion from field observations had to be reinvestigated under laboratory conditions. It turned out that the temperature which eye gnats select if given a choice is intimately linked with the moisture content of the atmosphere. Thus in an atmosphere of 93% relative humidity the optimum temperature was 39° C. While at 1% relative humidity 30° C. was the preferred temperature. Intermediate values for the optimum temperature were found for humidities between these extremes.

Eye gnats are attracted by *air flow*. Our studies in the laboratory showed that eye gnats are attracted by air movement up to about six miles per hour. They fly upstream at speeds up to 2 m.p.h. and crawl upstream at speeds between 2 and 6 m.p.h. At higher wind velocities the gnats apparently cannot move upwind anymore.

Whether the results of our laboratory studies on the response of eye gnats to various physical factors apply to field conditions as well is not known at the present time.

Despite our extensive work aiming at creating optimum physical conditions for laboratory olfactometry we have not been successful to date in designing an olfactometer usable under laboratory conditions. Even our field olfactometer used under laboratory conditions did not permit evaluation of attractancy. It would appear that eye gnats in confinement react differently from gnats in the field.

Natural Attractant Materials for Eye Gnats

The use of rotten liver or egg as eye gnat attractants is well known. Although nothing can be stated with certainty it may be reasonably assumed that these and other decaying proteins (Mulla *et al.* 1960b) form chemical attractants which are similar in nature if not identical. The chemist faced with the problem of isolating a chemical attractant from decaying protein can then essentially choose the one which is best suited for experimentation. When it was found (Mulla *et. al.* 1960b) that eye gnats ground up in water with mortar and pestle contain an attractant for eye gnats, possibly an even more powerful one than egg bait, it was thought that this attractant might well be chemically different from the one contained in decaying protein. However, not all samples of ground-up eye gnats were equally attractant and the suspicion arose that ageing of the samples, even though only

for a few hours, might influence their attractancy. A very careful investigation of the influence of ageing on the attractancy of ground-up eye gnat preparations was then undertaken. Gnats transported to the field alive and ground up immediately prior to testing yielded a homogenate which showed only very slight attractancy. But after ageing for a few hours the preparations showed as much attractancy as standard egg bait. Thus, it would seem that much of the attractancy of ground-up eye gnats is due to products of some decomposition. What about the small amount of initial attractancy? While only isolation of the attractant could provide an unambiguous answer, all the evidence that we have gathered so far seems to indicate that the initial attractancy also is due to products of protein metabolism. Thus, there is no apparent advantage to the use of eye gnat homogenates over the currently used decaying eggs for attractant isolation studies.

Attractant Isolation Studies

We have been involved in attempts to isolate chemically the eye gnat attractant from rotten eggs for several years and the problem is one of great complexity. At the present time we are slowly accumulating an egg attractant, hoping to get enough eventually for chemical analysis.

Early work showed that the attractant can be extracted in alkaline medium but not in acid or neutral medium. This leads one to conclude that the attractant is an amine. We were somewhat surprised, therefore, when we investigated the attractancy of our extracts at various pH values and found that high pH values inactivated the attractant reversibly. This is certainly not the kind of behavior one would expect from a simple amine. What kind of a compound might fit the behavior pattern of the attractant? Taking all the evidence into consideration it would appear that the attractant could hardly be anything but a polyamine or a polyamino acid. Paper chromatography of the egg extract with butanol-acetic acid again gave results consistent with the idea that the attractant is a poly-amino compound. It turns out that the number of known naturally occurring representatives of these compounds related to protein metabolism is relatively small and we are in the process of testing all the ones available to us. Now, of course, there is no assurance that the attractant is a compound which has ever been isolated before. Our preliminary results from these screening experiments indicate that spermidine, a triamino compound, is an attractant for eye gnats. However, even at optimum concentration it is not as powerful an attractant as egg bait. Furthermore, our tests show a great and quite unexplained variability in the attractancy of spermidine. Clearly, much further work is required. From all indications, it would appear that spermidine is *not* the attractant found in rotten eggs but a compound sufficiently related to the egg attractant to confuse some of the gnats.

Routine Screening of Compounds for Attractancy

Routine screening of stock chemicals for attractancy to an insect species is one of the oldest and even now quantitatively the most important means of obtaining chemical insect attractants. In the past two years we have screened several hundred compounds, mostly supplied to us by the U. S. Department of Agriculture for the purpose. None of the materials showed sufficient attractancy for eye gnats to be of any practical value. However, the general trend of our results is encouraging. During the first year of our screening program only 15% of all the chemicals tested showed any attractancy at all. During the second year we tested mostly substances structurally related to the ones that had shown some attractancy in the first year with the result that 50% of the substances tested showed low grade attractancy. Thus, while none of these substances even approximate useful attractants it would seem that we are slowly learning about the structural requirements for attractancy.

Conclusion

While the major objectives of our project, namely to find a suitable chemical attractant for eye gnats has not been achieved as yet, we feel that we are zeroing in on the target from several sides.

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FIFTH SESSION

THURSDAY, FEBRUARY 2, 9.00 A.M.

A. D. HESS *presiding*

BIOLOGICAL CONTROL

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ABSTRACT

It is now evident that microsporidians belonging to the genus *Thelohania* commonly parasitize mosquito larvae in California. The following species of mosquitoes have been found naturally infected in the field: *Culex tarsalis* Coquillett, *C. peus* Speiser, *C. apicalis* Adams, *C. erythrothorax* Dyar, *C. thriambus* Dyar, *Aedes melanimon* Dyar, *A. squamiger* (Coquillett), *Culiseta incidens* (Thomson), *C. inornata* (Williston), and *Anopheles pseudopunctipennis franciscanus* McCracken. It appears that the *Thelohania* found in these larvae are host-specific, for although different species of some of the hosts are frequently found closely associated in the same aquatic habitats, in no instance have two different species of larvae been found infected by the same species of parasite.

The biologies of *Thelohania* parasites, their host-parasite relationships with mosquitoes, and their modes of transmission in the field are little known. It has been found in California that the levels of infection occurring in natural populations of host larvae vary greatly, depending upon the particular species of mosquitoes involved. Populations of *C. tarsalis* have been commonly found with levels of infection ranging from 5 to 15%; this same level of infection has also been observed in *A. franciscanus*, while populations of *C. incidens* with well over 50% of the larvae infected have been examined. In contrast with these, the larval populations of *C. apicalis*, *A. melanimon*, and *C. inornata* which have been sampled usually had less than 1% of their individuals parasitized.

Thelohania parasites apparently invade the hemocoele of the larval host. Individuals with frank infections become densely packed with spores by the time they develop to the fourth instar and are usually recognized in the field with little difficulty; these individuals invariably succumb to their infections.

Attempts to transmit *Thelohania* infections to healthy larvae in the laboratory by exposing them to spores and infected tissues from naturally parasitized hosts have been unsuccessful. It has been found, however, that infected adult female mosquitoes carrying sublethal infections are able to transmit the parasites to their progeny transovarially.

Larvae of *C. tarsalis* collected in Madera County, California, were found infected with a cytoplasmic polyhedrosis virus. Infected larvae were swollen with an accumulation of hemolymph in the thorax, and they assumed distorted, curled postures when hanging from the water surface. Subsequently it was found that these characteristic syndromes do not become evident until infected larvae develop to the fourth instar, when dense deposits of cuboidal inclusion bodies form in certain areas of the thorax and head of the moribund hosts. The virus apparently is highly pathogenic, as diseased individuals usually succumb before pupation takes place. In the laboratory it has been possible to transmit the virus to healthy larvae by exposing them to infected tissues from diseased individuals.

Several bacteria have been isolated from moribund larvae; most of these are gram-negative facilli, and it is thought that they were facultative pathogens which accidentally gained access to their host's tissues. The bacteria have been cultured on artificial media and will be studied in the laboratory.

CURRENT LOG POND MOSQUITO RESEARCH IN OREGON

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Log ponds comprise a type of aquatic habitat common in the lumbering regions of the Pacific coast and Inland Empire, where they are used in connection with lumber and plywood mills for the sorting and storage of logs. Surface areas range from 0.25 acre to over 100 acres; depths from 4 to over 30 feet, but mostly from 8 to 10 feet. Pond basins are steep-sided, with little or no shoal water. The water is characteristically dark in color, foul in odor and has a high dissolved and suspended organic matter content. About nine-tenths of all log ponds support populations of mosquito larvae, frequently very large ones: several hundred to more than three thousand per square foot. Where such heavy breeding concentrations occur close to inhabited places (provided the mosquitoes are man-biting forms which not all of them are), a difficult control problem arises.

Application of insecticides to log ponds for mosquito control is often difficult and frequently only partly effective. The large size of many of them precludes the use of ordinary spraying and dusting equipment from the bank, as does the fact that there are seldom access

roads around more than a part of the periphery of the pond; frequently the large piles of logs known as "cold decks" almost completely surround ponds. Boats cannot be used because the water surface is covered with logs and divided by booms. Airplane spraying, often done, is difficult and dangerous because of the proximity of tall mill buildings, smokestacks, guy wires, boom spars and high cold decks. Where logs are stored in "bundles," usually 10-15 feet in diameter, the upper logs protrude from the water and effectively shelter larvae in the spaces within the bundle. Cold decked logs, especially when the deck is built in the pond, shelter larvae in chinks between the logs at water level.

Higly polluted log pond waters rapidly inactivate most insecticides. It is not uncommon for such waters to become harmless to larvae within 48 hours, necessitating re-spraying within a week.

Use of insecticides on log ponds is always a potential danger from the viewpoint of water pollution. A standard practice in the lumber industry is to "dump" –i.e., empty–mill ponds once a year, usually during the 4th of July holiday, for the purpose of recovering sunken logs, repairing dikes and removing accumulations of bark from the bottom. This means that a "slug" of insecticides–carrying water, varying from 10 acre-feet in the case of a small pond to 1500 or more for a large one, empties into the nearest stream in a short time. Spray clouds, especially those from airplane spraying, are likely to drift over nearby streams. Many mills are located on the banks of streams for convenience in obtaining water for pond and mill supply. On the Pacific coast, most such streams contain trout, steelhead and salmon, and the possibility of wiping out a steelhead or salmon run is always present.

Finally, resistance to organic insecticides is becoming noticeable in Oregon log pond mosquitoes, especially in the Salem area.

Because of the many difficulties associated with the use of insecticides, emphasis in log pond mosquito studies is being placed on naturalistic means of control.

Species composition of log pond mosquito populations is largely determined by the degree of organic pollution (McHugh, Wilson and Miller, submitted for publication). Polysaprobic ponds attract only *Culex peus*, *Culex pipiens* and *Culiseta incidens*. At a lower degree of pollution, corresponding roughly to the alpha-mesosaprobic of Liebmann (1951), these three species occur with *Culex tarsalis*, *Culex territans* and *Mansonia perturbans*. At a still lower degree of pollution, approximately that of Liebmann's beta-mesosaprobic, only *Culex tarsalis* and *Culiseta incidens* are found; probably *Mansonia* can occur in such situations also. In ponds in which logs have been stored for over two years, in which mineralization of organic matter is largely complete, populations of *Culex tarsalis* and *Anopheles freeborni*, and of the latter alone, occur.

It is curious that polysaprobic ponds located close together may produce only *C. peus*, only *C. pipiens*, or both together. East of the Cascades, polysaprobic ponds occur without mosquito populations; these are probably those that would be attractive to *C. Peus* only, occuring in an area in which this species does not exist. As practically all log ponds receiving additional pollution from pulp mill waste or sewage produce *C. pipiens* only, it is possible that sulfur or nitrogen compounds abundant in such wastes may repel *C. peus* selectively.

Neither *Culex peus* nor *Culex pipiens* emerging from log ponds appear to bite man, at least in Oregon. This observation is based on house-to-house surveys made in communities closely surrounding ponds producing only these species, on questions asked night-shift employees working on or close to such ponds, and on 24 man-nights of biting collections made adjacent to ponds producing only these two species. *Culiseta incidens*, occasionally present in generally small numbers over the whole range of pollution, also appears to bite infrequently. A more extensive study of the biting habits of these three species is planned for the summer of 1961; should the earlier observations be confirmed, it would appear that larvicidal treatment of polysaprobic ponds is unnecessary.

If polysaprobic ponds produce only non-biting mosquitoes, then the possibility exists of adding additional organic matter to mesosaprobic ponds to convert them into polysaprobic ones. Several such ponds have in fact been observed. The Koch Lumber Company, Sandy, Oregon, serves also as the sewage oxidation pond for the town of Sandy, its sole water supply being the effluent from the primary sewage treatment plant. This pond produces only *C. pipiens*.

In three cases in which ponds received waste from paper-pulping mills (one sulfate process, two sulfite process) only *C. pipiens* were produced. Few ponds, however, are so situated as to receive direct discharges of such substances, and the cost of hauling large amounts of them by tank truck or other carrier would be prohibitive. The most practical way of achieving a high level of pollution is to utilize only small ponds–two acres surface area or less–for handling and sorting logs, and to rely on cold decks for log storage. During the present studies there has been encountered no case in which man biting mosquitoes have been produced in small ponds in continuous use during the mosquito breeding season. Virtually all *C. tarsalis*, *Mansonia* and *Anopheles* breeding occurs in large storage ponds with relatively low degrees of pollution, or in small ponds attached to mills which have ceased operations during the breeding season.

The effect of freshening polluted log ponds has been observed in a number of cases. In every case this has resulted in replacement of presumably non-biting species by *C. tarsalis* or *Anopheles*, and this practice is not recommended except in situations in which it might open the way for control by larvivorous fishes.

Fish have often been used in mosquito control in impounded waters. Few log ponds contain fish other than bullheads (*Ameiurus sp.*), which, along with bullfrogs, have been widely introduced into mesosaprobic ponds. Neither bullheads nor frogs have any anti-larval value. Most Centrarachid fishes (bass, croppies, sunfish) and some other types (carp, suckers, dace, red-sided shiners, sticklebacks) can live in mesosaprobic ponds, but do not reproduce there, probably because of lack of nesting sites and also because eggs and fry are more sensitive to low oxygen than are adult fish. In every case in which fishes other than bullheads have been found in log ponds, the pond has been

connected directly with a pond or stream; and in such cases complete elimination of mosquito breeding has often resulted. Red-sided shiners (*Richardsonius balteatus*) and sticklebacks (*Gasterosteus spp.*) were the most efficient larvivorous fishes in such situations. No fishes, frogs or other aquatic vertebrates can survive in polysaprobic ponds.

The mosquito fish, *Gambusia affinis,* has been widely introduced into mesosaprobic log ponds during the present study. Both California and the cold-acclimatized Utah strains have been used. These fish are very effective in small ponds (0.5 acre or less), and in larger ponds if the shape is narrow or irregular. *Gambusia* prefer to remain close to the shore, which limits their usefulness in larger ponds in which much of the surface is over 100 feet from the shoreline.

Ponds in which only western red cedar (*Thuja plicata*) logs are stored differ from ponds storing other species in their attractiveness to ovipositing mosquitoes. Although these ponds may have a high degree of pollution, as measured by biological and chemical oxygen demand, total and volatile solids, color, soluble carbohydrates and free CO_2, they attract only those species (*C. tarsalis, Anopheles* and *C. territans*), usually found in moderately polluted areas. This is not because of any repelling effect of the odor of cedar itself, as the admixture of small numbers of logs of other species, or the circulation of water from ponds storing other species is sufficient to encourage breeding of *C. peus, C. pipiens,* and *Culiseta incidens.* No biological work has as yet been done on these ponds but it is possible that some constituent of cedar wood inhibits the growth of microorganisms that would otherwise break down the primary pollutants (wood sugars, amino acids, fatty acids, terpenes) diffusing from the wood into decomposition products attractive to foul-water mosquitoes.

Studies on the chemistry of log pond water made in the course of this study will be reported elsewhere; the need for brevity permits only a few observations of particular interest. The dark color of such waters is derived mostly from soluble tannins, which form aggregates of larger than colloidal size after entering solution; practically all color is removed by a millepore filter with a pore diameter of 0.5 micron. Most color is produced by the bark alone, as it does not develop any degree in ponds storing barked logs or veneer peeler cores. All such waters are acid (pH 4.8–6.9), and this acidity is almost all due to free CO_2; shaking or aeration restores pH to source water levels very rapidly. Soluble carbohydrates (from wood sugars, starch, pectins, etc.) range from 2.3–12.8 ppm. The offensive odor of log waters is unfortunately difficult to analyze (it is probably the factor determining selective mosquito oviposition), but contains a definite "piney" element derived from the terpenes of wood and bark, which exist partly in solution, partly as oily surface slicks. Sulfur and nitrogen compounds do not appear to be important constituents of log pond water except where additional pollution from sewage or pulp mills is a factor.

Of particular interest is a group of highly polluted ponds in which no breeding whatever occurs, although the level of pollution, as measured by chemical indicators, falls within the general polysaprobic level. These ponds all used for storage of large numbers of logs of small diameter (8 inches or less), and observations suggest that such logs may exude large amounts of terpenes differing in quality from those of larger logs. That kinds and percentage composition of terpenes vary in trunk, branches, and needles of conifers is known (Guenther, 1948-52). It may therefore prove feasible to use such substances as crude sulfate turpentine in small quantities as a repellant to prevent mosquito breeding.

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EVALUATION OF HEALTH HAZARDS OF PESTICIDES[1]

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In the interest of conserving time I will not attempt to cover the more obvious health hazards of pesticides. I assume you all know that you will die if you drink enough parathion and also that if a workman is careless in how he handles the more toxic pesticides he is endangering his health. Rather I will devote what time I have available to the more difficult problem of evaluation of the more subtle effects that may be associated with long continued exposure to low concentrations of pesticides. Do they cause cancer or other degenerative diseases? What is the danger that an adverse effect will show up sometime later? Can indirect effects that reduce a pilot's efficiency result in an airplane crash? We must be cautious in jumping to conclusions on such questions.

First, we should consider some basic principles. In general the effects of exposure either as acute—those that are reasonably short-lived, resulting either in death or complete recovery in the course of a few weeks perhaps—or chronic—those that are permanent or at least from which recovery is very slow. Either type of effect (acute or chronic) may result from a single relatively large dose or from a series of exposures or continuous exposure to small doses over a longer period of time. The latter may be considered a cumulative effect and it may in some cases be different from the immediate effect of a large dose.

It is well known that the organic mercury compounds may produce, in man, a delayed effect that is chronic but may not become apparent until a considerable period of time after exposure. Of course, the same clinical course may begin during continued exposure. The mechanism of the delayed action of the organic mercury compounds is not fully known. Stor-

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age of a compound in a relatively inactive form and its subsequent release constitutes one mechanism of delayed effects. This phenomenon is sometimes seen in chronic lead poisoning in man and may be demonstrated in DDT poisoning in small animals (Fitzhugh and Nelson, 1947). In man, this phenomenon does not occur since both storage and metabolism are too low to produce the effect.

Whatever the form of poisoning, it is possible to rely on the general principle of toxicology that poisoning can be expected to occur most quickly, most frequently, most severely, and most diversely in those subjects whose exposure has been most intensive, especially if it has been prolonged. The importance of this principle can not be overestimated when dealing with those special interest groups who fear the insidious, delayed effects of low-grade exposure claiming that they may go unnoticed for years and then eventually erupt in some form of degenerative disease or chronic condition when it is too late. It is simply unreasonable that such delayed effects would be different in any significant way than immediate effects of larger dosages over a similar period of time. Therefore, if we continue to keep under medical observation individuals with relatively large continual dosages, we should detect any possible delayed effect at least as soon and probably much sooner than it would occur in individuals with lower exposure.

This then is the basis upon which the Public Health Service has based its program. We look first for immediate effects of heavy exposures in experimental animals and eventually in man. This sets the pattern of signs and symptoms (as well as pathology) that we expect to find in any poisoned subject. Next we look for effects that may show up only after prolonged exposure to sublethal dosages. In experimental animals, this prolonged exposure may extend over more than one generation so that effects on reproduction or even genetic effects might be observed.

I believe it is safe to say that in such long term studies we have never observed effects that differed in any fundamental way from the more immediate effects of the same pesticides. Of course this does not mean that such different effects may not occur in man. As Seevers (1953) has pointed out, studies in man provide the only sure guide to toxicity in man. Therefore, we have conducted experiments designed to observe any such delayed effects in those men who have had the heaviest continual exposure to pesticides—namely, men who manufacture and formulate the material and men who mix or apply it and are thus exposed occupationally. It is our plan to repeat observations systematically from time to time and continually to be on the alert for any unexpected effects.

Our Wenatchee Field Station conducted an experiment over a three year period that illustrated this approach (Sumerford, *et al.*, 1953, and Hayes, *et al.*, 1957). Several hundred individuals were classified into seven groups on the basis of their potential exposure to the pesticides used in the orchards around the predominantly apple-growing valley of Wenatchee, Washington. These groups ranged from mixing plant personnel who were considered to have the heaviest and most continual exposure, through several lesser degrees of occupational exposure, to residents living near orchards but with no occupational exposure, and ending with a control group of residents who lived entirely outside an agricultural area. Monthly blood samples from these people were analyzed for cholinesterase activity, and they were interrogated monthly regarding any possible minor complaint even to recording the use of eyeglasses or a tooth ache. As expected, evidence of toxic effects were found most frequently and most severely among those known to have the most severe exposure and were least common in those with least exposure. In fact, there was no significant difference between the controls living outside the area and the residents living in the area but with no measurable exposure.

It is now well known (Pearce *et al.*, 1952) that DDT and its metabolite DDE is stored in fatty tissues of man as well as experimental animals. Hayes *et al.*, (1958) have shown that the amount deposited in the fat is a direct function of exposure whether that be restricted to dietary intake or includes occupational exposure. This, of course, is another example of the principle expounded above. Moreover, Hayes, *et al.*, (1956) fed human volunteers up to 35 mg. of DDT (200 times the ordinary dietary level) daily for a year and found no clinical effects detectable either by the men themselves or by careful physical examination and laboratory testing. The same results were obtained in a follow-up study in which the exposure was continued for 21 months of DDT dosage and 27 months of post-exposure follow-up.

Of considerable importance was the finding that the deposit in the fat reached equilibrium after about one year at any given dosage of DDT, and, after that, continued intake of DDT at the same rate did not further increase the storage level. After exposure was stopped, the storage level reduced only very gradually. Observations are continuing on these men.

This experiment was corroborated under natural conditions by Ortelee (1958), who examined 40 formulating plant workers and measured the excretion of DDA in their urine. The results showed that 26 of these men had absorbed DDT at a rate equal to or higher than that of the volunteers who ingested 35 mg. per day. These men had been exposed at this rate for from six months up to six and one-half years but showed no apparent ill effects as judged by medical examinations, their own reports, or their work-attendance records. There were some few who had slightly reduced neutrophil counts. The significance of this is not yet clear but these men are also being carefully followed.

Under somewhat different conditions of exposure, Fowler (1953) looked for possible subtle effects of exposure to agricultural chemicals among the general population of an area in Mississippi where these materials are intensively used. He compared school attendance and mortality records, hospital admissions, and illness of the almost exculsively agricultural area of the Yazoo—Mississippi Delta with similar records for the State as a whole for years before and after the introduction of modern insecticides. No evidence could be found that pesticides were the direct or indirect cause of any chronic disease or a contributing

cause in diseases generally recognized as having other etiologies. Death rates decreased in a similar way for both the Delta area and the State as a whole in tuberculosis, dysentary, pneumonia, and deaths from all causes.

The Delta area showed a decline in death rate for diarrhea, while the State as a whole showed a slight increase. For cancer, the Delta showed no change, while the State as a whole showed an increase. Only in heart disease was there a pronounced rise in the Delta counties, and this was similar to the rise recorded for the State as a whole. Rates for certain diseases, particularly communicable diseases, showed a higher figure for the Delta than for the State both before and after the introduction of modern insecticides.

Goldsmith (1960), in testimony before the Governor's Special Committee on Public Policy Regarding Agricultural Chemicals, pointed out that the over-all mortality for any population followed for a sufficient period of time is precisely one thousand deaths per one thousand persons. That is to say, if we reduce the death rate from diseases that characteristically affect younger people at least as much if not more than older age groups, then we must of necessity eventually increase correspondingly the death rate among older people. Therefore, we must be extremely careful in attempting to interpret any increase in death rates due to chronic diseases such as cancer or other diseases that are characteristic of more advanced age. After all, every one must die of some cause eventually.

Goldsmith further pointed out in relationship to cancer as an example that "one can not speak of all cancer and its possible relationship to any common factor; rather one must speak of cancer by specific sites." Cancer of the trachea, bronchus, and lung has been increasing, and cancer of the breast is remaining rather constant. Cancer of the stomach, which might with some logic be associated with chemicals in food, has been decreasing. Work with experimental animals is necessary and important but exceedingly difficult to translate into human significance because of the currently extremely complicated though limited state of our knowledge of relationships between various types of cancer, especially in different species. Observations on men with the heaviest continued exposure as described above by Fowler is apt to be our most reliable source of information for some time to come.

