Copies of the Proceedings of the Utah Mosquito Abatement Association were not made for the first, second, and fourth meetings. However, all of the manuscripts that were submitted were saved as well as copies of the programs. There is no complete record of these Proceedings but all of the available material is included in this volume and should be of interest to all who are interested in the history and development of mosquito control in Utah and the Utah Mosquito Abatement Association.

PROCEEDINGS OF THE

FIRST ANNUAL MEETING

of the

UTAH MOSQUITO ABATEMENT ASSOCIATION

held at the

SALT LAKE TRIBUNE AUDITORIUM

143 SO. MAIN

SALT LAKE CITY, UTAH

SATURDAY MARCH 20, 1948

UTAH MOSQUITO ABATEMENT ASSOCIATION

P. O. BOX 307

MIDVALE, UTAH

PROGRAM

9:00 A.M. Address of Welcome. T. A. Schoenfeld-President, Board of Trustees, Salt Lake City Mosquito Abatement District.

9:15 A.M. Election of Temporary Chairman.

9:20 A.M. Paper -- "Importance of Mosquitoes as Pests and Vectors of Disease, With Special Reference to Utah." Dr. George F. Knowlton, Professor of Entomology, U.S.A.C. Logan, Utah.

9:40 A.M. Paper -- "History and Development of Mosquito Control Work Throughout the World." Arden R. Gaufin, Instructor, Zoology, University of Utah.

10:00 A.M. Paper -- "History of Mosquito Control Work in Utah." Karl D. Hardy, Member of Board of Trustees of Salt Lake City Mosquito Abatement District.

10:10 A.M. Paper -- "Mosquito Problems of the State Health Department." Dr. W. W. Bigelow, Acting State Health Commissioner.

10:30 A.M. Recess.

10:40 A.M. Paper -- "Problems of a Mosquito Abatement District." Dr. Don M. Rees, Entomologist, University of Utah.

11:00 A.M. Business Meeting.

Recess for Lunch.

1:30 P.M. Paper -- "Report of the Box Elder County Mosquito Abatement District." Supervisor, Karl F. Josephson.

Paper -- "Report of the Magna Mosquito Control District." Supervisor, Clem Toone.

Paper -- "Report of the Weber County Mosquito Abatement District." Supervisor, Dr. O. Whitney Young, Zoology Department, Weber College.

Paper -- "Report of the Salt Lake City Mosquito Abatement District." Supervisor, Robert A. Wilkins.

Discussion Period.

3:00 P.M. Field Inspection Tour conducted by Robert A. Wilkins.

PROBLEMS OF A MOSQUITO ABATEMENT DISTRICT

Don M. Rees, Ph.D.
Entomologist, Salt Lake City Mosquito Abatement District
Professor of Zoology, University of Utah

In order to consider the problems of a mosquito abatement district the purpose of such an organization should be defined. It is apparent from the title that the purpose is to abate, or if more optimistic, to control mosquitoes in a certain area, the boundaries of which are established by the legal boundaries of the district.

The success of this endeavor is dependent upon a great many factors, each of which presents numerous problems that must be solved in order to obtain the desired results. Mosquito abatement work is, therefore, a very extensive and complex program made up of many problems that must be given individual attention and over-all coordination. The extent to which this can be accomplished determines the degree of effectiveness of the control program.

In Utah we now have four organized mosquito abatement districts and I am confident there will be others that will organize. We, as the personnel of these districts, have agreed to provide a public service that the people demand. We know it can be done and we would like to do the best job possible with the least expenditure of money. That is the purpose of this meeting today, to advance the cause of mosquito abatement work in Utah. To do this we must work together to solve our common problems. It is true that each district has it's own problems, peculiar to that district, but it is equally true that they are common problems of mosquito control found in all districts. I shall try to review in this paper some of these problems of common interest and their best known solutions. This information has been obtained by experimental research and from practical experience of mosquito control workers from all of the world. I hope we can profit from this information as experience is always a hard and costly teacher.

Mosquito abatement, like any planned attack on a natural enemy of man, may be attempted from several different angles. Numerous methods have been tried and all of them are effective to a certain extent. A single method of attack may eventually prove successful, providing sufficient funds are available to supply the necessary labor

and equipment. However, some control methods are too costly and the results too uncertain to be practical. Mosquito abatement is a combination of several methods adopted because of the different life histories of the various species of mosquitoes involved and the different kinds of situations in which they are produced.

It is recognized good strategy when fighting an enemy to strike at the weakest point of defense. In mosquito abatement work there are two possibilities for attacking the enemy: (1) to remove the water in which mosquitoes develop; (2) destroy the insect. As mosquitoes can develop only in standing or slow-moving water, the removal or regulation of mosquito-producing waters is not always practical or even desirable; but when feasible it is usually the most effective and inexpensive method.

The removal of mosquito-producing waters is desirable, when possible, because it is a preventive rather than a curative measure. This is logical, and in harmony with all modern scientific methods of control.

The second major method, that of destroying the insect, is essential when it is impractical to remove the producing waters. It is desirable in considering this phase of the program to determine the most vulnerable point in the life cycle of mosquitoes and direct the attack at this point.

It is not practical to destroy adult mosquitoes after they have left their breeding waters and scattered far and wide in search of food. The destruction of adults has been tried by some pioneers in mosquito control work, but the results have been unsatisfactory. No effective, inexpensive method has yet been devised for collecting and destroying adult female mosquitoes once they have become scattered. However, DDT, TDE, and Parathion have been used very effectively as residual chemicals for killing adults under certain conditions, and pyrethum, thanite and other chemicals have their place as "knock down" adulticides. These adulticides are only part of a well balanced mosquito abatement program and should not be relied upon as a principal method of control.

The same problems are present in the selection and use of larvicides. So many new chemicals are now available such as DDT, TDE,

Parathion, Benzene-hexachloride, and others, that it is difficult to make a selection. Most of these larvicides are a great improvement over anything available a few years ago, however, it is advisable to try them out on a small scale first until you learn how to use them properly and find out if they are adaptable to conditions in your own district. The same can be said about the equipment used in the application of these insecticides. The machines for spraying, fogging, dusting, ditching, and the use of dynamite all have their place in a well organized mosquito control program but do not forget the hand spray pump and the shovel are still indispensable under certain conditions.

With all these new developments in mosquito abatement work the control of mosquitoes should be assured. There are no physical or mechanical reasons why mosquito abatement work should not be successful. The degree of success or failure of the work, therefore, rests upon the human factor, which brings us to the responsibility of the mosquito control workers.

First - The Board of Trustees constitute the governing body of the district and all authority for the control program is vested in this board. The members therefore, should become acquainted with the general principles and modern methods of mosquito control and they should become thoroughly familiar with the operation and control problems within their own district.

Second - The supervisor of the district is directly responsible for the degree of success attained in control work. He must be able to coordinate the entire program to obtain the best results for the least expenditure of funds. This requires an understanding of mosquito control principles and methods and a desire to constantly improve on existing conditions. It also requires daily planning and supervision to do the right thing at the right time, in the right place. Mosquito control work requires careful planning in advance and continuous, diligent effort every day throughout the mosquito season.. Anything short of this will never result in maximum control.

Third - The inspectors and field men must understand the principles of the mosquito control and feel a direct responsibility for the job they are doing. These men daily meet the public and actually put the control measures into operation.

PROCEEDINGS OF THE

SECOND ANNUAL MEETING

of the

UTAH MOSQUITO ABATEMENT ASSOCIATION

held at the

LITTLE THEATRE

UNION BUILDING

UNIVERSITY OF UTAH

SALT LAKE CITY, UTAH

MARCH 18-19, 1949

PUBLIC INVITED

UTAH MOSQUITO ABATEMENT ASSOCIATION

P.O. BOX 307

MIDVALE, UTAH

PROGRAM

Friday, March 18. Morning

Technical Session

9:00 "Address of Welcome." Karl D. Hardy-President, Salt Lake City Mosquito Abatement District.

9:10 Announcements - Introduction of Guests.

9:20 "Mosquito Control Problems in Utah." George F. Edmunds, Invertebrate Zoology, University of Utah.

9:30 Discussion.

9:35 "Essentials of an Effective Mosquito Abatement Program." S. D. Durrant, Vertebrate Zoology, University of Utah.

9:45 Discussion.

9:50 "New Insecticides and Equipment: Their Use and Limitations in Mosquito Abatement." Arthur H. Geib, Manager, Kern County Mosquito Abatement District, California.

10:05 Discussion.

10:10 "Pre-Hatch Treatment for Mosquito Control." T. G. Raley, Manager, Consolidated Mosquito Abatement District, California.

10:25 Discussion.

10:30 Recess - 10 minutes.

10:40 "The Use of Gambusia in a Mosquito Abatement Program." Arden R. Gaufin, Zoology, University of Utah.

10:50 Discussion.

10:55 "Effective Use of Light Traps in Mosquito Abatement Work." S. Mulaik, Invertebrate Zoology, University of Utah.

11:05 Discussion.

11:10 "An Attempt ot Control the Biting Black Gnat, Holoconops kerteszi var. americana Carter, In North Salt Lake City." James V. Smith, Assistant in Entomology, University of Utah.

11:20 Discussion.

11:30 Business Meeting.

Noon Recess.

Afternoon Session March 18

1:30 "The Affect of Mosquito Abatement on the Honey Industry." George F. Knowlton, Entomologist, Utah State Agricultural College.

1:45 Discussion.

1:50 "Mosquito Abatement as it May Affect Insect Populations." G. E. Bohart, Entomologist, Utah State Agricultural College.

2:05 Discussion

2:10 "Mosquito Abatement in Relation to Agriculture." Don R. Merkley, Entomologist, State Department of Agriculture.

2:25 Discussion.

2:30 "Mosquito Abatement in Relation to Wild Life." Jack H. Berryman, Assistant Federal Aid Coordinator, Utah State Fish and Game.

2:45 Discussion.

2:50 Recess - 10 minutes.

3:00 "Rice Field Problems of Mosquito Control." T. M. Sperbeck, Manager, Sutter-Yuba Mosquito Abatement District, California.

3:15 Discussion.

3:20 "Mosquito Control in the Mountains of Utah." Illustrated. Lewis T. Nielsen, Invertebrate Zoology, University of Utah.

3:35 Discussion.

3:45 Adjournment.

Please confine your papers or remarks to the time limit indicated on the program, otherwise you will unintentionally take time allotted to other speakers. A copy of all papers presented must be turned over to the presiding officer at the time of presentation.

General Sessions March 19, 1949

Saturday

Morning Session

9:00 "Address of Welcome." Dr. A. Ray Olpin, President, University of Utah.

9:15 "Cooperation Between Salt Lake City, County, and Mosquito Abatement District." Honorable Earl J. Glade, Mayor, Salt Lake City.

9:30 "The Flood Control Program in Relation to Mosquito Abatement." Honorable Ray P. Greenwood, Commissioner, Salt Lake County.

9:45 "The Purpose and Value of Mosquito Control Meetings." Harold F. Gray, President, American Mosquito Control Association.

10:05 Discussion.

10:10 "History and Development of Mosquito Abatement in Utah." Don M. Rees, President, Utah Mosquito Abatement Association.

10:20 "The Program of the Utah Mosquito Abatement Association." Roy F. Tygesen, Secretary-Treasurer, Utah Mosquito Abatement Association.

10:30 Discussion.

Recess.

10:40 "The State Health Department and the Mosquito Abatement Program." W. W. Biglow, M. D., State Health Commissioner.

10:55 Discussion.

11:00 "Mosquitoes as Pests and Vectors of Disease in Utah." Albert W. Grundmann, Parasitologist, University of Utah.

11:10 Discussion.

11:15 "Experiences in Fly Control in Salt Lake City." James Z. Davis, M. D., Health Commissioner, Salt Lake City.

11:35 Discussion.

11:40 "Insect Control Program of the United States Public Health Service." Illustrated. Fred C. Harmston, S. A., Sanitarian (R) United States Public Health Service.

Afternoon Session March 19

1:30 "Report From California." G. E. Washburn, President, California Mosquito Control Association.

1:50 Discussion.

1:55 Announcements.

Reports From the Districts

2:00 Robert A. Wilkins, Supervisor, Salt Lake City Mosquito Abatement District.

2:10 Discussion.

2:15 Karl L. Josephson, Supervisor, Box Elder Fly and Mosquito Abatement District.

2:30 Clem Toone, Supervisor, Magna Mosquito Control District.

2:40 Discussion.

2:45 O. Whitney Young, Supervisor, Weber County Mosquito Abatement District.

2:55 Discussion.

3:00 Recess - 10 minutes.

3:10 Symposium on the Tax Levy and Expenditure of Mosquito Abatement Funds. Harold F. Gray, President American Mosquito Control Association, presiding and selecting the panel.

4:00 Round Up - Roy F. Tygesen presiding.
All questions and problems in need of further discussion will be presented for further consideration.

4:30 Adjournment.

ADDRESS OF WELCOME

Karl D. Hardy

President, Board of Trustees,

Salt Lake City Mosquito Abatement District

Speaking for the Salt Lake Mosquito Board on this second anniversary of the organization of the Utah Mosquito Abatement Association, it gives me great pleasure to welcome the delegates from the other Utah Districts, and our distinguished guests and others interested in mosquito abatement work.

There is no doubt that our task will be greatly helped by these get-together conventions where we can listen to the carefully prepared papers, by those learned in the scientific treatment of the mosquito nuisance.

