# PROCEEDINGS OF THE THIRTEENTH ANNUAL MEETING

OF THE

# UTAH MOSQUITO ABATEMENT ASSOCIATION

*held at the*

Box Elder High School

Brigham City, Utah

March 18 and 19, 1960

*edited by*

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UTAH MOSQUITO ABATEMENT ASSOCIATION

463 No. Redwood Rd.

Salt Lake City, Utah

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## THE UTAH MOSQUITO ABATEMENT ASSOCIATION; OBJECTIVES AND ACCOMPLISHMENTS

By Don M. Rees, Ph.D.
*Department of Zoology and Entomology, University of Utah, Salt Lake City, Utah*

*Introduction*:

Mr. President, Members of the Utah Mosquito Abatement Association and Guests. It is a pleasure to meet in Brigham City to hold the thirteenth annual conference of this association. I had the pleasure of attending the sixth annual meeting of this association which was held in Brigham City on February 21, 1953. That was a one day session attended by a relatively few, but an enthusiastic group of mosquito abatement workers. Today seven years later, there is visible evidence of the progress that has been made in this association in the increase in the numbers attending the meetings and in the excellent program that has been arranged by your officers which requires two days for its presentation. Our President Karl Josephson, Vice President Morris Swapp, Secretary-Treasurer Glen Collett and other members of the Board of Directors are to be congratulated on the arrangements made and program prepared for these meetings.

*History*:

The Utah Mosquito Abatement Association was organized March 20, 1948 in a meeting held by those interested at that time in mosquito abatement work in this state. The meeting was held in the Salt Lake Tribune Auditorium. Many of you here today were present at that meeting. In a business session held during these meetings the Utah Association was organized and the first officers of the association were elected. This was followed by a tour of inspection of the Salt Lake City Mosquito Abatement District conducted by Robert A. Wilkins, Manager of the district.

Participating on the program at these meetings were Professor George F. Knowlton, Entomologist Utah State University; Professor O. Whitney Young, Weber College; Professor A. R. Gaufin, University of Utah; Dr. W. W. Bigelow, Acting State Health Commissioner; representatives of the Box Elder, Weber, Magna and the Salt Lake City Mosquito abatement Districts, which were the only organized districts in the state at the time. Since then the association has held these annual meetings each year following some-what the same pattern but steadily increasing in membership and extending our program to include all other agencies concerned with mosquito abatement problems. Twice during these thirteen years of our existence, in 1952 and 1959, we have been honored by having the American Mosquito Control Association hold joint meetings with us in Salt Lake City. Unfortunately the proceedings of the first few meetings of the Utah Association were not published. The proceedings or papers presented at the later conferences have been published and have not only been of great value to those interested in mosquito abatement in this state but they have assisted others in various parts of the world who are confronted with similar mosquito abatement problems. These publications have also brought a measure of distinction and recognition of our succesful mosquito control efforts in this state.

*Objectives*:

An early attempt to formulate and state the objectives of the Utah Association is contained in a circular letter prepared by your officers and dated August 11, 1948. This letter states, "The Utah Mosquito Abatement Association was organized in March of this year . . . to promote close cooperation among those directly and indirectly concerned with, or interested in, mosquito control and related work; to increase the knowledge of mosquito abatement; and to advance the cause of mosquito abatement and extermination in the state of Utah and elsewhere."

This was our original objective and I am pleased to state we have tried to carry out these objectives without fear or without requesting or expecting special political favor. We want this organization to stand and continue on its merit. This to date we have accomplished.

In this letter thirteen years ago it states that the annual dues of each district is $25.00 and to please mail your check to Roy F. Tygesen, Secretary-Treasurer, Magna, Utah. At that time we were not attempting to print the proceedings of the meetings. A dollar had a much greater buying power than it has at present, yet our dues have never been increased. In this I am strongly of the opinion we have been negligent. If we spend the time and energy required to arrange an excellent program such as this and then take the time necessary to collect and edit the papers for publication, it is disappointing to find we do not have the funds to publish the proceedings. The Board of Trustees are authorized according to law "to take all necessary or proper steps for the extermination of mosquitoes." In my opinion the amount of money required to support this association and publish these proceedings, could not be spent in any other way where it will bring greater returns in abating mosquitoes in a district.

We might ask what is the purpose of these association meetings? The answer unquestionably is to improve the public service of mosquito abatement in this state and elsewhere. It is an attempt at cooperative effort to insure that the tax payers in each district will get the maximum for the money expended for this purpose. These meetings are a means of getting together in order to confer with each other on ways and means of doing the best job possible at the least cost. To the extent that this purpose is kept in mind, these meetings are a wise expenditure of time and money.

By the exchange of information, relating both our successes and failures, we can help each other to obtain better results, and more uniform results at less cost. This exchange can be either formal, through the prepared papers which are later printed and distributed, or informal, through direct man-to-man discussion of problems. There is also the opportunity to bring to these meetings various scientists and technicians who have new and specialized information which we can make use of in our own districts. When such information is presented it should be preserved in a written record and disseminated for our use and benefit in the future and as a medium of exchange with others engaged in this work in other parts of the world.

It is unnecessary for me to continue enumerating the contribution of the Utah Mosquito Abatement Association to more effective mosquito control, as most of you are members, and you have always been loyal supporters of this organization.

I, therefore, would like to summarize and make a few observations concerning conclusions I have arrived at concerning the Utah Association's contribution to, and other factors influencing more effective mosquito control.

1. The effectiveness of a mosquito control program is directly proportional to the ability and knowledge of the man or men directing the program. Boards of Trustees should always keep this in mind when appointing a District Manager, remembering, ability is inherited, knowledge acquired. This does not mean that the same degree of effectiveness of control can be obtained in each district by selecting the proper manager, as control possibilities vary greatly in the different districts. It means that the best results possible, under existing conditions, are dependent on the manager in charge expressed in the daily direction of the work to meet ever changing conditions.

2. Only through an association can we expect to eventually establish universally high standards of requirements for the personnel directing these programs and compensation sufficient to attract men of these qualifications and then keep them informed on the most recent developments in control measures. The manager or supervisor of these control programs should be just what these names imply regardless of special training or experience. He should possess sufficient information and judgement to know that the services of trained engineers, entomologists and other specialists are essential for the most effective mosquito control program. The clearing house for the problems of the man directing these programs and the specialists engaged in their solution can only be provided for in the annual meetings and official publications of a strong cooperative organizations such as the Utah and the American Mosquito Control associations.

3. There is no cure-all that will insure effective mosquito control. I have come to the conclusion that we all too frequently become self-satisfied with our own method of operating our local mosquito control program and if not disturbed we continue year after year with little change. When representatives from local districts attend meetings such as this and those arranged by the American Associations they frequently learn that they are not obtaining the effective results which are possible through the adoption of improved methods which are being used in other districts.

4. In my humble opinion, mosquito control is a service that, through public demand, will not only remain but will be extended until all major centers of populations in Utah and the Americas, where a mosquito problem exists, will eventually have a mosquito control program.

5. I am also convinced that this public service of mosquito control can be most effectively, efficiently, and economically conducted on a local level through the guidance and unification of a non-profit, non-political strong parent organization such as the Utah Association. I am further of the opinion that without such a strong organization mosquito abatement work will gradually be taken over by other existing local or federal governmental agencies, at greater expense to the public and with less effective mosquito control results. The Utah Association invites all agencies and workers interested in the program to participate in this organization dedicated to more effective mosquito control. I am confident if we do not cooperate, and assume the responsibility of directing and improving the mosquito control program through the Utah and American Associations, this work will unquestionably be taken over by some other agency with disastrous results for the program and increased expense for the tax payer.

## MOSQUITOES AND PUBLIC HEALTH

George W. Soffe, M.D., Director of Public Health
*Utah State Department of Health*
*Salt Lake City, Utah*

Mr. Chairman, Ladies and Gentlemen, and Fellow Workers:

It is indeed an honor and privilege for me to be here today to participate with you in this very important conference on mosquito control.

I am proud to know that when the first Mosquito Abatement Legislation was passed in Utah in 1923, Dr. T. B. Beatty, the then Director of the Department of Health, was very instrumental in the promotion of legislation, and that state and local health departments have been some of your loyal supporters to the present time.

Public health officials are concerned with mosquitoes. Mosquitoes over and above their nuisance aspect are directly involved in many diseases that man experiences. It has been demonstrated on numerous occasions that to remove or even decrease the number of mosquitoes in a locality is the best and most economical way to prevent the spread of certain diseases.

Mosquito control or abatement in simple theory at first impression might make one to postulate that it would be easy to rid our environment of mosquitoes. In practice, this has not been proven to be correct. All mosquitoes, even of the same species, are not affected the same by the natural and artificial environment. There appears to be the sheep and the rats in each mosquito species. Some will die from little apparent cause, while others live on when it is thought impossible. Many interesting combinations of potentials and habits are responsible.

Mosquito abatement is a young science and experiencing its growing pains. As with any youth, mosquito abatement has come in contact with a great many others. Many have been pleased with the activities of this youth, many have ignored him, and some have resisted some of his actions. The youth being intelligent, attending the best schools and associating with learned men, has tried to re-evaluate and re-program. However, there is still much to be done by way of research and understanding, and I am thrilled to learn that many, if not all, of our mosquito abatement districts are directing part of their time to research activities.

Because of our limited knowledge, we do not know the potential of the disease producing power of mosquitoes for Utah residents. Some mosquito-borne diseases broadly investigated appear not to be too important here, such as malaria; however, in some of the mosquitoes in Utah has been found the viruses of Western Equine and St. Louis Encephalomyelitis. Some birds and fowls of Utah are known to harbor these viruses. All the facts concerning the transmission of the viruses from bird to bird, bird to mammal, or mammal to bird are not clearly defined; however, in the light of our present knowledge, it appears that these diseases can be controlled by removing the adult mosquito from the environment of the animal. This can only be accomplished by well-trained, adequate mosquito abatement effort.

I am very appreciative of the work of the Mosquito Abatement people in Utah for your intelligent know-how and willingness to cooperate. In mid-summer of 1958, it appeared that the entire population of the Wasatch front might be subject to an epidemic of Western Equine Encephalomyelitis, and it was apparent to you that conditions in the field were somewhat altered from previous years. There was an immediate request by the Abatement people through the State Health Department to the U. S. Public Health Service for help. Federal and State Health Departments and the Abatement personnel worked 'round the clock to improve the situation. The people of Utah have much for which to thank you. This work did not stop with your immediate effort and by next year great improvement had been accomplished in each district. I am confident that this year will prove further improvement.

Good public health in Utah requires the abolishment of mosquito-borne diseases—the men who organize and carry out mosquito abatement programs are by their very work a part of the public health team. Close cooperation and exchange of information between the Mosquito Abatement people, their scientific advisors, and the personnel of local and State Health Departments is seriously encouraged and appreciated.

Effective mosquito control is broad in scope. It usually involves water management, the proper use of insecticides, well planned drainage and fill projects, and close working relationship with wild life conservationists, soil conservationists, agricultural specialists, and many others.