Goldsmith went on to point out that diabetic mortality in the United States is decreasing slightly possibly due to earlier detection and improved management in control and treatment.

Coronary heart disease is increasing in frequency, but is relatively less common in farmers, a group who may have occupational exposures to agricultural chemicals.

It seems safe to conclude that the evidence to date, both that resulting from a specific search and that based on more general statistics, fails to implicate agricultural chemicals as a cause of any significant rise in death rates or morbidity from any chronic disease.

To complete our search for evidence of possible ill effects of pesticides on humans, we must look for effects that are reasonably rare, and therefore, might well be missed by review of statistics.

On the positive side, we would be remiss if we did not mention the frank cases of poisoning and of death resulting directly and clearly from exposure to pesticides. I suspect you are all reasonably familiar with some of the statistics and evaluations of these cases that have been presented in various places by a number of people.

The number is small but regardless of the frequency, a death, or even a disabling illness, is of great importance to the individual suffering it and to his immediate family and close friends. It is for this reason that nearly everyone concerned is very interested and is making a sincere effort to reduce the frequency of these cases to still lower levels.

We believe it wise to give serious consideration to all responsible reports of illnesses or disfunctions that appear to result from exposure to pesticides. We have gone to considerable lengths to investigate some of them. Thus, there was the suggestion that exposure to organic phosphorus insecticides might be interfering with the ability of crop dusting pilots to pilot their planes efficiently. The first reports were that TEPP, which was known to produce pinpoint pupils, might be interfering with vision. We arranged for certain pilots to volunteer for vision tests that involved instillation of TEPP directly into their eyes during the off-season. (Upholt, *et al.*, 1956).

The first results based upon instillation into both eyes showed miosis, a decrease in light perception, and an increased depth of focus, but no change in depth perception. Next, we tried instilling the TEPP in one eye only and found unmistakable evidence of loss of ability to judge distances under dynamic conditions, even though more or less static tests of stereopsis were negative. More recently, Quinby *et al.*, (1958) reporetd that a pilot who had been applying TEPP and was having great difficulty in landing his plane found that his vision cleared when he closed one eye, and he landed without further difficulty.

Holmes and Gaon (1956) have reported persistent mental effects from exposures to organic phosphorus compounds. Should these prove to result from occupational or other exposure to insecticides, they could well contribute to serious accidents. The Toxicology Section of the Communicable Disease Center, is actively involved in an attempt to evaluate this possibility, but it is not simple. For one thing, it obviously does not occur with all heavy exposures, and therefore, selection of cases for study is a problem in itself. Unfortunately, they have nothing to report as yet beyond the rather obvious fact that if it occurs at all, it is certainly not serious in a high proportion of exposed individuals.

Finally, some recognition is necessary of various types of allergic reactions. These or related types of hypersensitivity have been reported for many different compounds. Therefore, it would actually be surprising if none was found for pesticides or auxiliary materials used in their formulation. These atypical reactions range from mild and transient skin rashes, through asthmatic types of reaction, to the severe and even fatal blood dyscrasias including aplastic anemia. Un-

fortunately, there is no simple and completely reliable way to associate such reactions with their cause in every case. Even a positive skin test properly done can be misleading. Therefore, we are not apt to get any good statistics on frequency of occurrence of such reactions.

In spite of our lack of basic understanding or good statistics, it is none the less clear that if such allergic reactions were typical instead of atypical—in fact, even if they were at all common the association of cause and effect would be obvious and could not have been missed with the effort that scientists have made to look for such a relationship. It seems safe to say then, that in spite of the seriousness of such reactions to the individuals directly concerned, they are sufficiently infrequent to be of minor importance from the standpoint of "upsetting the balance of nature" or even from the broad standpoint of public health in general as contrasted with the health of each individual.

These, then, are some of the more subtle effects that we have been looking for in our evaluation of the health hazards of pesticides. We do not believe the picture is alarming but we do believe we must remain constantly alert.

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SUMMARY OF SIGNIFICANT RESEARCH DEVELOPMENTS DURING 1960 WHICH HAVE CONTRIBUTED TO THE ECOLOGY AND CONTROL OF MOSQUITOES AND RELATED FORMS*

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Introduction

Research involving mosquitoes and related insects appears to have proceeded at an unparalleled rate during 1960. Upwards of 550 publications by approximately 1,000 authors, appearing in more than 125 scientific journals provides some indication of the international interest and progress in this field.

An examination of the contents of these publications reveals certain interesting trends. First of all, there has been a marked upsurge in attention devoted to the mosquito-borne encephalitides, particularly from the point of view of ecology. Equally striking is the rate of discovery of new viruses of mosquitoes, a number of which have still not been related to human disease.

With malaria eradication programs focusing their principal attention on the destruction of vectors with residual insecticides, insecticide-resistance has become an ever-increasing problem, thus accelerating investigative efforts to discover countermeasures. This in turn has led to significant advances in previously underdeveloped areas such as mosquito genetics as applied to insecticide resistance. By the same token, the magnitude and scope of the resistance problem precipitated during 1960, the greatest international effort ever made to develop new effective control methods, including biological as well as insecticidal means.

Although comparatively few investigators conducted studies concerning *Simulium, Culicoides* and related forms, substantial progress was made during the past year towards a better understanding of their ecology and control.

Except for several personal communications in which pre-publication data was kindly supplied, the material covered herein is restricted to work published during 1960. Furthermore, it is largely concerned with mosquitoes, with some coverage of sand flies and black flies. Limitations in time and space preclude the inclusion of all important research findings reported during the period covered.

Mosquitoes

Malaria. In the area of malaria research, the experimental transmission of *Plasmodium cynomolgi bastianellii* from rhesus monkeys to human subjects by *Anopheles freeborni* (Eyles et al, 1960), is particularly noteworthy and raises the possibility of an extra-human reservoir of the disease in man. After many unsuccessful attempts by a number of investigators,

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Yoeli and Most (1960) succeeded in obtaining three successive, consecutive cyclic transmissions of *Plasmodium berghei* in *Anopheles quadrimaculatus, A. aztecus* and in young white rats.

Of considerable interest to those of us who for years have been studying factors influencing the susceptibility of mosquitoes to malarial parasites is the observation that the zygote of *Plasmodium gallinaceum* is passively incorporated into the midgut epithelium of *Aedes aegypti* and apparently possesses no innate motility at any time following fertilization (Howard, 1960). That zygotes are "caught" in inter-epithelial spaces during the process of alteration in epithelial cell shape was demonstrated with polystyrene latex spheres. The experimental infection of *A. aegypti* with exoerythrocytic stages of *P. gallinaceum by* Weathersby (1960) has provided additional evidence that malarial parasitism of the invertebrate host preceeded parasitism of the vertebrate host.

Moving out of the laboratory into the field, evidence has been collected to show that the recent decline in the prevalence of indigenous malaria in Japan is associated with a change in the relative abundance of memebrs of the *Anopheles sinensis* group (Otsuru and Ohmori, 1960). They succeeded in classifying three types according to egg characters and suggested that malaria epidemiology in the Far East be reinvestigated from a taxonomic point of view. The intensity of the infectivity for mosquitoes of untreated or inadequately-treated *Plasmodium falciparum* during the primary parasitemias and the long period of low grade intermittent parasitemias has been shown to be of great importance in the maintenance of the disease in endemic areas (Jeffrey, 1960).

An interesting development following the failure to discover breeding areas of malaria vectors found in houses in one section (Eastern Cline Town) of Freetown, Sierra Leone and their continued presence even after larviciding and residual spraying, was the collection by Thomas (1960) of 85 vectors from trains during July and August of 1959. This work suggested that the importation of mosquitoes might be of importance in malaria transmission in this area, where the incidence of malaria was significantly higher than in the remainder of the controlled area.

Viruses. Research on mosquito-borne viruses reached a new high during 1960. This topic was given special attention in the form of a symposium presented at the last joint meeting of the American Society of Tropical Medicine and Hygiene and the American Society of Parasitologists, and will be so included in the present meeting.

The 1959 outbreak of Eastern encephalitis (EE) in New Jersey stimulated increased attention to the epidemiology of the disease and the ecology of potential vectors. Twenty-two of the 30 isolations of EE virus from naturally-infected mosquitoes incriminated *Culiseta melaneura* as the enzootic vector among wild bird hosts (Chamberlain, 1960). Mosquito light trap records of Fort Dix, New Jersey, for the past five years suggested that a correlation may have existed between the unusually high 1959 *C. melaneura* population and the concommitant outbreak of EE (Flemings et al, 1960). Likewise, Hayes and colleagues (1960b) noted an apparent correlation between the type of mosquitoes which were the most abundant in inland and coastal regions and the types of hosts stricken in these regions. More recently, host preference studies with *C. melaneura* at the Taunton, Mass. field station have confirmed that this species feeds primarily on birds but that it will also feed on mammals and even on reptiles (Hayes, 1961). *Culex pipiens* also showed a high preference for birds, but *Culex salinarius* fed about as much on mammals as on birds.

EE virus was isolated from *Culex restuans* collected in New Jersey during the encephalitis outbreak (Hayes et al, 1960c) and from a pool of 13 *Aedes vexans* in Connecticut (Wallis et al, 1960). On the other hand, Favorite (1960) reported the absence of detectable EE virus in the mosquito populatoin of Florida during a seasonal period when few equine cases attributable to EE were reported. The finding of 30 per cent immunes (EE) among the wild bird population led him to conclude that the infection was of recent and local origin. Evidence collected in Massachusetts with four flocks of sentinel chickens showed that high levels of enzootic transmission of EE virus could occur without involving horses or humans (Hayes et al, 1960a). That other states possess the potential for outbreaks of this disease is exemplified by New York state where all but two of the 16 species of mosquitoes known to be suspectible to EE virus and to transmit it in the laboratory occur, and where the virus has been isolated recently (Collins, 1960).

Investigations concerned with Western encephalitis (WE) and St. Louis encephalitis (SLE) have been characterized by an intensified study of vector ecology. Several interesting findings have resulted from the work of Hess and associates of the Encephalitis Section of the U.S. Public Health Service at Greeley, Colorado and field stations. At Greeley, it was observed that visual and chemical stimuli played an important role in attracting blood-seeking *C. tarsalis*. After the mosquito reached the foliage of trees where its avian hosts were available, low concentration of CO_2 no longer played a role in its orientation within the vegetation canopy (Dow, 1961).

Seasonal observations on the nulliparity of *C. tarsalis* in the Greeley area indicated that in the fall, a physiologically different population of adults develops which does not seek blood meals (Blackmore and Dow, 1961). Hibernating mosquitoes seemed to be almost entirely of this type. The chances that they could serve as overwinter reservoirs of encephalitis viruses seems therefore to be very remote. It was also observed in the Greeley area that *C. tarsalis* was rare or absent in higher elevations where high transmission rates for WE occurred in sentinel chickens (Blackmore et al, 1961), suggesting that some other vector may be responsible for this high altitude transmission.

Eleven of 15 isolations of WE virus from mosquitoes in the Eastern United States were from *C. melaneura* (Chamberlain, 1960). SLE virus was isolated on eight occasions from *C. quinquefasciatus* during an epidemic of St. Louis encephalitis in Cameron County, Texas (Brody and Browning, 1960).

Over a five year period in California, 764 virus isolations were made, of which 433 were WE, 186 were

SLE and 145, Turlock (Meyers et al, 1960). All three viruses were isolated from *C. tarsalis* and *C. peus*. WE and Turlock viruses were found in *C. pipiens*. During this same period of time, the predominant species found in nearly all collection stations in four study areas of the Central Valley of California were *C. tarsalis*, *C. pipiens* complex, *C. peus* and *A. freeborni* (Loomis and Meyers, 1960). However, there were important differences in the relative abundance of these species from area to area. Virus infections in mosquitoes could usually be found in an area one to two months prior to the finding of human illness (Longshore et al, 1960).

It has been suggested that a possible relationship between encephalitis virus activity and the date of the spring soil temperature inversion might provide the earliest seasonal indication of a potential increase in mosquito-borne virus (Bennington and Sherman, 1960). Graham and co-workers (1960) showed that a positive correlation existed between the percentage of times *C. tarsalis* larvae were found alone and the number of cases of WE reported in horses.

In studies conducted at the Columbia Wildlife Refuge near Othello, Washington, it was found that dense vegetation provided satisfactory resting sites for *C. tarsalis* through mid July (Harwood and Halfhill, 1960). Mammalian burrows and rock fissures provided shelter for *C. tarsalis* and *A. freeborni* throughout the summer of 1959. While *C. tarsalis* preferred burrows in ground contact for resting, *A. freeborni* showed a preference for mammalian burrows. Evidence has likewise been produced to show that in the Minnesota region, caves and man-made structures only rarly afforded hibernation sites for *C. tarsalis* (Price et al, 1960). According to Harmston and colleagues (1960), the principal species based on relative abundance of adults over the entire season near seven log ponds in Douglas County, Oregon during 1956 were *C. tarsalis*, *C. peus* and *C. pipiens*.

In addition to the investigations conducted in this country, many new virus isolations were made in other parts of the world during 1960. Between August of 1953 and December, 1958, 842,581 mosquitoes collected in Trinidad by personnel of the Rockefeller Foundation Regional Virus Laboratory yielded 94 strains of virus (Aitken, 1960). A strain of Mayaro virus was isolated from *Mansonia venezuelensis*, the first record of isolation of this agent from wild caught mosquitoes (Aitken et al, 1960). Anderson et al (1960) reported the isolation of Kairi virus, a new agent, from several species of Trinidadian mosquitoes and detected the presence of neutralizing antibodies in the sera of animals and humans of the area. Witwatersrand virus, apparently a new agent, was isolated from a pool of 20 *Culex rubinotus* collected at Germiston Lake near Johannesburg, South Africa (McIntosh et al, 1960). The presence of neutralizing antibodies in sera from residents indicates that this agent may have a potential role in human disease. Germiston virus was also isolated by this group from a mixed pool of *Culex theileri* and *C. rubinotus* and from a pool of *C. rubinotus*, collected at Germiston, Union of South Africa (Kokernot et al, 1960). Two clinical cases of infection with this virus have been observed.

Dengue viruses were isolated by Hammon and colleagues (1960) from wild caught *Aedes aegypti* and *Culex tritaeniorhynchus* in Manila and *A. aegypti* in Bangkok. Concurrent cases of a newly recognized severe febrile hemorrhagic disease of children, which appeared in epidemic form in Manila in 1956 and in Bangkok in 1958, appeared to involve *A. aegypti* as the vector, on the basis of studies by Rudnick and Hammon (1960). Sindbis virus was isolated from a pool of *Culex vishnui*, *C. khazani*, *C. mimulus*, *C. bitaeniorhynchus* and *C. sp.* collected in Mysore State in India to provide the first evidence of the presence of group A arthropod-borne viruses in India (Shah et al, 1960).

Several interesting experimental transmission studies, each concerned with a different virus, were conducted during the past year. Hurlbut and Thomas (1960) carried Phlebotomus fever virus through 34 serial passages in *Culex univittatus*. A gradual increase in titer was observed to the point that the virus was 300 times more infective for the mosquito. The virus produced the infection in mosquitoes upon parenteral introduction, but not when taken into the alimentary canal of the host. Experimental mouse to mouse transmission of Semliki Forest (SF) virus by *Aedes togoi* was demonstrated by Nye and Lien (1960). This species maintained high levels of SF virus for at least 31 days. Boorman (1960) found that Uganda S, yellow fever and Semliki forest viruses appeared in the hemolymph of *A. aegypti* about 10 minutes after the infective blood meal, disappeared after about three hours and then reappeared about 48 hours later. In mosquitoes with infections of over one day duration, the virus in the hemolymph represented usually from 0.01-1.0 per cent of the total in the insect. The Tamilnad strain of West Nile virus, isolated from *C. vishnui* in Sathuperi in the North Arcot District of Madras State, propagated in *C. pipiens fatigans*, *C. vishnui* and *A. albopictus* following parenteral introduction of the virus (Varma, 1960).

In an intriguing study by La Motte (1960) involving titration of Japanese B encephalitis (JBE) virus in various tissues of members of the *C. pipiens* complex and *C. tarsalis*, it was demonstrated that the abdominal part of the gut was the site of initial virus multiplication. Subsequently, virus was detected in the hemolymph and various tissues. The maintenance of high virus concentration in the salivary glands suggested that virus multiplication occurred in this organ. Mosquito species used exhibited high infection rates and transmission rates with JBE virus and there was a definite correlation between the virus dose imbibed and the percentage of mosquitoes infected. Thomas and Eklund (1960) succeeded in infecting *C. tarsalis* with WE virus from experimentally infected garter snakes and transmitting the virus to 1-day old chicks.

Biology and Ecology. There have been a number of noteworthy contributions in the field of mosquito bionomics and ecology during the period under review. Techniques for estimating the age of mosquitoes, based chiefly on changes which take place in the ovaries have been confirmed and refined (Rosay and Barr, 1960). Supplementary information was gained from examination of the gut, spermathecae and rem-

nants of muscles. In mating experiments conducted at different temperatures, Parker and Rozeboom (1960) showed that *C. fatigans* was more active than *C. pipiens* at all temperatures, but was less inhibited than *C. pipiens* at the highest temperature. It was pointed out that this could be a means of limiting the establishment of *C. pipiens* in warmer areas where it would have to compete with more active *C. fatigans*. Conducting further experiments with this complex, Tekle (1960) found that the adults of both subspecies required carbohydrates or a combination of carbohydrates and blood to carry them through the winter. Hibernating *C. pipiens* females outlived *C. fatigans* females because they were able to utilize their fat reserves whereas *C. fatigans* could not. This may offer one explanation for the absence of *C. fatigans* in colder regions. In studies with *A. aegypti* and *A. nigromaculis*, Judson (1960) has found that very low levels of dissolved oxygen were required to induce a high degree of hatching, whereas even a slight lowering of the oxygen level while eggs were flooded produced a powerful hatching stimulus. He noted that the latter seemed to represent the natural mode of stimulation.

Migration studies of saltmarsh mosquitoes, conducted by personnel of the Vero Beach Entomological Research Center, Florida, have contributed much to our understanding of saltmarsh mosquito habits and dispersal. Methods of studying the migratory exodus in *Aedes taeniorhynchus* have been described (Provost, 1960), and evidence has been obtained that this species may be carried 30 to 60 miles from breeding areas in Southern Florida (Harden and Chubb, 1960). It was further noted that *A. taeniorhynchus* sometimes fed on nectar before the exodus and mated during it (Haeger, 1960b). The direction of migrating populations could be correlated with wind velocities.

A major contribution towards a better understanding of mosquito bionomics was the five year joint study by Weitz of the Lister Institute and the Division of Malaria Eradication, World Health Organization (1960) of blood-feeding patterns of *Anopheles* mosquitoes through precipitin tests. This investigation, the largest of its kind even undertaken, covered 51 species and 56,377 tests of which 93.9 per cent yielded positive results. Also using precipitin tests, Downe (1960) determined that *Aedes* mosquitoes collected in the Ottawa Valley had fed on farm animals, humans, rodents, raccoons, deer and probably foxes, but that very few specimens had fed on birds. Preference shown by the mosquitoes for a mammalian host was found to be related to the surface area of the host.

New laboratory rearing methods have made some species more amenable to experimentation under controlled conditions. For example Haeger (1960a) and Ramachandran (1960), in separate laboratories, have devised methods for maintaining *Mansonia* species. These techniques have enabled Haeger to undertake studies on plant preference for egg laying and larval attachment to plant and artificial material.

Bite Reaction. Hocking (1960) has reviewed the physiology and behavior as well as the biology and ecology of mosquitoes as one of several groups falling in the category of northern biting flies. Working on the bite reaction mechanism in certain species, Hudson et al (1960) showed that the salivary glands of *Aedes stimulans* are the source of an antigen which produces typical bite reactions in laboratory rabbits and humans. Using the unique technique of cutting the salivary duct, they demonstrated that the saliva may contain an anesthetic component since bites without saliva were more painful. Furthermore, the typical bite reaction was not produced when the salivary duct was cut. McKeil and Clunie (1960) produced a reaction equivalent to that caused by mosquito bite with extremely minute quantities of dialyzed *A. aegypti* extract from which the ninhydrin-staining peptides had been removed. Acetone extracts of *aegypti* were shown to contain at least 4 fractions capable of producing skin reactions in sensitive volunteers.

Cytology and Genetics. The past year has also seen the application of cytology and genetics to problems of speciation and inheritance of insecticide-resistance, respectively. The value of differences in chromosome complements as taxonomic aids has been demonstrated (Breland, 1960). Likewise, chromosome maps of the larvae of several strains of *A. aegypti*, prepared by Mescher (1960) showed characteristic variation with respect to size of salivary gland nuclei and diameter of chromosomes. The inheritance of DDT-resistance in several resistant strains of *A. aegypti* has been studied with the use of marker genes on the two autosomes (Brown, 1960b). Evidence has been obtained that the inheritance of DDT-resistance in a Philippine population of *C. pipiens fatigans* is probably due to selection for a single dominant gene (Rozeboom and Hobbs, 1960).

Of special interest was the discovery by Craig et al (1960) of an inherited factor which causes a predominance of males in certain strains and in progeny of single pairs of *A. aegypti*. This factor appeared to be transmitted only by males and was not due to differential mortality, at least in postgametic stages. This finding suggests the interesting possibility of the mass release of male-producing males in control operations. Laven has demonstrated that sympatric speciation may take place in *Culex molestus* by means of cytoplasmic sterility factors, a finding which has recently been substantiated using genetic markers (Kitzmiller, 1961).

Insecticide Resistance. By 1960, the continuous use of insecticides in malaria eradication and other programs resulted in no less than 35 species of mosquitoes developing resistance to one or more insecticides (Brown, 1960a). In this country, Blakeslee et al (1960) reported DDT-resistance in larvae and adults of *Anopheles quadrimaculatus* from the U.S. Army Chemical Center in Maryland. Likewise, a strain of this species was discovered at Clark Hill Reservoir, Georgia, of which both larvae and adults were highly resistant to DDT following eight years of control with DDT larvicidal applications (Mathis et al, 1960). A dieldrin-resistant field strain of *A. quadrimaculatus* from Cleveland, Mississippi, when colonized by Weinburgh and Fay (1960), showed high dieldrin-resistance. Field observations in Morocco showed as high as 85 per cent survival of *A. labranchiae* captured in DDT-treated dwellings (Sacca and Guy, 1960). Specimens from both treated and untreated areas exhibited a high degree of irritability to DDT-treated papers. Thirty

per cent of the test population in certain villages was unaffected by one and two-hour exposures to 1.6% dieldrin papers. *Anopheles subpictus* collected from the field in the Lahore District of West Pakistan by Maldonado-Capriles and Nasir (1960) showed resistance to DDT, 4-hours exposures to 4% DDT giving 54% mortality.

Rao et al (1960) noted that in a few villages in Thana District, Bombay State, India, where dieldrin-resistance had been detected in *A. culicifaces* in October 1958, a gradual reversion towards susceptibility had occurred by October 1959. The numbers of resistants and susceptibles in the population (75% and 25%, respectively) had exactly reversed in this period of time. Similarly, Belios (1960) reported a slight recession of physiological resistance of *A. sacharovi* in Greece to DDT, probably due to the discontinuance of air larviciding since 1956. He also found this species to be much less anthropophilic than before. Belios attributed control failure in certain areas to behavioristic resistance wherein DDT-irritability led to exophily. It was noted that some of the susceptible individuals were driven off sprayed premises due to DDT-irritability, and could survive long enough for malaria transmission to occur in areas with large mobile groups. During the three years following the spraying of houses with dieldrin in the Taveta-Pare area in East Africa, it was observed by Gillies and Smith (1960) that *Anopheles funestus*, previously one of the most prevalent species, disappeared almost completely from the outdoor catches while *A. rivulorum*, previously taken in small numbers, showed an increase of about seven times above its former level. Although dieldrin caused some irritation in *A. gambiae*, it was found to produce a high mortality in this species (Draper and Smith, 1960).

Hecht et al (1960a), working in Mexico, found *A. albimanus* to be more DDT-irritable and more susceptible to knockdown than *A. quadrimaculatus* and *A. aztecus*. Blood fed *A. albimanus* and *A. quadrimaculatus* were approximately one-half as irritable as unfed females. DDT and diazinon were the most irritating to *A. albimanus* of eight insecticides tested by Vigueras and Corzo (1960). In further studies with *A. albimanus*, *A. aztecus* and *A. quadrimaculatus*, Hecht et al (1960b) concluded that factors other than differences in luminosity direct the flights of DDT-irritated mosquitoes in their escape from sprayed houses. A critical examination of the literature failed to reveal any convincing proof as to the existance of behavioristic resistance, i.e., cases in which the phenomena of irritability and avoidance are reported to have appeared or to have been intensified only as a result of continued insecticide pressure (Muirhead-Thomson, 1960).