If all of you might have the pleasure of attending one of the annual conventions of the New Jersey and California Mosquito Abatement Organizations which have been functioning for many years, and which gather delegates and scientists from all parts of the country, including representatives of the United States Public Health Service, there would be no doubt in your minds about the progress being made in mosquito control work from year to year.

Our Association has greatly benefitted from our attendance at these conventions and I am certain the members of our Association will derive great benefit and advancement in our work through this organization, which will grow by the addition of new districts from year to year.

We are all indebted to Dr. Don M. Rees and others, for fostering and carrying this Organization to a reality last year, and I know you will all agree that this second meeting assures us of the wisdom of its formation and the certainty of its being recognized as a leader in mosquito control work.

Since I have been a member of the Salt Lake District almost from its beginning, I have had an opportunity to observe the progress of Dr. Rees since he came to the District as a field

worker in his early school years, and watched his advancement to the position of Supervisor where he built up an excellent organization which made great strides in mastering the elimination of mosquitoes.

After he completed his work at the Utah University, he attended Stanford University, where he received his Doctor's Degree, and returned to Salt Lake City where he was appointed one of our Trustees. His work did not stop here, for he has been recognized as a National Leader in his line, and has been called into world wide undertakings.

Our Board is proud of its development and progress, which has been accomplished with a very small tax levy. Through economy, we have been able to secure our own headquarters plant with an office building, storage building, and housing for our automobiles and field machinery, all of which have been acquired without increase in the tax levy. We hope to be able to show you this plant, and part of the field in which we operate. It would be interesting if it were possible, to compare the field of operation in its present condition with what we had to contend with in the beginning.

I am certain I speak truthfully when I say, land that has been made useable by drainage and mosquito control work in sections which would not develop because of the stagnant water and prevalence of mosquitoes, which is now used for agriculture, pasturage and housing development, have increased values for tax purposes far in excess of our small levy for mosquito control work.

The 1949 season is a challenge to all of us and will require the utmost skill in handling the flood waters which we now have, and with the heavy run off from the mountains will continue late in the season.

A part of our crew is now busy opening and cleaning drains in cooperation with the City and County forces. With the early control of this flood condition it will greatly minimize the need for spray work, which will shortly be required in the field.

A large part of our field organization has been in our

employ for many years, and as a result have become very familiar with the district and the work needed for the proper treatment in killing of the abundant larvae.

Much of the success in our work can be attributed to the splendid support and cooperation of the Mayor and members of the City and County Commissions. And, to the Engineering Departments of both the City and County, as well as the legal departments.

We greatly appreciate the privilege of holding our convention here on the campus of the University of Utah, and for the generous contribution of President Olpin and the faculty members, who will so generously contribute to the success of this convention.

Again let me welcome you all to this second annual convention of the Utah Mosquito Abatement Association, and I trust your attendance here will not only prove instructive and helpful in the handling of your own personal problems, but that you will make contacts and acquaintances here that will prove a source of joy to you for all time to come.

I thank you.

MOSQUITO CONTROL PROBLEMS IN UTAH

George F. Edmunds, Jr.

Department of Zoology

University of Utah

This paper might well have been called "Water Management Problems in Utah." As all mosquitoes spend their immature stages in water, mosquito control is very largely a problem of water management.

The immediate source of most of the water which creates the mosquito problem in Utah is principally: (1) from precipitation either in the form of snow melt or rain; (2) from flood waters which overflow natural channels; (3) from underground sources such as natural seeps, springs or wells; (4) from man-made impoundments such as ornamental pools, storage reservoirs, gun clubs, or federal or state migratory waterfowl refuges; and (5) from irrigation waters in the form of overflow from canals, seepage, and misuse of irrigation water on the farm.

In the valley areas where mosquito abatement constitutes the greatest problem in Utah the average monthly precipitation is generally from one and one-half to two inches during the months from September to May but during the summer months the average rain in only one-half to one inch per month. The combination of spring rain and snow melt are thus important water sources. These spring pools produce large broods of Aedes dorsalis, A. campestris, and A. niphadopsis. During the summer, precipitation is seldom sufficient to be significant but an occasional summer rainstorm may form numerous pools which remain long enough to allow the adults to emerge.

Ecological changes in the plant cover of Utah mountains due to mismanagement have increased the rate of spring runoff to the point where the original natural channels are no longer capable of handling the water. This, combined with man-made obstructions in the stream has created a serious source of

mosquito producing waters. Large broods of the pain inflicting Aedes vexans often originate from such sources.

Underground sources such as natural seepage, springs and wells contribute to the mosquito problem in Utah. Springs and natural seepages usually have established drainage channels that are effective unless tampered with by man. Wells are usually more of a problem because of the fact that the men who have drilled the wells have no obligation to drain the water away or to cap the wells when they are no longer needed. Storage reservoirs are generally of minor importance but may occasionally be serious. Although ornamental pools do not in general produce large numbers of mosquitoes, those that emerge become serious pests because of the proximity of man. Gun clubs whose waters fluctuate are often extremely prolific producers of mosquito broods. Not only do these clubs often add to the mosquito problem, but may defeat their own purpose by flooding out duck nests or by creating conditions which are ideal for the production of Western Duck Disease or Botulism. In discussing mosquito migration in the Salt Lake area, Rees has shown the gun clubs to be the sources of most migrations of Aedes dorsalis. State bird refuges whose source of water is often erratic may also at times produce many mosquitoes. In general, Federal Refuges are a little better managed and when water levels are kept constant are not important sources of these pests.

When we realize that practically every community in Utah is dependent upon irrigated agriculture it is not surprising that irrigation water is responsible for a large share of Utah's mosquitoes. Rees reports that from 1930 to 1936, 61% of all larvicide used by the Salt Lake City Mosquito Abatement District was used in the treatment of water originating from irrigation. Since 1936, by means of improved drains, better cooperation on the part of gun clubs, and the clearing and dredging of some natural channels, other sources of mosquito producing water have been reduced. Meanwhile, the amount of available irrigation water has been increased, so it is very probable that at the present time, irrigation waters account for an even greater share of

Utah's mosquitoes. High farm prices have encouraged many farmers to increase their acreage on alkali soils surrounding Great Salt Lake. In an attempt to clear the alkili from these soils, the farmer allows irrigation water to run on these lands for days at a time. The problem is further complicated by the fact that even though water may not be needed at the time it is available it is taken and allowed to run to waste. This is often necessary or the farmer may lose his watering rights.

The seriousness of the irrigation problem is pointed out when we realize that most of the valley areas of Utah where our population is concentrated would be comparatively mosquito free during the summer months if it were not for the misuse of irrigation waters.

The old adage "an ounce of prevention is worth a pound of cure" is especially applicable to mosquito control. However, a mosquito abatement district in itself is unable to prevent the undesirable conditions from arising. Complete cooperation on the part of the various state, federal, and private agencies concerned with water and land management in Utah must be brought about by appropriate legislation and education.

At the present time Utah communities are spending thousands of dollars to obtain more irrigation water. Such projects as those on the Provo River, the proposed Central Utah Green and Colorado River projects, and many minor undertakings will deliver more water to the populated mosquito producing areas of the state. Any person or agency that diverts water from its natural channels into new areas must be held responsible for the removal of that water by appropriate drainage channels. None of the appropriations made for the purpose of bringing water into Utah valleys make any provision for the removal of that water.

Perhaps better and more cooperative management of Utah land and water may be hoped for in the future. The Hoover Commission report proposes consolidating and coordinating all federal agencies dealing with land and water management. A plan for reorganization and consolidation of state agencies, and liaison with the federal government agencies has been presented to the

state legislature but unfortunately was defeated. A plan for coordinated control of all waters originating in the Weber River basin has also been presented to the state legislature. All mosquito abatement districts should take an active interest in promoting or joining projects that will give Utah a sounder basis for water management. This, coupled with sound program to educate the public and all interested parties concerning the need for a proper water management should be very effective in decreasing Utah's mosquito control problem.

THE ESSENTIALS OF AN EFFECTIVE MOSQUITO ABATEMENT PROGRAM

Stephen D. Durrant

Department of Vertebrate Zoology

University of Utah

While conversant with the fact that abatement procedures vary depending upon the locality, I am limiting my remarks to areas like our own here in the Intermountain West. I assume before launching into the more pertiment aspects of an effective abatement program, that for the proposed district, finances and laws are adequate for the successful development and accomplishment of the project.

I plan to treat my topic under the following general headings: (1) Knowledge of the area to abated; (2) Personnel; (3) Methods of procedure, and (4) Public relations and education.

The first and certainly the most important step in establishing a district is the complete knowledge of the area in which the insects are to be abated. This necessitates the complete survey and mapping of the area. Since the surest, least expensive and most adequate time to abate mosquitoes is before they emerge from the pupal stage, it is absolutely essential that all surface waters within the area, such as ponds, lakes, rivers, canals, drains, wells, etc., be located and mapped. In addition, such information as to the various sources of the water, its occurrence, reoccurrence, times of year when present and varying amounts are most pertinent to the problem. These maps should be of a formal type, but on which only the necessary features are indicated. By this it is meant that each locality containing water be definitely located, given a number, and enough detail included on the map so as to enable a worker to locate the area with dispatch in the pursuit of his duties. Poorly made, inaccurate maps are costly in time lost in the execution of the work and cause for inefficiency. These maps, once prepared should be reproduced in two sizes. One large, wall-size set should be set up in the central working headquarters, to act as a "nerve center" and clearing house for

the information relative to the abatement activities. This latter is accomplished by placing different colored pins on the map, which indicate the daily findings and results of the activities of the program. Other smaller sets of the maps should be available for each inspector and foreman of the various crews of workmen.

The personnel should for maximum efficiency consist of a diligent, conscientious, trained supervisor, a corps of inspectors and such workmen as are necessary for various phases of the actual work of abatement.

Upon the supervisor will naturally devolve the final responsibility of abating the mosquitoes within the district. This, as many of us know will tax his abilities to the utmost, but is the only reason for his appointment in the eyes of the public who finance the project. In such a position, results are almost mandatory since the public only understands one thing, that is, are they being bitten or not. Excuses, no matter how meritorious, are of little value in the event of failure. The supervisor must marshall all his resources of men, equipment, training and above all of organization, to accomplish his ends.

No battle against the insects can be efficiently waged unless the position, condition, numbers and distribution of them is known at any given moment, throughout the district. The obtaining of this information is the main business of the inspectors. The inspectors are the first line of defense and attack. To operate a district without adequate inspection is to court disaster. I, personally feel that no program of mosquito abatement can possibly succeed without thorough, competent inspectors. Merely sending men out to find and treat areas containing mosquitoes is inadequate, inefficient and costly. While they are treating one area that could have gone a few days longer, in several other areas, unknown because of poor inspection or none at all, the insects may be emerging in countless numbers. Furthermore, the spraying of pools which contain no larvae is a ridiculous, costly process. It is then essential, that the supervisor know the conditions throughout the district at any given time in order to wage a successful abatement. This is only possible by detailed,

careful inspection of all localities at least once a week. The inspectors are the eyes and ears of the project. While the primary concern of the inspector is to locate and report upon the mosquitoes within the district, he has other duties as well. He should report the condition of drains, differences in water levels, evidences and causes of flooding and prospects of flooding. This should all be in writing and dated. The inspector aids the supervisor in control and guidance of the work of the other crewmen. This is not a personal thing or one of snooping around to see if they are working, but he accomplishes much by the nature of his own work. For example, few sprayers would be likely to empty their oil into a drain and loaf the day away, or take joy rides in abatement equipment if they knew that the inspector would note their negligence when he next inspected the ponds they were supposed to have treated.

The remainder of the abatement crew are employed in spraying, drainage, fish planting and in other abatement activities. The abatement of mosquitoes in areas such as in the intermountain west with its variable sources of water can only be accomplished by a well organized, coordinated, flexible staff. Because of the constantly changing conditions, almost daily at times, caused by flash floods, irrigation, broken canals etc., the crew must be versatile and trained in all phases of the abatement work. Under such conditions no member of the abatement crew is solely a sprayer, a drainage man, a fish planter, etc., but all move as a coordinated unit to meet the emergency at hand.

The primary factors in procedure are to know where the insects are and the correct methods to control them. Everything else is subservient to these. The inspectors should be constantly afield and not encumbered with other duties. They should visit weekly each locality on the map, and report daily in writing on their findings. By this means every locality having surface water would be reported upon in sufficient time to handle any hatching of the insects. At the end of the day the inspectors place red pins on the map indicating the location of pupae and green pins for larvae. They also inform the supervisor on all

other observations having bearing on the work. The supervisor then knows by glancing at the map where the danger spots are and then studies the map and prepares a list of places for the next days treatment, listing those localities indicated by the red pins first and the green pins next. A copy of this list together with the sequence in which the localities are to be treated, is given to the sprayers. By this means the supervisor knows where his sprayers are throughout the day. This is necessary if an unexpected emergency arises. When the sprayers have treated the localities on their list, they then remove the red and green pins from the map and place yellow ones in their stead. A few days later the inspectors revisit the area and remove the yellow pins if the treatment was successful. No pins on the map indicate that all is under control. I cannot overemphasize the absolute necessity of this day by day indicating of the findings on the map.

Concerning drainage there should be two things in mind. The first is to remove water in emergency areas, and secondly an overall permanent drainage program. All drainage should be carefully evaluated and undertaken only after consultation with other interested parties.