While the incidence of mosquito-borne diseases in Utah may be low, we must realize that mosquitoes in Utah do transmit disease and it may well be that they are transmitting more disease than we know about.

The Utah State Department of Health acknowledges and encourages the Mosquito Abatement program in Utah.

## CLINICAL ASPECTS OF ENCEPHALITIS IN HUMANS

Arley Flinders, M.D., Director
*Ogden City Health Department &*
*Weber County Health Department*

I have been asked to discuss in the limited time of 10 minutes the clinical aspects of Western Equine Encephalomyelitis. Etymologically, the term "encephalitis" means inflammation of the brain and nothing more. "Encephalomyelitis" broadens the involvement to include the brain and spinal cord.

While infection with any one of a number of viruses; for example, measles, mumps, influenza, etc., may eventuate in an encephalitis, these diseases do not generally take this clinical form. The encephalitic end-result in these infections is an incidental event hence they are not primarily encephalitogenic. On the other hand the encephalitogenic capacity of certain viruses seem to be an inherent property of the agent. Clinically apparent infection with these agents progresses to a frank encephalitic syndrome in so large a proportion of individuals that they are recognized and designated as "encephalitis viruses". The most important encephalitogenic viruses are insect-transmitted (mosquitoes primarily) and are often collectively spoken of as the "arthropod-borne viral ensephalitises".

In America (so far as is known) only three arthropod-borne viruses have a role of any consequence in the production of encephalitis. They are Western Equine Encephalomyelitis, Eastern Equine Encephalomyelitis and St. Louis Encephalitis.

In 1931, Meyer, Haring and Howitt isolated from the central nervous system of horses with an encephalitic disease, a virus which has since come to be known as the Western Equine encephalomyelitis virus. It was suspected that the virus might be involved in the causation of human as well as equine illness, and this suspicion was confirmed in 1938 when Howitt recovered the virus from the brain of a child.

In 1933, an epizootic of encephalitis occurred among horses along the eastern seaboard. A virus was recovered from the central nervous system of effected animals which was found to be distinct from the virus reported from the Western United States. This virus was consequently designated as Eastern Equine Encephalomyelitis virus. Its relationship to human illness was also demonstrated in 1938 when this virus was recovered from a fatal human case in a small epidemic in Massachusetts.

St. Louis (and Kansas City) suffered a large epidemic of encephalitis in 1933. A virus was recovered from the central nervous system tissues of fatal cases. This recovery together with the fact that the clinical picture differed from that of the lethargic encephalitis lead to the designation of this disease as St. Louis encephalitis.

In the diagnosis of the viral infections of the central nervous system the first problem that faces the physician is to recognize that there is involvement of the central nervous system. This is not always easy, especially when an infant (under 1 year) is involved. Also a well-defined syndrome is probably the least common manifestation of infection.

In the severe type, patients exhibit prodromata of headache, drowsiness, fever and gastro-intestinal disturbances; this is the *systemic* phase; in many the disease process stops here. In others it continues with fever and the development of neurological signs and symptoms which consists of severe headache, insomnia, and marked pain in the muscles, especially the back. Lethargy, disturbances of speech, ataxia, nystagmos, tremor, or convulsions, mental confusion and even coma may supervene. Paralysis is not common. The acute phase endures from 7 to 10 days and recovery might appear complete.

You will note that many of the symptoms and signs are subjective and discernible only in adults able to convey their feelings. Epidemiologically a good number of cases occur in early infancy. Here the first indication might be a convulsion or irritability in the child along with a mild fever. In fact, that has been observed locally as the initiating indication that something is wrong with the infant. There are some indicative signs from spinal fluid studies but definitive diagnosis must await laboratory studies.

Here it must be emphasized that abortive forms may be seen. Some of the prodromal symptoms such as fever and headache may be the sole indications of infection. Clinically in apparent cases with no obvious signs except the development of serum anti-body apparently occur with Western equine encephalomyelitis.

As to the public health importance of Western Equine Encephalomyelitis the attack rates in the most severe epidemics (such as the 1941 outbreak in the central states and the 1952 outbreak in California) were around 20 per 100,000 population. During "non-epidemic" years the attack rate may be as low as 1 per 100,000 population or less. From this standpoint it would hardly constitute a public health problem of pressing importance.

Nevertheless the occurence of sporadic cases or, on occasion, the occurence of what might be regarded as outbreaks the disease is greatly feared by the public not only because of the occasional fatal case but because of the possible after-effects of the disease in the victim. I have in mind the mental disturbance and psychiatric problems that may develop as post-encephalitic sequelae, especially in the very young infant with an encephalitis caused by the Western Equine virus.

## LABORATORY ASPECTS OF ENCEPHALITIS

Russell Frazer, Chief, Bureau of Laboratories
*State Department of Health, Salt Lake City, Utah*

Dr. Flinders has discussed the clinical aspects of encephalitis. The clinical symptons will vary among patients. It is only when one has access to a fairly large number of clinical histories that a general pattern becomes established as a rule, and an outbreak of encephalitis becomes recognized. It is impossible, however, to classify the encephalitides by symptomology. Specific identification is dependent upon the findings of the virologist.

The science of virology has grown out of technics developed by the bacteriologist. The latter, however, deals with a biologic agent that can be seen. Seen, that is, if magnified to the fullest extent made possible by the compound microscope, or 970 diameters. A staphylococcus measures about one micron, or 1/25,000 of an inch which is pretty small but is 40 times larger than the virus that causes WEE.

The bacteriologist has another advantage over the virologist in fact, with the exception of a few of the parasitically adapted bacteria, the organisms he studies can be grown on an artifical substrate. Most bacteria will divide once every 15 minutes under highly favorable conditions. At this rate one cell will have produced one trillion cells by the end of ten hours, and the growth itself is readily visible to the naked eye, and can be studied and subcultured to various substrates to determine its biochemical and growth patterns.

Viruses, on the other hand, are not only ultramicroscopic, they have reached such a high degree of parasitism that they will grow only within certain living cells upon which they are dependent for part of their metabolism. The viruses that cause encephalitis have prediliction for nerve tissue. They are known as neurotropes.

To obtain the virus for study and identification, brain tissue, taken at autopsy, is the specimen of choice. These viruses have been recovered from cerebro spinal fluid and from blood samples, but so rarely has this been accomplished that viral studies on such material is considered inadvisable as a diagnostic measure.

If a patient has died of suspected encephalitis, and we wish to prove that it is encephalitis, and determine which of the encephalitides it might be, a small portion of brain tissue is removed, ground-up and suspended in saline, and then injected directly into the brains of living mice, using about ½ minimum per mouse. At one time we preferred to use 21 day old mice, but we now have found that 10 day old mice are more susceptible. This is one of the limiting factors of the test. We must either have mice of the right age on hand, and this required a good sized animal colony, or we must hold the specimen in a frozen state until we do have animals to use. The specimen should be frozen in dry ice soon after they are taken, and must be held in a dry ice chest or super deep freeze. An ordinary deep freeze is not cold enough and the grinding action of the ice crystals is believed to destroy the virus.

If viruses are present in the specimen, the infected mice will appear listless in about five days. Their hair will be rough and their backs humped. A paralysis may become evident preceding the death of the mice, which usually takes place seven to ten days after inoculation, but paralysis is more common to the more strictly neurotropic viruses such as the rabies virus. As controls one may heat some of the brain tissue to a temperature sufficient to destroy the virus and inject this material into other mice which should survive the ordeal.

An even better technic than mouse inoculation is the injection of suspected material into wet chicks—that is chicks that have hatched within the past 24 hours. They seem to be more susceptible to the virus, and the illness becomes evident three or four days earlier than it does in mice.

The illness and death of the chick, or mouse, simply indicates that an infectious agent was present in the specimen. Post mortem findings may rule out a bacterial infection, which can be controlled by the addition of antibiotics to the specimen prior to the injection, for these viruses are not susceptible to antibiotics, but post mortem findings are of little value in diagnosing the virus. For this we turn to the virus neutralization tests.

Nearly eighty years ago it was found that if an organic substance foreign to a given animal is inoculated into that animal, the cells of the host, as part of the defense mechanism against infection, will produce complex substances we call antibodies which will immobilize and destroy the foreign substance, which is known as antigen. The antibodies are highly specific against the infecting agent or antigen. Excess amounts produced by the cells are excreted into the blood stream as circulating antibodies and these can be detected in the serum of the blood and measured by serologic procedures.

If we take the virus of WEE and inject it into a susceptible animal, such as mice, the mice will produce specific antibodies to destroy the virus. We use the serum of such animals in the virus neutralization test.

Some of the brain tissue from mice or chicks that have died following injection with the specimen from the patient is macerated. Immune serum produced in other animals is added to this suspension which is then allowed to stand for a period of time sufficient for the antibody to react with virus. The brain tissue containing virus and serum mixture is then injected into a series of mice. In a study of encephalitis we will probably inject some mice with brain tissue treated with WEE antiserum, other with the tissue treated with EEE antiserum, a third lot treated St. Louis encephalitis antiserum, and we will inoculate a fourth series with untreated brain tissue. If WEE virus is present the mice that have received the brain tissue treated with WEE antiserum should survive, all the other mice which were not protected against this virus should die. Through this method we have identified the virus. If all of the animals should die, then we can assume we are dealing with a different virus and the tests are continued until we find the correct virus-antibody combination.

The technic just described for isolating and identifying virus from brain tissue can also be used to identify virus from mosquitoes. The insects to be tested are selected by the entomologist. They are macerated and treated with ether to remove oils that may interfere with the test, and then from here on the same procedure is used.

Of course if we are faced with possible cases of encephalitis, we can not sit around waiting for someone to die so that we can get some brain tissue. We have stated that when a virus is injected into a susceptible host, the host will react against the virus by producing specific antibodies to destroy the virus. This is as true of natural infections as it is of induced infections. With the encephalitides the mosquito takes the place of the syringe. As the infection progresses antibodies against the virus will begin to appear in the blood stream. We simply reverse the virus neutralization test, this time using known virus to detect and identify the unknown antibody in the patients serum. Again mice or chicks may be used, and are often preferred because of the clear cut results that can be obtained. But this method is expensive and time consuming and other methods must be used if we are dealing with more than an isolated case or two.

We have learned how to grow living tissue cells in the test tube. This technic was greatly enhanced in the development of poliomyelitis vaccine. The encephalitis viruses can be grown in tissue cultures. We have had our greatest success using human amnion or minced chick embryo tissues. We have not had much success in growing freshly isolated virus from mosquitoes or brain tissue in these cultures, but tissue culture adapted viruses will grow with considerable success in tissue cultures.

As the virus grows, it produces changes in the invaded cell which can be recognized by the proficient virologist. The smallpox virus, for example, or the herpes virus of the cold sore, cause a rounding up of the cells. The encephalitis virus causes the cells to shrivel and coalesce. This can be checked microscopically. If the cells are destroyed by the virus, a change in the pH of the fluid in which the cells are grown will take place. This can be detected by a suitable indicator.

These tissue cultures can be used in the place of mice or chicks intesting for antibody in the patients serum. Or we can grow the virus in tissue cultures or in the brains of living mice and use the virus so grown as an antigen in a complement fixation test similar to the Wassermann test for syphilis. This latter test is the easiest to perform read and interpret and is the one in most common use.