Turning our attention to resistance in culicines, Fox et al (1960) collected *A. aegypti* larvae from natural rock holes in Aguadilla, Puerto Rico and found them to be highly resistant to DDT, dieldrin and lindane. Another strain of this species established from the field at Isla Verda, Puerto Rico, was reported to be resistant to DDT, lindane, dieldrin, malathion, Dipterex, diazinon and Bayer 21/199 in the larval stage and to DDT and dieldrin as adults. Resistance levels of field populations of a malathion-resistant strain of *Culex tarsalis* and a parathion-resistant strain of *Aedes nigromaculis* in California declined from 1958 to 1959 (Lewallen, 1960). In Texas, adult *Culex fatigans*, *C. salinarius* and *Aedes sollicitans* reared from larvae collected from a number of localities along the Gulf Coast exhibited dieldrin-resistance. However, larvae of *C. salinarius* and *A. sollicitans* were highly susceptible to this insecticide as well as to BHC and DDT. *C. fatigans* also showed DDT-resistance (Micks et al, 1960a).

1960 was a year of more intensive investigations on the bio-chemistry of insecticide-resistance, particularly in culicine larvae. Chattoraj and Brown (1960) showed that larvae of three DDT-suspectible strains of *A. aegypti*, when exposed to 1 ppm DDT for 24 hours, contained approximately one-tenth to one-fourth as much DDE as larvae of three DDT-resistant strains. However, in the naturally-tolerant Panang strain, there was little correlation between DDT-resistance and DDE content. Larvae of a strain of *A. aegypti* from Malaya, selected with malathion for eight generations increased in malathion tolerance by five times and increased only slightly in their tolerance of parathion or diazinon (Brown and Abedi, 1960). Their cross-resistance also increased by five times to Sevin and 30 times normal to DDT and DDD. A 40-fold DDT resistance was developed in the F_2 of a strain of *A. aegypti* from Penang, when the larvae were subjected to selection pressure with DDT (Abedi and Brown, 1960a). This resistance rapidly reverted to susceptibility on relaxation of pressure. A third application of selection pressure, however, induced a 200-fold resistance, which was comparatively stable on relaxation of pressure. The resistance was specific to DDT. Abedi and Brown (1960b) discovered that when larvae of DDT-resistant strains were exposed to DDT, they excreted long streamers of peritrophic membrance which contained about 5 gamma DDT and 0.5 gamma DDE per milligram of membrane. Larvae of susceptible strains, even when they survived, excreted less than one-fifth as much membrane, DDT and DDE. It was shown by Weidhaas and Schmidt (1960) that larvae of *A. quadrimaculatus, A. taeniorhynchus* and *A. aegypti* did not excrete DDT except when exposed to concentrations above the minimum LC_{100}. The toxic action of DDT *A. quadrimaculatus* was different from that on *A. aegypti*. Resistance to DDT in a strain of *A. taeniorhynchus* was not related to the uptake or excretion of the insecticide. The exposure of *A. aegypti* larvae to LC_{50} concentrations of DDT for various periods of time resulted in a selective increase in the alanine level of a DDT-resistant strain after 4 to 8 hours contact with the insecticide (Micks et al, 1960b).

In the first investigation of its kind by taking equipment into the field in Greece, Turkey and Italy, Perry (1960) found, in general, that the detoxication potential of DDT-resistant anophelines was a mesaure of the ratio of DDE to absorbed DDT rather than of the ratio of DDT recovered. No definite correlation could be established between the detoxication of DDT and resistance in the anophelines tested.

In one of several studies dealing with mechanisms

of organo-phosphorus resistance in culicine larvae, Matsumura and Brown (1960) found that larvae of the malathion-resistant Fresno strain of *C. tarsalis,* when compared with a normal strain, detoxified malaoxon faster and produced more water-soluble metabolites thereof, the increase being greater in carboxyesterase than in phosphatase activity and the result being a lower internal level of malaoxon after administration of malathion. Following administration of paraoxon to mosquito larvae, chromatographic results indicated differences in detoxification rate between resistant and normal strains (Mengle and Lewallen, 1960). Darrow and Plapp (1960) showed that a colony of *C. tarsalis* 60 times resistant to malathion was also resistant to malaoxon and the diethyl homolog of malathion, although to a lesser degree. Aside from slight resistance to Co-Ral, no resistance was found to any other of a series of 14 organophosphorus insecticides. Larvae of the resistant and susceptible colonies degraded malathion at about the same rate, largely through the formation of carboxylic acid derivatives.

Chemical Control. The development of insecticide-resistance gave impetus to the search for effective insecticides for both mosquito larvae and adults. Studies by Rai and Lewallen (1960a) on the residual toxicity of malathion granules to *C. pipiens quinquefasciatus* larvae in a mud-water complex in the laboratory showed that malathion applied at one and 10 pounds per acre was effective over a 3-day period. Bayer 29493 was found to be the outstanding insecticide tested against 4th instar larvae of *A. nigromaculis* and *C. tarsalis* larvae in irrigated pastures (Lewallen and Gjullin, 1960). Granular formulations were about as effective as sprays against these larvae (Rai and Lewallen, 1960b). Investigations by Miles (1960) showed that preflood applications of granular dieldrin at 0.25 lb/acre and post-flood applications of granular DDT at 1.5 lb/acre gave almost complete control of mosquito larvae in Chinook, Montana. Granular heptachlor and dieldrin emulsion were effective in controlling larvae in log ponds in Douglas Co., Oregon, for 13 and 14 weeks, respectively (Ogden et al, 1960). Preliminary tests at the Taunton, Mass. field station with dieldrin residual larvicide have given promising results for the control of *Culiseta melanura* in swamp habitats which serve as enzootic foci for eastern encephalitis (Hess, 1961).

In work with new formulations of an old larvicide, Rogers and Rathburn (1960) have reported good results with granular Paris green for the control of chlorinated-hydrocarbon resistant saltmarsh mosquito larvae by both ground and air equipment. Likewise, the results of a one-year field testing program in Virginia conducted by Carter et al (1960) proved that 15 per cent Paris green on vermiculite pellets is a valuable asset to mosquito control programs. When breeding areas with third and fourth instar larvae were so treated, living larvae were rarely found on the following day.

In cooperation with the World Health Organization, the Orlando Laboratory of the USDA has stepped-up its program of screening insecticides for use against adult mosquitoes. Laboratory tests with 19 insecticides as residues on plywood panels at 100 mgm/sq. ft. against *A. quadrimaculatus* adults showed Hercules AC 5727 (m-isopropylphenyl methylcarbamate) to be the most effective, giving 100% 24-hour mortality after 15-minute exposure on panels aged for 24 weeks (LaBrecque et al, 1960). Malathion usually gave 100% kills after 30-minute exposure, and DDT, after 30 to 60-minute exposure. Malathion fogs dispersed by airplane over residential areas in Florida were highly effective in killing caged *A. taeniorhynchus* (Davis et al, 1960). Dosages of silica aerogel (Dri-Die) as low as 50 mg./sq. ft. produced high mortalities in adult female *A. quadrimaculatus, C. fatigans* and susceptible and DDT-resistant *A. aegypti* exposed to treated filter paper for one hour (Micks, 1960).

A noteworthy development in malaria control was the development of gamma-BHC/Cereclor, a new long-acting lindane formulation. Field trials by Hocking and others (1960) showed that this formulation, a gamma BHC-resin combination, retained its efficacy for at least six months even on surfaces of low sorptive power. The opinion was expressed that this approximates the ideal insecticide for spraying native huts in malaria control. Facing a somewhat more difficult problem of vector control, the failure of different insecticides to produce significant reductions in filariasis in Fiji has led Burnett (1960) to the suggestion that mass drug administration may be the most promising line of attack. The fact that there are several vectors and fairly low infection rates have provided some basis for this approach.

Important advances in adult mosquito control with DDVP as a residual fumigant have been made by the Technical Development Laboratories of the CDC in Savannah, Georgia. A solid type of formulation of DDVP has been developed which, when placed in huts of approximately 1000 cubic feet, was able to provide satisfactory kills of *A. quadrimaculatus* adults for periods of 12 to 16 weeks. A mechanical vapor dispensing system for aircraft disinsection was evaluated in a DC-7 aircraft. Thirty-minute treatment of the aircraft passenger compartment with full ventilation produced kills which would be effective against *A. aegypti* and *A. quadrimaculatus* at vapor concentrations of 0.15 and 0.25 microgram of DDVP per liter of air.

Biological Control. Aside from the control of mosquitoes with chemicals, biological control has been helpful in some areas. In Kano, Nigeria, the introduction of *Tilapia* fish into borrow pits by Service (1960) was of value in bringing about a larval reduction even when *Pistia,* a weed, overgrew the pits. Ehrlich and Spielberg (1960) observed that a nutria population was able to keep the Naaman river course and adjacent ponds in the Acre District of Israel clear of vegetation for three years. This decreased substantially the amount of insecticide needed, increased spraying effectiveness and no new breeding sites for mosquito larvae were created. This area had presented a serious problem in malaria control.

At the last annual meeting of this Association, Laird (1960) discussed microbiology and mosquito control. Since his mention of a World Health Organization pilot project in biological control of *Aedes polynesiensis* in the Tokelau Islands in the South Pacific, using the fungal parasite *Coelomomyces stegomyiae,* several

other parasites of mosquito larvae have come into view. Rioux and Pech (1960) collected 33 larvae of *A. gambiae* parasitized with *Coelomomyces grassei*, a new species, in the North Chad area of French Equatorial Africa. They noted that the larvae were always intensely parasitized throughout their length. More recently, Lum (1960) has described the infection of *Psorophora howardii* with *Coelomomyces psorophorae*. Kellen and Lipa (1960) have noted the presence of a microsporidian parasite, *Thelohania californica* in *C. tarsalis* larvae in which they invaded the adipose tissue and were highly pathogenic. Less than 2% of the infected larvae reached adulthood in the laboratory. These larvae were collected in two California counties. The presence of a parasite of this same genus but unidentified as to species was found by Welch (1960a) in larval populations of *Aedes communis* in forest pools in Churchill, Manitoba. This microsporidian likewise killed the host by infecting the fat body, preventing pupation. It was responsible for a reduction of from 3-11% in the larval population. Welch (1960b) noted further that approximately ten per cent of the larvae were killed by a parasitic nematode, *Hydromermis churchillensis* n. sp. Mortality was as high as eighty per cent in individual pools. The commercial microbial insecticide, Thurcide, incorporating *Bacillus thuringiensis* Berliner, was found to be unsuitable for the economic control of *A. nigromaculis, C. tarsalis* and *C. pipiens quinquefasciatus* (Kellen and Lewallen, 1960).

The Orlando laboratory, USDA, initiated an interesting project concerned with the control of adult mosquitoes by other than chemical means. Pupae of laboratory-reared *Anopheles quadrimaculatus* were exposed to 12,000 r of gamma radiation in a cobalt-60 chamber. Males from these were released on islands in the Lake Okeechobee area at the rate of 2,000 to 4,000 per square mile per week. These islands are naturally populated by *A. quadrimaculatus*. Following indications that initital releases were helpful in reducing the population of this species during the winter months, a build-up occurred during the following spring and summer. Efforts are being made to determine the causes of the more recent failures and further studies are in progress. (Weidhaas *et al*, in ms.).

Sand Flies

During 1960, blood-sucking flies of the genus *Culicoides* and to a greater extent *Simulium* also were studied from the point of view of ecology and control. Jones (1960) worked out mass production methods for the colonization of *Culicoides variipennis sonorensis*. Observations were made on the breeding habits of *Culicoides* species in the Panama Canal Zone (Breeland, 1960). Through extensive soil sampling, Rogers (1960) showed significant *Culicoides* production to be limited to the narrow peripheral areas of Florida salt marshes which are filled or impounded for mosquito control. Studies of the flight range of *Culicoides impunctatus* in Scotland by Kettle (1960) showed that control areas needed to be extended from a 200-yard radius around dwellings to ¾ of a mile or more, thus tending to require community control in place of individual premise control. Wall (1960) demonstrated that 0.1 lb. of dieldrin per acre was completely effective in controlling *Culicoides melleus* in small intertidal plots at Cape Cod, Massachusetts. DDT emulsion at 1.0 lb./acre gave the best larval control in small plots in salt marsh.

Black Flies

In studies of *Simulium*, Fredeen and Shemanchuk (1960) found the immature stages of nine species in 79% of 341 collections from 69 irrigation canals and 18 adjacent rivers and streams in irrigated areas of southern Saskatchewan and Alberta in the years 1950 to 1958. Laboratory experiments showed that all instars of larvae of *Simulium vittatum* and S. *venustum* could obtain adequate nutriment from particles as small as *Bacillus subtilis* (Fredeen, 1960). This finding suggested that sewage bacteria entering a river may serve as food for black fly larvae. Two species of *Simulium* larvae were found attached to the larvae of dragonflies in streams near Salisbury, Southern Rhodesia and Lokoja, Nigeria, Lewis (1960). In studies of adult *Simulium*, Lewis (1960) made some interesting observations of ovarian changes in relation to age and biting habits of S. *damnosum* in the Southern Cameroons and Liberia. That some species of *Simulium* (and ceratopogonids) show marked host and habit preferences has been reported by Bennett (1960). Wolfe and Peterson (1960), studying black fly populations in the region of Baie Comeau, Quebec from 1954 to 1956 observed that the flies were most active approximately one hour before dawn and sunset. Essentially no black fly adults emerged from streams within an area sprayed with DDT at ¼ mile intervals in 1956 until the middle of July (West et al, 1960). In contrast, emergence of adults in numbers began in unsprayed areas about June 10. An 11% solution of DDT in oil applied at 0.22 lbs. of DDT per acre to an area of 10 square miles by Stearman planes reduced the number of black flies for a period of more than 10 days (Peterson and West, 1960). Studies of the natural enemies of black flies by Peterson and Davies (1960) in Ontario and by Peterson in Utah (1960) revealed certain larval Trichoptera to be the most important predators of simuliid larvae while dance flies were most frequently involved in predation of the adults.

Simulium columbaczense a black fly which breeds in the Danube, was found as deep as 10 meters below the water surface in the larval and pupal stages and the larvae were also found at 26 meters (Lazarevitch and Zivkovich, 1960). Although laboratory investigations by these workers revealed no toxic substances in the head and thorax of female black flies, a single protease could be extracted. This protease, when inoculated into the mucous membrane of the bitten animal caused an infiltrated oedema which led to suffocation or uremia of the host. Death of cattle was also noted to be due to aspiration of these flies blocking respiratory tracts and causing asphyxia.

It is obvious from this review that 1960 has been marked by many significant research developments which have led, directly or indirectly, to a much better understanding of the ecology and control of mosquitoes and related insects. At the same time, it is apparent that many new problems have arisen for which the solutions will require more than ever before, our combined global efforts. Certainly 1961 promises to be an even more exciting and fruitful period.

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TRUSTEES CONCURRENT SESSION

THURSDAY, FEBRUARY 2, 1961

CHARLES F. SCHEEL, *Presiding*

Gentlemen:

As you undoubtedly know this session has been especially arranged for the purpose of providing a means of presenting and discussing matters of mutual interest to trustees and commissioners of control areas.

The Association has for some time been aware of a desire on the part of administrators for such an opportunity at the national convention level and inaugurated this plan at the Boston meeting.

It is hoped that meetings such as this may become progressively more profitable as a medium of exchanging viewpoints and experiences in the handling of various administrative functions. Conceivably something may be said or developed in these discussions which could lead to a chain of correspondence among participants.

The subject matter of today's session has been solicited from four gentlemen who have offered to make various presentations at this time and is by no means indicative of the scope of future programming. Undoubtedly broader interest in such sessions will indicate a desire for different approaches and more diversified material.

In this connection it is requested that you register your name, title and address on the sheet being circulated so that you may be contacted later on for your views relating to procedure and subject material.

The speaker for our opening presentation will be Christian Vieser. He is the first President of the Texas Mosquito Control Association which was formerly the Gulf Coast Mosquito Control Association and has been a member of the Jefferson County Mosquito Control Advisory Commission since 1955.

Gentlemen, permit me to present Mr. Vieser who will introduce and lead a discussion on the subject of "Organization of New Districts in New Territory," covering the need for necessary legislation, tax revenue and basic organizational training.

ORGANIZATION OF NEW DISTRICTS IN NEW TERRITORY

CHRISTIAN A. VIESER, *Advisory Commission, Jefferson County Mosquito Control District, Nederland, Texas*

Mr. Scheel and fellow commissioners: After having an opportunity to hear your names and the places that you come from, I realize that many of you have been in this business a great deal longer time than I have; and when Mr. Scheel says that whatever we talk about here today is not intended to cover all of what we know about mosquito control but is just a beginning of it, certainly most of you have a broader knowledge of management and organization in mosquito control as I see it throughout the country at the AMCA meetings. It behooves me to limit myself to say a few words on the organization of new districts in new territories.

We must assume, first, that we are salesmen and that we are going out and sell a county, and possibly a state, on the fact that mosquito control is a realistic thing and that the public can gain from it. We have to deal with the public—they are really our bosses, they provide the tax money, and—I don't like to say this but—some of the biggest sceptics we have, are right in the public and they have to be sold. They have to be afforded good public relations and they have to be given the opportunity to understand what mosquito control is and that after you establish mosquito control, you still don't have a 100% sure thing, and that is, you are not going to get rid of all the mosquitoes at one time. You can control them, you can abate them to a certain extent, and you can make life more enjoyable.

In going out and trying to develop new territories, new places, regardless of where they are, you have to establish a need, even though the mosquitoes are obvious and are biting everyone. You have to let people know that there is a need for mosquito control. You have to let people know that by means of a control program, you can greatly alleviate the mosquito incidence. You have to let them know that outdoor jobs or that people on the outside can do much better work if you have a control program.

With the proper control or abatement program medical expense declines. You cut down the expense as a result of less encephalitis and malaria. People who work out in the open are subject to bites from disease carrying mosquitoes and are a cost burden to industry or employer through hospitalization and medical care, as well as having to replace a person on sick leave. A mosquito control porgram will, in a measure, help reduce those expenses incidental to malaria, encephalitis and related mosquito-borne sicknesses.

You must also realize that in this country we are doing an increasing amount of outdoor living, in fact our homes today are built a little bit differently than they were twenty years ago, they all have an area or zone for outside recreation. If you and your wife, your friends and your kids want to enjoy the outdoors more, you have to sell the people on the knowledge that a good control program will give them more days of outdoor living, free from mosquito incidence.

Another point that you need to sell to people owning a great deal of land is that it will increase their property values. When you go out and promote reclamation, drainage and modifications to recover the land, especially marshy or mosquito breeding lands, you get more for a piece of property, land which may have been worth only $250 per acre may then bring $1,000 on acre. Sometimes people don't like the idea of more taxes, but you have to show them that it is

profit to them, when they sell that improved property for whatever purpose, you increase the tax returns, therefore the revenue for the county increases and is good for you because you are able to get more tax money for control work.

Another thing that mosquito control will bring is improved sanitation in the rural sections. So many times—and I know you have experienced this—when a city is growing it reaches out and grabs the rural areas and brings them in; and the people say, "You charge us taxes, but you don't provide us sanitation." That is something that has to be worked out. Certainly, it is necessary to provide good sanitary conditions for a community, because if you are going to have a good control program, then sanitation is one of the things that must accompany it.

Everyone benefits from mosquito control. There are many intangible benefits, which we cannot discuss today, which could be used to show the public how they could benefit from a mosquito control program.

Then, once you have the public sold and interested, you have to have people to work with. You have to get some people interesetd enough to want to organize. You either have a State that already has mosquito control laws, or you do not. Assuming that the State has no existing laws for such control work, you can always find that working through organization, within your city there is always a way to afford temporary financing.

In Port Arthur, Texas, in 1950, under the direction of Dr. Paul R. Meyer, M.D., when he was Chairman of the Health Section of the Port Arthur Chamber of Commerce, Dr. Meyer headed a drive to raise funds, to try out mosquito control on a temporary basis and thereby let people know that it would work. They couldn't take that money from taxes, there was no place in the tax structure that mosquito control money could come from, so it was raised by solicitation. This shows that temporary financing is important, and if people really look around, they can find it. You can always go to the City or County Attorneys and get all of the free legal advice necessary to promote a control program.

Then you must select leaders, leaders that are pushers, leaders that are important, people that are really willing to do something. You can always find someone that is ready to vote your way, but they will not help you carry it out. You not only have to have people that are ready to help you institute a program, but stay with it until it works. You can solicit the aid of many organizations, civic, service clubs, women's clubs, P.T.A.'s; that are interested and will give you moral support as well as a big boost if you have to go to a State Legislature for an act to establish a control program.

Then you have to have some type of permissive legislation. In the State of Texas we have enabling or permissive legislation. In the State of California and New Jersey, their mosquito control laws are old, they are quite extensive, and they even spell out in detail the functions of the Districts. Ours are very general, so therefore it takes the management of the commissioners, in this case whether you are a trustee or a member of an advisory board, it takes your ingenuity, and your intelligence, and your business ability to help organize and manage a mosquito control district.

Now, as to the type of laws, there are, generally speaking—I wanted to get a little more information on this question of the different types of organizations that exist in this country, when I arrived at this Conference. I didn't know it, but the AMCA has just finished publishing Bulletin No. 4, "Organization For Mosquito Control." It is the result of three years of research by people who have taken laws of every state, have analyzed them, have set them down, and it would be of great value to you to get a copy of this booklet. If you know of some place that wants to organize a district for mosquito control, refer them to the American Mosquito Control Association for Bulletin No. 4. I have found that after reading this publication, my own information and thoughts on this subject were not too far off. Generally, the things that I thought about mosquito control, and had experienced, are expressed here because you will find similarity of conditions throughout the country.

To return—when you start to organize, the most important thing is your legislation. You want legislation that will permit the control work to be handled locally. You want—although you usually have to take what the legislature passes—but you usually want legislation that leaves the authority of tax levying, the managemen and organization at the level of the local district. A very few cities, as a city, have an abatement district. Usually, districts are county districts and are working in conjunction with state organizations. It is highly recommended that any kind of legislation that is passed favors the local government, that it be in the hands of the local people. You can get more cooperation this way. The philosophy, today, is that the State interferes too much with the local people, the Federal Government likewise. So, to go along with this, you are better off to have control laws that are administered by the people in each locality or district.

Then there is the question of financing. The financing has much to do with the program. You should have financing that will provide for a continuing program. You have to make estimates of cost. There is always enough people available in the health departments of the state, and in other agencies, who are capable of making such estimates to set up a program and forecast the cost of it. To illustrate a point, in the State of Texas, we have five cents per hundred dollar valuation. In Jefferson County, we have high valuation because it has so much industry and it produces for us at the rate of five cents per hundred dollar valuation, about $176,000 per year. That included 4% for delinquent taxes as well as about $8,000 that the county takes for administration, collecting the taxes, making up the payroll and so forth. Your financing must have a range so that the county which does not have high valuation can get sufficient money to be able to operate; yet, the larger counties with a high valuation do not need such a high tax rate. A rate should always be flexible, so as to provide sufficient money to carry on an adequate program.

There are other topics to be discussed in this program here. The tax money and mosquito control in the urban sprawl is coming up and if we talk too much

on organizing mosquito control in new territory we would be getting into some of the other topics. But I believe that you, as individuals who are part of the governing body should take time to see your neighboring counties and states to help sell them on mosquito control, because the more control there is around you, the more beneficial it will be to you.

We in Texas have mosquito control only in the counties that border the Gulf of Mexico. There are seventeen counties in that stretch, five of which have voted to organize mosquito work, but four of those are actually in operation. Now, we have 254 counties in the State, you can see that the majority of the counties couldn't have mosquito control if they wanted to. The only place they could get money for operations would be as part of a sanitation district or part of a health district. When you do this, you are just an orphan, just a step-child, and the mosquito control district will not operate properly. We, at the present time, are hoping that the mosquito control laws can be amended to read so that any county in the State of Texas can have a mosquito control district that is in need of it. We are trying to raise the tax rate limitation from five cents per $100 valuation to 25 cents per hundred dollar maximum. This will help the small and large counties, and if we do that, we will have the basis and beginning of some real control work in Texas.

I believe I have reached the point where I have said all I can without repeating myself. Thank you.

Mr. Scheel: Chris, I think that is a very comprehensive coverage and I would like to turn this meeting over now to a general and informal discussion. Are there any questions you would like to ask Mr. Vieser? If he doesn't have the answers, he can get them.

Question: Would you repeat the name of the bulletin?

Mr. Vieser: Yes, this Bulletin is called "Organization in Mosquito Control." It has just been published by the American Mosquito Control Association as Bulletin No. 4. It has tables in here that show the different types of laws and amounts of money expended in each State. It shows the Districts for each State and gives a history of mosquito control, the types of control that exist throughout the different States, in many instances explaining the types of laws and control set up in detail. It costs two dollars and Ted Raley will be glad to sell them to you. It is coincidental that it just happened to be published at this time, and it is a very good thing because it treats all of these topics that we have just been talking about. There are copies available and you can get them at the desk.

Question: I know you do things big in Texas, and you mention a five cent tax rate. I just wonder how that compares with other areas? It sounds awfully high, particularly in industrial territory.