An other adequate abatement measure where feasible is the planting of mosquito fish. This is particularly efficient in heavily populated areas, where there are permanent ponds of the ornamental type. It is also good abatement procedure in all bodies of water of a permanent nature. The usual procedure in this type of abatement is to assign one member of the crew to find these ponds, make a list of them and plant them with fish.

An informed populace is a valuable asset in the furtherance of an abatement program. By constantly presenting to the people the significance of the program with reference to their health and happiness, the success of the program is enhanced. They should be informed of the ways in which they can aid, such as having no standing water on their premises and emptying of all containers of water after storms etc.

The supervisor will be wise to become acquainted with all

the agencies, both local, state and federal having interests in his project. These contacts are invaluable in the successful development of his abatement interests.

When laws are specific, the supervisor should never hesitate to carry out his abatement of the insects no matter where they occur. Some farmers and others who have surface waters on their lands which breed mosquitoes sometimes prove to be difficult. The supervisor should patiently attempt to get them to cooperate, but if unsuccessful should abate the insects no matter what. If one property holder is successful in arresting the program, others will readily follow. This is serious because not only do these localities enable mosquitoes to breed, but prove to be focal points of infection to an otherwise mosquito free district.

NEW INSECTICIDES AND EQUIPMENT: THEIR USE AND LIMITATIONS IN MOSQUITO ABATEMENT

Arthur H. Geib

Manager, Kern County Mosquito Abatement District

California

In the past few years, during and since World War II, great strides have been made by the insecticide industry in the development and manufacture of new toxic agents for the control of insect pests. Although not all of these are adaptable to mosquito control due to toxicity or other reasons there are several which are now being used or show definite promise in this field.

In the good old days when diesel and other oils were the primary standbys for temporary larval control it was necessary to expend what would now seem to be disproportionately large amounts of money for equipment and labor. Large and necessarily cumbersome larviciding equipment was the rule in order to carry sufficient amounts of oil to cover the area to be sprayed. It was also necessary to operate equipment to supply these units with oil. This normally involved the maintenance of tank trucks of some type and large storage tanks located strategically throughout the area to be covered. Now this picture is changed greatly.

It was in the course of the search through confiscated enemy patents during the war that the formula for DDT and mention of its insecticidal value was found. Trials of the material soon showed that it was a very potent material with a low toxicity to warm blooded animals. Enthusiasm for this material was so great that some of the early reports of its potency now seem almost fantastic.

The first use of this material for mosquito control was by the armed forces in their malaria control programs both in the United States and overseas. At the time DDT was considered highly strategic and neither the material nor any real information was released to the public until the end of the war.

The first use of DDT by the Kern Mosquito Abatement District was in the fall of 1945 when a large area of artificial duck ponds were treated with a DDT dust by aircraft. Since little information was available on the material a much heavier dosage was applied than might have been necessary. At the beginning of the 1946 season work was begun with the use of DDT by ground and air application. Emulsions, solutions and dusts were tested. Ground tests were first made with 25% emulsible concentrate, purchased from the War Assets Administration, in water and with 3% DDT dust using power equipment. Both of these materials were applied successfully, however, it was found that the emulsible material was more economical and lighter applications could be made so it was selected for routine application. The power duster is still used for special problems. In May 1946 the use of DDT dusts through aircraft application was attempted. The results at reasonable dosages were erratic and unpredictable so this method was abandoned. In June 1946 a plane equiped with spray boom was located and contracted for. An exhaust aerosol was later installed. With this plane trials were made using DDT-oil solutions. Exhaust aerosol equipment was also installed on the trucks but was found useful only where adulticiding is necessary.

At the present time DDT emulsions are used almost entirely in all spray equipment applied at the rate of 0.2 to 0.3 pounds of DDT to the acre.

During the 1946 season the first attempts were also made to obtain larval control by the direct introduction of DDT to irrigation waters as they entered the fields. Even though the equipment used was crude and many difficulties were encountered, results were so encouraging that experiments were continued in 1947 and 1948. The equipment used finally evolved to an automatic siphon with a metering tip with which control has been obtained routinely with an application of one part of DDT in 15 million parts of water.

During the seasons of 1946 and 1947 the emulsible concentrate used was purchased from the War Assets Administration. This formulation gave an extremely fine, self-dispersing emulsion of

almost indefinite stability and no difficulty was encountered in its use. At the end of the 1947 season stocks of this material were exhausted and proprietary emulsion concentrates were purchased on the open market. On the whole these materials were unsatisfactory and some were absolutely unusable. It was felt that the principle difficulty was in the physical characteristics of the emulsion formed. Nearly all formed coarse emulsions which remained dispersed for only a short time and then either creamed off, settled to the bottom, or broke. Since, for mosquito control they had to be sprayed into water instead of on solid surfaces, the use for which they were intended, these characteristics were considered of paramount importance. It was also found that some of the emulsifiers used reacted chemically with the extremely hard water in this region breaking the emulsion. During the winter of 1947-1948 laboratory work was initiated to test the physical characteristics of any samples sent to the district and to attempt to set up specifications. Several of the suppliers when informed of the difficulties encountered with the standard emulsible concentrates had their laboratories make up new formulations to meet the requirements of the mosquito abatement districts. It is now recognized that for this work the emulsion once formed should remain in a dispersed state for several hours without evidence of creaming off or settling out and should completely redisperse on reagitation. The emulsion should be finely divided and should remain dispersed and redispersed in the sprayer with no agitation other than that obtained from the motion of the vehicle. It is now routine procedure for the Kern Mosquito Abatement District to test samples of all materials purchased and to test any samples submitted for consideration.

In addition to the DDT emulsible concentrate which is the basic material used, other materials are often used when special problems require.

Diesel oil still finds considerable use in highly polluted waters such as sewer farms and dairy drains where DDT seems to be ineffective. It is also used where it is necessary to kill pupae.

In places having such heavy vegetation that liquid sprays

will not penetrate 3% DDT dust is applied with a Root Power Duster. This material will sift down through heavy tule growth to the water surface and can be drifted over considerable areas.

Experimentally pupal kills have been obtained with aerial applications by adding 1% Lethane 385 to the normal DDT spray emulsions. More experimentation is needed with this method.

For adulticiding a 7½% DDT oil solution is usually used by exhaust aerosol, however, occassionally a 5% suspension of wettable powder may be sprayed on buildings and shrubbery.

The efforts of this district are directed almost entirely toward the destruction of the larval stages of the mosquito. Adulticiding is resorted to only when necessary. Because of this no equipment, other than exhaust aerosol generators, is maintained for primarily adulticiding purposes.

With the development of the use of DDT there also was a considerable evolution in the type of spray equipment to make the most of the advantages offered by this type of material. In this district, where it is constantly necessary to traverse water covered terrain and other difficult areas, economy and speed of operations is inversely proportional to the size and weight of the equipment used. When diesel oil was the principal material, heavy equipment with sprayers having a capacity of several hundred gallons were a necessity.

With the use of DDT emulsion, it now is possible for the operator to pick up water at almost any point on his run and carry enough concentrate in a small space to carry him through even a heavy day's spraying, using a 35 or 50 gallon sprayer. The increase in economy of operation is easily seen. There is no longer any necessity to haul large volumes of larvicide about. Light, less expensive vehicles may be used with smaller and lighter spray units not only giving a direct savings in cost of gasoline, etc., but also decreasing time lost due to stuck equipment and more laborious methods of spraying areas which the heavy equipment could not traverse.

With the early use of DDT the Kern Mosquito Abatement District purchased from War Assets Administration military ½ ton, 4 wheel drive trucks and mounted on them 100 gallon power sprayers. It

became evident before the season was over that even smaller sprayers could be used more economically so subsequent units purchased had a capacity of 50 gallons. Civilian jeeps were purchased for foremen and inspectors and proved so efficient that as the ½ ton trucks wear out they are being replaced with jeeps equiped with 35 and 50 gallon sprayers.

With the development of DDT the commercial organizations began research on the chlorinated hydrocarbons and have since discovered a number of new and efficient insecticides and at this time are working on others. Since by far the greatest amount of experimental work done with these materials is related to agricultural pests and animal parasites relatively little information is available concerning their use in mosquito abatement. For this reason, if full advantage is to be taken of any new and more effective materials which may be produced, for mosquito control, the control agencies must work with the manufacturers and do most of the developmental work themselves. Toxicological and physical testing of new insecticides and formulations was begun by the Kern Mosquito Abatement District and will be continued as routine in search for more efficient and economical larvacides. It must be remembered, however, that in this activity caution must be exercised, especially before field trials. All of these materials are toxic to a greater or lesser degree and full information as to their toxicity to warm blooded animals is usually not available until sometime after research with the chemical has been initiated. Field trials, especially in grazing areas should not be attempted until there is some assurance that no harm will be done.

The testing procedure used at the Kern Mosquito Abatement District involves three steps. First the material is tested for physical characteristics. If these do not compare favorably with materials in use the toxicity trials would not be considered fair comparison.

Secondly, toxicity trials are made in the laboratory against fresh caught 4th stage larvae to determine the approximate LD50. On the basis of this information a trial field dosage is deter-

mined and preliminary field trials are made by hand on small plots. In these trials comparison is made with a standard test larvacide set up by and prepared for the Sub-Committee on Insecticide Formulation and Testing of the California Mosquito Control Association.

Blank control checks are left unsprayed. If these tests prove satisfactory and no danger is indicated in use of the material it is put on some of the trucks for operational field trial.

The two most promising materials at this time are Gamma BHC, which is used as a wettable dust since no satisfactory emulsible concentrate is available, and Toxaphene emulsible concentrate.

THE USE OF GAMBUSIA IN A MOSQUITO ABATEMENT PROGRAM

Arden R. Gaufin

Department of Zoology

University of Utah

That fishes are of value in mosquito control has been recognized since the latter part of the nineteenth century. An article which appeared in Insect Life in 1891 reported an Englishman as having successfully used carp in controlling mosquito breeding in a water tank. The renowned entomologist, L. O. Howard (1901), was first to advocate the use of Gambusia for the control of mosquito larvae. The first, and most extensive investigation on the use of fish in the control of mosquitoes was inaugurated as a public health measure in July 1915, by the U. S. Bureau of Fisheries and the U. S. Bureau of Entomology, assisted by the U. S. Public Health Service. The majority of this work was carried on in the "malaria belt" of the southeastern United States, and the mosquito fish, Gambusia affinis, was found to be more effective than any other species.

In different parts of the world other species of native fish have also been used effectively in mosquito abatement work. Several species of the killifishes (Fundulus) have been found very useful in salt water. In Salt Lake City, two species of native fish, Gila atraria (Girard) and Iotichthys phegethontis (Cope), have been found useful as predators on mosquito larvae in their natural habitats in streams and gun club marshes west of the city. However, both of these species have a restricted seasonal reproductive period and do not reproduce rapidly enough to provide the fish necessary for stocking purposes. In addition, while both species feed voraciously on mosquito larvae during the spring, they seem to ignore them as food later in the season.

Hildebrand (1919, 1921, 1925), in an attempt to gain information relative to the actual value of Gambusia as eradicators of mosquito larvae and pupae under a wide range of conditions, made

a thorough investigation over a period of four summers in the vicinity of Augusta, Georgia. The information secured from his work indicated that the mosquito fish had effected a reduction in number of mosquito larvae and pupae amounting to 57.8 percent in the anopheline and 80.0 percent in the culicine populations. In his conclusions, Hildebrand listed the following reasons why Gambusia affinis is especially suited to mosquito control work:

> "(a). It seeks its food at the surface; (b). It is very prolific; (c). It gives birth to well-developed young, therefore requiring no special environment for depositing and hatching the eggs; (d). It lives and thrives under a large variety of conditions and frequents areas especially suitable for the support of mosquito larvae; (e). It usually lives and multiplies in ponds with predacious fishes, providing it has very shallow water for refuge."

The female Gambusia affinis is larger than the male. Fully grown, under normal conditions, she is about one and one-half to one and three-quarters inches in length. The male averages about one inch in length when fully grown. In color the fish are olive green above and silvery on the sides and abdomen. Seen from above in natural ponds they appear blackish. As in other poeciliids, mature individuals exhibit sexual dimorphism; the anal fin of the female is small and rounded whereas that of the male is modified into an elongated intromittent organ.

Krumholz reports that the female mosquito fish present in a wild population at the beginning of the summer in Illinois are virgin. Those fish become gravid for the first time at an age of eight to ten months, and after liberating a single series of broods, disappear from the population. Their reproductive period extends over ten to fifteen weeks depending on the number of broods liberated. Female offspring of the first and possibly the second brood liberated by the parent fish usually become gravid at an age of four to six weeks and have a reproductive period of four to ten weeks.

The gestation period for Gambusia under laboratory conditions ranges from 21 to 28 days. The number of broods liberated by a female mosquito fish depends on the age at which maturity

is reached, the climatic conditions, and the available food supply. Overwintering parent females often give birth to three to four broods whereas offspring that become mature in four to six weeks, liberate only one to two broods. A single brood may contain from as few as four or five young to as many as two to three hundred.

In Illinois, Krumholz found no mosquito fish that had survived two winters and entered the third summer of life. In general, mosquito fish die the same summer in which they reach maturity. The maximum life span is that of females which do not become mature until their second summer. These fish die at an age of about fifteen months.