The antibodies for WEE make their appearance in the serum of the infected patient seven to ten days after the onset of symptoms. Some believe that those measured by the complement fixation test are slower to develope, than those detected and measured by the virus neutralization test, but we have not found this to be true in our experience during the 1958 outbreak. These antibodies increase rapidly in quantity, reaching a maximum strength in about 4 to 6 weeks. Those measured by the complement fixation test then begin to diminish, and are usually no longer detectable six months after the illness has subsided. The virus neutralizing antibodies, however, will persist for two years or longer.

It is necessary, therefore, if we are to replace assumption with fact, to examine both a specimen taken as early as possible after the onset of symptoms, or an acute specimen, and compare it with one taken not less than two weeks later, or a convalescent specmen. If the illness of the patient was due to infection with the virus of WEE, then, if the first specimen was taken during the early acute stage, antibodies should not be demonstrable in the acute specimen, but they should be readily demonstrable in the convalescent sample. If the acute sample were taken a week after the onset of symptoms, we might find that we can dilute the patients serum with 8 parts of serum before the reaction between virus and antibody disappeared, while a dilution greater than 1:32 was required with the convalescent specimen. It is this rise in antibody titer, then, that is the basis for the laboratory diagnosis. If no increase in antibody takes place, that is if both specimens are negative, we can assume that the patient had not been infected with the virus we are using as an antigen. If there is a reaction in both tests, but no significant rise in antibody titer in the convalescent as compared with the acute, then we can predict that the immediate illness was not due to WEE, if this is the virus we are using, but that the patient had been infected with this virus sometime in the past, and is now immune. In all cases it is necessary to have a sufficient lapse of time between the time the specimens were taken. If the laboratory tests do not confirm the diagnosis of WEE, but the clinical history seems to indicate that the patient did have encephalitis, then a third specimen should be taken in about another two weeks. Of course we can not content ourselves with just the exclusion of a disease. If the tests for WEE are negative, the specimens should be examined using the viruses of EEE and St. Louis Encephalitis. If these are negative, the search must be continued using other viruses that may cause a disease with similar symptoms, such as lymphocyticchoriomeningitis or certain of the ECHO virsuses which are known to cause aseptic meningitis.

During the 1958 outbreak in Utah, we were unable to confirm about a third of the cases in the laboratory. In this third we were able to demonstrate a rise in antibody titer in some of the specimens for ECHO 9 virus, the one that had caused an epidemic of aseptec meningitis in Minneappolis the previous winter. There is always a danger in any outbreak of assuming that all those who become ill have the same disease, to form sort of a disease of the month club. Two outbreaks can occur at the same time. A WEE outbreak can be controlled by the control of mosquitoes, but an EHO virus outbreak will possibly be due to polluted water. The two diseases may be indistinguishable by a brief clinical history. It is only when a careful study is made of a large number of carefully taken clinical histories that two different types of clinical disease may become recognized.

It is, of course, apparent that if the virologist must either wait for a patient to die in order for him to obtain a bit of brain tissue to demonstrate the virus, or for the patient to be well on the road to recovery for him to do his antibody studies, these tests are not going to be of much value to the patient. They are of value, however, in aiding the physician to make an exact diagnosis, to establish the presence of an infective agent in a community, and to provide factual information for the epidemiologist, and to indicate what specific control measures can be taken to control and eradicate the disease.

## THE ROLE OF THE UTAH STATE ENGINEER IN THE ELIMINATION OF WASTE WATER AS A MEANS OF MOSQUITO ABATEMENT

By Jerry Tuttle, Water Resource Engineer, Utah State Engineer's Office

### I. Statutory Authority

The state laws of Utah have provided the State Engineer with some powerful authority in dealing with waste water. Three sections of the Utah Code Annotated, 1953, are recited here.

> 73-2-1: "The state engineer . . . shall have general administrative supervision of the waters of the state, and of the measurement, appropriation, apportionment and distribution thereof . . . He shall have full authority to bring suit in courts of competent jurisdiction to enjoin the unlawful appropriation, diversion, and use of both surface and underground water and to prevent waste, loss or pollution thereof and to otherwise enable him to carry out the duties of his office."

Under a second section, 73-2-21, is this:

> "The state engineer is authorized to plug, repair, or to otherwise control artesian wells which are wasting public water. He may, on behalf of the state, enter into cooperative agreements with well owners by the terms of which the state may agree to provide all necessary equipment and supervision for such well control operations or shall otherwise share the expense and the well owner shall supply material in an amount not to exceed $50.00 for each well, and power, provided that the state engineer shall exercise all reasonable precautions to preserve the flow of water from such wells.
>
> "Abandoned wells on public land may be plugged entirely at the expense of the state. Wasting wells on private lands which cannot be plugged under cooperative agreement with the owner of the lands or wells, may be plugged entirely at the expense of the state and the state engineer is authorized to create a lien in an amount to cover the expense of plugging or repairing the well not to exceed $100.00 by filing a notice of lien in the office of the county recorded in the county in which the well is located, and may foreclose such lien in the district court, as provided by law. The state engineer, through the state department of finance, may purchase pumps, compressors, and all other necessary equipment and material and may employ all necessary assistance to enable him to perform his duties under this act."

Under a third section, entitled "Powers of the State Engineer as to Waste, Pollution, or Contamination of Waters" (73-5-9) is this authority:

> "To prevent waste, loss, pollution or contamination of any waters whether above or below the ground, the state engineer may require the repair or construction of head gates or other devices on ditches or canals, and the repair or installation of caps, valves or casings on any well or tunnel or the plugging or filling thereof to accomplish the purposes of this section.
>
> "Any requirement made by the state engineer in accordance with this section shall be executed by and at the cost and expense of the owner, lessee or person having control of such diverting works affected. If within 10 days after notice of such requirement as provided in this section, the owner, lessee or person having control of the water affected, has not commenced to carry out such requirement, or if he has commenced to comply therewith but shall not thereafter proceed diligently to complete the work, the state engineer may forbid the use of water from such source until the user thereof shall comply with such requirement. Failure to comply with any requirement made by the state engineer in accordance with the provisions of this section shall constitute a misdemeanor. Each day that such violation is permitted to continue shall constitute a separate offense."

II. General Operation

While the office is equipped with considerable statutory power to deal with waste of water, up to the present time it has been primarily concerned with appropriation, adjudication, distribution, and use of water and only secondarily concerned with its waste and misuse.

Through the process of approval and certification of new water rights, our concern with waste water is generally that the applicant is not filing on waste water directly from an irrigated area, thus forcing the original irrigation operator to continue to waste water in order to satisfy a junior appropriator; and that the proof engineer and the appropriator certify that no more water is diverted than can be put to beneficial use. Admittedly the term "beneficial use" is a loose one and is necessarily subject to a wide interpretation.

In our adjudication procedure, a careful field investigation, mapping, and definition of quantities of water are undertaken by our office, and an involved legal procedure is followed. The term "beneficial use" is subject to close scrutiny at this time so that wasteful practices are not countenanced as a right by either new appropriators or old-time users. While adjudication is thorough, it is necessarily slow. Furthermore, the areas which are presently under such an adjudication scrutiny are far removed from Box Elder, Weber, Davis, Salt Lake, and Utah Counties, in which you mosquito abatement people are most concerned. It will take some time to get fully into these areas for effective control for your purposes.

In our distribution procedure, the commissioner on the river system attempts to distribute the water available during that year to those people who have established a legal right to use it. By no means does distribution by this office cover all of the areas of the state or of areas of immediate interest to this group. Further, the distribution of water from rivers to the user is based upon his legal paper right, and how he applies this water or wastes it is most often of his own choosing. While water distribution is carried out by our office, in most areas it is not done according to an adjudicated right as followed in our present approach, but often has to be done through old decrees which gave little or no cognizance of a limit of application of water per acre of land irrigated. Until these old decrees are readjudicated by our present system, little control can be exercisd through our present distribution procedures.

In a review of digests of legal actions of the Utah Supreme Court dealing with all Utah water law (whether initiated by this office or not), this writer could find nothing that dealt with waste water and its control for the sake of control itself—or for the sake of eliminating its undesirable effects, such as mosquito breeding. In each case involved with waste water, they were most often in areas where water is getting measureably scarce, they were frequently areas under adjudication proceedings by our office, and they always involved a contest between appropriators for *use* of the same water, not its elimination.

There are, however, some general activities in which our office is directly engaged or participating with other agencies to control waste of water. Since 1947, our office has been cooperating with the U. S. Department of Agriculture and the Utah State University's Agricultural Experiment Station in studying the consumptive use and irrigation water requirements of crops in Utah. These studies certainly help to eliminate speculation on what is beneficial use in the case of irrigation. There have been several publications by this office and others on the techniques and measurement of consumptive use developed in this state. One of the authors of the basic Blaney-Criddle formula used in estimating water requirements of crops is the present State Engineer, Wayne D. Criddle, so we are not unaware of the abuses of too much water. These basic data are used in our adjudication of areas in the state. However, as pointed out before, adjudication will probably not be completed in your area of immediate interest for some years.

III. State Engineer's Well Control Program

Perhaps the most significant operation in the State Engineer's Office with regard to your problems is the control and sealing of flowing wells.

Prior to 1935, wells could be drilled by practically anyone, anywhere, with any type (or lack of) casing, and perforated at any point by any means possible—including dynamite lowered on a string down the well to the desired strata. No controls existed, either in drilling wells or the appropriation or waste of water. As the drought of the 1930's became more intense, so did ground water development and the apparent need for its control. State law was enlarged at the time to give control of ground water to the State Engineer.

Since passage of the law in 1935, the State Engineer has assumed the yearly licensing of all well drillers operating in the state, has set forth standards of well casings and, when conditions required, has prescribed both depth of wells and areas of perforation for any new well drilled. The problems of leaky, wasting wells produced by faulty technique, improper casing, or other problems initiated at the time of drilling are now under control. This program was instituted early and has since been pursued by this office with considerable vigor. It is in full, continued operation.

Another program that was instituted shortly after the passage of the law in 1935 was the policy of encouraging the closing of flowing wells in the winter time and otherwise restricting the diversion of water to only beneficial use. This program was possible because of the large number of personnel available for field work in association with the Works Progress Administration and was carried on with some success up to the World War II. Through the 1938-1940 period an intensive survey of the state was conducted, the locations of all existing wells were pinpointed, their outputs measured, and their uses generally identified. At that time some 24,000 wells were located and some 4,000 were shown as wasting water; some were controllable, some uncontrollable. Through the encouragement of field parties and through one or two court cases initiated by this office, the majority of the controllable wells were closed in the winter time and otherwise restricted to beneficial use. The observation was made that, due to closing of wells, ground water pressures were built up in certain areas to the point where old wells that had ceased to flow for years were resuming their production.

Another observation was made during this 1938-1940 period that has special pertinence to your present concern. Many wells that might otherwise be controllable by installation of valves could not be controlled nor restricted in their flow because they were bottomed in sand—which condition would destroy or materially damage the wells if the flow of water were stopped. "In some counties, particularly north Davis and south Weber, entire areas exist in which it is now impossible to control the flow of wells because of sand conditions" (21st Biennial Report, page 21).