Mr. Vieser: I have a table here in the Bulletin that says:

Arkansas: 70¢/$100 valuation
California: 15-40¢/100
Florida: 15¢-$1.00
Idaho: 50¢
Illinois: 2½-25¢
Louisiana: 50¢
Minnesota: 20-50¢ (per capita)
Montana: 50¢
Nebraska: 50¢
Nevada: 20¢
North Carolina: 35¢
Ohio: 50¢
Oregon: 15¢ and 40¢
Pennsylvania: 2½¢
Texas: 5¢
Utah: 10¢
Virginia: 25-35¢
Washington: 40¢

Those are the ones that have legal limitations on tax rates for each $100.00 assessed valuation that may be used for mosquito control in the states mentioned.

Mr. McFeely: That list of figures means very little to anybody because it depends on the way they value the property. So it is not significant and gives us no information at all about that. It probably all works out about the same. The valuations are all different.

Mr. Scheel: Gentlemen, before you speak would you kindly identify yourselves, for the matter of recording.

Harold Gray: I have something to say as editor of that bulletin. It was designed for just you people to give you a fairly specific idea of not only what was being done, but what can be done. I would like to ask the speaker: Why don't you get something in your State Enabling Act so that you can combine a lot of those microscopic little counties that you have. For a big State like Texas, why do you have so many little counties? Many of the counties in this State are a thousand square miles.

Mr. Vieser: I am sorry, frankly. They are small, but they are independent. I will assure you of that, to try to consolidate them would mean you had a real fight on your hands.

Mr. Rees of Ballona Creek MAD: Unless I misunderstood your figures there you said Texas had a rate of 5¢/$100 valuation. And what was it for California? That it started at 15¢ to 40¢?

That is a great error, because we operate one of the lowest tax rate operations on earth. It has been ½ of 1% up to 1% per hundred dollar valuation.

Mr. Vieser: I see. We will have to say then that the book stands to be corrected. Thank you very much.

Phil Butcher: Maybe I can explain some of that in Texas. I am from Orange County, Texas, and we get to five cents. But say they value the land at $60,000,000, they take 15% of that and give us 5% of the fifteen. So we get about $30,000 per year in Orange County, Texas for mosquito control.

Mr. Vieser: Yes. So it depends upon how the valuation is made in the county. These are just the tax rates (actually, maximum permissible tax rates) which I was reading to you.

Question: In regard to Orange County, what is the population of Orange County so that we can cut that income from assessed valuation down to a per capita ratio? We have 50¢ per capita.

Mr. Butcher: We have 49,000 population in Orange County, Texas.

Mr. Vieser: That would be about $30,000 for 49,000 people. So there you have your ratio.

Mr. Smith, Delta MAD: The California law, as I understand it, is fifteen cents legally that the Board can levy. Then in an epidemic or something, if you need more, you ask the Board of Supervisors and they give permission; or you can put it to a vote in your district for a higher tax rate than 15¢, up to 40¢.

Question: Do you have a maximum?

Harold Gray: Yes. That is the point Charlie Smith was talking about. Fifteen cents and forty cents on approval. The figures given in the Bulletin are the *Maximum Permissive Tax Rates.* But you don't always use them.

Fresno-Westside District: Did I understand the gentleman there to say that we had to vote on this 15¢ tax rate?

Mr. Smith: Fifteen cents is the regular maximum rate that the District Board can levy, or anything under that; but if you want more, then you have to go to the Board of Supervisors and they can allow you that. Or if they won't grant the rate, you have the recourse of putting it on the ballot for the people to vote on.

Fresno-Westside: We operate on a 30¢ rate of assessed valuation. We are a new District. We started two years ago and were one of these more or less poverty districts. We have 1325 square miles of fairly rich territory, but our assessed valuation is very low. We don't have any metropolitan areas in our District and we had to borrow money to start. We borrowed from the Bank of America and we got help all the way through from the Board of Supervisors.

Mr. Vieser: Thank you very much. I hope we answered the gentleman's question.

Mr. Steiner, Orange County: I would like to have clarification on this California situation. I am not 100% sure if I remember the figures or not, but although the tax rate limit that may be set by the District is 15¢, the State has a subvention fund in the amount of $400,000— Oh, I understand that has been cut out. Anyway, in Orange County our rate is .008/$100 valuation. And I understand that the Tax Assessor here in Orange County takes 25% of the actual value of the real estate for assessment purposes which I understand is very high. I think we have the lowest rate right here in Orange County.

Speaker: I think a better way to approach this subject would be to give the square miles in your district, and how much money you get. Now we are all speaking a different language. It means nothing—so much on a dollar or anything—it all depends on the levy on valuation of property. Why should we in Illinois learn about how taxes are levied in California? If he would say, "We have 76 square miles and we get so much money, $150,000." I think you would have it clarified if you would do that.

Mr. Scheel: Harold Gray, does this Bulletin indicate on what premise these figures were set?

Mr. Gray: We did not try to confound and confuse you by going into such variations. If you can get hold of an old copy of Herms and Gray's "Mosquito Control," there is a little broader discussion of the tax base. But I think you would have three basic figures: (1) the cost per square mile, (2) the cost per capita, and (3) the cost per hundred dollars assessed valuation. But all of those again come back to the proposition—how much is the assessed valuation, and what is the real valuation.

In some states they have a means of state equalization of assessments by local county or city assessors. In California, our State Board of Equalization is supposed to bring all counties up to approximately 40% of the real valuation. Actually, I don't think very many are as high as even 35%, and some of them have been down even as low as 10%, even though the Board is still trying to equalize it. Thus, you have to try to figure out some unit of measure, and I think that the best thing that you can do is to take those three figures of area, population and assessed valuation and try to figure out where you are from that.

Mr. Scheel: Thank you, Harold. I think we have explored this matter of levy pretty extensively. I would like to suggest that we get into another phase of this organizational set-up if you would like to pose any questions on it with Mr. Vieser, here.

Mr. Vieser: Suppose now we change to the best type of organization. I, myself, would say that I think we have the best type of local organization—and you think you have the best type. Suppose someone starts it off on what he thinks is a good type. What would you want to say is the best type of local organization?

Roy Holmes, Eastside MAD: In order to get a district started, the first thing you have to do is take them out and have them help you irrigate some night. After they have been out there all night, along towards morning they will get their necks so doggone sore, and they'll be so doggone tired of figthing mosquitoes that they will want to know how they can get some control. The way we did, was to take them down into the Turlock District where they had plenty of them—we had so few in comparison that they might have thought we didn't need control—and also took them up into San Joaquin County, and then we didn't have any trouble at all in organizing a district.

But we didn't have any trouble in financing—everybody is talking about financing—but that will come about naturally as soon as they find out they can get mosquito control; then it will come about some way or other. If they find they want it after a bit of discussion, they are going to get it.

When I started in on this District, quite by accident—not that I knew anything about mosquito control, for I didn't—I knew that we had mosquitoes and plenty of them. I couldn't keep men in my orchard to pick peaches because the mosquitoes were so thick. Many of my neighbors had orchards and they had the same problems I had, so I went to Chet Robinson who was our manager in the neighboring District (we weren't annexed as yet), and asked him how it could be done. We had to go before the Board of Supervisors, and the Supervisors told us to bring in our neighbors and see if they wanted it. We brought them in and we had only one dissenting vote. And three days later I got a notice saying that I was ordered to serve on the Board of Directors or Trustees. That's how I got started.

Mr. Vieser: Thank you. Is there anyone else who would like to talk about the best type of organization?

You have a question?

Mr. Bobbe, South Cook County, Ill.: The question that comes to my mind is how do you get mosquito abatement districts organized in neighboring states where they don't have a statute providing for such?

Mr. Vieser: I believe that is a real tough job. You have to go over there and talk to the leaders in the other part of that state and get them interested, preferably in those areas where the mosquito incidence is the worst. If you get people in those particular regions or territories interested enough so that they work toward enabling legislation, it will help. Get to the type of individual who will not only talk about it, but will help get the laws put through and help you work with them later on. Not just the type of person who gets on the band-wagon and then when the work comes around they turn about and walk away from it.

Mr. Bobbe: We have a problem in trying to do a job. We have waterways that extend between our district and the State of Indiana, and it is just impossible to do a complete job on the eastern perimeter of our district.

Mr. Vieser: We have similar problems in our district, because the counties to the north of us don't have mosquito control and their mosquitoes come over to us too.

Mr. Bobbe: I might add a word about what we think of our district along the line of your previous question. We have one paragraph that we have had in existence since our district began its operations. I happen to have been a member of the original board, and it took us a good many nights to figure out the phrasing of this one particular sentence. We are still abiding by that ruling. The policy of our district is to effectively and economically abate the mosquito nuisance, using modern scientific and practical methods of control applied in an orderly and systematic manner, giving due considerations to the rights of property owners, residents and political subdivisions in the district. I thing that that one sentence describes our whole operation.

However, there is one thing that I would like to say about that paragraph: we split an infinitive.

Mr. Vieser: Thank you. Is there any other phase that you would like to discuss? Of course, you are going to have other speakers, and you will have questions that you want to ask them, but is there anything else you would like to discuss along the line of organization of new districts, what is the best type of organization, any suggestions.

Harold Gray: Might I indicate that I don't believe that there is any best kind of organization, because there are so many variations in the type of structure in state government which will pass your enabling acts. There are different political philosophies and different types of people who think in certain ways that may influence the conditions. I will simply say that the best type of District is one which minimizes purely political considerations. Secondly, the best kind of district is the one that works.

Mr. Vieser: I believe that brings this part of the discussion to a close, and I want to thank you, gentlemen, for this opportunity to come before you.

Mr. Scheel: Chris, that was very ably covered, and we certainly had a healthy response to the subject. If there are any further questions to be asked, either of him or any of those who have spoken, please get in touch with them. You have their addresses, and you know how to reach them.

Our next leader is Dick Girkins, who is Secretary-Treasurer of the Toledo Area Sanitary District, and has been in that capacity for six years. He is Secretary-Treasurer of the Girkins Electric Company and a member of the Airport Advisory Commission in the City of Toledo. Also, he was a former Air Force combat intelligence officer for the U.S. Air Force, so be careful how you confront him when he completes his presentation.

I would like to present Dick Girkins who will lead the discussion on the subject of Public Relations.

Mr. Girkin: I have just a short talk this morning, this bulk of papers is merely to help answer any questions you may ask.

I might say that I certainly appreciate this opportunity this morning to appear before this group of trustees, or commissioners, or directors, or whatever name you may be known by. I invariably become a little nervous in addressing a group such as this, and I am always reminded of the advice that Mark Twain once gave to a very frightened speaker. He said it may help if you keep one thing in mind. Just remember, they don't expect much.

I want to preface my remarks this morning with a little on our own district. Our district was organized in 1947 by an initiative petition. We are the only district in the State of Ohio. In fact, we are the only district within a hundred and seventy miles of us. For you people who are bothered with foreign mosquitoes, we have foreign mosquitoes, too.

Our district was organized with a director appointed by the Judge of the Common Pleas Court. The Director is a direct appointee, a non-political appointee, and has sole jurisdiction, sole responsibility for the activities of the district. He is responsible to no one except the Judge of the Common Pleas Court. There is no Board that has any authority; he is the sole authority. He is on a fixed salary. He is allowed to appoint an assistant director and a secretary and a treasurer, also on a small salary.

We have an Advisory Board, which we have maintained ourselves and formulated ourselves, composed of interested city citizens, and we are used strictly as advisors, in the advisory capacity on specific problems. We also have a member of a legal firm on the board, a member of the City Council, a member of the County Commissioners, a member of an engineering firm. We use these people as we see fit. We have no regular advisory meetings. But I want you to bear in mind that the entire responsibility for activities rests in the hands of one man. It is a continuing appointment as long as the job is satisfactory. There is no political influence or patronage problems. We can hire and fire as we please, for we are not under civil service. The majority of the district personnel have been with us since the inception of the district, which makes for a very desirable situation in regard to control and experience.

Incidentally, we have a tax rate that goes all over the map. Our tax assessment is based on the amount of benefit to be gained in the control area. Thus the fringe areas around the outskirts of our district pay a lesser tax rate than the persons in the center of the district in the residential area. The industrial or down-

town area pays a minimum tax rate, since it is all rated on the benefits to be derived from the control program. I would hate to get started on a discussion of tax rates such as we have. Suffice to say, we have 152 square miles and we had a tax income last year of $242,000. We are not a poor district; I will say that. We have sufficient operating funds to adequately do our job. We also have sufficient funds to set some money aside, which we have been doing over a period of years for the large capital expenditures going into permanent control measures.

When Charlie suggested the subject for this little discussion, I was just a bit lost to know what to bring you in the way of information that could possibly be of value to you, and that could possible provoke a little discussion. Public Relations. Let us stop and think a minute. What does it mean to a group whose primary aim, so to speak, is the obliteration of the pesky little thing like a mosquito. In consulting Webster's dictionary, we find his definition of public relations as follows: "the activities of a corporation, union, government or other organization building and maintaining sound and productive relations with special publics, such as employees, customers and stockholders, and with the public at large, so as to adapt itself to its environment and to interpret itself to society."

As you can see from this definition, we really have two areas from which to discuss this problem. We have the actual relations with the public, or the taxpayer, or the stockholder as you might call it, and (2) we have the employee relations. Let us talk about them in that order.

We very readily admit that without taxpayers there could not be mosquito control or abatement districts; therefore, we must first of all satisfy them that the work we are doing is important enough to justify their continued financial support. Let us look at a few of the methods that we can use to acquaint them with our problems and aims. Number one, of course, is newspapers. A continuing newspaper public relations program is good, especially in reference to specific projects that you might be undertaking. In our case, where we have an isolated district and can have mosquitoes from as far as 170 miles away where there is no control and coming in on us unexpectedly, we can warn the public of severe problems such as may result from flooding. If we can warn the public of it, that they are going to have problems and why they are going to have problems, we are going to be on much better terms with our taxpayers. It is good to explain why such things are going to occur and why we are going to have a little influx of mosquitoes once in a while.

Along that line, we have been very successful in recruiting a specific reporter—we happen to be a town of one newspaper—and have given him specific background on the whole problem, and then do all of our newspaper publicity through him. That way you will get no half-baked comments and uninformed comments on various problems that may occur. We have found that that is a very satisfactory arrangement. Of course, we also have radio and TV spot announcements when they are practical, keeping in mind that your radio and TV stations have to allow so much special service time, free time, within a scheduled period. We also use, to a great advantage, civic groups, churches, schools, by the use of speakers and films to educate the public in what they can do to help control mosquitoes.

We have been successful in a few other methods. One of them is the inclusion of small pamphlets, brochures, in with the utility bill—the phone bill, the light bill. We don't do this regularly, but we do it at various times such as early spring when there may be such problems, trying to acquaint the public with what their problems are as well as what our problems are.

It is not enough that we use the methods that I have just outlined to acquaint our public with our problems, we must use them with direction. It must be on a planned basis with all of the picture being given with any of the media suggested. How many times have you seen a newspaper story, for instance, that appears and gives the reading public a completely different story from that which is actually the true picture? Again I reiterate the importance, if possible, of taking a reporter from your local paper or papers into your confidence, even having him attend some of your board meetings. I know a lot of you will throw up your hands at allowing newspaper reporters into board meetings if possible, but there is a time when that thing is very valuable.

Films for presentation to various groups have been a great help to us in putting our message across to the public. There are many excellent films available on mosquito control; but our most satisfactory method has been the use of a film which we produced in our own district of conditions in our own district. We produced it in color and we are using it continually, particularly in the schools. We have a fine program of education in the schools. It is surprising what the kids can do in cleaning up the little trouble spots in the backyard—the old tires, the open cans, and so forth. It is a good idea to get them educated to the problems of control early. By making your own film, it can more accurately picture the specific problems in your own area rather than a film made for nation-wide release. I sincerely recommend that any of you who have facilities should explore this method of dissemination of information on mosquito control. Use it, because as someone once said, one picture can be worth a thousand words.

Now let us explore the employee relations, the employee part of public relations. When I started thinking about this thing, I found that possibly your employees are your best source of public relations. It seems to me, first and foremost, that the people who work with us must be sold on mosquito control. They must be people who are convinced that our problem is of importance to society and that their part in this program is vital to the success of the whole picture. As Harold Gray said in his excellent address Tuesday morning, "we must get back to the era where men and women take pride in their work." This may seem a little idealistic in this day and age. It is up to you men in your individual areas to instill in your employees some semblance of this pride in workmanship.

Another area in which we must work with our personnel is in the area of salary. I feel that it is important to your employees that they know pretty well where they are going in the matter of income. Some sort of established salary schedule should be set up by your district which will enable our employees to have a fair idea of what they are working for, or toward, money-

wise. This still seems to be a power over most of us—what will be the final or future results of my labor today?

The third area in which we must give consideration is a close liaison between so called management and labor. This calls for some sort of group organization which will enable your employees to feel that should problems arise, they have a root that allows them to communicate their problem to the so-called management. I am not advocating unionism in mosquito control work. I am merely saying that an employees association of some nature be allowed to function. This gives the employees a feeling that they are part of the team and that you are willing to discuss problems with them. We ran into this problem in our own district several years ago when the public employees union attempted to organize our employees. We gave them pros and cons, we met with them, and we subtly suggested that they might want an organization of their own, rather than the employees union. In their own meeting they decided that they would not join the union, after much pressure by the union, but would form their own employees association. With small monthly dues, their own officers that they could control, they could thus control their own activities. That has thrown out the union attempt and has worked out very satisfactorily for us in bringing out the little problems before us before they grow into big problems. If you can solve these little employee relations problems at an early stage, you will find that you have a much better working organization.

Another area in which I think it is important to have the kind of employees you would want to have in front of the public as your representatives concerns the matter of education of the employees. George Hutton, a former superintendent of ours years ago, started an educational program of ours within our own district, at which time he instituted a yearly educational meeting of two days during the winter when the boys weren't too busy. At these meetings we brought in people from the State Health Department, the Highway Patrol, first aid people, all to provide a general employee educational program that will bring them up to date on our feelings on mosquito control. In that way they come to feel we are interested in them and they become interested in us.

Lastly, let me suggest the proper maintenance of your physical equipment—your land, jeeps, buildings, trucks, heavy equipment and so forth—can go a long way toward giving your employees, and incidentally you yourselves, a just feeling of pride in your district. After all, if a person is proud of his job and his place of business, you generally feel that it will show up favorably in his work. In a recent article in a leading business weekly, I came across the following remark: "A corporation may spread itself over the whole world and may employ a hundred thousand men, but the average person will usually form his judgment of it through his contact with one individual." If this person is rude or inefficient it will take a lot of kindness and efficiency to overcome the bad impression. Every member of an organization who in any capacity comes into contact with the public is a salesman. The impression he or she makes is an advertisement, good or bad.

In closing, let me say that it is important to tell our story by the usual methods to our paying public, but let me re-emphasize to all of us the good public relations to be gained by an employee group which is proud of its organization and the work that is being done. Thank you.

Mr. Scheel: Thank you, Dick. I think you touched upon a very sensitive aspect of our responsibilities, and I am sure that there are many comments that could be offered upon this, or questions that should be raised.

Speaker from the floor: Mr. Chairman, I think this is the best part of the meeting—of all the sessions.

Sandy Steiner, Orange County MAD: Could I ask how much area does your district cover in the State of Ohio?

Mr. Girkin: It is 152 square miles, which, of course, is just a little bit of the State of Ohio, only a pinpoint. No, there is no other mosquito abatement district in the State, there is none in Michigan except at Lansing, which is 180 miles north of us. There is a small local operation at Monroe, Michigan, which is strictly a small municipal operation with fogging. The closest control to the west is the Chicago area and there is none closer, so we are in an isolated area.

David Raider: Approximately how many employees have you?

Mr. Girkin: We have seventeen full time employees, during the summer we will run up to 54-60, including the temporary employees.

Francis Creadon, Des Plaines, Ill.: What do you pay your summer employees, at what do you start your full time employees, and what do you pay your non-technical employees?

Mr. Girkin: Our summer employees, and let me state this, the majority of our summer employees are a comeback proposition, they are college kids and they will start out in their freshman year and work with us every summer through their senior year. I believe that at the present time we are starting temporary employees at $1.40 an hour; permanent employees start out at $300 a month with six month increments. I can't tell you the exact figures, but they will go up to $6,000. We have a five year schedule and all the employees know that a particular job every year will take a certain increment increase if the job is performed right. They know at the beginning of their job that if their function is right even in that same job, they will get a steady increase to a certain limit. They also know that if there is promotion available, what the salary provisions are for that job. That is all general information to the employees. They know where they are going.

Mr. Scheel: Dick, how does that compare with similar work in the community?

Mr. Girkin: It compares favorably, naturally, with other City employee jobs. We are not connected with the City at all, but we have to correspond with the normal city rates. It does not compare with industrial rates in Toledo. Toledo is in a high industrial salary scale, but it does compare with the City employees and other county employees.

Mr. Carlson, Minn.: We have been comparing wage rates around the country, but the union organized our district and our starting wage is $2.05 an hour. Our full time people get $5,000 a year and they go on up from there as they get more technical. So we are paying out pretty good wages, but you talk about Toledo—I was making a survey of other country employees and

we discovered that Toledo has one of the lowest scales for municipal workers in the whole country. Perhaps this is the reason why your mosquito people are so underpaid. I don't know what we would be paying if we didn't have the union, but it seems proof to me that having the union has raised our wage scales considerably. Whether this is good or bad, I don't know. It is too early to tell, but you can make a pretty good case for good wages if you get good people because you can get that much more work done. $1.40 an hour does seem rather low.

Mr. Girkin: Those wages are for college kids. We have no problem. We have an excess of applications every year. In addition to these wage scales there are some fringe benefits--not too many--not like there are in industrial employment.

Mr. Bobbe, Cook County, Ill.: Incidental to the union problem, we were organized about a year ago by the municipal union in Chicago, and then last month the men voted themselves out of it. There is an indication that sometimes labor is not too pro-union. They were very unhappy about the union; it did them no good and apparently did them some harm because they had to pay dues. Their wage scale was not affected at all.

For our wages, we have an ascending scale that operates on a step basis over ten steps. For the various categories, we have different steps. The lowest scale, for beginning operators, is about $3,800 per year at the start. That same scale can go as high as $5,000 over a period of years if the man doesn't advance, which is unusual because they always do advance up into the operator scale to possibly the foremen level.

My question, actually, was about political influences. This is a rather touchy subject, but perhaps we should not discuss it, but I feel that anything that is brought in the open can benefit all of us. In Cook County we recently had a political situation where the major parties changed. The new change brought about a change in our program, because we are basically politically appointed members of the board. The party that took over our politics now from the November election has seen fit to project themselves into our program .You mentioned that in Toledo you managed to avoid this because the county judge actually does the appointing. What if the party should change there and take over, would not that affect your operation as it has ours?

Mr. Girkin: There it gets back to my original premise of letting the people know what is going on. They had an election here this November of course, in which the present county judge, who has been a county judge for twenty-eight years, was seriously in danger of being thrown out. It so happens that his opponent was a fraternity brother of mine. Thus through connections --knowing him--we briefed him on the whole program and on the importance of continuing the program as it was. We got his assurances, informally, that should he be elected that the program would continue as a non-political program. We have--and I am crossing my fingers--yet to run into any political appointments in any of our jobs or in any of our operations. We tried to cover that this year because there was a serious threat to the incumbent judge. But we would have had no problem had either one been elected.

Mr. Bobbe: I think that that is where you yourself did a very prominent job. I said that politics changed, but actually, it didn't; people changed, although the same party stayed in power. We had a county judge there before who was an extremely honest man, who is now the governor of Illinois.

Mr. Girkin: I think honesty doesn't really have anything to do with it; when a new man comes in he has his political appointments and you can't control mosquitoes when you have different people working it every two years. You have to have a continuity of employers.

Mr. Bobbe: How then, can we get a solution to this so-called problem? We feel that patronage is going to rear its ugly head in our work in Cook County and we would like to try to be able to avoid that.

Mr. Girkin: The only solution that I know of is to try to pass enabling legislation in order to make your organization autonomous. That is idealistic, it is true, but that is the only solution to getting away from legal patronage if you are involved in it.

Floor comment: I think the easiest way is the union. If you have a union, you can't have political patronage, if you have a union contract and seniority.

Mr. Bobbe: The union that we had in Cook County and our area was pretty closely linked with the local politics.

Mr. Girkin: I think here we are getting into local situations that won't help in providing answers to the group.

Dr. Meyers, Jefferson County, Tex.: I think I could answer your questions. It probably requires considerable change. It happens that I had something to do with drawing up the enabling legislation that was submitted to the legislature creating the districts, the authority for each county to vote themselves.

The way that we did that was that we required, first, that the appointed advisory commissioners serve without salary. Therefore, it was not a political plumb. No one in particular wanted it, and no one in particular sought it.

I think that really answers the question as to how you avoid the political problem. Incidentally, our director is hired theoretically by the commissioners court, which is the county organization, but he is responsible to the advisory commission who in turn are responsible to the commissioners court. We hire them and we fire them only by recommendations, but they actually have the authority.