Gambusia are capable of maintaining population in salt, brackish, or fresh water and of adapting themselves to diverse chemical and physical conditions. They have survived winters under the ice in northern Illinois in ponds having hydrogen-ion concentrations (pH) which ranged from 6.6 to 7.8 and total alkalinity readings between 12.8 ppm and 320.4 ppm. In California, Emerick has adopted Gambusia so that they thrive in sewage ponds which are practically devoid of all dissolved oxygen. In Salt Lake City they have become adjusted to highly mineralized sulfur water and increase rapidly in such water every year. The water in these "main stock ponds" has a hydrogen-ion concentration of around 8.4, total alkalinity around 150 ppm, and contains large quantities of sodium and potassium chlorides and rather large amounts of various sulphates.

Gambusia are easier to transport over long distances than are many other fish. Ten gallon milk cans make very satisfactory shipping containers, and if the temperature is kept cool they can be transported long distances without excessive losses. The tops of the cans should be punched with many holes for air, and if possible the covers should be left off entirely during the journey.

For distribution on a mosquito abatement project it is possible to carry 500 fish per ten gallon can for four or five hours with only a moderate loss. The writer has on many an

occasion in the spring even transported 1000 to 1200 fish per can for up to thirty miles with no loss of fish. During the hotter summer months, however, it is necessary to frequently add colder aerated water to the container to prevent undue losses.

The problem of establishing Gambusia in Utah in a region over 4200 feet in elevation and between 40 and 42 degrees north latitude, with resulting rigorous winters, was not an easy task. The first attempt was made in the spring of 1927 when some 50,000 Gambusia were shipped from southern California and planted in several lakes and pools in Salt Lake City. These fish thrived and increased during the summer but all perished during the first winter. After another unsuccessful attempt at introduction in 1929 the fish were finally established in several different types of pools in various parts of the city in the summer of 1932. The winter of 1932-33 was extremely cold and the fish perished in all outside pools except a pool fed by a warm spring. Since then Gambusia have continued to thrive in several ponds and streams fed by these thermal springs north of the city, with water temperatures at the source ranging from 98° to 105° F. These warm water ponds became the stock ponds from which Gambusia were obtained for planting purposes. In addition, the number of cold water localities in which Gambusia survive the winter has increased until it now approximates each year from one to two hundred localities, depending on the severity of the winter.

In southeastern United States where Gambusia are native to the region they are reported by certain investigators as not being entirely effective as a mosquito control factor even in small ornamental pools. This may be the result of the establishment of a dynamic balance in nature which would eventually include the fish as well as the mosquito larvae. If so, this may account for the phenomenal success of Gambusia as a control agency in ornamental pools and other small temporary bodies of water where they are, in most instances, replanted each year and in sufficient numbers to do the job. Under these conditions in Utah, up to the present, it has been definitely proved that Gambusia are the most effective and economical method of mosquito

control in most small ornamental pools and even in some small ponds, lakes, and certain types of streams.

The 1424 ornamental pools located in Salt Lake City vary in size from 7 to 144 square feet in surface area, with an average of 39.4 square feet, and are from 9 to 36 inches in depth, with an average depth of about 18 inches. During the 1947 season, which is typical, overwintering Gambusia were found in many wells and springs, and 1400 additional pools were stocked several times while others were stocked only once. Children removing the fish was the most frequent cause necessitating the restocking of pools, although birds, snakes, and even cats have been known to destroy the fish. During the season 30,023 fish were used in these plantings, the number used in each planting varying from 6 to 100 or more, depending on the size of the pool.

The remainder of the ornamental pools were satisfactorily treated as follows: 254 were stocked with goldfish, 320 were drained, 45 were filled, and 281 were treated with pyrethrum larvicide. A total of 5,329 visits was made to ornamental pools at a total cost of $947.84, or at an average cost of about 66 cents per pool for the season.

In addition to the Gambusia utilized in ornamental pools, 27,375 were planted in 234 drains and 4,567 were planted in 33 lakes during the season. However, the utilization of Gambusia for mosquito control purposes in large bodies of water such as large lakes, reservoirs, and especially extensive fresh water marshes has not proved to be effective in Utah. Under certain conditions in a few of the larger bodies of water Gambusia have become established but in most water of this kind these fish have been unable to survive or, if they have survived, they are unable to increase to sufficient numbers to be of any appreciable value as a mosquito abatement measure.

In a few larger bodies of water where Gambusia have been successfully established they act as a check but are not always entirely satisfactory as a mosquito control measure for the following reasons: first, the fish in larger bodies of water seem to congregate in certain areas and neglect other parts in

which mosquito larvae may develop; second, Gambusia are not always present in sufficient numbers, especially during the spring, to devour all the larvae before they complete development; and third, these fish may be prevented by aquatic vegetation from reaching certain areas where larvae develop. An example of this latter situation has been offered several times involving the lake on the Moyle Estate, 6400 Hyland Drive. From midsummer till late fall thick marginal vegetation provides an ideal breeding place for Anopheles freeborni. On several occasions the author has collected 10 to 12 Anopheles larvae and pupae per dip along the edges of this lake while numerous Gambusia could be seen swimming in the open water.

EFFECTIVE USE OF LIGHT TRAPS IN A MOSQUITO ABATEMENT PROGRAM

Stanley B. Mulaik

Department of Zoology

University of Utah

The use of a variety of lights and mechanisms for the elimination, reduction, or sampling of insect populations has been carried on for quite a number of years.. Open flames have been used for many years to attract and destroy insects. A variety of baits have been used to attract insects to traps. More recently the use of a draft of air to carry insects into traps has received considerable attention. At Salt Lake City the use of insect traps by the local mosquito abatement district is a regular part of the program primarily to determine the occurrence, density, and seasonal species change. Here the equipment is a light placed above a fan which forces air through a trap mounted below. However, in my estimation, this equipment needs critical investigation to determine whether it meets qualification as a standardized, efficient apparatus on which to make comparative studies.

Standardization of apparatus and procedures in its use have been worked on most intensively at the New Jersey Experiment Station at Brunswick. Here it was early recognized that the ability of traps to catch mosquitoes was closely related to the volume of air moved through them. The tests were made by using batteries of six traps variously moved about. These traps were equipped with fans and motors of identical design.

A number of problems arose after the traps were run for a number of weeks. It was discovered that continuous use caused the motors to run under rated speeds. Correllated with this was a decreased catch. Replacement of these motors by some of better make eliminated this problem. Using the performance records of

these fans, standards were set up as follows:

1. Fan blades shall be 8 in. in diameter.
2. Fans should move 360 to 400 cu. ft. of air per minute.
3. Motors must be suitable for continuous operation in a verticle position and fitted with suitable oiling devices.

It was discovered by workers in states adjoining New Jersey, that by using fans with greater capacity the mosquito catch was increased up to 50%. Experiments in New Jersey with giant fans increased the catch enormously; so it was readily concluded that the performance of fans to be comparable, the volume of air moved through the trap must be equal.

In any program where a day by day, weekly, seasonal or yearly comparison of mosquito populations is desired, several factors must be carefully investigated. The New Jersey studies indicated the following as contributing to poor performance of traps resulting in inaccuracy for comparative purposes:

1. Lack of proper lubrication.
2. Dead insects and debris accumulated inside motor cases interfering with free operation of the fans.
3. Bent fan blades and blades not in true pitch. This can lead to vibration and undue wear on the motors.
4. Fan blades not matched to the motors.
5. Interior of trap screens clogged with insects and dirt.

It is recommended that traps be so constructed as to permit ready metering of the air flow anytime there is suspicion the performance has dropped. These meters must be of a diameter little or no smaller than the diameter of the air intake, or if they are smaller, the region just above the point of attachment of the meter must be gradually diminished in size so as to minimize turbulence which would bring about inaccuracy in calibration. The traps should be cleaned at least weekly or as often as needed to eliminate any loss of efficiency due to clogging with debris or insects.

The use of lights of different wattage and perhaps of different colors for attracting insects should be investigated carefully and standards set up. The performance of traps are

could be correlated to the nature of the point at which the traps are set with respect to proximity to trees, shrubbery, buildings, and known breeding places. A haphazard, uncontrolled program of trapping will lead to considerable uncertainty regarding the effectiveness of the mosquito abatement. This will too often result in complaints from many mosquito bitten persons as the only true guide to the number of mosquitoes in an area. This type of checking on the incidence of mosquitoes we must avoid.

AN ATTEMPT TO CONTROL THE BITING BLACK GNAT *Holoconops kertexzi* var, *americana* Carter IN NORTH SALT LAKE CITY

James V. Smith

Assistant in Entomology

University of Utah

In many parts of Utah and other Western States the small biting gnats of the genus *Holoconops* (Leptoconops) are extremely annoying each spring for a period of about six weeks. In North Salt Lake City and Tooele Ordnance Depot, an investigation of the gnat problem for the purpose of control has been conducted by the authors for the past two years. As a result of this study, approximately 250 acres of gnat producing ground was located in North Salt Lake City and effectively treated during the spring of 1949, with one pound of DDT per acre. This resulted in about a 90% kill of the gnat larvae and pupae. The relatively few adults that emerged were destroyed by 5% DDT used as a residual and 7½% DDT used as an aerosol. As a result of experiments now in progress in this area it is believed more permanent control measures will soon be developed.

THE EFFECT OF MOSQUITO ABATEMENT ON THE HONEY BEES

George F. Knowlton

Research Professor and Extension Entomologist

Utah State Agricultural College

Mosquito abatement programs, like agricultural pest control operations, have at times caused death loss of adult honey bees. This has been especially true where heavy dosages of DDT and other poisons have been applied, or have drifted upon weeds, grasses, sweet clover, or other vegetation at a time when the plants were attractive to bees. In fewer cases, damage has occurred to young hive bees and brood, where paris green or other arsenical dust drifted onto attractive plants and was collected and stored with hive pollen, later causing bee mortality when the pollen was consumed as food.

Some things which might be kept in mind during mosquito control operations, to help avoid risk of poisoning beneficial insect pollinators, including honey bees and various wild bees, are:

Consider drainage, filling, natural enemies (mosquito fish, etc.) and other control means at the time mosquito control programs are laid out. Have permanent measures gradually eliminate as much of the chemical field treatment as is feasible.

Further educational work is needed to help reduce mosquito breeding in ponded irrigation water in farming areas.

Time control operations well, in connection with effective field surveys. Proper timing increases effectiveness of control and decrease spray costs with corresponding reduced risk to beneficial insects. Confine chemical treatments to areas where treatment is needed. Excessive drift, or unnecessarily heavy dosage applications under conditions which cause loss to property or rights of individuals, result in criticism of control programs.

Train control project help to use correct dosages. Have the men apply a given amount of dust or spray, then measure the

area treated. There is a tendency for new and unskilled help to treat wastefully. This ups the per-acre cost and increases hazard to beneficial insects and other wildlife. Use minimum effective dosages, regardless of the chemical used. Apply treatment uniformly over areas to be treated.

Avoid use of arsenical dusts or occurrence of dust drift over areas of blossoming or pollinating plants and weeds being worked by bees.

Particle size of many poisons affects toxicity to the bee. Paris green or other arsenicals of fine particle size will kill bees with a lower amount of arsenic than is necessary for similar bee mortality of the same poison but of larger particle size.

In areas where bees are abundant, confine extensive control operations to hours before bees leave hives, and to hours after bees leave the field (return to the hives.) Dust, in general, has caused greater risk to bees than spraying. Daytime application of poisonous dust, fog or spray will greatly increase risk to bees over similar early morning, evening, or night treatments.

Airplane spraying and dusting might hold increased hazards to beekeeping, as compared to use of ground equipment. Drift of fine dusts, in particular, is difficult to control during airplane application.

Bees may be killed by aerosol drift, direct contact spray, by the lapping up of poison in water used as a drink, or from poison contaminated pollen transported by the bees to the hives. When eaten, arsenic contaminated pollen has resulted in extensive colony bee death losses. Bees taking poison into the stomach while in the field seldom reach the hive, so risk of poison contamination of commercial honey is remote.

Arsenic and DDT treatments, applied repeatedly during the season, and year after year to the same soil areas, tend to build up residues to amounts dangerous to bees sipping water from such wet soil. Here again, dosage used is an important factor in determining rate of poison residue build-up.

Aerosols are deadly to bees if applied during hours when bees are active in the field, or if permitted to drift to places

where bees occur in abundance. Dr. G. E. Bohart has observed aerosols killing bees within two minutes of the aerosol drifting into an area and reaching plants being worked by honeybees and wild bees, even after the aerosol had drifted for one-fourth of a mile before reaching the bees. This observation was made in connection with a daytime aerosol release.

Quite a lot of literature exists with regard to relationship of insecticides to bees, with particular regard to farm and orchard operations. This is the field in which your speaker has had most experience. One pound of actual DDT per acre, applied as a dust to areas being worked by bees, has caused substantial adult bee mortality. In experiments conducted in Utah during 1948* use of three-fifth pounds of actual DDT per acre, (30 pounds of 3 percent DDT) applied as a dust in early morning, killed approximately 28 percent of the average honeybee field force found to work this field. In addition to honeybees, wild bee pollinators also were killed. Parathion proved to be even more deadly to field bees than DDT, while toxaphene killed fewer bees than DDT.

Formulations and dosages which are effective for mosquito control, but of least risk to bees, should be applied in areas where complaints of bee poisoning losses have occurred. It is about as important to preserve the wild bee pollinators, and the beneficial parasitic and predacious insects, as it is to safeguard the honeybees. All these may suffer from some types of treatment, yet be relatively safe under conditions of some modified or different type of insecticidal treatment.