With the advent of World War II, the office and field staff were so depeleted that this well inspection and closure practice has essentially ceased. The staff has never reached that pre-war level. One present attempt at this type of control is a simple announcement in the papers in October of each year that all wells must be closed, and individual notices sent to people in the Flowell area of Millard County. Some 35,000 wells are now in existence and no doubt many flow unchecked.

Our third program of well control is that of sealing wells with a grout of clay and cement forced into the well under high pressure and up on the outside of the casing to the surface. This program was started in 1945 and to the end of the 1958 biennium has closed some 576 wells (see Table I on page 6). In general, it is operated under a cooperative agreement with the well owner who desires to eliminate the well. Some of our more recent, large-scale activities have been with the Weber Basin Conservancy District in closing some flowing wells in the Willard Bay area, and with the State Highway Commision in sealing of wells of condemned homes through the proposed freeway areas. Individual well sealing also continues. Currently about fifty wells a year are being sealed.

IV. Problems in Control of Waste Water

One might reiterate here the problems already identified in our preceding discussion and call this a summary of problems in control of waste water. We would be begging the question if we did. Waste water problems are linked to every physical aspect of water, its control, its use, to every watershed from top to bottom, and to the various men and agencies tied up with water in any way.

We have in Utah a series of conflicting physical problems, agency problems, and public attitudes that tend to promote waste, refute control, and confuse the solution of even one problem. While we have some 1.4 million acres of suitable irrigation land lying dormant because of not enough water, we have some 2 million acres of swamps, marshes, and alkali flat that have too much water. While our programs of land drainage move forward on the general scale of a single farm unit basis, our water development and additions to the area are on an entire valley basis and compounding the existing drainage problems with more water. While ground water reservoirs in many areas of the state are so full they squirt water from natural cracks and fissures and from pipes driven into the ground, yet, because of lack of proper reservoir storage, many a farmer applies and wastes more water in the spring than he needs and still faces failure in the fall through lack of water. As population and industry grow in this area, the demand for purer water will increase, and yet the amount of waste will increase as more sewage is developed from their effluent.

Table I. Wells sealed or repaired and water controlled in Utah during 1945-1958 period.*

| *Period* | *Wells sealed or repaired* | *Rate of flow controlled* |
|---|---|---|
| | *No.* | *g.p.m.* |
| 1945-46 | 62 | 3,593 |
| 1947-48 | 98 | 7,415 |
| 1949-50 | 126 | 7,079 |
| 1951-52 | 49 | 2,737 |
| 1953-54 | 45 | 2,847 |
| 1955-56 | 83 | 2,453 |
| 1957-58 | 113** | 2,928 |
| | 576 | 29,052 |

** Includes the sealing of 10 test holes drilled in artesian areas for highway subsurface investigations by Utah State Road Commission.

Floods also are a source of waste water and a greater potential damager every year. Yet houses are being built every day in both the natural surface drainage ways and those created by man to control the floods; more highways, roofs, and pavements are surfacing off areas of recharge into the ground, and more water added every year to already inadequate storm sewer systems.

To further confuse the picture are the multitude of overlapping, duplicating, and often competing agencies in every field of water development and control in the area. At the Federal level is the U. S. Department of Agriculture with its several agencies; the U. S. Army's Corps of Engineers; the U. S. Department of Commerce's Weather Bureau and Health, Education, and Welfare; the U. S. Department of Interior's Bureau of Land Management, Bureau of Reclamation, Bureau of Sports and Fisheries, and Geological Survey, Ground Water Branch, Surface Water Branch, and Quality of Water Branch.

At the state level are the Department of Health, District Forester, Fish and Game, Park and Recreation, Public Service Commission, State Engineer, and the Water and Power Board. At the local levels are various county commissions, water and sewer improvement districts, conservancy districts, public utilities, mutual water companies, irrigation districts, mosquito abatement districts, city governments, and a variety of planning boards as well. No doubt I have missed some, but this serves. Each has its own function and philosophy and although some degree of cooperation is evident among them, there has been no real effort toward solving the total regional water problems of an area in development, supply, flood control, drainage, or waste water.

While this independent approach has worked to some degree in the past, it would seem that future developments along any line shall have to have a more unified and regional approach to the problems.

V. Conclusion

The State Engineer's Office has a considerable statutory responsibility in the field of elimination of waste of water, as well as its control and development. While our present operations are limited, we would like to extend whatever help we can to assist you in your immediate problems of waste water control. At the same time, we must all realize and promote where possible the concerted effort of all agencies and water users in the area toward a comprehensive regional program of water development, positive control, and proper use. Let us not devote all our efforts to small brush fires when the whole forest is aflame. This regional approach no doubt will involve a reconsideration of most of the presumed water rights in the area, and indeed bona-fide rights must be respected. However, the concept of the right to waste water is being and will continue to be challenged.

## REPORT ON A SEMINAR ON MANAGEMENT FOR MOSQUITO CONTROL ADMINISTRATORS

By

HOWARD R. GREENFIELD, Manager
Entomologist
Northern Salinas Valley
*Mosquito Abatement District*

Probably the best way to launch into the topic at hand would be to describe the Durham Mosquito Abatement operation in 1918, as William Bollerud[1] described it:

> "It must be borne in mind that at this time there were but two weapons—drainage and stove oil. It took 30 gallons of stove oil to larvacide one acre of water surface.
>
> We had no planes or jeeps nor power sprayers nor Tifas.
>
> We had no DDT or Toxaphene or wettable powder or emulsible concentrates. We had no collecting stations nor adulticiding nor residual spraying nor vector control specialists. We had no regional conference nor state conference nor state subvention nor state auditors. Our outlook was stuffy indeed.
>
> But, we had a drainage program. With a budget of $1200, one man, and model T pick-up and a half dozen hand tools, we strode forth to conquer the world."

At the time I heard Bill describe his early operations, I thought how easy it was to control mosquitoes in those days and how "darn" difficult it has become to control mosquitoes today. We have the auditors, the vector control specialists, the Miller Act, the Pure Food & Drug Laws, Social Security programs, Retirement programs, purchasing procedures, legal difficulties—in short, we have many more problems to cope with, which were only the dreams of bureaucracy in Bill Bollerud's day.

It was these divergent and perplexing problems of administration occurring in our daily routine that finally forced the Education and Publicity Committee, headed by Lester Brumbaugh, Manager of the San Joaquin Mosquito Abatement District, to develop the ideas and plans for a seminar on management.

The idea of a seminar on administrative techniques had definite appeal to the members of the Education and Publicity Committee. The project was discussed and the Committee members agreed that a plan be submitted to the Board of Directors of the C.M.C.A. for approval.

After presenting the ideas of a seminar to the Board and obtaining permission to proceed, questionaires were devised and sent out to the managers of all the districts. The purpose of the questionaires was to ascertain the areas of interest each district manager had and the problem to which solutions were seemingly very distant.

I must state that the Education and Publicity Committee submitted the questionaire to the managers with trepidation; however, the response was very gratifying in that almost every manager indicated an intense interest in the proposed project.

Armed with the suggestions received from the questionaire. Mr Brumbaugh approached the State Department of Health, Bureau of Vector Control, to discuss the proposed seminar wih the Chief of the Bureau, Mr. Richard F. Peters. It was agreed that "basic principles of administration" should be the foundation of the initial seminar. It was also agreed that if the seminar was successful, more specific subject matter would be set forth in future seminars. Mr. Peters made the suggestion that Mr. Howard Dunphy, Health Educator, B.V.C., assist in the development of the seminar program; a suggestion, I might say, which was quickly accepted.

Once agreement was reached on the general format, the specific program developed rapidly, due to the extremely cooperative spirit of members of the University of California Business School, University of California Extension Service, and the Department of Health Education, State Health Department, who participated in the program discussions. These men helped tremendously in the success of the Seminar.

One important aspect of the Seminar Program, as developed by the Planning Committee, was the allocation of time for discussion after each speaker had terminated his speech. Usually the time alloted was two hours, with a member of the staff in charge. It was these groups that the principles set forth by the speaker were tested and applied to mosquito control administrative problems. It was in the group discussions that we discovered our managerial problems were very similar, and that no one was without administrative difficulties. These reaction panels, as they were called, (I prefer "bull sessions") produced the greatest amount of interest, in that each member had an opportunity to express his ideas and expound on how he had developed his program and met his daily problems. This active participation was undoubtedly one of the highlights of the Seminar.

Now what did we as managers receive from the Seminar? Basically I believe each and every one of the managers was made aware of the sameness of problems, the close relationship of district goals, the

1. Bollerud, William, "Proc. and Papers of the Twenty-second Annual Conference of the Calif. Mosq. Control Assoc.," p. 69.

interpedendency of each agency, and, above all, the need for a close working relationship with the Boards of Trustees.

We discovered that a proper line of communication up and down was absolutely essential to program understanding. I personally discovered there were "short circuits" in our line of comunication which were reducing the efficiency of the whole staff. When I applied some of the suggested methods of communication, the resulting 'clearing of the air' greatly increased the total personnel efficiency. The solution to the particular problem was certainly worth the cost of my attendance at the Conference.

In addition, the consensus of opinion of the managers regarding personnel problems was that they had received a better understanding of needs of their personnel—that security alone wasn't enough—that recognition, opportunity, and belonging were also important to the worker or staff member. When these were provided, the efficiency of the staff would be greatly increased.

One phase that hasn't been mentioned, but possibly has been wondered about, is the cost of putting on such a seminar; how much did the speakers cost and what agency underwrote the cost.

The C.M.C.A. underwrote the venture with the expectation that any costs incurred would be returned through the registration fees. Registration fees were set at $25.00 per person. The three speakers received $100.00 each. The registration fee included not only the speakers' fees but the costs of assembling and duplicating the proceedings of the Seminar and sufficient copies of background information in order that each member could return with a complete file on Seminar activities.

All in all, I believe the attitude of the managers in regard to the Seminar was, "When can the C.M.C.A. sponsor another seminar?"

## MOSQUITOES AND DAVIS COUNTY

Finley Wilkinson, Legislator
*District One, Davis County*

Mr. Chairman and Gentlemen: It's a pleasure to be here with you today, and to be allowed to take up a few minutes of your time at this convention.

When I was asked to give a short talk, I was asked also upon which subject I would talk. About the only thing appropriate I could think of was "Mosquitoes in Davis County." Not that we have the only county with mosquitoes, but we certainly have our share. I am not an expert on mosquitoes, nor am I an expert on mosquitoes in Davis County. All I am is an automobile dealer doing business in the city of Bountiful. However, I have been taught throughout life that there is little use in complaining about government and the things that occur in government, unless one is willing to give some time to try and help correct these inequities. Thus I ended up running for the State Legislature from the South Davis area during the year 1958, and in doing so I ran into the biggest campaign issue of that year, namely, "mosquitoes in Davis County." In Bountiful during that summer you could set your clock by the activity of the mosquitoes, at 6:00 in the evening. One had better get in the house behind screens or be carried off to the lake. The people were talking about nothing else and were demanding action from every level of government, State, City, County, and the mosquito abatement district. Naturally, they were blaming everyone, managing the city water sewage system, irrigation companies, and most of all the State Fish and Game department for the Farmington bird refuge at Farmington bay.