Mr. Maynard, San Mateo County, Calif.: You spoke earlier of a program by which you kept aware of potential influx of mosquitoes from the outside area. This sounds to me something like an early floodwarning system. Could you enlarge upon how it works, and exactly what is involved? How do you keep aware of the situation? Do your men work outside of the district?

Mr. Girkin: We have considerable flood plain areas producing flood water mosquitoes from outside of the district. We know pretty well from the flooding conditions what is going to happen over a period of time, if the prevailing wind is in a certain direction. I can't go into the technical aspects of it as to how they do it; I am not that familiar with it. All I know is that they do it; not every time, no. But if we have a heavy rainfall, we know that there might possibly be an influx of white mosquitoes from a particular section. That is in effect what we have; and, incidentally, the boys do work outside of the district. They will go outside,

within reason, without any problem. But if there is a point where we know there is going to be an unnecessary nuisance then we will advise.

Mr. Bobbe: I would just like to remark on Dr. Meyers' comments. The members of our board are serving without pay. We are appointed by the county judge. The patronage system doesn't care too much for the trustee jobs, but—and perhaps Mr. McFeely can correct me—but I think we have about 100 employees in our districts around Chicago, and 100 jobs is a lot of patronage.

Dr. Meyer: They have nothing to do whatsoever with the employees. It was an understanding that we had with them, with the Commissioners Court, that all hiring and firing would be done entirely through the mosquito control itself. They have absolutely nothing to do with it.

Mr. Bobbe: That is basically the way we operate, but it just doesn't seem to work out that way.

Mr. Smith, Delta MAD: I am going to put you gentlemen on the spot. In reference to public relations, do you gentlemen as trustees, when there is a complaint referred to you, do you refer it to your main office or do you try to take care of it yourself? I am appointed by the City Council of Woodlake without politics of any kind. If I get a complaint, I know our chief operator. I do not tell them to call our main office in Visalia. I ask them their name and approximately where they live. I catch the operator when he comes in at noon and tell him to take care of it. Whereas I understand some of the trustees refer them to Visalia at the main office. The Superintendent has to catch the operator at noon to refer him to the complaint. I tell the people that I am not sure which day the operator will be in their area, but he takes care of it as soon as he can. I think that is better public relations than referring them to the main office.

Mr. Girkin: Thank you. I would like to give you my own impression on that, if I may. We have, during the summer months, temporary help, a girl operator who handles all the incoming phone calls. At her side she has a map—a pin map—where she plots the complaints. We find that is much more satisfactory to route all of our complaints through one particular office. No, we don't have depots, just the main office.

We have a planned schedule of adult fogging during the adult season when we are just killing adults. We funnel everything through them and then we can see by the pins on our maps where the complaints are coming from. If a particular section is receiving a heavy number of complaints, and our schedule of fogging or treatment operations does not include that section, we can alter our schedule. We have found that is very unsatisfactory for different people to take complaints and try to do something about it right away. Maybe you can't. Maybe your crews are someplace else, and it may take a day or so. Our procedure has been to channel all complaints through one operator, one person, and then it is much easier to control. I don't mean to say that your idea is wrong, because several differences of distance and work assignments may be involved.

Mr. Steiner, Orange County MAD: I would like to answer a question in our position if you are interested. As a trustee, and we have twenty-three trustees on our board representing twenty-three cities. I represent the coastal area of Newport harbor. When I get a call, they personally look my name up in the telephone book, and they tell me to do something about these so-called mosquitoes, or flies, then I simply tell them that I am not the person who actually does the abatement of mosquitoes. I am merely a trustee representing Newport Beach, but I do ask them where the problem area is, take note of it, and call our district manager, Jack Kimball, and tell him about it. I also tell the people that I have nothing to do with it, so that they won't be calling me day and night to tell me about mosquitoes and flies and gnats—that you have to call the District Office in Garden Grove. But I do make a point of it to make Jack Kimball aware of the situation and check with him. Every month he supplies us with complete reports of every area that a nuisance is reported. In our bulletin every month we get a report of every area and its number of complaints, the number of service calls, the number of calls made in answer to the requests, etc., so that every man on the Board knows what happened in the District during the month. He also indicates what he has done, or his men have done in service on these calls.

Mr. Scheel: We do still have a little time, but thank you very much Dick Girkin. If there is anything that comes to your mind later on, we may have some time to spare.

Our next speaker is Mr. McFeely. He has been a trustee of the Des Plaines Valley MAD, Illinois, since 1927 when the district was established and has been its president since 1951. He has also been a regional director of the American Mosquito Control Association.

I believe I am safe is saying that Mr. McFeely is the oldest mosquito control man in the business, born some eighty-five years ago in Indiana. He maintains a keen interest in not alone the Des Plaines Valley group, but the national association as well. It gives me considerable pleasure to introduce Mr. McFeely, who will present and lead the discussion on the subject of "Management of the Field Force."

Mr. McFeely: Mr. Chairman, and soldiers in the army of the common good. I will call you that for the nonce, anyhow. I will not take up much of your time telling of my long and amazing campaign against mosquitoes.

However when I got mad at the mosquitoes, my little daughter three months old was vulnerable to them, and I got awfully mad about it. This has cost the taxpayers, federal and local, about six million dollars in the last twenty seven years. If I had only gotten mad enough about making money for myself, I might have been very opulent indeed.

Now I would like to ask the trustees here, are there any laws in your state that have anything to do with the use of poisons? That is what our business is, the use of poisons.

Floor speaker: There are no states where such laws do not apply.

Mr. McFeely: I have found some evidence that there are about sixteen states in the United States that have strict laws regarding the use of insecticides, especially the agricultural insecticides. Last year in Boston, when we were there, there was a movement on, and the State Legislature worked on it to have a law adopted there to license people that use these poisons. I just received a letter two weeks ago from the Secretary of State of

Massachusetts who said they were unable to get it adopted because there was so much opposition to it. Sad to relate, there was influence from the mosquito control people to it. I thought it was a very strange thing that they should do that, but they did. Of course, the greatest influence against the adoption of that law was the commercial people that scatter poisons on the trees and kill cockroaches.

One of the most important things for trustees is to see that they do not do harm to the community or the flora or fauna. We had an experiment in 49,000 acres of the forest preserves surrounding Chicago in conjunction with the State authorities about ten years ago. They came to the conclusion that we were not harming the flora or fauna. Since then there has been a great increase in the number of men that spray trees for certain insects that are harming them. Nobody has any control over them at all. There are also private operators in mosquito control in our region. I suppose that occurs all over the country. Nobody has anything to say about them. Now I would like to ask of you what you do in that regard. That is our chief business in my opinion.

Has anyone here anything to say on what they know about the poisons and what have you to say about the use of them? There is no answer. I am very sorry indeed. Ten years ago, when I was elected president, the board installed a new system. Everything that we use is a record. Every formulation or mixture must be made in the presence of the technical director or the superintendent of the field force. He must sign this record and it is in detail. In the blank that he signs is the amount of the poison in it and the amount of the solvent and other things, and where it is to be used and when. Of course that is a protection to us so that if anything should happen, although nothing ever had, we would know just what we had done. Am I to understand that none of these trustees have any such arrangements as that?

Mr. DeBenedetti, San Joaquin County MAD: I am a little bit familiar with insecticides. I carry a state pest control operators license. Your rule number 1, the Federal Government, the Pure Food and Drug people. They are very, very strict. Your formulation has to be released before you can use it. Then you get it from the State, then from the county level; and it is very, very strict in the State of California as to what you use, where you use it, and how you use it, and the amount. You are policed very thoroughly. You can't just go out and use anything, anytime, anyplace. It has to be released for a particular insect, it has to be passed by the Pure Food and Drug people, it has to be approved by the State, through the State Department of Agriculture, and we are foreverlastingly required, even on our containers, packages, to specify what we use, how much we are going to use and what we are going to use it for. The State of California is very, very thorough on insecticides.

Mr. McFeely: Do you do your own mixing? Do you mix it your own way at headquarters?

Mr. DeBenedetti: You are only allowed to purchase it in the first place already mixed, only to a certain toxicity. Then you are allowed to use only so much as determined by the Department of Agriculture and the people who manufacture it who must get a permit to use it. And in most cases you can't use it without a permit. You must have a release from the Department of Agriculture.

Mr. McFeely: I just don't understand. . . .

Mr. McLeod: Mr. Chairman, may I answer this question? Let me wear another hat entirely. It is my responsibility in the eleven western states, for the Niagara Chemical Division of Food, Machinery and Chemical Corporation, to see that these materials which are used in any sense whatever meet the requirements under which we have to operate in the insecticide business. There are 1876 laws. Of these laws, a large proportion of them during the last 5 years have come under the Miller Amendment as Mr. DeBenedetti points out. These are interstate, controlled by the Food and Drug Administration under the United States Department of Agriculture. These apply, primarily, to agricultural crops; agricultural crops which move in interstate traffic, and most of them do, in one way or another, must come under these laws.

In addition to this, each state has, or has not—and you are quite correct in your statement that there are states in which there are no state laws applying—however the Federal law does apply even within those states. It supercedes the state law. Now what Mr. DeBenedetti was explaining for our California is unique, because California had this before the Federal Government started it. Actually, we have a State Bureau of Chemistry within the State Department of Agriculture, with whom every compound sold that contains any pesticide, any fertilizer, any chemical for use, must be registered with them. The label which is going on that container must have all of the information required by the State, by the Federal Government, both departments. This label must be approved and an actual label has to be transmitted to them.

The use of these materials is further restricted and is different within every county of California because we have an Agricultural Commissioner system. The Agricultural Commissioners issue permits to all of the pest control operators or users of these materials. But again you are right, sir, because the mosquito abatement district, dealing with an entirely different phase from the agricultural in urban but not rural areas, faces no such rules or regulations, except that the pest control operator or the mosquito abatement district must operate within the legal structure of the county, the State, and the nation. Now this is what we have in California. This is not applicable everywhere, because you are right, there are some states where state and county level of control does not exist.

Mr. McFeely: I will give you a little example of what this gentleman means, if I understand it. A woman might have a sick child and she gets a doctor and he would give her a bottle of medicine, along with the directions. If she would disobey the directions, she could give the child too much. Now this poison is delivered to your headquarters—what you do with it then is decided there. It is not decided by anybody else in the world, but the fellow that is mixing it. Isn't that true?

As with the mother that gives her child too much medicine, it is the person handling the material. You have to trust someone at your headquarters to mix it. Isn't that true? That is what I meant to say. Has anybody considered that?

Mr. Steiner: As a trustee on my board, for instance,

we formulate policy. We have absolutely nothing to do with chemicals. We have an entomologist who is responsible for this. I don't know anything about chemicals and have nothing to do with that aspect.

Mr. McFeely: Yes, you do. You have the responsibility. You are the power on these vital things. You cannot escape that by saying that you turned it over to somebody else. You must see that he does it properly. You must have a system. And now may I have the temerity to tell you what we do. I don't know if I mentioned it before. Everything that we use we know exactly what is in it and where it is used and the spreading of it. And it cannot be done by anyone unless they are responsible for it. I feel that should be done in every mosquito control organization. Have people that you trust—the technical director or chief engineer, whatever his title is, should be responsible for it.

Mr. Merchaud, Merced County MAD: I don't think there is a district in the entire State of California that doesn't have a complete record on their spraying operations, especially in the rural areas, because we are tied up with so much red tape that we have to do it. We can tell you from the time we started what we sprayed, where we sprayed, what proportion we sprayed and everything else.

Speaker: One other thing on the California laws—the other two gentlemen covered them very thoroughly with one exception—we also have a Fish and Game Commission. . . . .

General response: Let's not get into that.

Mr. McFeely: It is controlled with the many laws about it, but actually it is the use of the thing that counts and is a very important aspect.

Well, we have talked about insecticides, and when we started our campaign for control of mosquitoes in Cook County, Illinois, there were a great many people that came around with their own ideas on it. One of them was that we should have a women's club go around with a big fish pole and a sponge on it with which they could reach up and get the water out of the gutters. Another man thought that if we would punch holes in every tin can that that would reduce the mosquitoes. Fortunately, we engaged a man, who died untimely, J. Lyell Clark; maybe some of you met him at these conventions earlier. He played a large part in starting the American Mosquito Control Association.

We were put on an official basis and were the beneficiaries of the WPA, which was a great thing for us. They excavated six hundred miles of drainage in our District, mostly laterals, and also in the hinterland, and those ditches are there yet. You people who have been organized lately can only hope for another big depression when you can get some WPA men to do your work and have the Federal Government pay it.

Now we can go to public relations. Of course there is one sure way to stand well in the eyes of the public. I have been introduced as a mosquito commissioner. Now nobody in this business can ever be aggrandized by his title here. While a mosquito is not considered a disaster, it is considered a joke, and it is an awful laugh at the Rotary Club or other places. Maybe you gentlemen have had that experience. Mosquito Man—what could be more belittling than that. We must be of good heart because we know that we are doing a noble job, and the perfect way for good public relations is to do a good job. If you don't, there is hardly anything you can do to provide proper public relations. You might hire a newspaper man and spread the right propaganda around, but the evidence against you would be very great; and what you said wouldn't have anything to do with it if you weren't doing a good job.

We have found in some 34 years that we have no trouble whatever. I had suspected that there would be an uprising against us, because the mosquitoes did annoy people. But we have never had any trouble whatever. We have a District that is 76 square miles, and a large human population, 300,000. And last summer we had the amazing number of complaints—180—and the technical director was quite disturbed about it. It was an increase of about ten over the year before. But some of them were from cranks and others from people who either were bitten by a gnat or a cockroach or something and blamed us. So. we have had very great success, and we have had terrific success with our fogging operations. Of course, we couldn't do anything like that up until the time of the DDT epoch, the only way to fight the mosquito was in its infantile life. After he was on the wing, nothing could be done about it except to put up the screens and get a swatter. Now we can kill them on the wing and it is very successful.

We have about 26 municipalities. Some of them like Oak Park in Illinois has about 70,000 people in it. Now besides killing the mosquitoes, the public likes to see us doing it. Once in a while they complain of the odor in the oil, or some neurotic is disturbed by the noise of the machine. This is not something that is unique with Illinois, this is something which might interest all of you—not like a cactus which is unique in each state and you can't arrive at any information about it. We have four or five trucks out every night when the traps show that we are going to have a climb in mosquitoes. We have a foreman, who is a very competent man, and he has a two-way radio and thus knows when any of the other drivers are in trouble and can go help them. We always notify the police if we are going to fog in their town; and the only trouble we have is small boys, early in the evening, running into the fog. Often we have a policeman along to keep the boys away from it. Fortunately, we have never hurt any of them. I am of the opinion that we have done something in that effort since the end of the war—that we have soaked that country with DDT. We had an interesting case last summer. We have 29,000 catch basins, and ever since we have been operating we have always sprayed those catch basins. Mosquitoes did live in there and did multiply there. Last year the special motorcycles we had to do this broke down, and when they went around and checked, they found there were no mosquitoes in these things. The conclusion seems to be valid that what we had poured in there over so many years was there yet. Then I recalled that about fifteen years ago, at a meeting in Atlantic City, a professor from Cornell University, who had written books about mosquitoes, had reported this: he had made an experiment and come to the conclusion that DDT was cumulative, residually. Nobody paid any attention to that old man's idea that I had ever heard of. We thought that just as soon as you put the DDT on there you were through with it. I am inclined to the opinion that we are not. One of our great successes now in

our region is that we have got that stuff splattered all over the 76 square miles of our district. Have any of you anything to say about that?

Question: Are you still using DDT? (Yes.) Where we are in California, we don't. We've got other residuals, such as toxaphene and others; but change now and then to follow through. But we can't use DDT in agricultural areas anymore—it goes into the dairy cows and into the milk and butter—and we have just had to stop using it.

Mr. McFeely: Just after DDT was released for civilian use, after the war, the University of Illinois, the Agricultural Department, had an experiment. They killed the mosquitoes in the cattle barn with DDT, and it was a great help to the cattle. They got out a nice book on what a magnificent thing this was; but before they distributed this book, they found out that the DDT was right in the cows' milk. So we may be doing some great damage.

We had a recent experiment on what insecticides will do. Maybe you've heard of the fire ant? A miserable creature that was discovered first on the gulf coast of Alabama. It is way up north now, damaging crops and when it bites a person, it causes a blister. They recently adopted a considerable sum to control this little thing, the fire ant. Then, within a few months they found out that the insecticide they had used on the coast of Alabama and the gulf had gotten into the shrimps. So people who throw around poisons are under a very grave responsibility.

Roy Holmes: There may be a similarity, but I am not Harold Gray. I am going to get up here where some of you deaf people can hear. We have another reason why we can't use DDT in California. The mosquitoes have built up a tolerance to DDT, or resistance, so that now we use other insecticides, such as malathion and parathion. But DDT has been eliminated by most of us several years ago. We have a very unique district, because in the past several years we have never had a complaint about mosquitoes. Whenever they call up, it is merely to report that they *have* mosquitoes.

Speaker: The reason we quit DDT is because if the milk inspectors find any DDT in their sampling, they will throw out the whole load and the farmers really complain; so we quit DDT and Chlordane.

Mr. McFeely: We don't have any farmers around our district.

Mr. Bobbe: I came to this meeting originally so that I could get some information and help as a trustee, and I think I've got something out of it so far. But for my personal use, I feel that as a trustee I have only to do with the overall operation of the District, the expenditure of public funds and attendance at the meetings monthly. I don't care a hoot about how much DDT they put down; we've got efficient technical people that are responsible to us for that. If they cease doing the job, we'll get rid of them.

Mr. Gray: You are absolutely right.

Mr. Scheel: I think we have had a very exciting half hour here, and I know that there have been some things gleaned of benefit and of a controversial character, no doubt, as has been evidenced here. I know that we can carry this to bed with us tonight and continue it in our dreams. Thank you, Mr. McFeely.

Our next speaker is Dr. McLeod. He is formerly Technical Vice-President of Sunland Industries and now Manager of Public Relations and product promotion for the Western Agricultural Department of Niagara Chemical Division of Food Machinery and Chemical Corporation. He is an authority on both the control of insects and on insect physiology and he is currently Secretary of the Board of Trustees of the Fresno (California) Mosquito Abatement District. I am now pleased to present Dr. McLeod who will introduce and lead the discussion on Tax Money Obligations of Trustees. Dr. McLeod.

Dr. McLeod: I am quite amused at this typical American gathering. Dick Girkins gives you a very fine exposé of public relations, which is my official job, and I give you a discussion which is obvious to everybody. But this is a typical meeting. Public Relations, Dick, if you want a definition of it which is much easier than Webster's, you can say that "public relations is the art of treating the public the way you do not treat your relations."

It takes an individual with a lot of presumptuousness and a lot of temerity to get up before this group and tell you what to do with regard to your obligations as a receiver of tax monies. It is presumptuous, I am sure, but I think that if you will stop and consider a moment with me, you will know that as well recognized as the rules for using tax derived funds are concerned, there are some gray areas. These we have explored at some length. Most of the previous speakers have readily covered the field which I should cover anyway, and we will simply go on and leave out the toxicology and technology, because I am quite in agreement with you that this is a field for management. We as a group are policy determiners, not managers. This is a very sharp line.

There is no argument that everybody here is associated with the expenditure of tax funds—and what rules do you follow? I judge that many board members, if not all of them, are business men, primarily. They are not technologists; and a business man is merely one of those unfortunate individuals whose daily routines and decisions are complicated only by securing a return on investment within the parameters of legal restrictions.

Now in California, at least, the powers of a district are astounding. We have mosquito abatement districts, we also have fire districts, we have hospital districts, and we have fair districts, and so on, ad infinitum. Now these districts, set up under California law, repose in the governing body—a board of trustees, directors or commissioners, or whatever you want to call them—these people have an autonomy that is not enjoyed by most political groups. An autonomy in being self-determining. Now this is California.

What are some of these major policy decisions that would be involved in the expenditure of tax funds? At the outset let me point out that this is a recitation of what has been followed in the Fresno District for several years. It is not a recommendation, a condemnation of procedures in other areas, nor is it a master plan. We leave those to the great white father. There may be some areas, however, where an exchange of ideas could lead to an improvement, and this is the justification for this presentation of this aspect of mosquito control.

Now first, with respect to membership on a board

or a commission. We in the Fresno group feel very strongly that acceptance of an appointment carries with it the obligation to attend meetings regularly. Where compensation for attendance at board meetings is involved, the attendance and participation at such meetings are a must, of course. Failure to attend at least seventy-five per cent of the board meetings should result in the resignation of such a member so that appointment of another member may be made. This is our feeling; this attendance matter is an obligation, connected with the expenditure of tax monies. I am unwilling to commit my decisions to my very muchly beloved colleagues without knowing at least what is being committed.

Now since the expenditures of monies involves a cross-section of some kind of an area, both the major vocations and the sub-areas involved should enjoy representation as far as possible. We do not feel—and this I have seen you discuss a little bit—in the Fresno Mosquito Abatement District that political expediency, popularity, nor economic status should supercede interest, business ability, and integrity in the selection of directors of the mosquito abatement district. Continuity is both desirable and necessary in policy determinations of a board; this we see. Continuity is well provided, and we have discussed it—how directors are appointed and through what systems and schemes.

Considerable proportions of our budgets are spent in salary. It has been quite customary, and was explored here this morning, for groups in the same category to be surveyed, and long lists of salary for each category within the district are scanned. While we look at these figures on a nationwide and statewide basis, we tie our compensation to the local labor market for comparable ability. We tie to it and we have to; after all, how would you compete for labor without meeting the local market so far as the labor market is concerned? What we do is tie our salaries to comparable county jobs. When there is an upgrading occurring over the general county to meet a cost of living increase, we upgrade our people. We follow that procedure and it is tied to the general county level.

We also feel quite strongly about the misuse of our funds to influence legislation, either directly or indirectly. For this particular reason it is considered essential that we have a detailed budget of any organization to which we may pay dues or make any kind of contribution. These activities and the activities of any organization of which you are a part need careful scrutiny as to their objectives, procedures, expenditures and membership. You are well acquainted, many of you, with the list of organizations that are not desirable organizations, and certainly it would be very easy under pressure to agree to use district funds for membership in an organization without knowing in detail what that organization is going to do; nor will their objectives remain static. One must be ever alert and on guard lest they take you as a policy determiner into a region where you would not like to be found in the public eye.

Now volumes could be written about records and reports. Certain records appear to be indispensible; we have agreed on some this morning. There should be a monthly record of operations and expenditures in writing for each board member to study and question. This I think is of the utmost importance. This should be correlated with an annual budget. All vouchers or checks should be signed by at least one board member. When he signs that, he has a responsibility, whether or no, just as you say, sir. Mr. McFeely, you pointed that out real well. An annual report summarizing the activities and accomplishments of the district should be prepared for each Board member and such officers, county, city or anyone else as may be interested.

It is almost superflous to mention the need for an annual audit by a competent accountant, but these firms frequently can be of great help in suggesting financial and operational records, slight changes, which simplify, yet clarify, the responsible accounting to the tax payer.

Finally, there is an attitude of posture incumbent upon board members as guardians and dispensers of tax monies. Theirs is more a responsibility than an authority. Abatement, of necessity, like crime prevention, carries the needed authority; but even in mosquito abatement work, patient, tolerant, understanding attitude in public contacts rather than pompous austerity will solve an awful lot of problems before they arise.

With an exploding population, urban sprawl into suburban areas adjoining, in many instances, agricultural land, there are increasing problems and increasing funds from skyrocketing assessed valuations. Alert board memebrs can reduce the tax rate for mosquito abatement in many areas without impairing efficiency. It can be done, and we have done it. This too is a function, and one contrary to what seems to be common philosophy in many areas of government. In a society where specialization of government goes hand in hand with technical progress, the mosquito abatement district trustee will do well to consider policies from the standpoint of a taxpayer as well as a board member.

Mr. Scheel: Thank you, Dr. McLeod. Open to discussion.

Dr. Meyer: According to your talk, it seems as if handling and disbursement of the funds emanates within the prerogative of the board itself.

Dr. McLeod: With final approval of the expenditures, that is so.

Dr. Meyer: That is not the case in our area. We set up the budget, which is sent to the Commissioners Court for their approval, the funds which are derived from taxes are under their control. They are set aside especially for mosquito control districts themselves, but the dispersal, the purchases, must go through the county purchasing agent.

Dr. McLeod: This is a matter of record with us. We actually have county funds, and we go to our county counsel if there is any question in regard to this thing; but the actual warrants are produced in our own mosquito abatement district office, they are brought to us to sign, and to Mr. Davis, and we disperse those without interference. I commend to any trustee who finds himself in your position, the exploration of the

California system, so that you may have more direct control over your funds. He who controls the purse strings, has a pretty darn good control over the personnel.

Dr. Meyer: Actually, we do have the indirect control and it is no problem as far as we are concerned, but we do not have to sign any checks. We do have to requistion the purchase, which has to go through us, but the dispersal and payment of those has to be paid by the county agent himself.

Dr. McLeod: Which, of course, brings the scrutiny of your requistion under a man who may or may not appreciate the problems with which you are confronted.

Dr. Meyer: No. We don't have that set-up. But it does go through the county auditor who keeps a current record so that we are limited in the amount of funds that we could dispense, and we are controlled by the budget which we have to prepare and have to approve before we are eligible for spending it.