Many common weeds are worked by bees for pollen and/or nectar. Bees collect large amounts of pollen from rosinweed, Russian thistle, and from various other weeds as well as grasses, at the time these plants are producing pollen. Also, nectar is collected from many of the common farm and roadside weeds,

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*Todd, F. E., Lieberman, F. V., Knowlton, G. F., and Nye, W. P. Toxicity of DDT, chlordane, parathion and chlorinated camphene to honeybees. To appear in Agricultural Chemicals.

although to the average "layman" this does not appear to be the case.

Extent of area treatment will be a contributing factor. In cases where small area treatments may not create recognizable bee loss, large scale treatments of the same type, affecting all plants in the area, may be very detrimental to beneficial insects.

Beekeepers, if notified of contemplated large scale mosquito control operations, may prefer to temporarily move their bees out of the area, thus eliminating risk to the bees, or criticism of control operations. Such notification usually can be made through local press releases a few days before chemical treatments begin.

MOSQUITO ABATEMENT IN RELATION TO AGRICULTURE

Don R. Merkley

Entomologist, State Department of Agriculture

It is my opinion that the Utah Mosquito Abatement Association is carrying on one of the best eradication programs of its kind. This program is one of necessity and is far reaching in its results.

It may be said that "The health and wealth of the world lies buried in the earth," and how well we know, that much of the arable land on this earth is uninhabitable because of the unbearable hordes of mosquitoes. Not only is the land useless for agriculture, due to these pests, but the habitation of man is limited to areas where these troublesome insects do not abound in great numbers. Many businesses such as summer resorts, manufacturing industries, and others are curtailed sharply because of the presence of the mosquito. The money loss becomes most apparent in the vicinity of large centers of population. For example, in the Gulf Region of Texas at times the market value of livestock is greatly reduced by the abundance of these insects. In portions of southern New Jersey there are lands eminently adapted to the dairying industry, and the markets of New York, Philadelphia and the large New Jersey cities are at hand. In these localities herds of cattle have been repeatedly established, but the attacks by swarms of mosquitoes have reduced the yield of milk to such an extent as to make the animals unprofitable, and dairying has been abandoned for less remunerative occupations.

Perhaps the most important economic effect of mosquito abatement lies in the increased valuation of reclaimed agricultural lands. The general value of lands reclaimed from swamps is obvious. Practically all of Holland has been reclaimed from the sea. Large areas of the most valuable farming land in the world have been reclaimed from nonproductive swamps. To the nonproductiveness of swamp land must be added the great danger that exists in its continuance through the invariable presence

of disease-bearing mosquitoes. The drainage of swamps not only destroys unlimited breeding places of mosquitoes, but vastly increases the value of the land for farming purposes and for other utilitarian uses. Either reason amply pays for the operation. It has been shown that fields gained by marsh drainage possess the greatest fertility and their endurance to cropping without manuring exceeds that of any other agricultural land except possibly arid regions which are irrigated. The range of crops is great and includes all ordinary farm and garden crops. Reclaimed swamp lands are especially adapted for truck farming, because it is easy to maintain the level of underground water where the roots of the plants can reach it.

This state like many others is predominantly agricultural. Nineteen percent of the employed people in Utah are gainfully employed in agriculture, and much of their time is spent in irrigating the growing crops. One of the big problems faced by the farmer has been the problem of getting water onto his land. Once this was accomplished, the land became proportionately more valuable. The methods of irrigation are of two types: First, the water is carried over the ground in small furrows; second, the ground is flooded with water to a depth of several inches and the water allowed to remain until it sinks into the ground or evaporates. The first method of irrigation is the usual practice for all cultivated farm crops. The second method of flooding is the usual practice for all cultivated farm crops. The second method of flooding is used principally in the production of meadow grasses for pasturage and forage, and in some sections for the production of timothy and alfalfa. Both methods, under certain conditions, create extensive mosquito producing water. In addition, seepage from irrigation canals, and water remaining in the bottom of canals, drains, and ditches from which irrigation streams are periodically removed, create numerous prolific mosquito producing situations. In many instances the water used to insure the farmer good crops has become a menace to him and the populated area around him. Through careless irrigation practices, excess water is allowed to accumulate in barrow pits

along the roadside, and in many of the low lying areas to become a breeding place for mosquitoes. The seepage of this waste water to even lower levels tends to bring the undersirable salts to the surface of the ground, and upon evaporation of this water this land is left in an alkaline condition unfit for agricultural purposes.

In every case where a drainage problem arises, it is desirable to drain off only surface water where mosquitoes may breed. It is therefore good judgment to consult guidance for such a project from trained personnel, so as to achieve the best results in mosquito eradication.

The malarial forms of mosquitoes are of minor importance in this state; but, other diseases transmitted by mosquitoes have been found here. Western Equine Encephalitis, and St. Louis Encephalitis has caused the death of many horses in Utah. Mosquitoes are known to compare favorably with the worst insect vectors, and millions of dollars are spent annually in the control of this pest and the diseases which it transmits.

Thousands of dollars are also spent on farms, and suburban homes for screening which must be used on houses, and farm buildings, to keep out these insects.

The widespread use of larvicides has brought about a decided reduction in the population of mosquitoes. The advent of chlorinated hydro-carbons and the use of some of these has and may bring about great possibilities in the control of mosquito larvae. It is desirable to have trained men in the employ of the abatement districts, so that the use of oil sprays will be applied to the best advantage and that property damage caused by the use of oil will be held to a minimum. It is undesirable to use oil on pasture lands where such forage will be damaged by excess spraying.

With continued cooperation between property owners where mosquito breeding areas lie, and the Utah Mosquito Abatement Association, the old saying, "We must face the fact that we have mosquitoes and must live with them," can be regarded as wholly false.

THE EFFECT OF MOSQUITO ABATEMENT ON WILDLIFE

Jack H. Berryman

Assistant Federal Aid Coordinator,

Utah State Department of Fish and Game

I wish at this time, on behalf of the Utah State Department of Fish and Game, to express appreciation that this Department was included in these discussions. We feel that public service agencies that deal with complex problems involving many and varied interests should cooperate to insure that benefits to one group are not secured at the expense of another. Our Department is charged by law, under Section 30-0-1, "to protect, propagate and distribute game animals and birds and fish throughout the state...," (Utah Fish and Game Code), and we are, therefore, primarily interested in the protection of wildlife. Most of you here are charged with the destruction of mosquitoes. In as much as both of our programs are dependent upon water manipulation and control, we must coordinate our efforts in order to prevent a conflict of interests. It is well known that water is our basic and most important resource and that the interests involved are extremely complex and any program involving the use or administration of water invariably affects everyone. In accordance with this principle, we wish to indicate a willingness to cooperate with other agencies involved in the administration and management of water, and, therefore, with those charged with mosquito abatement.

The Fish and Game Department is well aware that in addition to the pest or nuisance value, the mosquito is the vector of many serious diseases, some recently introduced into this country with the return of the service men from overseas. We are in complete agreement that mosquito control is necessary.

We also wish to point out the importance to Utah and to the rest of the nation of any program affecting marsh management in Utah. Waterfowl hunting provides recreation to over thirty thousand sportsmen in Utah alone and waterfowl is of aesthetic value to all. Hunting also affects our entire economy. Birds

banded on Utah's marshes have been recovered in thirty-eight states and three foreign nations. The higher elevations of some of our waterfowl refuges also support excellent populations of upland game birds. It is evident, therefore, that caution and intelligence must be exercised before any programs are initiated that affect our waterfowl populations, since the effect is nation wide.

With reference to control of the mosquito, Dr. Clarence Cottam has said, "There is nothing wrong with its control as such, but some of the methods, abuses, and common improper practices employed in attempts to exterminate mosquitoes are open to serious and warranted condemnation because of their needless detrimental effect on wildlife," (1938:81). This comment was made at the Third North American Wildlife Conference in 1938, in a discussion that dealt primarily with the problems of mosquito abatement and wildlife in the eastern and southern parts of the nation. The theme of the discussions was cooperation, but the reports convey the impression that the discussion became heated and, as someone has said, "more heat than light was thrown on the subject." The Fish and Game Department feels that such disagreements can be avoided through careful planning and cooperation, and that well planned and executed mosquito control and wildlife management practices are not incompatible. We also recognize the fact that when the public health and wildlife interests actually conflict, wildlife must be subordinate to health.

Merely to agree on cooperation is not sufficient unless such agreements are followed through with concrete action. For this reason, we take this opportunity to present our views in the matter and to make specific recommendations.

Mosquito control work lends itself well to public work projects. When such projects are undertaken, they usually are on a large scale basis and are often not well planned or supervised. As a result, large areas are drained or oiled in the name of mosquito control and the results are often disastrous. We feel that if such projects are initiated in the future, mosquito

control experts should exert their influence to curb or guide such activities in behalf of their own interests and those of wildlife.

The following remarks are confined to a well managed mosquito abatement program.

Mosquito control may adversely affect wildlife by: (1) habitat and food destruction, and (2) by the outright destruction of wildlife. In Utah, the forms of wildlife that may be affected are: (1) migratory waterfowl, (2) muskrats, (3) fish, and (4) upland birds, in some cases.

Probably the oldest known method of mosquito control is by ditching and draining of mosquito breeding bodies of water. In Utah this practice has been limited largely to semi-permanent or fluctuating bodies of water. Such bodies of water, usually highly alkaline, are good mosquito producers, but are generally poor waterfowl producers. The Fish and Game Department has no objection to the drainage of areas that do not produce food for waterfowl. There are some fluctuating bodies of water that do, through spring run-off, produce food and hold some birds, the birds following the receeding water levels. The Lake Front area west of Farmington Bay is an example of this type of marsh. Utah's man-made marshes are constructed to permit irrigation or freshening of the water. In addition to this irrigation system, the banks or dykes of these marshes slope gradually so as not to puddle, or impound stagnant water. Control of water levels is important in the management of waterfowl marshes to help control botulism and to provide ideal conditions for the production of food plants. Such control also limits mosquito production.

It is necessary to point out that most of Utah's waterfowl refuges lie at the lower elevations in populated valleys. As a result, surplus irrigation water usually drains and lies in the vicinity of the refuge. Such accumulations of mosquito breeding water is not an overflow from the refuge, although they often appear to be. These areas are sometimes used for pasture land, and cattle hoof prints in the mud provide ideal breeding places for mosquitoes. When complaints from such areas are received, a

thorough investigation should be made before control activities are needlessly initiated on the refuge.

The drainage of any area invariably lowers the water table, thus altering the ecological balance of the plant cover and usually adversely altering the climax vegetation, and is another factor for consideration.

Ditching and draining of most areas also reduce the muskrat population. Although of secondary importance, the muskrat as a fur resource must be considered.

The effects of oiling are well known. Used in sufficient quantities, both plants and animals may be killed, especially when non-volatile oils are used. Pyrethrum has advantages over oil in that it may be used in concentrations that will not harm wildlife, or the aquatic plants and animals that are utilized for food. In speaking of this chemical, Dr. Don M. Rees has stated, "It is not as objectionable as oil, and in the future will probably be used to replace oil in certain parts of the district," (Rees, 1941:23). We endorse such a change, wherever possible, in the hope that the dangers of oil may be avoided.

From the point of view of the conservationist, biological control is, of course, the ideal, although the difficulties involved are realized. In the case of our refuges, where fluctuating water levels may be avoided and populations of the mosquitoes' natural enemies may be permanently established, biological control will help solve the problem. Gambusia fish have already proven useful on some of the privately owned duck clubs.

Although it is rather premature to speak with any degree of certainty, careful studies by Stewart (1946:201), and others have proven that when properly used, DDT may be used in sufficient quantities to kill mosquito larvae, and yet have relatively no effect on waterfowl or the animals and plants upon which the waterfowl feeds, except, of course, for the mosquito. Use of DDT must be carefully supervised since it has been proven (Surber, 1946:190) to be highly toxic to fish. This use of a larvicide offers a good deal of encouragement for use on marshes in Utah. It is felt, however, that the use of such a toxic poison should

be used with extreme caution and general use should not be initiated until experimental work has been done in this area.

The Fish and Game Department believes that there is the possibility of future danger to wildlife if there should occur an outbreak of mosquito-borne disease, followed by public hysteria. Should such an occurrence take place, an aroused public may make demands on mosquito control agencies, as well as upon the Fish and Game Department, for needless widespread oiling and draining. Now is the time to arrive at understandings and prepare cooperative agreements in order to avoid being forced in the face of public pressure.

In view of the matters already discussed we make the following recommendations:

(1). That, whenever it is necessary to subject any area to mosquito control that supports or contributes to a wildlife population, the Fish and Game Department be called in to present their case.

(2). That, whenever the Fish and Game Department draws up plans for the impoundment of water, the mosquito abatement control agency for that area be called in to offer advice that may, without altering the essential features or cost of the project, reduce mosquito production.

(3). That, preparatory to mosquito control activities, the control agency consider the flight range of the mosquitoes involved, and prevailing wind conditions in relation to communities involved.

(4). That, whenever it is found absolutely necessary to apply control measures that will affect wildlife populations, the Fish and Game Department be given ample time to apply protective measures for the wildlife present.