It was while this clamour was going on that I, State Senator Barlow, and Mr. Gardner, State representative from the northern end of the county, were asked to attend a meeting in Kaysville with the county board of health, the mosquito abatement workers and others, to see if something could be done through legislation to help alleviate the situation along the lake front. We came away from the meeting pledged to do all we could to rid the area of mosquitoes.

By the time legislative session began, I had asked workers in the district to give me a list of some of the problems they had encountered during abatement work, and I have the list with me, along with the answers supplied by the Attorney General's office.

The questions went like this:

1. When a person refuses to turn off his well water or move it from place to place to keep the water from ponding and thereby causing a mosquito breeding area, may I turn off the well valve?

2. When state owned property is a mosquito breeding source, may I drain such property?

3. When state land is leased by a private individual and such land has ponds, old drains, plugged ditches etc. on it, may I take the necessary steps to control the mosquito breeding hazard?

4. May I turn off irrigation water on pasture land which has had the water running continuously on it six or more days, causing a mosquito breeding hazard?

5. When open sewers extend from people's homes can they be forced to install a cesspool?

The Attorney General stated that a good law exists in the state of Utah regarding mosquito abatement districts, but that there were sections in the present law that were ambiguous. It was decided that the situation be examined in an attempt to determine if anything could be done to strengthen the law so that those trying to abate mosquitoes could proceed without feeling that they would get themselves into legal difficulties. When our problems and ideas were presented to Mr. Thatcher, of the State Health Office, he gave us very little encouragement, stating that his office was not ready at that time to put forth legislation to help mosquito problems in our area. He also felt that what we were proposing was of not too much importance. Frankly I did not know myself just how much could be accomplished, but felt that we must try to do something, and so we continued as follows:

After having two attorneys look over the present section 26-14-8, Utah Code Annotated in 1953, we decided this section could be strengthened by amending it in several places. Thus Mr. Carl Taylor, Mr. Kenneth W. Gardner, Mr. Levi Beus and I introduced in the State legislature what was known as House Bill #84, and with a little persistence, we were able to get it passed unanimously through the House. The bill then went to the Senate and after many weeks of laying around on the Senate calendar with the session drawing rapidly to a close, we finally had to ask for help from our constituents to see if we couldn't get something done. A few telephone calls from us resulted in such a flood of phone calls and cards that Senator Haven Barlow was able to push the bill past the Senate without delay. Later the Governor signed the bill into law.

I would like to read the contents of a memorandum that was passed out to the members of the legislature, stating what our objectives were. This expresses better than I, what our aims were, and after reading this, I will let you decide just how much help our efforts have been. Personally I feel that we now have a good tight enforceable law:

MEMORANDUM RE HOUSE BILL 84, RELATING TO POWERS OF MOSQUITO ABATEMENT DISTRICTS:

Title 26, Chapter 14, U.C.A. 1953, provides for mosquito abatement districts. It sets forth how they are organized; that a board of trustees shall be appointed for the enforcement of the aw; that they shall be financed by taxes levied within the district, and new territories may be annexed to the district, and also as set forth in Section 26-14-8, which is the subject of this memorandum, it provides the powers that the board shall have regarding the abatement of mosquitoes, flies or other insects within the district. This section sets forth that the board of trustees may go in and abate as nuisances all stagnant pools of water and other breeding places for mosquitoes, flies or other insects located within the district. However, the section places the limitation that before the board may act, it must receive permission from municipal or other public authorities. It is this portion in line 5 of the said bill which is being deleted, the purpose being to put some teeth into the law, giving the board the authority to go ahead and act to alleviate the mosquito condition before mosquitoes have had time to breed and multiply while districts are receiving permission from the public authorities.

On page 2, line 5, of the bill, it provides that any person who prevents, hinders or delays the board from the exercising of its duties is guilty of a misdemeanor. However, it now leaves some question whether before it becomes a misdemeanor the cities or towns must enact an ordinance stating that it is a misdemeanor and prescribing the punishment therefor. The purpose of the amendment is to clear up this uncertainty and to give the board the power to act upon its own and not make it subject to control of the cities or towns in any manner. The purpose of the deletion as found on page 2, line 7, is to give the board the power to act, and if anybody interferes with it, it is a misdemeanor, without the cities and towns having to make it so by an ordinance."

After making these changes, we felt that the mosquito district now could act to kill mosquitoes without special permission, and those hindering the work would be guilty of a misdemeanor, and the courts could prosecute them as such.

As the session continued, the Fish and Game Commission also had a bill introduced in the Senate by Senator Browning of Ogden, and Senator Bullen of Logan, Senate bill #39. The purpose of this legislation concerned the use by the Fish and Game of certain unsurveyed State owned land. The bill is very short.

Let me read it:

"Be it enacted by the Legislature of the State of Utah:

Section 1. The State fish and game commission is authorized to use any and all of unsurveyed state-owned lands within the townships hereinafter described for the creation, operation, maintenance and management of bird refuges, sanctuaries, public shooting grounds and fishing waters. Township 1 North, Ranges 2, 3, and 7 West; Township 2 North, Range 2 West; Township 3 North, Range 2 West; Township 4 North, Ranges 2 and 3 West; Township 6 North, Range 4 West; and Township 11 North, Ranges 8 and 11 West; Salt Lake Base and Meridian."

The Townships referred to, if you are acquainted with your map, are mainly along the Lake front in Davis County, with one in Salt Lake County, one in Weber County, and several in Box Elder County. We didn't find any objection to the use of the land as outlined by the Fish and Game, but we felt that we wanted the department to be responsible for mosquito abatment measures in these areas if they were going to develop them. Thus an amendment was successfully attached to the bill stating thusly:

"Section 2. Pest Control on Designated Land.

Before the State fish and game commission uses any of the lands above authorized said commission shall provide for and continue to maintain adequate control of mosquitoes, flies, other insects and pests on said lands.

—Approved March 17, 1959."

Maybe this was unnecessary, but it certainly made our people feel better to be assured that the fish and game would commit themselves to take care of all pests on the land they would develop. I think that it is necessary and important that agencies developing our lands take care of them properly and that they do not become breeding grounds for pests of any kind.

I have tried to outline as briefly as possible the changes in the law affecting mosquito abatement districts that were made by the last legislature. I hope again that we have been of some help, and further pledge that I will be happy to do whatever I can to see that mosquito breeding areas are cleaned up. As you may know, I spent three years taking Atabrine and sleeping under a mosquito net every night in the South Pacific during World War II, and I have no desire to do so at home.

Incidentally during the summer of 1959, we were able to go outside again in the evenings in Bountiful without annoyance. Maybe the mosquitoes heard about the changes in the law and were scared away, but I am certain that we had better give the credit to Mr. Swapp and the mosquito abatement workers for the fine job they have done in controlling the mosquitoes last summer in Davis County. Thank you.

# INSECTICIDES AND THE PROBLEMS THAT MAY ARISE FROM THEIR USE IN MOSQUITO CONTROL

George F. Knowlton, Ph.D.
*Utah State University, Logan*

Thirty-five years ago, almost anybody could develop an insecticide. As long as it killed the insects claimed for it, he could sell it. Few restrictions were placed upon the manufacturer, distributor, retailer, or user of insecticides and other pesticides in the "good old days."

We now have the Miller Bill, or Public Law No. 518. We now must determine the dangers if any, for each pesticide, and under what conditions it can be used safely and beneficially by the public. Much research must go into developing and marketing a modern insecticide. Only after the owner of the patents conducts research, corroborated by independent federal, state, and other agencies, can the insecticide secure registration—acceptance by U. S. Food and Drug Administration, and acceptable uses be approved and set up by the U. S. Department of Agriculture. The U.S. Department of Health, Education and Welfare plays a dominant part in making the top decisions; they wield the authority. In general, state departments of health and agriculture work in closely with federal decisions and registrations, so far as pesticide uses in our various states are concerned.

A O-tolerance exists in milk for practically all of the chlorinated hydrocarbons used in mosquito control. Even for methoxychlor, the formerly allowed use-spraying of dairy cattle for lice and hornfly control was withdrawn when some of the chemical turned up in the milk. Now we may use some dry methoxychlor for hornfly control, in amount and manner acceptable to the federal agencies responsible for watching out for our health and well being. We need, and in general appreciate, the supervision, guidance and cooperation of these important agencies.

At this time there is a O-tolerance for aldrin, dieldrin and heptachlor, on forage crops. This year the USDA will have no recommend uses for aldrin or heptachlor on the alfalfa forage crop, I am informed. Heptachlor and heptachlor epoxide now are being re-evaluated, but both are on a O-tolerance basis. Since January 19, 1960, when the Commissioner of Food and Drugs. Department of Health, Education and Welfare, published an order in the Federal Register (25 F.R. 404) establishing a tolerance of zero for the combined residues of the pesticide heptachlor and heptachlor epoxide, on the raw products: alfalfa, apples, barley, beets (including sugar beets), brussels sprouts, cabbage, carrots, cauliflower, cherries, clover, corn, cotton, grain sorghum (milo), grapes, grass (pastures and range), oats, onions, peaches, peas, potatoes, radishes, sweet clover, tomatoes, turnips, wheat, and some other crops.

Prior to this order, we could make our use recommendations on the basis of an established tolerance of 0.1 ppm for heptachlor residues in or on these crops.

At this writing, we at Utah State University have withdrawn our use recommendations for heptachlor on all forage alfalfa, and even on the alfalfa seed crop, until uses have been allowed. A number of uses now exist, such as control of white grubs, wireworms and earwigs in and about the lawn and flower garden; soil treatments before cane fruits are planted or before they begin to blossom, etc. For grass and pasture, 3 ounces actual heptachlor to the acre may be applied, provided we—"Do not graze dairy animals on treated areas. Do not graze animals being finished for slaughter for 90 days following treatment." Probably the same conditions will now apply for dieldrin and possibly for aldrin. This makes mosquito control more difficult to accomplish on meadow and pasture lands.

At this time, with the tightening up on uses for chlorinated with regard use of malathion, Diazinon, and some of the other low toxicity phosphate insecticides. However, we must keep in mind that what may be good usage today may be dis-allowed next week, next month, or next year.

Good public relations demand that we control mosquitoes without contaminating privately owned wet pastures and roadside standing water, which will result in DDT, dieldrin, heptachlor or other adulterants appearing in the milk supply. "Farmer Jones" may not spray his hay crop or his pasture with certain pesticides. If we do this for him, and he gets into trouble, *we* may be very unhappy people also.

USDA Agricultural Handbook 120, "Insecticide Recommendations of the Entomology Research Division for Control of Insects Attacking Crops and Livestock 1959 Season, on page 3 states: "Do not feed plants, straw, or threshing treated with aldrin, dieldrin, or DDT, or ensilage made from treated plants to poultry, dairy animals, or animals being finished for slaughter." At this time, heptachlor and heptachlor epoxide must be added.