Dr. McLeod: Of course, our expenditures also are reviewed by the County Auditor. Now, we too prepare a budget. I think this is a vital part. You have to make a budget of some kind. You can't operate without it. Certainly if you are in the business, your experience should be such that you are able to prepare a reasonably good budget. Our problem has been that unfortunately in our area, we are in a rapid growth area, a big growth area; and our assessed valuation has skyrocketed so that we have had to look critically at a budget that is increasing above our needs and have to recommend reductions. In that connection, one of the things that comes up is, if you decide to reduce your tax take by a fraction, you immediately run into very serious discussion with the county bookkeepers because the machines don't have fractions on them.

Mr. Steiner: I would like to make another comment on this division of responsibilities and duties of the trustees and the management. A couple of years ago, at one of our board meetings, a man appeared with the permission of the manager. This man has written several letters to some of the trustees that he has come in contact with and asked permission to come before the board and bring his case to us, since he was fired by our manager. We heard his case and it came out that he had taken time during the hours that he was supposed to work for the district and took the truck and went over and worked for some orange growers spraying his orchard. It seems that Jack Kimball, our manager, had warned him once or twice about this, or had given him permission to go there after work; but didn't give him permission to take our equipment and so forth. Whatever the whole situation was, Jack finally thought it necessary to fire him. The Board members, being soft hearted, said, "Let's listen to him, give him a chance." He gave us a story about having a family and so on, naturally. It was about to come to a vote as to whether we keep this man and give him another chance or not. Then I got up, with others, and insisted that if we rehire this man in the face of the manager's decision, then we have to fire the manager. If the manager has found it necessary to fire him, and we, who come there once a month for two or three hours, should reinstate this man, we are setting a precedent for everybody from now on that is fired should come to us, then we may as well get rid of the manager.

Dr. McLeod: Harold, on the basis of your years of seniority in mosquito control, what is your comment.

Harold Gray: I have a question, primarily. I think you have noticed a recent decision of the State Supreme Court in which government, including the State, can now be sued by an individual citizen, even when they are operating under what is known as governmental functions as contrasted to proprietary functions. I wonder if it would not be worth while to have some comment from you on that, and as to means of protecting trustees or commissioners by insurance against a lot of these liabilities, which I think can be done on almost anything except some type of criminal activity where you break the laws somewhat knowingly.

Dr. McLeod: You are quite right, Harold. This area of responsibility on the part of a trustee or a director, or a commissioner, seems to be one of the gray areas of which we have talked. This legislation which Harold mentioned makes it parallel in government groups to exactly what happens in a commercial group. That is that the directors are responsible for the management, and if the directors disperse the funds, then they have the responsibility for the management of every detail. How much they can endow that manager with depends upon the personal abilities of the manager. But, the point that Harold makes, and this I feel is a good one for anyone to take home that is a director, you should have insurance against this type of thing.

We had a sleeping beauty, incidentally, Ed had a sleeping beauty on the force; and Ed Davis, our manager, talked to us about this previously, having warned the man several times, and fired him. And that man never even had an interview with us. That is Ed Davis' business, and that is what he got from the trustees, every one of them.

Now back to Harold's question about the insurance. I think that here is an area of great import to us as individuals or individual trustees. It certainly is here in California because of this ruling that Harold mentions now. You as a trustee are susceptible to suit in exactly the same way as you are as a director of a corporation. For that you can have certain brands and types of insurance. This is not expensive, and to my way of thinking, is a necessity in a mosquito abatement district.

Speaker from Chicago: Dr. McLeod, I have been going to these meetings for about three years, and when I tell my neighbors back in Riverside in Chicago that I am going to a mosquito meeting, they laugh at me. I am always interested in knowing what my associates do, and since you are all on boards of trustees, I would like to take about two minutes and ask what all of you gentlemen do. For example, I am in the life insurance business, and when I say I am going to these mosquito meetings, they laugh at me. Could we take a minute and find out what some of you people do professionally. What do you make your living at?

Replies: I am a walnut grower. Grape grower. Real

estate broker. Retired. Purchasing agent. Sales manager. Farmers Life Insurance. County Treasurer. Vegetable farmer. Steel fabricator. Stationer. Retired. Corporation employee. Pediatrician. Veterinarian. Retired and tired. Petroleum. Retired merchandiser. Sanitation director. Locksmith. School administrator. Pharmaceuticals. Insurance. Sanitation director. Osteopath. Retail merchant. Salesman. Auto parts. Construction engineer. Real estate. Funeral director. Sanitary Engineer, Transportation. Public health. Citrus grower. Farmer. Public accountant. Automobiles. Insurance broker. Physician. Public health. General contractor. And our Chairman I know is the retired Superintendent of the Western Electric of Chicago. Mostly business people.

Dr. McLeod: Now, there is one question that we didn't fully answer, and I would like a show of hands—and this is going to be difficult because there will be several trustees from one district showing their hands—but I would like to know by a show of hands, how many districts handle their own funds? It is fairly clear that of those here, most districts do handle their own funds. It is a rather smart thing to have, because if you are going to be imposed upon for a certain responsibility, then authority on fiscal lines is rather necessary.

Question: Could you say something about expense accounts?

Dr. McLeod: Oh, yes. Who wants to discuss expense accounts? Wife or secretary? Under the new IRS laws, you have to be extremely careful. Have we an accountant? An accountant in the group who would like to say something about expense accounts? Let's have an eastern expression. How do you handle your expense accounts for this trip here?

Dr. McLeod: All right, gentlemen, the next question, if you have one.

Mr. Lee, Turlock MAD: I would like to ask you Doctor, in your district, do you have this liability insurance yet?

Dr. McLeod: Yes we do—isn't that right, Ed? (Yes, for $1,000,000.) That is for anything that happens within the District, any operational activities.

Mr. Vieser, Jefferson County: Would you have the rate, or premium on what that million dollar coverage is?

Dr. McLeod: Ed, tell them exactly what our premium coverage is.

Ed Davis, Mgr. Fresno MAD: That million dollars just covers everything. Our premium runs about $2,500.00 and it covers up to one million dollars on any type of accident or anything, general liability. It covers crop damage, automobile, property or anything. It provides blanket coverage.

Speaker: Let me ask a question there. That doesn't cover certain types of insecticides as you may apply them?

Dr. McLeod: Yes. I am afraid it does.

Mr. Davis: No, we do not have it under Lloyds. We have it under United Pacific, and it runs about $2,500 a year.

Dr. McLeod: $2,500 premium in United Pacific Insurance covers us for all of our operational activities under the Fresno Mosquito Abatement District.

Question: Does that also cover the trustees—to and from the meetings?

Mr. Davis: Yes. If they are on the way to and from the meeting, it covers them also.

Dr. McLeod: A trustee in all of his activities—in fact we have been subpoenaed and sued, and all the rest in the case of an automobile accident—and we are covered by that insurance. I commend it to your thinking in every mosquito abatement district.

Mr. Vieser: You were saying, how do we cover the expenses for this meeting? Can I talk about that?

Our accountant, and I may be able to show you, says that we can make these expenditures that are reasonable; but we must bring back—and this is the embarrassing part of the whole thing—a signed receipt. Now, the hotel bill is signed and it shows paid. Pardon me, but this isn't worth a tinker's dam, because you still have to get this receipt signed by the person who received your money for paying the hotel bill. Now that is funny. So we go out here to a dinner, and we happen to have done so last night. We went to Knotts Berry Farm, and we got to talking and the lady put down all the orders on one ticket, and it came up to $6.55. There were three of us, so we sit down and figure out how much is our part. One was $1.85, and another $2.85 and the other totalling up to $6.55. So we had to have three separate receipts with our name, the amount of money, the date, the place, the town—it's all right here, and it says Jefferson County, Texas. Now if we send this in, this is the way we get our money back. We have to bring back a signed receipt. When we sent our plane ticket in, that is the only thing that does not have this sort of receipt, because that is marked on the ticket. And it had better not have any Federal Tax on it, because they won't pay it. We even sign a voucher certifying that we made this expense and so on and so forth to the best of our ability.

No, we do not have a per diem allowance. We are permitted reimbursal of expenses, but even then there is a limitation on these expenses. But we have to turn in signed receipts for everything. They just want to keep us honest, that's all.

Mr. Scheel: Did you wish someone to try to provide an answer for this thing or . . . ?

Mr. Vieser: No. I would just like to find out how all of you do it.

Dr. McLeod: Well, this is obviously subjected to the vagaries of a county group, whose requirements are borne within their own distorted abliities to bring up certain requirements within that county based on actual happenings in the past in many instances. I would suspect, that as we surveyed even the California counties, we would find divergences in the kind of expense accounts we submit. Ours is a very tolerant capitol of world agri-business. We merely submit expenditures detailed as to lodging, as to meals, and so forth, and the total sum is put in as an expense account. The county somehow believes that the leaders in the Fresno Mosquito Abatement District would not misuse their funds much more than does my own Corporation.

Question: I would like to ask about that "and so forth."

Dr. McLeod: That involves the hot and cold running maid, sir.

Dr. Manning: You asked about the east. The commission obtained our plane tickets for us. That was on one voucher. Then they gave us expense account money—so much for lodging, meals, etc. as you said. If there is anything left over, they will see that they get it back.

Sandy Steiner: I would like to explain our procedure which is probably the same as some of the others. I have been on the board nine years and I have attended four conventions. I have gone to Berkeley and Monterey and Marysville. To Marysville, I went with our entomologist, but we are allowed first rate railway fare in transportation expenses, whether we take a plane, or what. If I take my own automobile, I will get credit for the cost of the railway fare. Then we are allowed registration fees, our hotel expenses and actual costs expended. If I buy you a drink during the supper I imagine I am allowed to put it in. Then we turn this in to our manager and he writes out a check which is passed on by the board. This comes up to the board meeting and they must pass upon it. If they find it excessive, why, they could turn it down.

I am sorry to say that being a local board and having twenty-three trustees on it, I am the only one present. I want to say that there are only two business men on my board of trustees. Myself and another real estate man, also a doctor who might be so classified. The rest of them are all county and city employees—mayors, councilmen, engineers, and so on. Perhaps the reason they are not here is that they may be busy with their other duties, or they don't want to spend the five dollar registration fee from county funds to come in; but I am sorry to say that I am the only one representing the County of Orange.

Dr. McLeod: Thank you, very much, Sandy. I think, gentlemen, in the interests of time, I will thank you all for your participation in this discussion, and I would like to extend to you a personal invitation to be with us on the bus at Fresno when we will try to show you the urban sprawl.

Mr. Scheel: Thank you, very much, Dr. McLeod. I think this concludes our session this morning unless there is someone in the group who has an item of interest that he would like to throw in and that hasn't been touched upon. Those of you who came in after we passed around this little roster or registration sheet, would you please fill in your name so we have a record of it? Thank you very much.

CONCURRENT SESSION

THURSDAY, FEBRUARY 2, 9:00 A.M.

MISCELLANEOUS SUBMITTED PAPERS

Thomas D. Mulhern, Technical Consultant, Bureau of Vector Control, California, presiding.

BIOLOGY AND CONTROL OF *AEDES SIERRENSIS* IN CALIFORNIA

ROBERT F. PORTMAN AND LEON L. HALL [1] [2] [3]

The Butte County Mosquito Abatement District
Biggs, California

The western tree-hole mosquito, *Aedes sierrensis* (Lud.), is frequently a severe pest during the early spring months in residential and recreational areas which contain or are adjacent to certain species of mature trees, especially native oaks and cultivated olives.

Distribution.—Since the original description of this mosquito by Coquillett (1902) from a single female collected in Williams, Arizona, it has been reported in 52 out of 58 counties in California by Freeborn & Bohart (1951) and by subsequent records on file by the Bureau of Vector Control of the California State Department of Public Health, in Arizona, Nevada and Oregon by Dyar (1922), in Oregon by Reeves (1940), in Washington by Boddy (1948) and Stage et al. (1952), and in British Columbia by Twinn (1949).

Description.—The size of this small mosquito, varying from 3 to 5 m.m. in length, seems to be closely correlated with the number of larvae developing in a tree hole. Field and laboratory observations reveal that the smaller adults are produced by tree holes containing a high concentration of larvae. The smaller specimens of this mosquito readily enter residences by passing through ordinary 16 mesh window screening. The females bite readily in the daytime and at a season of the year when other mosquitoes are few in number or inactive. The males are attracted to vertebrate hosts, increasing the impression of mosquito attack, Reeves (1940), Lowe (1933).

Although the larvae in a densely populated environment seem to mature more slowly due to their small size, they reach the pupal stage in about the same length of time as do those which are not overcrowded. In the pupal stage the difference in size is very noticeable, with some of the pupae being only about one-fifth as large as others, which apparently is due to environment as well as sex. Reeves has observed that the extremely small pupae uniformly produced males and that the large ones produced females; and Hall has observed that the first emergence of a brood is composed principally of males.

The larvae are easily distinguished in the field from those of other California species, with the exception of *Orthopodomyia californica* (Theo.), by their restrictive occurrence in tree holes. They differ from all other California species by their long anal gills, and by their peculiar snake-like movement through the water. Reeves (1940) has also found the larvae of *Culex quinquefasciatus* (Say) and *Culiseta incidens* (Thom.) in tree-holes, but this is not their normal habitat.

Life History and Habits.—The females commonly lay their eggs in the live oak, *Quercus agrifolia* (Nee'), and the common valley oak, *Quercus lobata* (Nee'). Reeves (1940) lists the holes in 15 species of trees as well as a rock pool, a barrel, and a watering trough all located beneath trees as larval habitats. Personnel of the Alameda County Mosquito Abatement District (California) have found the larvae in cemetery flower containers. Personnel of this District have found the larvae in holes in the cultivated olive, *Olea europaea* (Linn.), in the eucalyptus, *Eucalyptus globulus* (Labill.) and in the madrone, *Arbutus menziesi* (Prush.). They have found the larvae in crotches above the ground and at the base of tree trunks, and in other water-holding receptacles containing leaves, bark and twigs, including a concrete irrigation box, an old automobile tire, and a commode in a wooded dump site. Numerous field observations show that this mosquito does not necessarily have a preference for the holes of any particular species of tree, and will lay its eggs at or just above the water level of almost any accumulation of water in a receptacle which contains woody plant debris and leachings. The predominance of larvae occurring in the holes of any one species of trees is apparently due to the fact that there are more holes available for oviposition in that species.

A portion of the eggs laid the previous spring hatch within 48 hours in the water provided by the first fall rains. Freeborn (1926) states that there is some evidence that the eggs may drop off of the sides of the hole after a period of desiccation or, as an alternative method, the larvae may hatch without the intervention of actual wetting and fall into the water below. Reeves (1941) states that only a portion of the eggs in a tree hole hatch at one time and that several successive wettings and dryings will result in a like number of broods. Field observations indicate that during

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[3] The authors wish to express appreciaton to the Board of Trustees of the Butte County Mosquito Abatement District who made this project possible.

the late spring when the level of the water in the hole is low, eggs may be laid near the bottom, and that the first rains of the next fall inundating these bottom eggs and washing others off the sides of the hole produce the first fall brood. Later rains wash off additional eggs and by raising the level of the water will inundate more of the eggs laid at higher elevations, including those laid two or more weeks earlier in the same season, thereby producing successive broods.

Most of the larvae are light gray in appearance although others are dark. Their undulating motion through the water is very characteristic of the species. Part of the time they lie in the debris at the bottom of the hole with only their anal gills and a small part of their abdomens visible; when disturbed while feeding at the surface they swim rapidly to the bottom and either assume this position or lie motionless. When feeding at the surface the bodies of the larvae frequently assume a vertical "U" shape, with the siphon at one end of the "U" puncturing the surface and the mouth brushes at the other sweeping it. The very rapid motion of the mouth brushes propels that arm of the "U" in a circle with the siphon acting as a pivot. Larval development which is very slow under natural conditions requires during the winter from 2 to 5 months; however Reeves (1940) found that in the late spring under optimum conditions of temperature and rainfall *Aedes sierrensis* may complete its life cycle in as short a time as 14 days. Observations made in Butte County show that larvae can survive for a considerable length of time under semi-aquatic conditions. Several infested tree holes which were under observation dried to a moist mud condition, within two days after a heavy rain fourth instar larvae were observed in some and first instar larvae in others. On another occasion when water was added to a larval sample in a card board carton, which had dried during a period of 13 days to a moist mud condition, the third and fourth instar larvae again became active.

The mosquitoes, with favorable weather conditions, start to emerge early in February and continue to emerge until the latter part of April, a few have been found emerging in late June. In olive groves utilizing sprinkler-irrigation systems and in the lower mountains the emergence may continue into July. Many of the viable eggs not hatching during one season survive the dry summer and hatch the next fall and winter producing the infestations of the following spring.

Control Methods.—Aedes sierrensis was a severe pest for many years in Bidwell Park, Chico, California, a large wooded, recreational area containing many large oaks and other trees. Most of the trees were quite old and contained many holes and cavities which served as excellent larval habitats. During the winter of 1950-51 an attempt was made to eliminate these larval habitats by cleaning, filling with sand and capping them with cement. This control method did not prove to be economically feasible due to the labor required and the great number of trees involved; therefore it was discontinued.

The Alameda County Mosquito Abatement District (California) found that it took several years after effective treatment of the tree holes for the infestation to recur. But, in some cases where the tree holes were merely filled with a dry sand-cement mixture, without careful chipping and cleaning of the hole, new rot would occur and a few larvae would appear.

The Kern County Mosquito Abatement District (California) found that excellent control was obtained in an olive grove by treating the holes with small quantities of dry 50 per cent DDT wettable powder. Therefore during the winter of 1951-52 a program of treating tree holes with insecticide was initiated in Butte County. The tree holes in a number of heavily infested olive groves were treated with a wettable powder spray containing 0.4 pound of DDT per gallon. As the work progressed it was soon found that dry cavities in the trees, which would not hold water, provided resting places not only for *Aedes sierrensis* but other species of mosquitoes. Crotches and hollows at the base of the olive trunks, hidden by dense sucker-growth or covered with leaves and debris, frequently contained water and larvae. Thereafter, all potential and infested larval habitats, as well as mosquito resting places, were thoroughly sprayed.

The use of power sprayers required an excessive amount of labor in handling the hoses, driving the vehicles, and cleaning the filter screens which frequently clogged with wettable powder deposits. Knapsack and compression sprayers proved much more efficient especially when an emulsion spray containing 0.4 pound of DDT per gallon was used. Later the concentration of DDT in the spray was reduced to 0.2 pound per gallon and an adjustable nozzle was used instead of a fixed fan spray nozzle. A summary of three season's control work in southern Butte County during which 116,686 trees were treated showed the following averages: 18.84 trees were treated per gallon of spray, and 45.57 trees were treated per man-hour using 2.41 gallons of spray.

Experimental Evaluation. — The results obtained from the DDT treatment of tree holes during the winter of 1951-52 indicated that this might be a feasible method for the control of *Aedes sierrensis* which infested many of the 4,600 acres of cultivated olives and hundreds of thousands native oak and other trees in Butte County, therefore experiments were set up to determine: 1. The degree of infestation in trees containing potential breeding sites. 2. Whether samples of bottom debris and side scrapings from tree holes would indicate in the laboratory the presence of an infestation, and if infestation would recur in treated tree holes. 3. The longevity of the residual toxicity of DDT sprays. 4. If *Aedes sierrensis* would lay eggs in simulated tree holes.

1. A survey of 165 trees was made in a typical, mature, untreated, olive grove in which *Aedes sierrensis* had been a pest problem every spring. A similar survey of 129 trees was made in three separate areas containing the native California live oak, *Quercus agrifolia.* The findings of the two surveys are shown below:

INFESTATION IN TREES CONTAINING POTENTIAL *AEDES SIERRENSIS* BREEDING HOLES

	Olive Trees No.	%	*Oak Trees* No.	%
Trees checked	165	100	129	100
Trees with potential breeding holes	141	85	72	56
Trees with water in holes	120	73	43	33
Trees with holes containing larvae	53	23	22	17

2. Early in December, 1952, six 1-acre plots, each containing 100 trees, were selected in four widely separated olive groves. Three of the plots were located in two groves which contained many excellent larval habitats and had been infested prior to treatment with a spray containing 0.2 pound DDT per gallon during the previous winter. Samples were taken from two of these plots on December 3, and from the other on the 11th, 1952. The other three plots were located in two untreated groves known to be infested and containing many larval habitats. Samples were taken from two of these plots on December 4, and from the other plot on the 11th, 1952. In each of the six plots the 10 trees having the most potential larval habitats were selected. One sample was collected from each of the 60 selected trees, either from a tree hole or a crotch whichever appeared most likely to be infested. Each sample, consisting of scrapings from the sides and debris from the bottom of the tree hole, was placed in an individual, waxed, ½-pint carton. If rain water was present in the hole or crotch enough of it was added to the carton to fill it two-thirds full, if the hole was dry tap water was used. Inspections of the cartons which were kept in the laboratory were made daily through February 15. Water which evaporated from the cartons was replaced by tap water. The tree holes from which the collections were made were examined periodically until May in order to confirm the laboratory findings. No larvae appeared in any of the 30 treated plot samples, nor in any of the tree holes from which they were taken. Larvae appeared in 12 of the 30 untreated plot samples and in their corresponding tree holes. These results indicated that infestation did not recur the following winter or spring in treated tree holes.

3. During the winter of 1953 tree holes in olive groves which had been infested prior to treatment during the winters of 1951-52 and 1952-53 with sprays contaniing 0.2 and 0.4 pound of DDT per gallon were used to evaluate the longevity of the toxicity of DDT residues in tree holes. Two water samples were taken from each of five tree holes in each of five olive groves which had been treated during the winter of 1951-52, and in each of five olive groves which had been treated during the winter of 1952-53, making a total of 100 samples. The water samples from each tree hole were of two types; one from the supernatant water and the other after the debris in the hole had been stirred up into the water. The samples obtained were emptied into individual, waxed cartons and taken to the laboratory where 10 fourth-instar *Aedes sierrensis* larvae were placed in each of them. These larvae had been obtained from untreated tree holes. Similar controls were made using water devoid of larvae from untreated tree holes, and larvae from the same source as used for the other samples. Counts of the surviving larvae were made after the third and seventh days; the findings are shown below:

LONGEVITY OF DDT RESIDUE TOXICITY IN TREE HOLES TO *AEDES SIERRENSIS*

	Days of Exposure Fall of 1953	Number of Live Larvae Sprayed 1951-52 5% DDT	Sprayed 1952-53 2.5% DDT	Not Sprayed
Supernatant Water	0	250	250	130
	3	41	88	129
	7	4	25	129
Stirred Water	0	250	250	130
	3	12	24	128
	7	7	12	125
TOTAL LARVAE	Exposed	500	500	260
	Surviving at 7 days	11	37	254

Field observations made in the spring of 1955 in the five treated groves did not reveal the presence of *Aedes sierrensis*.

4. Simulated tree holes, 3 ot 4 inches in diameter and 12 to 18 inches long, were made from the internodes of bamboo stalks, with the nodes forming the tops and bottoms. A ¾ inch entrance hole was provided by drilling through the side wall about 4 inches below the upper node. A cap to facilitate filling and examination was formed by sawing through the internode about 2 inches above the entrance hole. Ten of these simulated tree holes half full of water were hung in trees of an infested olive grove on March 15, 1953. Periodic examinations were made for eggs and to maintain the water level.

On May 25, 70 days later, they were removed. Examination showed that nine of the simulated tree holes had collected 38 clusters of singly laid eggs plus 80 separate single eggs, totaling 1,090 eggs. All the eggs were deposited within 0.5 inch of the water line. One simulated tree hole cracked and was discarded.

Summary and Conclusions.—The aquatic stages of the western tree hole mosquito *Aedes sierrensis* (Lud.), which frequently is a severe, spring pest in some areas of California, are found in the holes of a wide variety of trees and to some extent in other water holding receptacles. A series of over-lapping broods

breeding season, and from currently laid eggs which are produced each spring from eggs laid the previous have been subject to inundation. The eggs begin to hatch with the first fall rains and continue to do so throughout the winter. A single application of a spray containing 0.4 pound of DDT per gallon to tree holes and to other larval habitats will provide control for at least three years. Reinfestation has not occurred in majority of the completely treated groves of trees. Some olive groves have not become reinfested after eight years. One olive grove bordered by heavily infested oak trees has not become reinfested seven years after treatment. The presence of an infestation can be determined in the laboratory from sidewall scrapings and the bottom debris of potential larval habitats before the breeding commences. The reinfestation potential can be measured by the exposure of simulated tree holes.

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USE AND DEVELOPMENT OF GRANULAR INSECTICIDES IN THE KERN MOSQUITO ABATEMENT DISTRICT

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The Kern Mosquito Abatement District has for many years been interested in the use of granular formulations of pesticides for mosquito larviciding purposes.

Earliest trials in the District with such formulations were in 1950. These were made with DDT impregnated tobacco by-products applied by airplane. Results were erratic and disappointing. During the next several years other carriers and insecticides in various combinations were tried from time to time. Results continued to be inconsistent and disappointing.