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MOSQUITO CONTROL IN THE MOUNTAINS OF UTAH

Lewis T. Nielsen

Invertebrate Zoology

University of Utah

In the mountains of Utah the following species of mosquitoes constitute serious pests: Aedes cataphylla, communis, excrucians, fitchii, impiger, intrudens, pullatus and punctor. All produce a single seasonal brood. The larvae develop principally in temporary pools formed from melting snow; hatching in great numbers during May, June and July. The adults live only a few weeks, but are so annoying that control is desirable around most mountains recreational areas. In Utah, control of these pests has been carried on since 1937 at Camp Cloud Rim, a Girls' Scout Camp near Park City, and at Brighton and lower Big Cottonwood Canyon since 1940. Results have been very satisfactory. Control methods used have been drainage and the application of larvicides, principally light oils, and DDT. At present experimental work is being conducted at the University of Utah in testing the effectiveness on mountain mosquitoes of DDT as a prehatch larvicide.

THE PURPOSE AND VALUE OF MOSQUITO CONTROL MEETINGS

Harold F. Gray

President

American Mosquito Control Association

The primary purpose of mosquito abatement meetings is to improve public service by discussing ways of doing the best possible job at the least cost. Values are gained through hearing formal papers and by participating in informal discussions. Panels or symposia are particularly valuable in that they tend to promote discussion. The value of becoming acquainted with others doing similar work is one of the major benefits derived from such meetings. Two common failures of mosquito abatement meetings are failure to allow sufficient time for discussion of papers and failure to fully exploit the news values of the meetings.

HISTORY AND DEVELOPMENT OF MOSQUITO ABATEMENT IN UTAH

Don M. Rees

President

Utah Mosquito Abatement Association

It became apparent soon after the settlement of Salt Lake City and numerous other localities throughout the state, that hordes of mosquitoes would annually torture the inhabitants of these communities. It also was evident that the mosquito swarms increased in numbers and became more continuous throughout the season as irrigation projects were extended near these communities.

For many years in Utah, as in other parts of the world, these pests were accepted as inevitable, just as unfavorable weather conditions are accepted, with numerous complaints and caustic comments but with the belief that there was nothing that could be done to improve the condition. Then, just prior to the beginning of the present century, when the role that certain mosquitoes play in the transmission of disease was discovered, it was soon demonstrated that the abatement of mosquitoes was not only possible but practical.

During the first decade of this century a few progressive individuals in different communities in Utah are reported to have attempted limited mosquito control work. In Salt Lake City, E. W. Senior, a prominent lawyer and businessman, became interested in a mosquito abatement program for a reclamation and building project he and others were trying to develop on the flats west of the city. He was aware of the fact, as others had previously determined, that one of the principal reasons why Salt Lake City had never extended its growth westward, was the mosquito annoyance existing in that area during the greater part of the year. Mr. Senior soon discovered as did other individuals who attempted mosquito control work in the state, that a mosquito abatement program to be effective is a civic or group project that must be continued each year, like water, sewage, roads and similar community services.

The attempt at this time to extend Salt Lake City westward was a complete failure and the remains of the streets and buildings are mute evidence of an important building division that was never completed due in part to the attacks of pestiferous mosquitoes. Mr. Senior was convinced that mosquitoes were the principal factor that doomed this project to failure. He therefore became a strong proponent of mosquito abatement and was perhaps the leading figure in building support for the beginning of organized mosquito abatement work in Utah.

Shortly after World War I, Mr. Senior and other progressive citizens obtained the ready support of Dr. T. B. Beatty, State Health Commissioner, in a drive to obtain a mosquito abatement program in Utah. Dr. Beatty as Head of the State Board of Health requested assistance from the United States Public Health Service. In 1922, the Public Health Service sent Major J. A. LePrince to assist Utah with its mosquito control problems. Major LePrince was a veteran in this work having played an important role in the control of mosquitoes in Panama and in the southern United States.

According to Major LePrince's account, as he later related it to me, when he stepped off the train in Salt Lake City he was met by Dr. Beatty and a swarm of mosquitoes and he knew he was in the right place. Major LePrince made a preliminary survey of the mosquito situation and with Dr. Beatty held a number of public meetings to discuss mosquito problems. Most of the meetings were held in Salt Lake City and vicinity but one meeting was held as far north as Tremonton in Boxelder County,

As a result of this preliminary work a mosquito abatement law was drafted with the able assistance of Major LePrince. This law was passed by the state legislature in 1923, becoming effective on May 8th of that year. The law provided for the organization and administration of mosquito abatement districts in the state of Utah. The law has since received minor ammendments in 1931 and 1939, to provide powers for enforcement and extension of operation. There are a few other minor changes that would improve the law but the Utah law as it now stands has been cited as one of the

best state laws on the subject in existence. It would have been disastrous to the mosquito abatement program of this state if H.B. 136 introduced by Kerr and White from Boxelder County had not been defeated. This bill would have placed the taxing power of all mosquito abatement districts, and therefore the control, entirely in the hands of the County Commission rather than in a non-political, independent public service board as now provided by the present law.

The Salt Lake City Mosquito Abatement District was organized in 1924 as the first mosquito abatement district in the state. This district began field operations in 1925 and continued to operate for 20 years before another abatement district was organized. However, during this period numerous mosquito control projects were conducted in several other counties in the state under Federal Government, ERA, CWA, and WPA funds. During this period the principles of mosquito abatement were being slowly but surely brought to the attention of the people of the state. With this background the emphasis placed on mosquito control during World War II was sufficient to stimulate the organization of other mosquito abatement districts in Utah.

In 1945 the Boxelder Fly and Mosquito Abatement District was organized. This district includes one of the largest counties in the state, covering some 5,594 square miles. Fortunately, from the standpoint of mosquito control, most of this vast area is semi-desert country with no significant mosquito control problems and few human inhabitants. However, the Boxelder District is confronted with a tremendous problem of mosquito abatement in the Bear River marshes, and other fresh water marshes, along the shores of the Great Salt Lake.

This district is also engaged in an active fly campaign, in which buildings and fly breeding material are sprayed with DDT. This service is conducted on private property only at the request and partial expense of the owner. This part of the program has been very successful and has been an important factor in selling the idea to the public of supporting a mosquito and fly abatement district. However, requests from private property owners for the

treatment of their property for fly control have become so great that it is difficult to provide this service and at the same time develop necessary mosquito abatement work. The tax levy of the Boxelder District was raised this year from .25 to .75 of a mill in the assessed valuation of the County in order to provide funds for both mosquito and fly abatement work.

The Magna Mosquito Control District was organized in 1946. This district is located in the west part of Salt Lake County, adjacent to the Salt Lake City District. The Magna District operates on a one mill levy and a $10,000 annual contribution from the Utah Copper and American Smelting and Rifining Companies. To date the Magna District has been concentrating on, and recently completed an extensive drainage system. Most of the drainage work was constructed by the use of ditching dynamite. During last December some of the blasts were of such magnitude they caused distinct earth tremors which were reported by inhabitants in the west part of Salt Lake City some eight miles from their source. These so called earthquakes received front page publicity for several days in Salt Lake City newspapers until it was discovered that it was only Magna shooting at the lowly mosquito at times at the rate of a ton or more of dynamite per shot. This is one way to publicize mosquito abatement work although we do not recommend the practice as standard procedure. It is too startling for public nerves.

The Weber County Mosquito Abatement District was organized in 1947. This district includes a large county surrounding the city of Ogden. Organized abatement work was started last year with very satisfactory results. The tax levy for 1949 was set at .3 of a mill. (1948 report not available.)

The Salt Lake City Mosquito Abatement District has never exceeded .3 of a mill tax levy which now provides about $50,000 annually. In addition the district has succeeded informing a cooperative agreement between the district, Salt Lake City and Salt Lake County; each to contribute $10,000 a year to a fund to be used for maintenance of the installed drainage system. The burden of this maintenance work in the past has been assumed by

the mosquito abatement district.

As a result of this program relief from mosquito annoyance has become a reality in Salt Lake City. People are able to enjoy their homes, gardens, parks, outdoor entertainments and sports without being constantly plagued by mosquitoes. This in itself is worth the cost and effort entailed by the program but there are numerous additional benefits. Mosquito abatement has provided an extensive system of surface drains in Salt Lake City and vicinity that has materially improved farm, pasture and building ground. The drains have also improved public roads, railroads, airports and water-ways. It has made it possible to build the city westward as evidenced by the residential building boom now in progress on the west side, on ground which a few years ago was considered unsuitable for building because of the absence of drainage and the presence of hordes of mosquitoes. It has also opened this area for new industries which have established numerous plants in this area within the past few years but not before investigating drainage facilities, health and working conditions, including the mosquito menace. All of these improvements and developments within the past few years have greatly increased property values and therefore, tax returns to the city and county, that far exceed expenditures made on mosquito abatement which have made these things possible.

Other districts which have more recently started mosquito abatement work have already noticed a great reduction in the mosquito population within their boundaries. As the program is continued these other benefits will become increasingly evident each year if the work is well planned and directed towards the purpose of mosquito control.

The total area now included in mosquito abatement districts in Utah covers some 6,251 square miles. A fifth district comprising the remainder of Salt Lake County, not included in existing districts, has practically completed organization. This new district will cover approximately 130 square miles. Three other counties are at present considering the organization of abatement districts.

The mosquito abatement districts of Utah are providing a public service the people of these districts demand. It is possible with modern equipment and methods to provide protection against mosquitoes at a relatively low cost. Mosquito abatement and other additional benefits derived from a well planned mosquito abatement program provide greater tangible returns to the public for the tax dollar expended than any other single tax supported program in the state.

We have made considerable progress in the development of the mosquito abatement program in Utah. This work has many loyal supporters. Let us keep it on a high plane of efficiency and for the purpose for which it was established, mosquito control, the other benefits will follow inevitably. If there are individuals who are critical of the existing state law or the mosquito abatement program it is a challenge to us to convince them through the results we obtain of the effectiveness and efficiency of the existing program and the sincerity of purpose of its personnel. As members of this state organization we are interested in improving and developing the mosquito abatement program. I hope these meetings will serve as a means of improving the work now in progress and stimulate the organization of other districts throughout the state where mosquito abatement work is necessary.

MOSQUITOES AS PESTS AND VECTORS OF DISEASE IN UTAH

Albert W. Grundmann, Ph. D.

Department of Invertebrate Zoology

University of Utah

The subject of mosquitoes as pests and vectors of disease is an old story to most of those assembled here. I know that all of you are familiar with the vast economic loss that can be forced upon a community where the mosquito is allowed to breed unchecked. Economic loss in the form of reduced property values and in annoyance to man and his domestic animals can be considerable. In some instances the development of desirable regions of the earth has been retarded and mankind deprived of its resources. However, at times, this is of secondary importance compared with the huge losses to mankind that mosquitoes can inflict when they act as vectors of disease. Although many of the most ravaging mosquito-borne diseases such as malaria, filariasis, yellow fever and dengue are largely diseases of the tropics, mosquitoes create two problems in regard to disease transmission in Utah. The two to which I have reference are malaria and the virus encephalitis. While the former is known to be present to a low degree, the extent of the latter is still uninvestigated.

From known records and reports malaria has been known to exist in Utah since early pioneer settlement. It has been transitory in nature in many parts of the state with the exception of Washington County which has a record of a continuous hypoendemic condition. This implies that in Washington County the disease is constantly being transmitted to a low degree each year and that a reservoir plus an efficient vector is constantly present. Many of the first settlers in this region had contracted the disease in the Mississippi River Valley where endemic conditions existed at that time and migrated to this region while still in the latent period of the disease. These individuals upon relapse would demonstrate the gametocyte form of the parasite in their blood.

According to local residents, malaria broke out in Salt Lake Valley in 1880, causing several deaths. The disease raged all summer and was brought under control in late fall. This outbreak is unrecorded in medical literature, however, it is substantiated through statements of residents of that period. Other than this outbreak the history of malaria in Utah has been one of a few reported cases each year with most of them being relapses in individuals who had contracted the disease outside of the state. At intervals, cases are reported that were definitely contracted in the state due to an occassional transmission through the agency of our local anopheline species. Only in Washington County are indigenous cases reported with any regularity.

From 1900 to 1943, the State Department of Health files show but a few reported cases each year, but in 1943, there was a sixty two fold increase. Figures for the last ten years are: 1939, 1 case; 1940, 5 cases; 1941, no cases; 1942, 5 cases; 1943, 313 cases; 1944, 151 cases; 1945, 112 cases; 1946, 93 cases; 1947, 43 cases; 1948, 2 cases. In addition to the reported figures, there were undoubtedly many sub-clinical attacks that were not reported. This rapid increase of cases in 1943 can be explained by the influx of persons working in defense installations and by soldiers stationed here who had contracted malaria in other parts of the country. This group, in addition to causing an increase in the malaria rate which rose to 19.1 per 100,000 population during 1943, would occassionally act as a reservoir of infection were it not for the effective mosquito abatement carried on by the armed services and by the local public health and abatement organizations in those areas.

For those not familiar with clinical malaria, I will explain some of its aspects. There are three common species of which Plasmodium vivax causes approximately 75% of all infections, P. malariae causes about 4% and P. falciparum causes about 20% of all infections. An individual becoming infected suffers an initial attack. Since drugs available at present do not cure the infection, the individual passes into a period of latency that is marked by one to many relapses. This period lasts about two years in P.

vivax and about four to six years in P. malariae. Since the drug atabrine tends towards a cure in many cases, there are very few relapse cases of P. falciparum. Most of the cases that occur in Utah, then, are relapse cases of P. vivax that has a latent period of about two years. Following this latency the individual enters upon an indefinite period in which the parasite may still be present, but where relapses no longer occur. Though much more rare than in the earlier period, the presence of parasites in the blood is possible, and unless the individual has become a gametocyte carrier, which very few do, there is little possibility of them serving as reservoirs of infection. By 1947 and 1948 almost all cases had entered upon the period of tolerance or had actually cured themselves of the parasite.