Doubtless a committee from the American Mosquito Control Association should have the responsibility of advising state and county pest control associations and districts, as to permissible and non-permissible pesticides and usages. Probably some such commitee already exists. A pesticide useful in non-grazed swamp areas might be extremely objectionable on range or cultivated lands. Only with continuing guidance from a constantly informed source, can mistakes and possible law suits be avoided. Week to week and month to month guidance, by a competent source is needed in mosquito control, just as it is in agriculture, if we are to avoid pitfalls.

# THE EFFECTS OF INSECTICIDES ON AQUATIC LIFE

by

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During the last decade many new insecticides have been developed. While the rapid development of these insecticides has assisted in the control of injurious insect populations, many of these materials have been widely used without proper testing to determine their possible effects on fish and wildlife.

Large scale application of some insecticides, such as in forest spraying, cotton dusting, and mosquito control, may cause widespread destruction of aquatic life. Several such incidents, involving chlorinated hydrocarbon insecticides such as D.D.T., have already occurred. Some organic phosphorus compounds have been reported to be even more toxic to mammals than any of the chlorinated hydrocarbon insecticides. Laboratory bioassays conducted with malthion and parathion, however, indicate that these substances are less toxic to some warmwater fish and juvenile salmon than are D.D.T., toxaphene, and dieldrin. Even so, the fact remains that some organic phosphorus compounds such as Sarin can be toxic to fish in concentrations as low as 0.002 p.p.m.

While there have been some excellent laboratory studies evaluating the comparative toxicity of some of the new insecticides to fish, information as to the effects of most of the organc phosphorus compounds on fish as well as other aquatic life is still very limited. With the expanding use of insecticides there is a marked need for comprehensive studies by entomologists, fishery biologists and chemists to determine both the immediate and long-term effects on aquatic life. In order to determine the possible effects of some of the insecticides in current use in the Intermountain Region on aquatic life in the streams and lakes of the area, the author initiated a series of toxicity bioassays at the University of Utah during the past year. While many different toxicants will be tested in the future, only those insecticides of most common use in the region have been tested to date. The results of the bioassays which have been completed will be given in this paper, but it is the chief intent of the author to cite as many pertinent studies as possible in treating the subject under consideration.

D.D.T. is highly toxic to fish but exact figures are difficult to cite. The age, size, and condition of the fish influence their reaction to D.D.T. Treatment with amounts to 1.0 pound per acre is considered safe by some, whereas other authors demonstrate toxic results at 0.01 pound per acre.

A slowly moving stream in woodland in West Virginia was sprayed with a D.D.T. suspension at 1.0 pound per acre and some stoneroller suckers and black bass were killed. Treatment the following year at the same rate with an oil formulation resulted in six times the mortality of fish. (Surber and Friddle, 1949).

One pound D.D.T. per acre applied to trout raceways in Pennsylvania resulted in no loss of trout but a loss of 4 to 12 percent bluegill. An emulsion was more toxic and faster acting to all fish than oil or dust formulations. In a small Pennsylvania stream the fish loss after spraying was estimated to be only 1.3 percent of the total population. In this instance, however, only about one quarter of the applied dosage of one pound per acre actually reached the water surface. The forest canopy effectively screened out most of the D.D.T. (Surber, 1946).

Mosquito larvae are easily controlled with dosages of 0.1 and 0.2 pounds per acre of D.D.T. Even at these low dosages desirable invertebrates and fish may be killed. Studies conducted by Tarzwell (1947) indicated that dusts were the safest formulations. Emulsions killed aquatic insects and fish at 0.2 pounds per acre. The extent of the kill depended in part on the season and the species. The rate of flow, the depth of water, the nature of the substrate, and the amount of aquatic vegetation all condition the toxicity of D.D.T. in the field.

In addition to the directly poisonous effects of D.D.T. on fish several secondary effects have been demonstrated. The most significant of these is high mortality because of depletion of food supply. Often this effect is delayed until winter weather when the food supply may become critical. Such indirect effects are more likely to occur in mountain streams as a result of forest insect control rather than through mosquito or crop insect control.

Such delayed fish kills have been reported in the Yellowstone Park area and in Canada. In the summer of 1955 a considerable area of forest land along the Yellowstone River was sprayed to control spruce budworm. An estimated 99 percent of all aquatic invertebrates along a 100-mile segment of the river were killed. Losses of trout, whitefish, and suckers appeared in early October, three months after the spraying. It is believed that many fish died of starvation as a result of the extremely high mortality of aquatic insects at the time of spraying (Rudd and Genelly, 1956).

In general, under field conditions 0.1 pound per acre of D.D.T. as used in mosquito control and 1.0 pound per acre as used in forest insect control are relatively safe levels of application from the standpoint of fish. However, laboratory bioassays indicate that no general rule can be applied as different species of fish and aquatic invertebrates may vary widely in their sensitivity to different insecticides. For example, Lawrence (1950) found that only 0.01 p.p.m. of a D.D.T. emulsion was toxic to largemouth bass, whereas Surber (1948) found that trout could tolerate concentrations as high as 0.14 p.p.m. The author in conducting bioassays on stoneflies obtained 96 hour TLm (median tolerance limits) values of 0.18 and 0.32 p.p.m. D.D.T. with *Acroneuria pacifica* and *Pteronarcys californica*, two of the most common species found in streams of the Wasatch mountains.

The most comprehensive research on the effects of D.D.T. on aquatic life is that of Hoffman and his co-workers. In most of their studies the purpose has been to determine the effects of gypsy moth control on stream invertebrates.

Two watersheds in Pennsylvania were sprayed in 1948 with D.D.T. in oil at one pound per acre in order to control the gypsy moth. Following the application there was a rapid loss of stream bottom insects, but in no species was there complete elimination. Trichopterans, or caddis flies, were most susceptible. They were not taken in variety and amount until 16 months later. Insects belonging to the orders Megaloptera and Odonata were most resistant. Insect repopulation began about two months after the treatment. The water did not remain toxic for long, but moss in the stream contained toxic amounts of D.D.T. for severals months. Chemical analysis of moss collected one month after spraying contained 0, 44, 110, and 128 p.p.m. of D.D.T. at distances of 1, 2, 3, and 6 miles, respectively, from its source. In quiet water in the stream, submerged invertebrates seemed to be little affected, whereas in rapids, larvae and nymphs were almost completely destroyed (Hoffman and Drooz, 1953).

Two other insecticides commonly being used for mosquito larviciding in Utah are malathion and parathion. Malathion is considered as the safest of the organic phosphates now in common use. It is approximately one quarter as effective as parathion, but one-hundredth as toxic to warm-blooded animals. Parkhurst and Johnson (1955) reported that a concentration of 0.1 p.p.m. of a malathion emulsion was decidedly toxic to chinook salmon fingerlings. The next lower concentration tested, 0.032 p.p.m., killed no fish in six days. The toxicity of the emulsion was not altered by remaining in water up to six days before the introduction of the test fish. The values reported for salmon are at wide variance with the 96 hour TLm value of 12.5 p.p.m. reported for fathead minnows by Henderson and Pickering (1957).

In bioassays conducted with stoneflies by the author, malathion was found to be several times as toxic as D.D.T. Ninety-six hour TLm values of 0.01 and 0.1 p.p.m. were obtained using *Acroneuria pacifica* and *Pteronarcys californica* respectively as test animals. Large specimens (4-5 c.m. length) of the latter species were more resistant than smaller specimens (2-3 c.m.). The larger specimens tolerated up to 0.32 p.p.m. during the 96 hour test period, or three times the lethal dose of the smaller ones.

Parathion is effective in the control of many insects but is particularly toxic to aphids, scale insects, and mites. It is most commonly applied to orchard and row crops. The application rate to row crops is most frequently betwen 0.1 to 0.2 pounds per acre. For mosquito larviciding 0.05 pounds per acre is commonly used.

Parathion is many times less toxic to fish than are most chlorinated hydrocarbon insecticides. Linduska and Surber (1948) reported the toxicity of parathion as approximately the same for bluegills and rainbow trout (0.3 p.p.m.). Henderson and Pickering (1957) on the other hand obtained 96 hour TLm values of 0.71 and 1.6 p.p.m. with bluegills and fathead minnows respectively. Rainbow and brown trout in aquaria survived concentrations up to 0.38 p.p.m. in experiments performed by Surber in 1948.

In the bioassays with *Pteronarcys californica* being conducted at the University of Utah parathion appears to be more toxic than either D.D.T. or malathion. A concentration as low as 0.0032 p.p.m. was toxic to 80% of the specimens tested during a 96 hour period. Further tests, however, are necessary to confirm this figure.

The exact physiological action produced by the chlorinated hydrocarbons and organic phosphorus insecticides has not been fully elucidated but the former group is known to act on the central nervous systems of animals. The toxicity of organic phosphorus compounds is believed by (Kodama et al., 1955) to be due to one or more of several different effects: (1) chlolinesterase inhibition; (2) degeneration in the nervous system; (3) stimulation and depression of the central nervous system; and (4) irritation of surface tissues.

From the toxicity data reviewed, it would appear that most of the organic phosphorous compounds are less hazardous to aquatic life than many of the chlorinated hyrdocarbons. However, both groups of compounds can be extremely toxic to aquatic life when used carelessly and indiscriminately. To avoid needless destruction of valuable aquatic resourses in the future further research is needed to determine the toxicity of different insecticides to various species of fish and other aquatic organisms at different stages in their life histories as well as to determine conditions under which the toxicity may differ.

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# MOSQUITO SURVEY OF CENTRAL UTAH VALLEY, UTAH


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## INTRODUCTION AND DISCUSSION

From July, 1958 to August, 1959 a mosquito survey of Central Utah Valley was made by the Zoology and Entomology department. This was done under the sponsorship of Utah County, as proposed by the city-county health departments. Supervisor and director of the project were Roy J. Myklebust and D. E. Beck, respectively.

Principal objectives of the survey were to:

1. Determine species of mosquitoes present.
2. Establish the general geographic and ecologic distribution for each species.
3. Determine the seasonal population index for each species.
4. Gather as much data as possible on bionomics, with special attention directed to factors related to life cycles and hibernation.
5. Show relationship to vector potential of transmissable diseases, especially encephalomyelitis.
6. Recommend steps which could be taken to initiate mosquito control.

Subsequent to a county-wide survey of breeding and resting sites, 125 survey stations were established. These included larval, light trap, biting and hibernation sites. Collections were made on scheduled dates at selected stations. Data were gathered in such a way so as to be analyzed statistically.