Beginning in 1955, increased interest and emphasis was devoted to investigations of granular formulations. Annually thereafter proprietary formulations were tested in considerable number. The primary insecticide used was malathion; prepared with Attaclay, KWK, Attapulgite, Bentonite and Vermiculite. Trial applications were made using both aerial and ground equipment, usually with 5% malathion applied at a gross rate of 10 lbs. per acre.

By 1957, two formulations of malathion, one on Bentonite and the other on Attapulgite, proved sufficiently satisfactory that they were provided operators for standard use in many larviciding situations. During the years 1957, 1958, and 1959, these formulations were used in considerable quantity, applied in most instances with rotary hand seeders.

During this period, investigations disclosed that satisfactory results could be obtained when using a gross of 5 lbs. per acre, adjusting the percentage of toxicant to maintain the desired dosage rate.

Also during this period we were encountering an ever-increasing degree of malathion resistance. Parathion, the only other toxicant used by the District, continued to be extremely effective while being used only in liquid formulations. It was natural, therefore, that we turn our interest to the possibility of preparing this exceptionally fine mosquito larvicide in granular formulations.

First trials with parathion granules were in 1957, followed by an increasing number during 1958. In 1958, in cooperation with a number of mosquito abatement agencies, the University of California College of Agriculture at Riverside instituted basic studies on the problems of formulating granular insecticides for use in control of mosquitoes. Some of the early results of these studies (1), (2), (3), aided two chemical companies (4), (5), with whom we were working, to produce by 1959 two highly satisfactory malathion and parathion granules for mosquito control purposes. These were respectively, sand cores coated with the toxicant, and Attapulgite impregnated granules.

We have found the preferred granule size ranges from 8 to 28 mesh, depending upon how it is to be used and applied. The larger sizes for hand application and smaller sizes for airplane. With these formulations, the District began using more and more granular insecticides for hand larviciding purposes.

During 1959, approximately 3 tons of 5% malathion were used for general larviciding, This was applied with hand seeders at a rate of 10 lbs. per acre. An excess of 3 tons of 2% parathion granules, at 5 lbs. per acre were also used. Only limited amounts however, were applied by hand seeders, most going on by air. In addition and for comparative purposes, a small amount of 1% parathion granules, applied at 10 lbs. per acre, were used. This dosage and rate proved no more effective than the 5 lbs. of 2% material. Approximately 90% of the parathion granules were applied by airplane and power driven rotary seeders for continued evaluation of this pesticide in various formulations.

The 2% parathion formulations seemed to be the most promising tested. They proved to be extremely effective as larvicides when used at the 5 lb. rate or .1 lb. parathion per acre. In addition we found them to be equally effective when used as pre-hatch treatments at the same rates as when used for larviciding purposes. Many pre-hatch treatments were attempted, and all proved 100% effective. The longest interval of time between application and flooding was 19 days.

During 1960 we used only 2 tons of 5% malathion granules, but increased our use of parathion granules to more than 18 tons. This was the 2% formula, except for small amounts of 1% and 5% parathion for additional testing purposes. Both KWK and Attapulgite impregnated and sand core granules were utilized, with the sand core coated type accounting for more than 90% of the total.

Results were most gratifying. In May and June, following the lead of the Consolidated Mosquito Abatement District, we switched from the hand rotary seeders to the horn type seeder to afford maximum safety in handling the parathion granules. These seeders proved effective, easy to use, and in some instances, superior to the rotary type.

With both the horn seeder and the rotary seeder, we have found the effective swath to be 25 to 30 feet when using granules in the range of 8 to 20 mesh. Using the larger size granules, we found we could extend the swath width to a maximum of 40 feet under favorable conditions. Smaller sizes reduced the swath to 20 feet or less. The power seeder, Anderson Twin Rotar, developed an effective swath width of 50 feet.

In 1960 an excess of 10 tons of 2% parathion granules were applied by air as pre-hatch treatments at the 5 lb. per acre rate. Most of this was undertaken as routine application, but some additional trials were made. Results were extremely satisfactory. Of the total acreage treated, we found only 4 or 5 *Aedes* larvae, limited to 2 or 3 locations.

Again in the 1960 series of pre-hatch trials we attempted to determine how long the insecticide would remain effective in the interval between application and the time of flooding. Where in 1959 the longest interval attempted was 19 days, in 1960 we extended the interval between application and flooding to 140 days with excellent results.

Among 7 test locations treated, averaging 75 acres each, the average number of days from time of pre-hatch treatment to flooding was 95. Complete control of *Aedes* species was had in all these locations. *Culex* reinfestation appeared in approximately 7 days following flooding.

Limited trials for residual activity were attempted. Granules applied at 3 times the normal rate, or .3 lbs. parathion per acre, extended the time interval between treatment and larval reinfestation from 7 to 13 days. When applied at 12 times the normal rate, or 1.2 lbs. per acre, residual activity was prolonged to 43 days.

For airplane applications we have used a Stearman, equipped with a standard seeding type spreader and a slot gate, as well as a Pawnee with standard Piper equipment. The plane's swath widths varied with height of flight. At low level, or on the deck, the width was 33 feet, approximately that of the wing span. The width increased proportionately with the height of flight, reaching a practical maximum of a 66 foot swath at 50 feet. Heights above 50 feet did not increase the width of the swath. No evaluations were attempted on drift and effects of wind. It was observed however, that little problem was encountered even with gusty conditions up to 20 miles per hour. Penetration of vegetative canopy has proved very effective and larviciding results excellent.

Material costs with the highly satisfactory formulations available in 1960 were:

5% malathion—17½¢ per lb. or $1.75 per acre at the 10 lb. per acre rate.

2% parathion—15¢ per lb. or $.75 per acre at the 5 lb. rate.

Material costs alone are not a true and complete cost evaluation. There are other benefits and savings which tend to reduce the actual overall treatment cost per acre to a level fairly comparable with the emulsifiable formulations commonly used the past several years. Perhaps the greatest of these benfits can result from a savings in labor. We find that under most circumstances a man can treat approximately twice the acreage per hour when using granules applied with the horn seeder than when spraying with hand equipment. The rate of coverage can exceed that also obtained with power sprayers, except where the sprayers are driven in, through, and around the water area to be treated.

At the present time we feel that we are probably near the practical minimum limits for hand applications when applying a gross of 5 lbs. of granules per acre. Attempting to use much less poses a problem of adequate coverage. However, for airplane application, it may be possible that we can very considerably reduce the gross poundage per acre necessary for adequate coverage. At any rate we have indications that this might be done successfully, and we are presently aiming at a rate of 2 lbs. of 5% parathion per acre. Material costs for such applications would be: 5% parathion at approximately 17½¢ per lb., or $.35 per acre.

If this could be done, the added benefits realized from load factor of the plane could bring costs in comparative range with liquid parathion as applied today.

In my opinion, satisfactory formulations of granular insecticides, such as the 2% parathion we used in 1960, have many excellent advantages for mosquito control. I believe that with further improvements, we might in time see granules used more commonly than liquid formulations.

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(4) Niagara Chemical Company; Food Machine Corporation, Fresno, California.

(5) Durham Chemical Company, Los Angeles, California.

ORIGIN AND HISTORY OF THE "CALIFORNIA MIST MACHINE"

ROBERT H. PETERS[1], ERNEST CAMPBELL[2], LESTER R. BRUMBAUGH[3]

The "California mist machine" as it is now known, was originally referred to as a "wind machine" in 1948 when the first model was placed in use in the Northern San Joaquin County Mosquito Abatement District, Lodi, California, by Ernest Campbell, then manager of the district and currently manager of the Contra Costa Mosquito Abatement District. This machine was custom built with the aid of a local manufacturer of dusting machines and has been only recently retired in favor of improved models.

The need was recognized for the development of a low cost, blower-type insecticide unit which could be fitted to the limited cargo space of the Jeep and yet be light enough in weight to enable access to boggy areas of mosquito production. Previous to the development of this highly efficient spray unit, only the spray boom with its very limited swath, and the antiquated hose type sprayer (which usually requires two men to effectively operate) were being used to supplement air-spraying of mosquito sources in California.

Since 1949, Robert Peters, Manager of the Northern San Joaquin County Mosquito Abatement District with the assistance of shop mechanic J. L. Durham, has further developed and utilized the "California Mist Machine" to where every zone operator in this Agency now performs his mosquito control operation primarily with this unit.

In 1955, with the formation of the San Joaquin Mosquito Abatement District, Lester Brumbaugh, its manager, was quick to recognize the potentiality of this insecticide unit and with the aid of Leon Hall (recently deceased manager of the Fresno-Westside Mosquito Abatement District) and Carl Barben, shop mechanic, further development was contributed by members of this Agency with the assistance of Thomas D. Mulhern of the State Department of Public Health.

Various types of blower fans, housings and innovations have been developed and used during this period, with the power furnished either from power drive units or separate engines. At present, the use is rapidly "catching on" and there are now over fifty of these units in use in this State for both larviciding and adulticiding operations, using sprays, dusts and granules as conditions require.

The effective swath for spray larviciding varies from 40 to 75 feet; for granules, from 30 to 40 feet; for adulticiding, the effective range appears to be at least equal to smoke aerosols and does not require such limited atmospheric conditions for effective operations; for dusting, this unit is particularly effective for pretreatment operations with an extended range up to several hundred yards, dependent upon prevailing winds.

Consequently, the "California Mist Machine" has proven itself to be an extremely efficient one-man mosquito control unit of varied usage and low-cost operation.

In 1959, recognizing the further need for evaluation and standardization of this type of spray equipment the California Mosquito Control Association prevailed upon the State Department of Public Health to negotiate an analysis of the "California Mist Machine" by members of the Agricultural Engineering Department of the University of California, Davis. We are happy to indicate that such a study was initiated during 1960 under the direction of Mr. Norman Akesson of this department.

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Paper Presented at 1961 Joint Annual Meeting, American Mosquito Control Association and California Mosquito Control Association

A UTILITY MIST BLOWER FOR USE ON A JEEP OR PICK-UP TRUCK

THOMAS D. MULHERN[1], OSCAR V. LOPP[2] AND ROBERT H. PETERS[3]

The Merced County Mosquito Abatement District encompasses an area of 1,995 square miles. Much of this is potential mosquito producing area, having heavy or alkali soils and being well supplied with surface water. A large part of the irrigation system was developed before the knowledge of irrigation system design and operation had advanced to its present high level, so that it is common in many of the irrigated areas to find that water control and drainage are not adequate to remove excess water early enough after irrigation to prevent mosquito development.

To most effectively and economically provide reasonable mosquito control, the District has evolved a program that is extensive in concept and scope, with wide-flung operations proceeding simultaneously over much of its area. Two aspects are particularly emphasized; the securing of "source reduction" through the co-operation of the landholders, and the application of chemical larvicides by District forces.

The larviciding program is based principally upon the operation of a fleet of 4 specialized spray aircraft, equipped with spray devices particularly suited to the operations being carried on. Although even small fields (5 to 10 acres) are routinely treated by aircraft, a survey of the equipment needs and logistics of the operations made by the manager in 1959 revealed that there was an unmet need for additional insecticide application equipment to be mounted on ground vehicles. This would be used to supplement the air-spray operations in several ways: by larviciding in small areas or those where the aircraft could not operate because of the proximity of residential areas, and for adulticiding of fields where adult mosquitoes had emerged, and in emergencies, for adulticiding residential communities.

After studying the various types of spray machines available, and reviewing the performance of several

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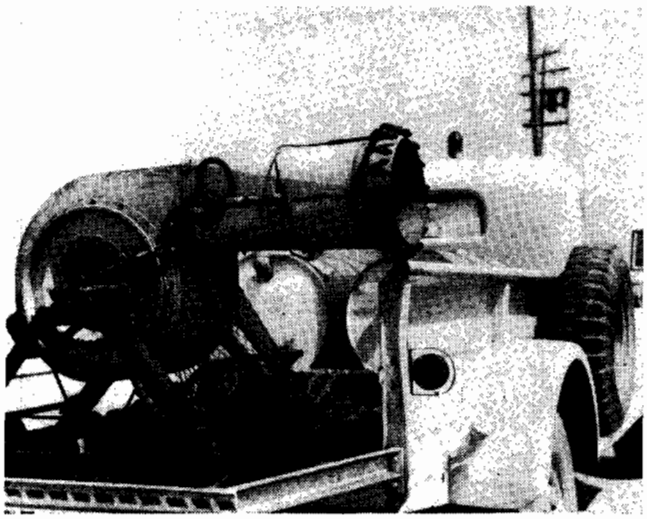
mist blowers already owned by the District, the conclusion was reached that two new mist blowers to supplement the existing equipment would best serve the purpose. Plans were made to build these, and to mount them on two 1955 Dodge Power Wagons, already in use by the District as utility vehicles. These will ultimately be replaced by Jeeps, so the mist blower bases were designed to fit the cargo space in a Jeep.

The manager, general foreman, and maintenance foreman of the District examined mist blowers of various sizes in use by other agencies, and decided that the larger, dual air wheel blower, built by the Northern San Joaquin Mosquito Abatement District would best suit the projected use. Therefore, two blower units of the same type and size were procured from the same supplier. Ideas for other features to be built into the new machines was an adaptation of the nozzle ring worked out with the San Joaquin Mosquito Abatement District, the use of a reversible electric motor for positioning the outlet "cannon" of the blower had first been seen on a blower built by the Sonoma Mosquito Abatement District, solenoid valves had been seen on spray machines used by the Consolidated and other mosquito abatement districts. A clutch of ample capacity was selected after conferring with several manufacturers' representatives and installed so as to permit stopping the blower while the insecticide pump operately continuously. A number of design and convenience features were worked out by Tom Derby, Maintenance Foreman, as he made and assembled the various components. These included an appropriate frame to support the various parts; two-way switches conveniently mounted on the dash of the truck to control the liquid flow to the nozzles, and the direction of the air flow; limit switches to stop the motor which positions the "cannon" when it reaches the limit of its travel; a screw type governor control to permit pre-selecting the precise speed at which the machines should operate; a permanently installed tachometer; paired insecticide supply tanks with appropriate valves to permit carrying two kinds of insecticides for operational use; and the strategic placement of lights to illuminate the key areas of the machine when operating at night.

No accurate information was available about the horsepower requirements of the fan, when used in an application of this type; hence an estimate had to be made. Since this machine might be operated continuously for as much as four hours at a time, drives of somewhat higher capacity were specified than would have otherwise been chosen. After completion of the machine, tests of an identical blower made at the University of California at Davis indicated that the power consumption was somewhat higher than estimated, and the drives, though of sufficient capacity for operation at the "normal operating speed," can be overloaded at the "maximum operating speed." Larger drives will be specified on any machines subsequently built.

The machine has given very satisfactory performance in 135 hours of field service, and will probably be scheduled for even more service during the coming year.



The principal significant specifications of the machines are as follows:

1. "Standard" engine speed while spraying "off the road" . . . . . 800 rpm.
   Speed maintained constant by screw type governor control, adjusted by reference to dash mounted tachometer.
2. Forward speed while operating "off the road," with engine at "standard" speed, transmission in low gear, transfer case in low range . . . . . 3.2 mph.
   Other traction speeds available, by changing gears without changing engine speed, are: 6.65, 12.1, 12.9, 20.4, 23.7, and 40.0 mph.
3. Power take off speed with engine at "standard speed" . . . . . 800 rpm.
4. Primary drive, power take-off to blower intermediate drive shaft:
   Drive-R sprocket – "Browning" #50P30, 30 T, ⅜" P., 800 rpm. Drive-N sprocket– "Browning" #50P15, 15 T, ⅜" P., 1600 rpm. Roller chain–"Browning" #50, ⅜" P., rated capacity at standard speed . 7.15 hp.
5. Secondary drive, blower intermediate drive shaft to blow head shaft:
   Drive-R sheave, "Dayton" #3BQ86, P.D. 8.40", on clutch sleeve, 1600 rpm. Clutch– "Rockford" #LMT5519, 1⅜" bore, with drive cup and sleeve, sleeve turned to 2½" diameter for mounting sheave, rated capacity 1.7 hp. per 100 rmp., runs at 1600 rpm. Drive-N sheave, on head shaft– "Browning" 3BK60, P.D. 5.40, 2200 rpm, 3 "Vee" belts, section "B," rated H.P. of drive at standard speed . . . . 9.9. hp.
6. Blower: dual high pressure air wheel, 16" diameter, similar to "Westinghouse" "509. Scroll case custom made, with dual air inlets and single air outlet, 11" diameter. Scroll case supported wholly by bearings fitted to a solid center web.

7. Control for positioning blower outlet "cannon" — Single pole double throw spring loaded toggle switch with center "off" position, located on dash. This actuates 6 volt D.C. reversible motor of the type used to raise and lower top of "Dodge" convertible coupe. This motor powers ½" roller chain drive which rotates blower case.

8. Insecticide control valve—Solenoid type, controlled by switch on dash board, Detroit Lubricator Company, Detroit, Michigan, #863, Type 3, Unit N8686, Maximum Press. 135 psi., stainless steel and bronze construction.

9. Nozzles, adulticiding—16 flat 70 degree fan spray nozzles, equally spaced about the periphery of the "cannon," at an angle of 22.5 degrees to the axis of the air column. "Monarch" nozzles, #F96-20, rated to deliver 59.2 gal./hr. at 60 psi.

10. Nozzles, larviciding—4 flat fan spray nozzles, located inside the throat of the "cannon." "Monarch" nozzles, #F96-59, rated to deliver 128 gal./hr. at 60 psi.

Air velocity tests were made at several motor speeds. A pitot tube was used for the highest velocities, at the throat and at the 2½ ft. location, and a velometer was used to measure the air speed at the 5, 10, 25, and 50 ft. locations. The following values were recorded:

TABLE 1

At various distances from throat-maximum readings

Air Velocity—Miles Per Hour

RPM		At Throat; Av. of 9 Pitot Tube Readings	2½ ft.	5 ft.	10 ft.	25 ft.	50 ft.
Motor	Blower						
500	1450	52.0	53.2	47.8	26.2	7.9	5.0
800	2250	82.0	84.0	68.4	46.5	21.0(?)	6.8
1000	2700	110.0	100.0	84.0	64.0	16.0(?)	6.8

Table 1 shows that at the "standard" engine speed of 800 rmp. an air velocity of 82 mph. is attained at the throat of the blower, and that this falls off to 6.8 mph. in fifty feet. About 1/10 second is required for the air to travel the first 10 feet, nearly 1 second to travel 20 feet, a little over 2 seconds to go 40 feet, and almost 4 seconds to go 60 feet.

The performance obtained appeared to confirm the selection of 800 rpm. as a moderate and reasonable speed to use as "standard." At this speed, the volume of air delivered at the 11" diameter throat of the cannon is 4650 cu. ft. per minute.

MOSQUITO ABATEMENT PROJECT MIST BLOWER STUDIES

NORMAN B. AKESSON*

In May of 1960, a fund of $3,000 was made available to the Agricultural Engineering Department by the State of California Bureau of Public Health to assist in conducting studies on the use of air carrier spray equipment for mosquito control spraying. This fund was continued for the 1960-1961 fiscal year.

The first phase of this program was a continuation of the studies on the blowers used for supplying the carrier air. A rough examination of the blowers the previous year had indicated the range of types being used and their relative operating characteristics. Because these blowers were not used under standard (NAFM) specifications, it was considered desirable to run approved tests with a proper tunnel to obtain their operating characteristics.

This has been done on four different units of the type commonly found in use by the Mosquito Abatement Districts, and details on these tests are available in our files. A summation of the tests, along with specific graphic presentation of data obtained, follows.

Data taken was: static and velocity pressure, with standard pilot tube and manometers. Both vertical and inclined manometers were used in order to obtain as high a degree of accuracy in the readings as possible. The tunnel section was 18 inches square with necessary adapters to the blowers and with an air damper at the discharge to control the pressure and discharge volume. Air temperature and humidity data were recorded and corrections for these factors were made where needed. From the air data taken, air horsepower was obtained as an output value.

The mechanical or input horsepower was obtained by the use of a Lima-Baldwin torque transducer, 0-200 inch-pound capacity. Torque recording was made on a Sanborn amplifier and recorder with a heat-type recorder chart. Some difficulty was experienced with this recorder since it had a high sensitivity to instantaneous torques and tended to record the impulses of each cylinder as it fired in the driving engine. Both mechanical and electrical torque smoothing devices

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were added, a flywheel to the blower, and suitable L-C filters on the torque meter.

Combined with the revolutions per minute, the torque data gave mechanical horsepower which was recorded as shaft input to the fan.

The following relations were used in all tests:

1. $P_{total} = P_{velocity} + P_{static}$
2. $\text{Velocity} = 1096 \frac{P_v}{G_{air}}$
3. $\text{Torque} = \frac{\text{mm deflection} \times \text{calibration constant}}{\text{mm scale} \times 12}$
4. $\text{Shaft hp} = \frac{\text{Torque} \times \text{rpm}}{33{,}000} \times 2 \quad P_{impact} = \text{Torque} \times \text{rmp} \times 0.00019$

Constants:

$K_1 = \frac{.075}{\text{air density (\#/cu ft)}}$ $K_2 = \frac{\text{std. rpm}}{\text{actual rpm}}$

$K_3 = (K_2)^2$ $K_4 = (K_2)^3$

cfm (cubic ft/min = Area (sq ft) × Velocity (ft/min)

$HP_{air} = .0001573 \times \text{cfm} \times P_{total}$ (inches water)

$Eff_{mech} = \frac{HP_{air}}{SHP}$ $Eff_{static} = E_m \frac{P_s}{P_t}$

The curves shown following, indicate: total pressure (P_t), shaft horsepower (Hp_s), and mechanical efficiency (Eff_m). Each of the four blowers listed as (1) Modesto, (2) Stockton, (3) Lodi single, and (4) Lodi double, were run at constant speed for a given set of changes in volume of air discharged. Then a different speed was taken for each, and another set of discharge volumes plotted.

The first runs (Fig. 1.) were with the Modesto fan. This is a relatively small wheel, double entry type, 8⅜" opening diameters with a wheel diameter of 15" and 10" in width. Notable here is the low mechanical efficiency of maximum 30%; the increasing efficiency as rpm (revolutions per minute) was increased; and the relatively low air output of 2000 cfm (cubic feet per minute) at 85 mph (miles per hour). This fan is usually operated at 2 or 3 hundred rpm higher, which would increase both the cfm (as a linear relation) and velocity (as the square). About 4 horsepower is needed to drive this fan at 3000 rmp, 2000 cfm and 85 mph discharge velocity.

The mechanical efficiency rose with increased rpm as it did for all the fans tested, except the top speed of the Lodi double fan. This presumably is a function of the fan design, and with specific output and velocity features, the fan could be designed to give greater efficiency. It is presumed that this fan would drop in efficiency at some given point in the higher rpm range.

The second fan tested (Fig. 2.) was the Stockton unit which had a Sturtevant 611 wheel in a MAD shop-built case. The wheel is 19¼ inches in diameter and 4 inches wide at the periphery. The single inlet was 10¼ inches in diameter as was also the outlet. Maximum efficiency of about 45% was obtained at 2400 rpm. At this speed and at 3500 cfm, the velocity was 103 mph and the horsepower was 5.4. Normally, this fan is also run at about 200 rmp higher which would increase each of the above factors.

An examination of the data published by the manufacturer of the Sturtevant fans indicates that with proper installation, mechanical efficiencies as high as 80% can be realized. That we are not getting more than 45%, indicates we are using nearly twice as much horsepower as engine size than we need to. While it is unlikely that our portable field use of these fans could give as high efficiencies as stationery and possibly ducted installations, it is nevertheless believed that a considerable increase in efficiency could be obtained with more careful design considerations. The efficiency problem is twofold: First, these type fans have best efficiency at 6 to 12 inches static pressure. Since we are discharging into free air with little nozzling we are operating them at low static. This could be improved then by building static pressure in the fan and converting to velocity pressure by a nozzle. However, nozzle losses occur when this is done. The second problem is caused by placing nozzles in and discharging spray into the air stream. Still a third problem arises from the blower outlet being smaller than the duct, which causes a higher static pressure in the fan case than in the duct. It is plainly evident that further information on characteristics of the air column and spray load it must carry needs to be known before most efficient operation can be found.

The next runs were made with fans from the Lodi district. The first (Fig. 3.) was a single 9-inch diameter entry fan with a 6 × 6¾ inch rectangular outlet. The wheel is 17½ inches in diameter and is 4 inches

wide at the periphery. The second unit (Fig. 4.) is a combination of 2 wheels like the first, side by side in a single case. The inlets are two of 8½ inch diameter and the discharge is 12¾ × 8⅜ inches .