At the present time, a thick film survey of known malaria cases is underway at this institution. Of the individuals tested thus far, none have been found with a parasitemia in the blood at the time of examination.

Several species of Anopheline mosquitoes have been reported from Utah. Of this group, Anopheles freeborni (Aitkin) is the most widespread and important in relation to malaria. It is found in almost every city, town and farming region in Utah up to an elevation of 7500 feet. This species is considered by Hermes and Gray (1944) as being the most efficient and important vector of malaria in the western United States. It breeds in pastures that are "flood irrigated" or those that contain fresh water due to seepage or springs. Any place where water is fresh, slow moving, and somewhat shaded by emergent vegetation or floatage constitutes a favorable location. Rapid moving water is generally avoided although at times larvae may be found in vegetation lined irrigation ditches.

To summarize the malarial situation in Utah, we have an efficient vector, Anopheles freeborni, that at least seasonally, May through August, can transmit the disease from gametocyte carriers to healthy individuals. There are apparently a few effective gametocyte carriers present, especially in Washington County, that are capable of infecting the vector. Few of the

veterans who contracted malaria abroad and have now had the disease for a period of two to four years are of importance as reservoirs at the present time although some of them may have been during the last several years. There is no question that the mosquito abatement program set up locally and by the Army and Navy about its installations and Prisoner of War Camps contributed largely to the effective control of what otherwise would have been a malarial outbreak among residents of these communities. This reservoir will further decrease until only a few cases will be reported each year as in the years prior to 1943 and these will consist largely of returned missionaries and visitors, with a few indigenous cases due to local transmission.

The other potential disease hazard posed by mosquitoes is probably of greater importance to the people of Utah than the malaria problem. This concerns the transmission among men and animals of the neurotropic viruses, namely, St. Louis Encephalitis and Equine Encephalomyelitis. Although Western Equine Encephalomyelitis, the common brain fever of horses, has been epidemic at times during the last twenty years in many Utah communities, the extent to which these two viruses are present in this region is largely unknown at this time. St. Louis Encephalitis has not been clinically diagnosed although its presence can be anticipated by the work of Hammon and his co-workers in the Yakima Valley of Washington and in the San Joaquin Valley of California.

The existence in this region of these two viruses in humans has been suspected for some time since a number of cases of atypical poliomyelitis show symptoms that are suggestive. The sera of many of these patients has been collected and will be examined during the next few months, through a research project that has been set up at this institution to determine the extent of these two viruses in human encephalitis. In addition, a survey will be made using human sera collected from all parts of the state to determine if antibodies are present in individuals showing no history of the infection. During the next few years, further work of the survey will include attempts to siolate the firuses from mosquitoes and other arthropods collected in localities

in which the diseases appear in man or animals. Attempts will be made to determine if antibodies exist in wild and domestic animals and birds in order to clarify the epidemiological picture.

Since little organized investigation has been carried out on these two diseases in Utah, its epidemiology also is not definitely established or understood. In many respects this area would be somewhat similar to the Yakima Valley of Washington in which conditions were determined by Hammons and his co-workers. This study indicated that several species of mosquitoes, principally one species, Culex tarsalis, were engaged in the actual transmission of these diseases among human beings and horses during epidemic conditions. It was known that the mosquito does not become infected by sucking the blood of infected horses. The domestic chicken proved to be the source of the virus for the vector. Chickens, temporarily have the virus in their blood and act as a reservoir during an epidemic, however, they do not show symptoms of the disease. The chicken gets its infection through the agency of the mosquitoes that feed upon it and also upon certain wild birds such as sparrows and house finches that also harbor the disease. These wild birds act as a reservoir which is maintained through the agency of the mites that feed upon them.

The viruses, both St. Louis Encephalitis and Equine Sleeping Sickness, have been isolated in nature from collections of mosquitoes made in areas where horses and human beings were sick with the disease. Species shown to harbor the virus in nature were Culex tarsalis, Culex pipiens, Culiseta inornata, and Anopheles freeborni. Since all of these species are present throughout Utah, and with the remainder of the situation similar to that of the Yakima Valley, it is not difficult to see the implications of the potential situation that exists.

Losses among horses have been considerable in some localities of the State of Utah, and with the added factor of possible human cases occuring, it is desirable that advantage of available measures to control the ravages of these diseases should be taken. We probably cannot ever eliminate these viruses from the community although we can probably prevent all, or almost all, human and

equine cases through the agency of effective mosquito control. While the mite to wild bird cycle continues indefinitely in nature, among wild birds, it will not become apparent unless the vector gets out of control. Thus, through a well developed and directed mosquito abatement program, we can control these two ravaging diseases.

REPORT FROM CALIFORNIA

G. Edwin Washburn

President

California Mosquito Control Association

Mosquito Control in California dates back to 1905 when certain salt marsh mosquitoes were brought under control at Burlingame. However, it was not until 1910 when the first anti-malarial mosquitoe control was instituted at Penryn, California, by W. B. Herms and Harold Gray, that mosquito control began to gather momentum. This project at Penryn was followed shortly by the enactment of legislation in 1915. This was an attempt to supplant free-will offerings for mosquito control campaigns by an equalization by means of a tax levy distributed over all the property owners who enjoyed the results. During the 30 years from 1915 to 1946, there were 39 mosquito and pest abatement districts established in the state of California controlling mosquitoes over a total area of 4,645 square miles.

In 1946 six new districts were formed and an additional area of 6,353 square miles came under control. This spurt in growth has continued up to the present date, 1949, until now there are 44 mosquito control agencies in California controlling mosquitoes in an area nearly 20,000 square miles in extent expending close to $2,000,000 annually. Districts vary in size from 20 square miles to several of near 2,000 square miles. Several other areas within the state are now in the process of organizing mosquito abatement districts and will soon be under control.

Factors which have contributed to this tremendous growth in three short years are many, but probably some of the most important are:

1. The impetus and publicity given to the control of disease transmitting arthropods during World War II.
2. The discovery of highly effective insecticides resulting in new control techniques at reduced operations costs.

3. The enactment of legislation within the State making less complicated the procedure of establishing new mosquito control agencies.
4. Grants or subsidies from the State Legislature to mosquito control agencies engaged in vector mosquito control.
5. The general up-swing of the economic level of the average property owner.
6. The desire and organized efforts toward recreation for persons of all age levels.

As the number of mosquito control agencies began to grow in California there arose the desire for some kind of an organization, whereby the persons engaged in this work could get together and exchange ideas and learn from specialists the results of technical experimentation in mosquito control and related fields. At first this was a loosely knit group but now has consolidated into the California Mosquito Control Association. The first meeting of this group was held March 20, 1926. It lapsed after two or three meetings then became active again about 1930. Except for the interruption of World War II this organization has met at least once each year. From only a few persons attending, the group has grown with each succeeding year. At the recently held 17th Annual Conference in Berkeley, nearly 500 persons were in attendance, representing mosquito control from all parts of the world. Foreseeing the need of a more formal organization, a Constitution and By-Laws were drawn up in 1947. During 1948, the California Mosquito Control Association has operated under this constitution and by-laws on a trial basis. Under this constitution, developed by the first executive committee, the present executive committee is functioning as the guiding body of the group and meets periodically to transact association business. Minutes of these meetings are sent to all member districts.

There are three general types of agencies engaged in mosquito control in California:

1. Mosquito abatement districts organized under the Health and Safety Code of California.

2. Pest abatement districts organized under the above mentioned laws.
3. County or City Health Departments carrying on mosquito control activities.

Membership within the present California Mosquito Control Association is voluntary in nature and is of twokinds: Active and Associate. Active membership is confined to mosquito control agencies in California who have paid their yearly contractual dues. An Associate membership may be obtained by any person or organization through the annual payment of dues. Several services are performed by the Association for the membership and others interested in mosquito control. Many of these have been developed on a cooperative basis between the California Mosquito Control Association and the State Department of Health, Bureau of Vector Control. Of interest to you are:

1. The Operations Manual.

   This working bible of California Mosquito Control was first unveiled at the last annual conference and has been received with enthusiasm wherever it has gone. It is a compilation of technical memoranda, results of experimental studies, improvisations and other developments in California Mosquito Control, many of which have resulted in unique accomplishment; all are systematically kept by each district in a binder. From time to time supplements are released which have been the results of new work accomplished. Over the years the information thus compiled should serve as a text of mosquito control progress in California.

2. The Buzz.

   Carried on as a joint project of the Association and the Bureau of Vector Control, this monthly publication has been a means of keeping all interested agencies in close contact with the very latest news of local, state, and national activities. It is a monthly news sheet with a mailing list of approximately 850, the "Buzz" probably reaches more individuals than any other

single effort of the association. It is now being sent to nearly all parts of the world.

3. Insignia.

During the past year the association through its executive board, undertook a statewide contest for an insignia which would typify mosquito control within the state. Considerable interest developed in this contest which was limited to elementary and high school students. As a result a suitable drawing was accepted which has since been developed into a decal for general use. It is colorful, and identified the wearer as a member of the California Mosquito Control Association. It has created a great deal of interest. Many districts have the identifying decal on all of their pieces of equipment.

4. Annual Conference and Proceedings.

At least once each year the association meets in annual conference to present papers and to transact business. During the past two or three years this meeting has been augmented by regional meetings with some district acting as host. These regional meetings have been planned more for the field personnel's benefit than for the technical personnel. As such they have afforded them with a real opportunity to see and learn just how each district operates.

One of the largest items of expense to the California Mosquito Control Association has been the cost of assembling, editing and publishing the proceedings and papers given at each Annual Conference. Through the generous efforts of Harold Gray and R. F. Peters of the Bureau of Vector Control, this enormous task has been accomplished and each member district furnished with copies of the proceedings. The actual cost has been met by the contractual dues paid by each member district and through sale of copies of the Proceedings.

5. Committees.

To run smoothly most organizations have committees.

We are no exception. Many standing committees are at work to develop better methods of control, more sound experimental data, consolidate, shorten and standardize many report forms used by the districts, and to attempt to set up standards to follow for testing new insecticides or performing certain accomplishments. The results of many of the efforts of these committees are often included in the Operations Manual. The true indication of any groups' progress is the interest shown by each member. Our committees have demonstrated that the California Mosquito Control Association is an active working body.

The California Mosquito Control Association enjoys a somewhat unique position in that within the state we have a very close relationship with the State Department of Public Health, Bureau of Vector Control. It is the policy of the State of California to support local agencies in attacking local problems, therefore, the State Department of Public Health has developed the Bureau of Vector Control to handle all field problems in connection with arthropods of medical importance. In the way of control programs perhaps the most significant factor which has aided in the development of mosquito control in California since World War II has been the State Subvention of monies for vector mosquito control. We are now in the third subvention program and the State has encumbered or expended some $1,200,000 during this period for assisting local mosquito control agencies.

In addition to the administration of the subvention program, the Bureau of Vector Control acts in an advisory capacity to all areas under mosquito abatement. The Bureau contains a staff of professional engineers and entomologists experienced in mosquito control problems. During the past two years the Bureau has conducted a training program for local mosquito control workers which has proven very beneficial. Through the medium of these schools all personnel of the districts have been given a sound knowledge of mosquito control principles and practices.

While this has been a rambling report on the California

Mosquito Control Association set-up, I trust that it has given you some insight as to our operations. We are still growing, and occasionally growing pains are experienced, but we are confident that by the conscientous effort of all local, State and Federal agencies, we may enjoy harmony as well as effective mosquito control programs not only in California but in all parts of the world troubled with the mosquito problem.

REPORT FROM SALT LAKE CITY MOSQUITO ABATEMENT DISTRICT

Robert A. Wilkins

Supervisor

Salt Lake City Mosquito Abatement District

The Salt Lake City Mosquito Abatement District has confined its principle efforts from 48th South to 36th North and from the mountains on the east to 4800 West, an area of 144 square miles. The District includes the Jordan River, the surplus canal, five large irrigation canals, and numerous irrigation ditches. In all about 300 miles of drains to patrol, 3200 field pools, and 1425 residential ornamental pools.

For ten months of the year the work was carried on by six key men, but during the summer months a total of eighteen men were employed.

General inspection and spraying was required from April 16th to September 29th.

Four light traps were operated in the usual places from June 8th to September 24th.

The spraying equipment included two weapon carriers mounted with Tokheim power sprayers, with attached hand-hose mounted on reels. Two Ford pickups with pressure tanks of 40 and 60 gallon capacity, and one ½-track with 280 gallon tank powered by Denver Fire Clay power pump. All five of these trucks were hooked up for ground aerosol fogging. Hand pumps for two men were carried on all trucks.

The excavating of drains, the construction of new drains, and the cleaning of old drains was done with dragline, D-4 tractor with angle dozer blade, and a new ditcher designed by the supervisor. The usual hand pick and shovel supplemented the drainage work where necessary.

Two trucks were used in inspection work, and one during the season on fish culture and planting in the pools and drains.