The year long survey revealed five genera and twenty species to be present. About ten of the total number are considered as common. Listed below are the genera and species found and the figure following each species indicates the relative abundance for the ten most common species; number "1" indicating the most abundant, etc.

| Genus | Species |
|---|---|
| *Anopheles* | *freeborni* (9) |
| *Culiseta* | *incidens* |
| | *inornata* (2) |
| | *impatiens* |
| *Mansonia* | *perturbans* |

| | |
|---|---|
| *Aedes* | *compestris* (10) |
| | *dorsalis* (3) |
| | *excrucians* |
| | *fitchii* |
| | *flavescens* |
| | *increpitus* |
| | *melanimon* |
| | *nigromaculis* (5) |
| | *niphadopsis* (6) |
| | *vexans* (7) |
| | *cinereus* |
| *Culex* | *erythrothorax* (4) |
| | *pipiens* (8) |
| | *salinarius* |
| | *tarsalis* (1) |

The one hundred and twenty-five stations, comprised nine larval habitat types. These types did not include those habitats for mosquito species which were considered rare, or unusual in seasonal occurrence. The following is the list of habitats and the species of mosquitoes collected from each type:

1. Permanent roadside pools: A good producer of each of the species listed are road-side pools which were more or less permanent due to subsurface flow of water. *Anopheles freeborni, Culiseta inornata, Aedes campestris, A. dorsalis, A. increpitus, A. nigromaculis, A. vexans, Culex pipiens, C. tarsalis,* with *C. erythrothorax* being only found occasionally.

2. Intermittant roadside pools: Another good larval type of habitat was the road-side pool which was intermittant. Water supply here was due to drainage from excess irrigation on nearby fields, rainfall run-off, and spring snow melt. Here occurred *Anopheles freeborni, Culiseta inornata, Aedes campestris, A. dorsalis, A. nigromaculis, A. niphadopsis, A. vexans, Culex erythrothorax, C. pipiens, C. tarsalis,* with *Aedes dorsalis, A. nigromaculis, A. niphadopsis, A. vexans, Culex pipiens,* and *C. tarsalis* predominating.

3. Marshland pools: Seasonal, yet productive situations for mosquitoes were marshland pools resulting from rise and fall of lake levels, and flooding by snow melt and rainfall in catchment marshland basins. Here were found *Culiseta incidens, C. inornata, Aedes campestris, A. dorsalis, A. nigromaculis, A. vexans, Culex erythrothorax, C. pipiens* and *C. tarsalis,* with *A. vexans, A. nigromaculis and Culex tarsalis* predominating.

4. Slowly moving streams: Slowly moving streams with abundant plant growth at the stream bank or with emergent vegetation in the stream course proper did not produce high populations of larvae of any species. Nevertheless, several species were found, *Anopheles freeborni, Culiseta inornata, Aedes vexans, Culex erythrothorax, C. pipiens* and *C. tarsalis,* with *A. freeborni, A. vexans, C. erythrothorax* and *C. tarsalis* predominating.

5. Artesian wells: Artesian wells were a source of supply for *Anopheles freeborni, Aedes dorsalis, A. vexans* and *Culex tarsalis,* with *A. freeborni* and *C. tarsalis* predominating. Populations were relatively low as compared to other larval habitats.

6. Irrigation ditches: Irrigation ditches on farms and pasture lands as well as in garden plots in towns and cities were perhaps one of the greatest sources for mosquito breeding. In this type of habitat were found *Culiseta inornata, Aedes campestris, A. dorsalis, A. vexans, Culex erythrothorax, C. pipiens, C. tarsalis,* with *A. dorsalis, A. campestris, A. vexans* and *C. tarsalis* predominating.

7. Street gutter and street intersections: Probably second in importance in towns and cities were the street gutters and gutter underpasses at street intersections. Here were found *Aedes dorsalis, A. vexans, Culex erythrothorax, C. pipiens,* and *C. tarsalis,* with *A. dorsalis C. erythrothorax* and *C. tarsalis* predominating.

8. Abandoned excavations: Abandoned excavations such as gravel pits, levee construction for flood control and protection of such places as airports, cellars in abandoned dwellings, excavation for bridge construction associated with railroad and highway rights of way, offered excellent situations for mosquito breeding. Larval forms commonly found were *Anopheles freeborni, Culiseta inornata, Aedes dorsalis, A. nigromaculis, A. vexans, Culex erythrothorax, C. tarsalis,* with *A. dorsalis, A. vexans, C. erythrothorax,* and *C. tarsalis* predominating.

9. Public ponds and residential pools: Still other types of larval breeding areas were the public park ponds and pools, as well as the private residential ornamental pools. In these locations were found *Culiseta inornata, Aedes dorsalis, A. nigromaculis, A. vexans, Culex erythrothorax, C. pipiens, and C. tarsalis,* with *A. dorsalis, C. pipiens,* and *C. tarsalis* predominating.

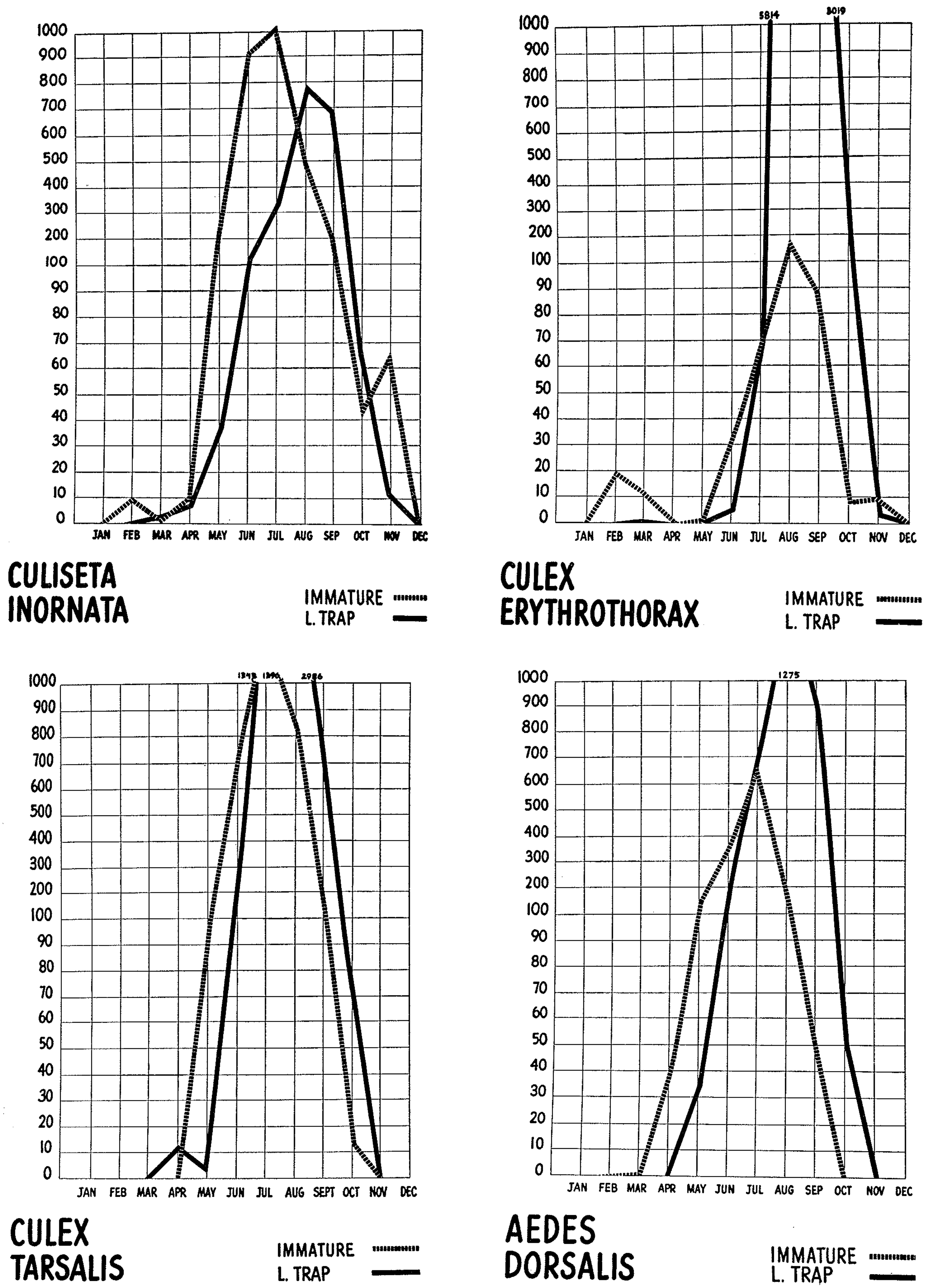


**Fig. I — Seasonal Population Index for Larval (Immature) and Adults (Light Trap) for the year 1958-59.**

A number of species of mosquitoes were found over-wintering in the larval stage. Most of our records indicated that they were those species found in marshland situations. They were collected in water covered by a coat of ice. The species found were *Culiseta inornata, C. incidens, Aedes campestris* (this may be *A. dorsalis*),* *Culex erythrothorax* and *C. pipiens.*

There were several species of mosquitoes found overwintering as adults. *Anopheles freeborni* was found in abandoned buildings, barns, airplane hangars, and in the early part of the season in rock piles in company with *C. tarsalis. Culex erythrothorax* for the most part was found in homes, potato cellars, fruit cellars, and in abandoned buildings sometimes associated with *A. freeborni. Culex tarsalis* was found under rocks in dry stream-beds at the mouths of canyons which enter the valley. They also were observed beneath stones in rocky talus slopes along the foothills around the valley.

Very limited observations on migration revealed that collections of adult specimens showed the following species to be as much as six miles from point of larval origin: *Aedes dorsalis, A. niphadopsis, Culex erythrothorax* and *C. tarsalis.* All other adult species seemed to be relatively close to where they were found as larvae.

Observation on biting with man as the host, showed *Anopheles freeborni* to feed most actively after dusk; *Mansonia perturbans* in early evening; *A. dorsalis* day and night but most active at dusk and dawn; *A. nigromaculis* day and evenings but most active during the evening and late afternoon when the air is quiet; *A. niphadopsis* during the day and evenings but most active during late afternoon and evening; *A. increpitus* late afternoon and evening; *A. vexans* any time during the day especially when the sky was overcast and at dusk; *Culex erythrothorax* day and night but most active in the evening. *C. tarsalis* started to actively bite at dusk but was most active about one hour after dark. *Culiseta inornata, Aedes nigromaculis, A. niphadopsis* and *Culex tarsalis* were observed feeding on cattle.

Seasonally, those species which were active as early spring biters were *Anopheles freeborni, Aedes campestris, A. fitchii, A. increpitus, A. niphadopsis, Culex erythrothorax,* and *Culex tarsalis. Aedes niphadopsis* and *A. campestris* appeared early in the spring, but had their peak population in early summer. All other species made their appearance in early spring and had population peaks in mid and late summer. This was especially true for *Aedes dorsalis, A. vexans, Culex erythrothorax, C. pipiens,* and *C. tarsalis.*

* We encountered some difficulty in differentiation of *A. dorsalis* and *A. campestris, Culex pipiens* and *C. salinarius.*

Mosquitoes affect man in Central Utah Valley both as pests and from a public health aspect. Affecting man as pests are *Aedes dorsalis, A. campestris, A. nigromaculis, A. niphadopsis, A. vexans, Culex erythothorax, C. tarsalis, Mansonia perturbans,* and *Anopheles freeborni. Culiseta inornata, A. dorsalis A. campestris, A. nigromaculis, A. niphadopsis, A. vexans, Culex pipiens, C. tarsalis, and Anopheles freeborni,* attack domestic animals in addition to man. *Culex tarsalis* and *C. pipiens* are especially bothersome to poultry.