The characteristics of these two are quite different in that the double wheel cannot be simply described in the relation of two single wheels. For example, the following indicates the variable characteristics:

at 2000 rpm and 4" P_t (90 mph discharge velocity if 100% conversion is assumed)

	cfm	*hp*	*eff*
Single wheel	1600	3	38
Double wheel	4500	8.3	33

at 2800 rpm and 8" P_t (127 mph)

	cfm	*hp*	*eff*
Single wheel	1800	5	27
Double wheel	6200	18	40

Principally, the above shows the essential nature of operating the fans at their proper speed and for their proper design. The maximum efficiency of the single unit was 40%, at 3000 rpm, 2200 cfm and 125 mph. The maximum efficiency of the double wheel was 55% at 2500 rpm, 4600 cfm, and 140 mph. It is to be noted that operating the double fan at 2800 rpm reduced the maximum efficiency to 48%.

The problem of what air volume and velocity to use for obtaining the best spraying results cannot easily be determined.

It is also difficult to determine how the hp input is effected by change in cfm or velocity alone since if one is varied, it normally effects the other. Since this change will alter the fan characteristics, it is easy to move off the peak of the efficiency curve and thus a sacrifice in efficiency may take place.

The energy in a moving air column is directly related to the mass or volume of air being moved, but is proportional to the square of the velocity with which it moves. Thus, theoretically to double the volume, doubles the energy or power involved, but multiplies the energy by 4 if the pressure or velocity are doubled. Thus, again theoretically, the energy in a moving column of air can be most rapidly increased by increasing its velocity.

Now the higher the velocity the greater distance a column of air can be forced through still air, and the greater the volume, the wider the column of air becomes. However, this is likely to be an over-simplification since increasing the velocity increases turbulence factors which dissipate the velocity energy at an increasing rate. Thus, it is likely that balance of volume and velocity is necessary in order to achieve the movement of an air column through still air. This in turn is further complicated by the need for carrying in this column of air the spray particles for depositing at some distance out from the sprayer.

It is expected that work will continue on the fans investigating a given fan for design characteristics and also the movement and distance of the air column and its ability to carry spray material. While the squirrel cage type fan has highest efficiency (relative to other fan design) at free air or low static pressure discharge, the normal discharge velocity of the squirrel cage type is too low for our use. Axial flow fans may be an answer, but not only must we have the proper air velocity-discharge relation, we must also have fans of compact type and at reasonable cost.

FIGURE 1

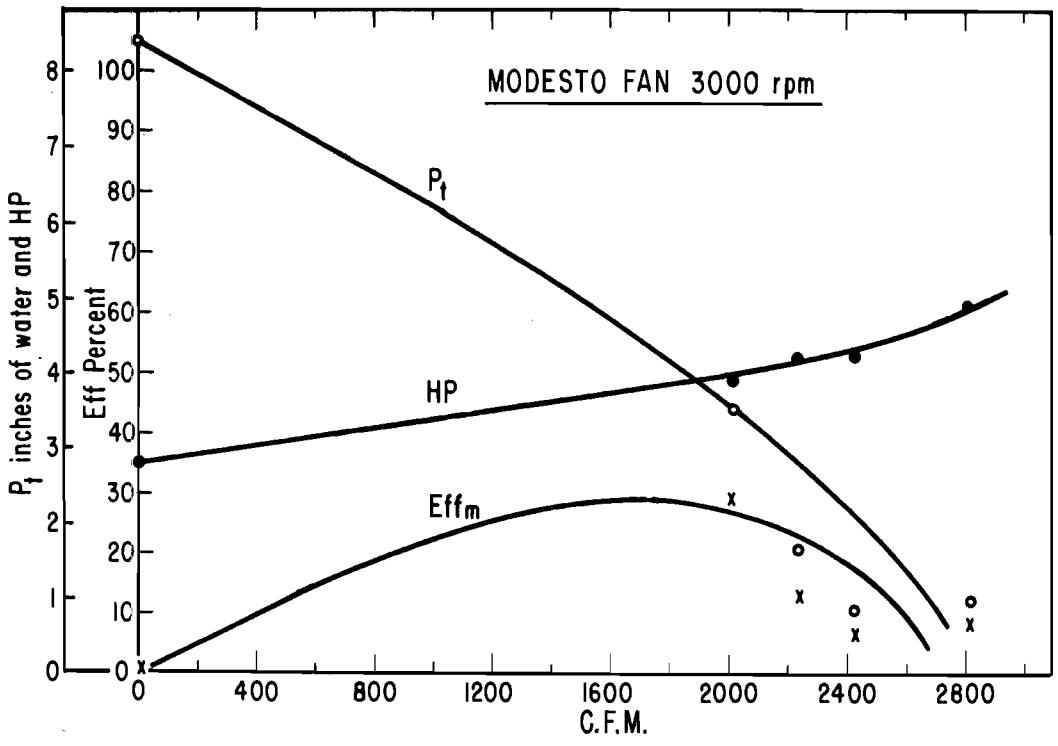


FIGURE 2

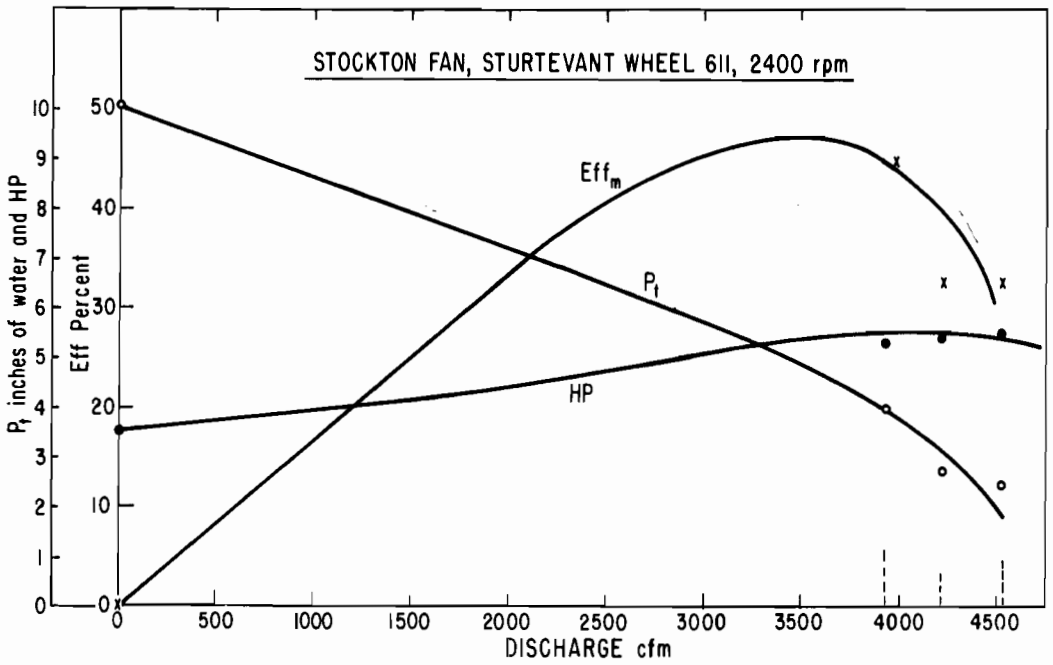


FIGURE 3

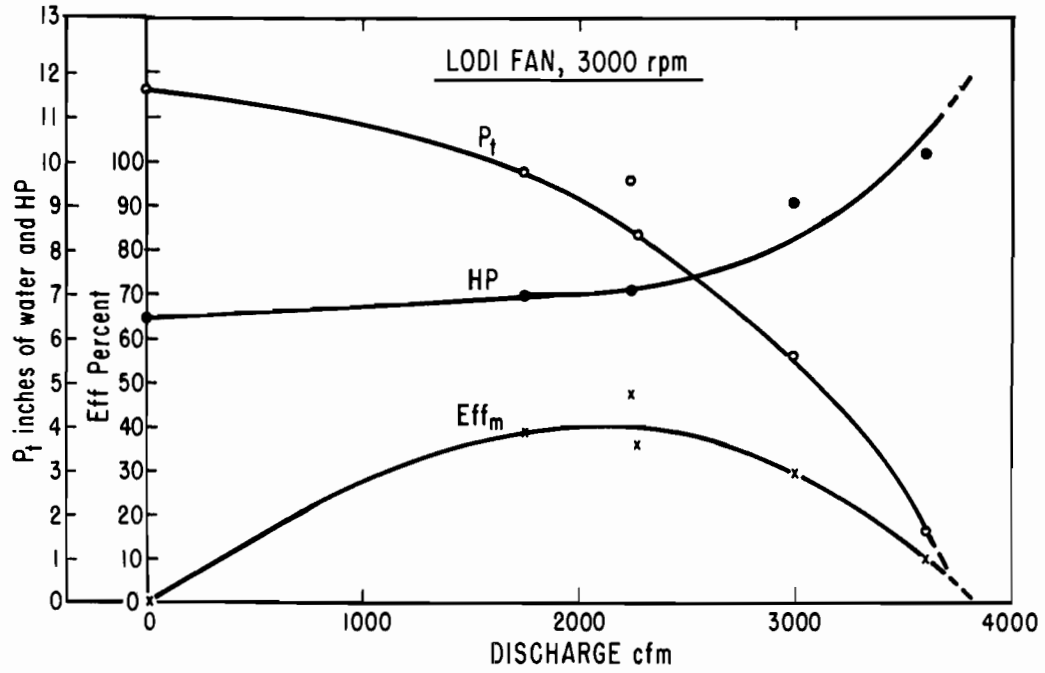
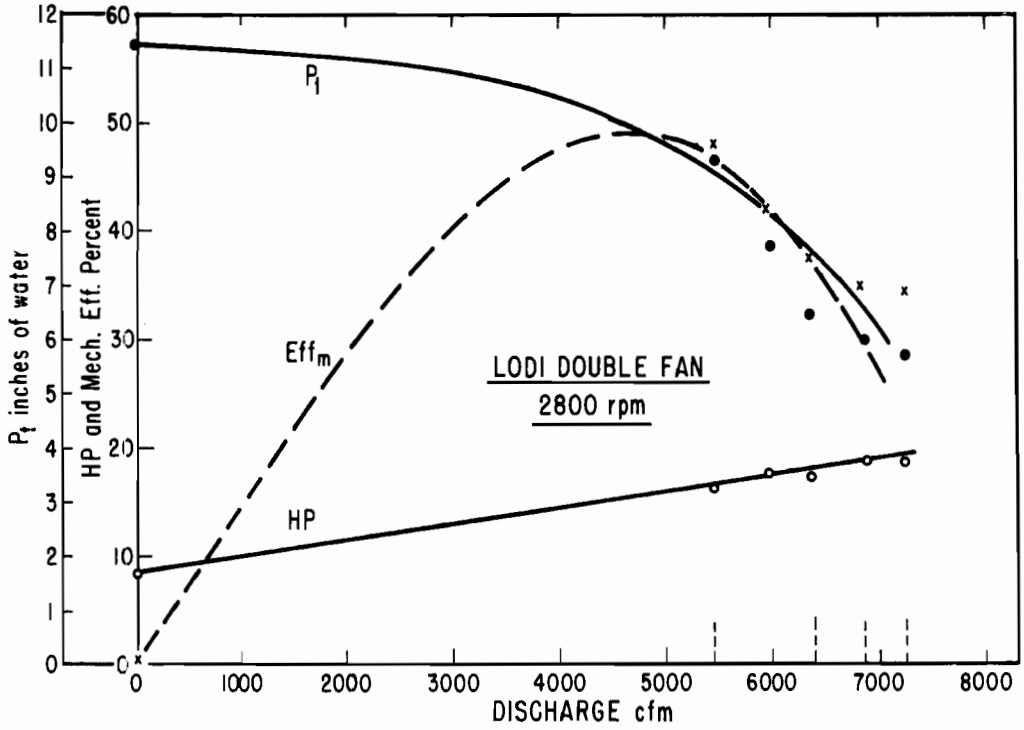


FIGURE 4



LAGOONS FOR SEWAGE, OTHER WASTES—AND MOSQUITOES[1]

WILLIAM E. BICKLEY AND JERRY MALLACK

Department of Entomology, Maryland State Board of Agriculture and University of Maryland

For several years there has been an increase in the number of sewage stabilization ponds or so-called oxidation ponds or lagoons. Until recently most of them were in the Missouri and Mississippi basins, but now they are being promoted in the East by various health and public works agencies because they appear to offer an economical method of sewage disposal for small communities. These ponds are designed to receive raw sewage and differ from sludge lagoons.

Wray (1959) discussed the control of *Culex pipiens* in sludge lagoons which are used for storage of activated sludge from sewage treatment plants near Chicago. These lagoons provide ideal conditions for *Culex* larvae. Control with chlorinated hydrocarbon insecticides has been extremely difficult at times. It appears that fuel oil mixtures are more effective than applications of granules or emulsions.

Mosquito problems in sewage stabilization ponds in the Dakotas were reviewed by Beadle and Harmston (1959). A survey reported in Public Works (Anonymous, 1959) showed that these ponds were in use in more than 650 cities in 1959. Beadle and Rowe (1960) have furnished an excellent resume of data on mosquito production in lagoons. Their studies have established the fact that in the Midwest and Southwest *Culex tarsalis* Coq., *C. pipiens pipiens* L. and *C. pipiens quinquefasciatus* say are often abundant in sewage lagoons. In many cases the numbers of mosquitoes are of real significance.

One of the points that Beadle and Rowe (1960) emphasized is the direct correlation between weeds and numbers of mosquito larvae. The weeds involved are both terrestrial plants along the shore and aquatic plants. It has been common knowledge that vegetation encourages mosquito development by protecting the larvae from fish. In the absence of fish one wonders why vegetation is so beneficial to the larvae. To minimize mosquito production, lagoons should be filled promptly after construction so that weed growth will be prevented. Lagoons should be designed so that the water level can be regulated. This in turn facilitates weed control and occasional killing of larvae by rapid draw-down. Another important consideration in design is provision for dikes wide enough to accommodate mowing, herbiciding and larviciding equipment.

Mosquito control workers faced with actual or potential sewage lagoon problems will find that the report by Beadle and Rowe (1960) is very helpful.

Comparable to sewage lagoons are those used for cannery wastes. The concentration of vegetable wastes —such as those resulting from the processing of corn, tomatoes or snap beans—is greater than the concentration of sewage in the usual sewage lagoon. There is another major difference. Properly operated sewage lagoons are stabilized with about the same amount of liquid moving in and out, whereas, lagoons for cannery wastes are filled in the summer and drained the fol-

[1] Miscellaneous Article No. 408, Contribution No. 3209 of the Maryland Agricultural Experiment Station.

lowing spring. Stabilization does not take place. These cannery lagoons almost invariably produce large numbers of mosquitoes.

Bickley (1955) described insecticide treatments of an eight-acre pond at Westminster, Maryland, to control *Culex pipiens*. It appeared that EPN (Ethyl p-nitrophenyl thionobenzene phosphonate) was superior to DDT. The larval population was found to be at a low level for nine days after EPN treatment. Interest in this pond was renewed in 1960. Plans were made to treat the pond early enough and often enough to prevent the development of mosquitoes in the tremendous numbers usually present.

Observations began early in June when only about one acre was flooded. Granular material was applied over the entire area as a sort of pre-hatch treatment. Table 1 shows the applications made, June to September. After the initial treatment the insecticides were applied as emulsions. Table 1 also gives information about the larval population. The first two treatments appeared to prevent larval development to some extent because *Culex* larvae were present at other sites during June. The DDT treatment on July 11 also appeared to be partially effective. However, after the middle of July satisfactory control was never attained.

The chlorinated hydrocarbons even though applied in fantastically large quantities were evidently rendered inffective by the heavy concentration of vegetable wastes. As the rate of bacterial decomposition increased, the effectiveness of the insecticides decreased. Canning wastes from corn are especially conducive to development of *Culex* larvae. It is virtually impossible to stop them with chlorinated hydrocarbons. This pond was a little more than nine acres in area with an average depth of about 4.5 feet at maximum capacity. The total volume of liquid was estimated to be about 14,370,000 gallons. The theoretical accumulative concentration of insecticides added was 2.05 parts per million.

TABLE 1.

LARVAL POPULATION AND INSECTICIDAL TREATMENTS OF WESTMINSTER LAGOON, 1960

Date	Avg. larvae per dip	Insecticide	Total pounds actual toxicants (± 9 acres)
June 2	None	DDT, dieldrin, aldrin	17
June 17	None		
July 6	1.5		
July 11		DDT	60
July 20	2.5		
July 25		heptachlor, aldrin	30
Aug. 3	17.5	aldrin	20
Aug. 8	20	dieldrin, aldrin, heptachlor, endrin	56
Aug. 9	None	dieldrin, aldrin	16
Aug. 22	55	BHC	12
Sept. 2		BHC	15
Sept. 8	17.5	BHC	18
		Total chlorinated hydrocarbons:	244

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MOSQUITO CONTROL AROUND THE WORLD BY DREDGING

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While mosquitoes are limited in the distance they travel, nevertheless they are found all over the world. Needless to say they are the same pest no matter where found. Many of you here today are faced with the problem of how best to eliminate this pest. We all agree the breeding places are the areas to be attacked.

There are several methods or ways to attack these breeding places. Conditions usually dictate the most practical method to follow. Many past experiences have proved that one of the best means for a permanent correction is the use of the hydraulic dredge.

In the time limited for this paper only highlights can be given of the successful applications of the hydraulic dredge.

Ohio

A contract is now in process for a DRAGON model 8-inch portable hydraulic dredge for the Toledo Area Sanitary District. It will be used in the widening and deepening of a creek about 8 to 10 miles long which runs through a heavily populated area. This area has been subjected to three or four flash floods each year which overrun the banks of this creek, because the creek is shallow due to a gradual depositing of silt and sand. The overflow water covers the low adjacent park lands permitting the hatching of mosquitoes to create a nuisance for the adjoining residential areas. The dredged materials will be used to build up the adjacent lands which in this case will produce more and better park facilities and assure sufficient capacity of the creek to quickly carry off the abnormal quantities of water. The expenditures for this project will pay big dividends to the City and greatly improve the health conditions in the City of Toledo, which can not be expressed on a monetary basis.

There are several projects worthy of mentioning which are all located in the Eastern and Southeastern parts of the United States, and many of you may be familiar with at least some of these.

New Jersey

In 1939, after using other methods of elimination, the Morris and Essex Counties of New Jersey made use of one of our 10-inch portable dredges. Sixteen miles of river have been widened and deepened by

dredging. This has brought under control the mosquito breeding in that area where at present more than two million people live.

Also in New Jersey, Mercer County, wherein is located the State capital of Trenton, found hydraulic dredging to be an economical solution to a similar problem. Swamp areas have had streams opened through them to effect proper drainage, and, at present, the unit which is now shown on the screen is dredging a lake to allow for drainage water storage and to improve recreation areas. This model dredge was designed especially for use in narrow canals.

Florida

Florida has seen lots of action in making use of dredges to eliminate mosquito breeding places.

In 1953 in Brevard County, a 10-inch DRAGON model portable hydraulic dredge was put into service. In the first four and a half months, 97 acres of breeding area had been eliminated at a field operating cost of only $12.86 per hour. So successful was this project that in September of 1955 a second similar unit was purchased and began operation several months later. By October 1, 1959 the two dredges had moved more than three-million cubic yards to fill 1,603 acres at an unbelievably low average cost.

Volusia County in Florida, whose principal city is Daytona Beach, purchased a similar 10-inch dredge in July, 1953, putting it in operation near the end of that year. This dredge is shown now on the screen. This dredge had to dig gumbo clay in addition to sand, silt and mud, and averaged over 200 cubic yards per hour at a very low operating cost. Now over 500 acres of breeding area do not exisxt any longer.

Again in Florida, Indian River County, in which is located Vero Beach, has been applying hydraulic dredging since 1954 with results paralleling the other Florida operations.

Finally, in Polk County, Florida, there was a 6-inch DRAGON model hydraulic dredge cleaning out a swamp for rapid drainage during the rainy season, although problems were encountered due to the area being interlaced with submerged roots and other obstacles, the work has been completed.

California

We in the West have not seen such special mosquito control work being carried on. However, there is one project near Blythe, California where the Palo Verde Irrigation District is now making use of a 10-inch DRAGON model portable hydraulic dredge to deepen their drainage canals where the land was becoming marshy and a mosquito breeding nuisance.

Now let's look at projects outside our Country.

Canada

Eight years ago a 6-inch Canal DRAGON model portable dredge was used in Canada by the Prairie Farm Rehabilitation Administration for re-silting 800 miles of canal drainage and irrigation system, and created new canals in Saskatchewan for the farmers. As with all such swamp land projects, the secondary benefits involve elimination of mosquitoes and general improvement to health and economic welfare of the area.

Viet Nam

Approximately four weeks ago today one of our field erecting engineers obtained the acceptance of two 12-inch Canal DRAGON model portable dredges in Saigon, Veit Nam. He carried on his training of native operators just outside of Siagon due to the conditions existing there now.

Indonesia

Due to the marshy conditions on the several islands of Indonesia and the large population, more dredges are working there than in other foreign countries. Many of these dredges have been working for several years draining swamps for the dual purpose of elimination of mosquitoes and reclaiming large acreages. It is interesting to note that, as far as I know, the largest dredge used for this purpose was the MUSI, a 22-inch hydraulic dredge. At times it has been used for creating proper drainage in large swampy areas to eliminate the mosquito breeding places near Djakerta.

Colombia

In Colombia, South America, in a so-called "black zone" of the city of Barranquilla, large areas were polluted by open sewers and the flood waters of the Magdalene River. A study proved hydraulic dredging to be the most practical and permanent cure for the mosquito breeding area troubles. In the summer of 1947, a 12-inch DRAGON model portable dredge was put into operation. It was assisted by another one of our dredges then in service in Colombia. In approximately three years the 12-inch dredge had pumped over one million cubic yeards of fill, and today the area has been developed for industrial purposes with the mosquito breeding eliminated.

The above projects were selected as examples where hydraulic dredges have proven most effective in the permanent control of mosquitoes.

It may be possible for two or more of your local abatement organizations having mosquito breeding area problems to join in the securing and operation of a suitable portable dredge as was done in the case of the two New Jersey counties. These dredges are very portable, and quickly and cheaply moved from one area to another.

Our Corporation has had many years of experience with the unusually severe dredging conditions often met with in this work, and have designed and proven the DRAGON model portable dredges with special strength of the critical parts to insure low cost of operation.

RECENT CHANGES IN *AEDES NIGROMACULIS* (LUDLOW) POPULATIONS IN THE SALT LAKE CITY MOSQUITO ABATEMENT DISTRICT

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Changes in mosquito population levels, both in numbers and in kinds, are continually taking place. From the standpoint of good mosquito control it is important that a district be aware of these changes and modify, if necessary, control methods and procedures in order to accomplish most effectively its purpose.

A conspicuous increase has taken place in recent years in the *Aedes nigromaculis* population in the vicinity of Salt Lake City. This species was present at the time mosquito abatement work was started in Salt Lake City and vicinity in the late twenties, but available records indicate that very few collections were reported as a result of these early surveys. Rees (1930) stated that *Aedes nigromaculis* was found in limited numbers west of Salt Lake City during the 1930 control season. It was not until 1935 that it was again mentioned as occurring in the Salt Lake City Mosquito Abatement District. During the seventeen-year period from 1935 to 1952 this species was taken in light trap collections on only two occasions, once in 1945 and again in 1948. Extensive larval collections made by Rees, Nielsen, and others during this period also indicate that this species was very rare in the vicinity of Salt Lake City.

Two sizable sources of *Aedes nigromaculis* were found in Salt Lake County in 1953, and although they were successfully controlled before the adults created a serious annoyance, a considerable number of adults were present in these localized areas. This was the first time this species had been recorded as occurring in any significant numbers in the county. Rees (1954) in reporting this situation made the following statement: "Is this a remnant of a species disappearing from the area under mosquito abatement pressures or is it a recent revival of this species which may develop into a major control problem such as exists in parts of California where this species has recently made an appearance."

Graham, et al., (1958) reported that larval surveys conducted by the South Salt Lake County Mosquito Abatement District showed a steady increase during 1957 and 1958 in the number of larval collections of *Aedes nigromaculis* occurring as compared with the numbers in 1956. Current survey records in this district, as reported by Graham, indicate there was a decline in larval numbers in 1959 and 1960 as compared with previous years.

Since 1953 the Salt Lake City Mosquito Abatement District has experienced an increase in the population level of *Aedes nigromaculis* as shown by light trap and biting collections, and larval samples; the increase has been more notable during 1959 and 1960.

During July, 1958, an outbreak of *Aedes nigromaculis* occurred in the Buena Vista area on the west side of Salt Lake City. These mosquitoes were produced in two rather small areas that had been overlooked by the inspector responsible for that sector. The adults were very annoying and persisted in this localized area for approximately three weeks. From this area there appears to have been a spread of this species over the past two years along the west side of the irrigated parts of the district. Unfortunately, in most of this area irrigation water is poorly managed with excessive water being used and inadequate drainage provided; thus, an ideal situation for the production of *A. nigromaculis* is created.

It is difficult to determine why this species which was present at least thirty years ago in the district should show a pronounced increase in numbers during the past few years, especially since there has been no appreciable change in agricultural practices in the area.

The possibility that this species may become a major control problem is of considerable concern to mosquito abatement personnel in the Salt Lake City District.

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