The Fish Culture required 2557 miles of travel and the work

the surplus canal at Fourth South. It is a well known fact that no irrigation water from the North Point Canal is put to a beneficial use until the flow reaches Tenth North. The expense of cleaning the seepage drains, paralleling the canal from Fourth South to Tenth North, is prohibitive, and should no longer be expected of the Mosquito Abatement District. Besides this expense there is the danger of the canal flooding the airport, between North Temple and Seventh North, as the canal is not patrolled regularly; and the dam at Jacketta's, for the constant water level at Hinkley's farm, is dangerous when a rain comes to raise the water level. This dam is not adjusted by the water master until after a flood occurs and the damage is done.

Improvement in Drain No. 6 Goggin by dragline dredging was continued between North Temple and Seventh North, 5500 feet; and south of North Temple into Williams Lake where two automatic headgates and culverts were installed, and the banks built up with a dozer.

As early as April twentieth, the diked area, a forty-acre tract owned by the Utah Sand and Gravel Company at Eighth West and Seventeen-hundred North, began breeding Aedes dorsalis mosquitoes and all summer this continued; and later in the summer produced Culiseta in abundance. The district constructed a drain from the northwest corner into Drain No. 2, but owing to the high grasses and the irregular level of the water, our oil sprays could not reach the breeding and adults immerged, causing a real problem. As a last resort dusting with 10% DDT was tried with good results. However, dusting was applied three times before a satisfactory control was made.

Early in May, the California Oil Company in North Salt Lake, had hordes of gnats to pester the outdoor workers. A turn-over in manpower occurred every few days. The district did what it could to fog the area with Tanite and 5% DDT solution, and oiled the ponds regularly. Yet the gnats were very troublesome. A new drain was run from Beck's north one-half mile into the property, and the company installed a culvert under the filled roadways to allow the seepage water to be diverted away from the property. Not enough

study has been made about the life cycle of gnats to know how to eliminate the nuisance, but about the time we dried up the area, the gnats were gone.

Considerable excitement was aroused about the sudden death of three cows, near Sixth North and Twenty-hundred West on May twenty-seventh. When the report came out that death was due to lead poisoning, the feeling against spraying died down.

Irrigation Canals. The constant flooding from Mill Creek continued throughout the summer. The dam at Third West and Twelfth West causing the most trouble. At the time when the area north of the airport was under water, the source of the wasted water was traced to the Twelfth West dam in Mill Creek. It is understood that a pump will be installed at this point for water users during the 1949 season.

On June first the North Point Canal broke the banks and flooded for four days before it could be repaired. This break at Fifty-hundred West and Thirteenth North caused a week's spraying and intensive work.

The Ridgeway Canal at Forty-two hundred West, south of Twenty-first South, broke it's banks three times during the irrigation season, flooding grassy acres both north and south of the canal, and contributed greatly to the mosquito nuisance.

The Surplus Canal and Drain No. 1. The rains of early June brought out the lack of drainage capacity of these important drains. For ten days the water over-flowed the banks of the surplus canal at North Temple and Thirty-five hundred West, where laterals had been provided for surface water to enter the canal. These drains being open allowed the high water to flow in reverse and so inundate thousands of acres. No relief from this condition was possible for several weeks, and so breeding of mosquitoes was terrific. After the water subsided the district installed four automatic headgates and diked the banks two feet higher than the 1948 high water level, and it is hoped that flooding here cannot happen again.

A similar condition prevailed from Nineth North to Seventeen-hundred North on both sides of Drain No. 1. When the de-mossing

accomplished included 4677 visits. The 1425 ornamental pools were stocked with 27,261 fish, 152 drains with 19,490 fish, and 25 lakes with 13,145 fish. 121 residential pools were sprayed during the season.

Inspection. Ten men spent 4785 hours on the inspection of field pools and drains making 16,850 visits.

Spraying. 4591 hours were spent in spraying. There were 1294 field pools, and 82 drains, requiring regular spraying, on which 13,300 gallons of oil spray, DDT in oil, and 100 pounds of DDT dust, and 1550 gallons of Thanite were spread. The 10% DDT dust was effective in grassy areas in the control of adult mosquitoes hatching where the oil sprays failed to reach the shallow water, under the grass. The Brighton and Camp Cloud Rim recreation mountain areas were sprayed during the month of June.

Drainage. The dragline was used on Drain No. 6 Goggin drain for 8500 feet between 9th North and South Temple Streets, and on east and west laterals in Williams Lake. 5958 cubic yards were removed. The district tractor was used 1415 hours, and hand labor 8,889 hours in cleaning 186047 feet of old drains; 23,564 feet of new drains, and removing blown weeds in 18 miles, 4420 feet of district drains. The tractor and ditcher removed 68,063 cubic yards of earth at a cost of .06¢ per foot. Dragline work cost .24¢ per cubic yard. Nine automatic headgates and high banks were raised up at crucial points along the surplus canal, and on Drain No. 1, between the Airport and 1700 North Street in an effort to ward off another high water flood such as occurred in 1948.

On February third a meeting was held, attended by Commissioner Homer Janes, Attorney Morrisey, County Surveyor Cassity, City Engineer William D. Beers; Trustees J. A. Giles, Don M. Rees, T. A. Schoenfeld, who discussed the need of flood control on the Jordan River, and the surplus canal. It was pointed out that as long as the surplus canal was used as an irrigation canal, and as a drain, it would never work. Mr. Cassity was of the opinion that the North Point Canal, should pump their water from Tenth North from the surplus canal, rather than maintain a dam across

of Drain No. 1 was finished on the fourth of July, the water level was lowered twenty-two inches. This vast acreage was difficult to spray and many mosquitoes escaped. As soon as possible after this experience three automatic headgates were installed at the outlet of open drains; and the banks built up above high water level. The spoils of the surplus canal on the east side between North Temple and Seventh North were leveled for access in spraying. The banks of Drain No. 1 were also leveled (both sides between Nineth North and Seventeen hundred North) to make power spraying possible when necessary.

On June twelfth Camp Cloud Rim was treated with 65 gallons of larvicide and inspected on the sixteenth. The kill was very good. Hat size pools around logs were heavy with larvae and sprayed on this inspection trip, and 100 fish were planted in the small lake two-hundred feet northeast of Brimhall Lake.

Big Cottonwood Canyon at Storm Mountain, Giles Flats, and the Brighton area including Lake Solitude were sprayed on June sixth and nineteenth, using 93 gallons of larvicide.

To eliminate breeding pools requiring weekly inspection and spraying, a thorough job of filling was undertaken during October and November beginning with the Arms Depot.

Parallel drains were constructed on both sides of the Brighton Canal, from Twenty-one hundred South to the open sewer ditch -- about Forty-hundred North. The seepage water from the canal covered large swales during the summer season along the canal, and the breeding of mosquitoes was deplorable. One large pool was filled two feet before the drain was constructed. All of the wells, allowed to flow the year-round for sheep and cattle, were diked and top drains provided, running to secondary roads where power sprayers can be used to speed up the spraying when necessary.

The slough at Thirteenth South and Redwood, six hundred feet long, was filled before running a drain thirty-seven hundred feet north to empty into Drain No. 1.

All of the low spots from Third South and Orange Street to Fifth South were filled and new drains constructed to lessen the mosquito breeding, and provide a way out for wasted irrigation water.

The sand holes along South Temple, dug many years ago west of the Jordan River, in which water has stood the year round and breeding mosquitoes regularly, were all filled and collecting drains constructed where possible.

The sand holes north of North Temple to nearly Third North were filled above the general water level from Twentieth to Twenty-first West. The irrigated ground on the west of this area has for many years furnished the stagnant water in these holes. The east edge was also diked along the low spots.

The D-4 Tractor and Ditcher has proved to be most valuable in the filling of breeding holes and dead drains. Also in the construction of new drains, and cleaning old drains during 1948, and should lessen mosquito breeding in our district during 1949.

PROGRAM

FIRST SESSION

March 19, 1951

9:00 Registration - Little Theatre, Union Building, University of Utah.

9:30 Address of Welcome. Dr. Jacob Geerlings, Dean of Faculty, University of Utah.

9:35 Response. T. A. Schoenfeld, Member, Board of Trustees, Salt Lake City Mosquito Abatement District.

9:40 The Utah Mosquito Abatement Association. Dr. Don M. Rees, President.

9:50 The Value of Mosquito Control to Home Gardners. Mrs. O. A. Weisley, Permanent Chairman, International Peace Gardens.

10:00 The Benefits Derived from the Cooperative Drainage Program in Salt Lake County. Ray P. Greenwood, Commissioner, Salt Lake County.

10:10 The American Mosquito Control Association. Lester W. Smith, President, Metuchen, New Jersey.

10:30 The Fly Control Program in Salt Lake City. Dr. James Z. Davis, Health Commissioner, Salt Lake City Department of Health.

10:40 Public Health and Insect Control. Dr. George A. Spendlove, Utah State Health Commissioner, State Capitol, Salt Lake City.

11:00 U. S. Public Health Service with Reference to Water Resource Facilities. Charles E. Kohler, S. A. Sanitarian (R) U. S. Public Health Service, Region 9, Denver, Colorado.

11:20 Motion Picture on Insect Control. Fred C. Harmston, S. A. Sanitarian (R) U. S. Public Health Service, Salt Lake City, Utah.

12:00 Adjournment.

PROCEEDINGS OF THE

FOURTH ANNUAL MEETING

of the

UTAH MOSQUITO ABATEMENT ASSOCIATION

held at the

LITTLE THEATRE

UNION BUILDING

UNIVERSITY OF UTAH

SALT LAKE CITY, UTAH

MARCH 19-20, 1951

UTAH MOSQUITO ABATEMENT ASSOCIATION

P.O. BOX 307

MIDVALE, UTAH

SECOND SESSION

Monday, March 19th, 1951

1:30 P.M.

1:30 Progress and Condition of the Salt Lake City Mosquito Abatement District. Robert A. Wilkins, Manager, Salt Lake City, Utah.

1:45 The Gnat Control Program in North Salt Lake City. James V. Smith, Field Supervisor of the Salt Lake City Mosquito Abatement District.

1:55 The Control Program of the Box Elder Fly and Mosquito Abatement District in 1950. Karl L. Josephson, Supervisor, Brigham City, Utah.

2:10 Results of Control Program on Flies and Mosquitoes in Brigham City. Roland A. Madsen, Sanitarian, Brigham City, Utah.

2:20 Report on Fly and Earwig Control in Box Elder County. H. Ross Coombs, Secretary, Board of Trustees of Box Elder County District, Brigham City, Utah.

2:30 Weber County Mosquito Abatement Program in 1950. Dr. O. Whitney Young, Director, Ogden, Utah.

2:45 Results Obtained in Weber County from the 1950 Abatement Program. Howard Widdison, Member, Board of Trustees, Weber County District, Hooper, Utah.

2:55 Weber County Mosquito Abatement District Program for 1951. Lewis E. Fronk, Director, Weber County District, Ogden, Utah.

3:05 Report from the Magna Mosquito Control District. Willard J. Jones, President, Board of Trustees of the Magna District.

3:20 Mosquito and Fly Control in Cache County. Reed Roberts, Sanitarian, Logan City Department of Health, Logan, Utah.

3:30 Mosquito Abatement Work in Spanish Fork. Linsey D. Snell, Spanish Fork, Utah.

3:40 Mosquito Abatement Program for Davis County. Dr. D. Keith Barnes, Health Commissioner, Davis County, Kaysville, Utah.

Adjournment.

Business Meeting

Monday, March 19th

(Immediately Following the Second Session)

4:00 P.M.

Reading of Minutes
Financial Reports
Election of Officers
Committee Appointments
Other Business

THIRD SESSION

Tuesday, March 20th, 1951

9:00 A.M.

Panel Discussion

Subject: Mosquito Control Problems in Utah.

Leader: Lester W. Smith, President, American Mosquito Control Association, Metuchen, New Jersey.

Panel: Boyd Sheffield, Past President, Utah State Association of County Officials, Brigham City, Utah.

Dr. George F. Knowlton, Extension Entomologist, Utah State Agricultural College, Logan, Utah.

Charles E. Kohler, Sanatarian (R), U.S. Public Health Service, Denver, Colorado.

Dr. A. W. Grundmann, Parasitologist, University of Utah, Salt Lake City, Utah.

Fred C. Harmston, Sanatarian (R), U.S. Public Health Service, Salt Lake City, Utah

Lewis T. Nielsen, Entomologist, University of Utah, Salt Lake City, Utah.

9:00 Introduction. Lester W. Smith.

9:10 Relationship and Cooperation Between Mosquito Abatement Districts and County Officials. Boyd Sheffield.

9:20 Discussion.

9:30 Organization and Duties of the Personnel of an Abatement District. Charles E. Kohler.

9:40 Discussion.

9:50 Effective Mapping and Essential Inspection in an Abatement District. Lewis T. Nielsen.

10:00 Discussion.

10:10 Temporary vs. More Permanent Control Measures. Dr. A. W. Grundmann.

10:20 Discussion.

10:30 Recess - 10 minutes.

10:40 Insecticides and their Effective Use in an Abatement District. Dr. George F. Knowlton.

10:50 Discussion.

11:00 Essential Equipment for Mosquito Control. Fred C. Harmston.

11:10 Discussion.

11:20 Summary. Lester W. Smith

11:30 Adjournment.

March 20, 1951

1:00 P.M.

1:00 FIELD TRIP.
Conducted tour of office and shop, of Salt Lake City District, including an explanation of control methods and inspection of equipment. A tour of inspection of the drainage system, of Salt Lake City and Magna Districts.