Insofar as known there is no published record listing the name of a disease agent being found in a mosquito species occurring in Central Utah Valley. This is interesting to contemplate, in view of the fact that in Central Utah Valley Western Equine Encephalomyelitis has been found in man and domestic stock with fatal consequences to both.

There are several species of mosquitoes found in Central Utah Valley which also occur in other parts of the United States, and which elsewhere have been shown to be vectors of disease organisms. Listed below are these species found in Utah and the diseases for which elsewhere they have been convicted as vectors:

Light trap collections showed *A. freeborni* and *Aedes niphadopsis* to rarely visit the light trap. *A. campestris, A. nigromaculis,* and *Culiseta inornata* were consistant visitants but never in great numbers. Those species which came to the light trap in abundance were *Aedes dorsalis, A. vexans, Culex erythrothorax, C. pipiens* and *C. tarsalis.* Of all species taken in light traps, *C. erythrothorax* was the most abundant. See Figure I for graphic representation of four of the most common mosquitoes. It should be added, that the less common species might have been taken if light traps had been placed near their areas of breeding. Such species would be *Aedes increpitus, A. cinereus, A. excrucians, A. fitchii* and *A. flavescens.*

Anopheles freeborni

Western Equine Encephalomyelitis, Malaria

*Culiseta inornata*

Western Equine Encephalomyelitis

*Mansonia perturbans*

Western Equine Encephalomyelitis

*Aedes dorsalis*

Western Equine Encephalomyelitis, St. Louis Encephalomyelitis

*Aedes vexans*

Western Equine Encephalomyelitis

*Culex pipiens*

St. Louis Encephalomyelitis, Western Equine Encephalomyelitis, Virus of Fowl Pox, Heart Worm of dogs.

*Culex tarsalis*

Western Equine Encephalomyelitis

## RECOMMENDED CONTROL MEASURES

Mosquito Control may be approached by: (1) Complete immediate eradication, (2) Continuous control, (3) Permanent control.

Complete eradication, although possible, is unrealistic either from the viewpoint of natural history or financial outlay. Continuous control as the name indicates, employs measures which suppress mosquito populations but do not eliminate them. A reduction or discontinuance of control in the latter case allows the mosquitoes to build back comparatively to the original status. Permanent control is the employment of measures which continue to permanently remove mosquito breeding situations over a long period of time. In a sense the latter attains a semblence of eradication but over a longer period of time.

A practical control program is one which will reduce mosquito populations below a point where disease will be unable to maintain itself; where the nuisance value is low, and where surveillance studies can be kept in operation: The surveillance studies being conducted to evaluate progress and status of control measures used, as well as determine the need for changes on emphasis. This is accomplished by research methods.

For mosquito control in Central Utah Valley, it is recommended that both continuous and permanent approaches be employed, with emphasis being directed to measures of a permanent nature. Insecticides (chemical control) are effective in dramatic reduction of both larval and adult populations in continuous control. Due to the phenomenon of development of resistence by mosquitoes to insecticides, it is recommended further that insecticides be primarily used for adult control. Permanent measures should be employed against larvae, such as removal of breeding sites by an engineering method, sometimes described as the sanitary approach.

The engineering (sanitary) approach is a high "initial-cost" program, but becomes less and less as time goes on, while in the case of the use of insecticides it means continuous outlay, and hence high cost. Working the two systems simultaneously speeds up control and continues to reduce cost.

Any program combining both procedures would require personnel trained in three aspects of operation under competent managerial supervision. These unit groups should be persons trained in the use and application of insecticides, engineering practices, and those persons trained as entomologists. Success of such a program is directly proportional to the number and training of people employed to conduct the work and how they are administratively coordinated.

No overall insecticide panacea can be recommended. The specialist in charge of pest control measures using chemicals, will have to determine the use for each situation. Due to the great variety of ecological conditions in Central Utah Valley where mosquitoes breed, plus factors involved with agriculture and industry, and where people live, insecticidal use becomes a complex operation requiring professionally trained personnel to determine kinds, amount, time, place and manner of application.

Various divisions of public services most likely to be involved in the engineering (sanitary) approach are:

1. Municipal departments concerned with supervision and construction of streets, curbs, gutters, and sewage disposal.
2. Departments concerned with county, state and federal highway construction.
3. Departments both involved with impounding or distribution of water for recreational, industrial, agricultural or other purposes such as boat harbors, land reclamation, and airport construction.
4. Farmers and especially those interested in using the services of the Soil Conservation Service.
5. Public as well as private agencies concerned with garbage disposal.

For surviellance, a corps of well-trained biologists (entomologists) will have to be employed. Due to certain seasonal aspects of mosquito biology it would be too costly to employ a corps of full time operators ready on call. Due to the close proximity of the Brigham Young University, it seems wiser that a working agreement be concluded with the Department of Zoology and Entomology of that institution to evaluate and assess the control operation from the standpoint of biology: In addition it could function in conducting the other related research when necessary.

From the standpoint of overall administration, it is recommended that the mosquito control program be established as a department within the City-County Health organization. This department should have its own director and budget. Activities of this department would be coordinated with other health units as well as county, state and federal agencies. The organization of the mosquito control division should be so organized as to give priority to mosquito control, but be of such design as to efficiently give emphasis to other pest control problems as the mosquito control program becomes progressively reduced.

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# BITING COUNT RECORDS IN WEBER COUNTY


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## INTRODUCTION

The taking of biting count records was incorporated into the program of the Weber County Mosquito Abatement District in the summer of 1958 at the suggestion of Mr. Louis J. Ogden. This was done principally in an effort to understand better and to cope with the problem of *Culex tarsalis* numbers and the prevalence of Western Equine Encephalomyelitis. The current report deals only with the results of the 1959 season, but a continuation of the program is planned for 1960 and an all inclusive report will be forthcoming.

## MATERIALS AND METHODS

Most of the collections were made with the use of a suction tube aspirator, but under conditions where very few or no mosquitoes were expected, some were made by collecting in a vial or by identifying the mosquito before it was slapped. A flashlight, watch, small piece of mosquito netting, and from one to three cyanide jars with two piece lids completed the equipment, exclusive of a cardboard box in which to carry the material. The piece of mosquito netting was stretched across the mouth of the jar and the ring part of the lid screwed on to hold the netting in place. The disc part of the lid was placed on top to prevent the cyanide gas from escaping. The piece of mosquito netting was slit enough to allow the end of the collecting tube to pass into the killing jar to effect the transfer of mosquitoes from the aspirator to the jar. Adult mosquitoes were mainly taken from below the knees of the bare legs of the collector. In some cases the collections were made in two or three consecutive thirty minute intervals using one killing jar for each segment of the collecting period. In other instances, this collecting procedure was used in the close proximity of a light trap which was equipped with the same number of killing jars; each used the same time intervals, thus allowing a comparison of the two methods of collection. The time of sunset was estimated from an almanac for 1959 by interpolation between the sunset times for forty degrees north latitude and forty-five degrees north latitude.

## THE SURVEY

Eleven species of mosquitoes were collected during bite counts in 1959. Collections were made between June 2 and September 29, and all were taken in the evening hours. An effort was made to accomplish the collecting as near to sundown as the mosquito control schedule would allow. Most of the collections during June and July were begun within one half hour after sunset, and during August and September most of the collecting began within one hour after sunset. The collectors and number of collections made by each are: Lamont Holmes one, Douglas F. Cave two, Lewis E. Fronk thirty-five and Earl A. Jenne sixty-four. A total of one hundred and two collections were made in seventy-seven collecting nights with no two collectors present in the same area. Thirty-two percent of the collections were made in rural areas of which six percent were made in extremely bad breeding areas, and sixty-eight percent were made in urban or suburban areas with forty-four in Ogden City. No mosquitoes were found in twenty-one of the one hundred and two collecting periods. Seventeen of the collections were made in answer to complaints.

The dates between which the mosquitoes were caught and the number of each species taken in the order of abundance are as follows. *Culex tarsalis*, 688 collected between June 11 and September 16 with the majority being collected between July 15 and August 20. *Aedes dorsalis*, 437 were collected between June 10 and September 22 with the highest counts between July 1 and July 15.

*Aedes increpitus;* 431 were collected between June 10 and July 28. The last date on which any were collected in the lower valley was June 30, but seventy-one were collected at the Girl Scout Camp on July 28.

*Aedes nigromaculis;* 199 were caught between June 11 and September 3 with high counts scattered between July 13 and September 3.

*Culiseta inornata;* 173 were found in the collections between June 11 and September 22. They were present mostly in low numbers, but on August 14 a total of 108 were collected in one half hour. Five other species totaling fifty-five more mosquitoes were collected at the same time. The irritation to the collector was so severe that the collecting period was shortened to a half hour rather than the usual hour. Quentin East a local farmer was present during about one half of the collecting time, but about all he said regarding the mosquitoes was that they were quite numerous.

*Aedes vexans;* 59 were caught between June 10 and September 3 with over half the total number collected on July 11.

*Anopheles freeborni;* 51 were collected between June 17 and September 3 with no high counts. The largest number collected on any one night was 16 on September 3.

*Culex erythrothorax;* 15 were collected during the period from July 13 to September 22. No high counts were noted, and much difficulty was experienced distinguishing this species from the following one.

*Culex pipiens;* 8 were found present in collections between July 8 and September 6, and no more than two were collected in any one night.

*Aedes campestris;* 3 was the total found. One was collected at the Taylor Church on June 11, and two were taken at Pine View Lake on June 17.

*Culiseti incidens;* 1 was collected on June 29 at 1523 Canyon Road in Ogden.

### *Segmental Collections*

On twenty-seven occasions the collections were made segmentally in consecutive thirty minute time intervals with a separate killing jar for each period. Collecting was begun on the average at forty-eight minutes after sunset with a biting time ranging from two minutes before sunset to ninety-nine minutes after sunset. These extremes exaggerate the condition however, since the range exclusive of these two is from thirteen minutes to seventy-eight minutes after sunset. The average time at which the first mosquitoes were collected was sixty-one minutes after sunset with a range of from twenty-three to one hundred nineteen minutes after sunset. In several cases however, mosquitoes were already active when the count began, and there is no way of knowing how long they had been active. The middle of the period of maximum activity for the twenty-seven times was seventy-nine minutes after sunset with a range of from fifty to one hundred twenty-three minutes after sunset. This then places the average period of maximum activity in the third half hour after sunset.

In eight of the twenty-seven collections, taken between June 10 and September 8, there was a waiting period of from ten to fifty-five minutes before mosquitoes appeared. In these instances, the first mosquitoes appeared during a period of twenty-three minutes to one hour fifty-nine minutes after sunset with an average of sixty-four minutes. In four of the eight collections, mosquitoes appeared on the scene within forty-seven minutes following sunset. These eight collections were made between June 10 and September 8, and nine species were taken.

### *The Effect of Weather on Prevalence of Adult Mosquitoes*

On August 17, a high count (one hundred eighty-eight) was taken in a one and one-half hour period at the West Weber School. *Culex tarsalis* and *Aedes nigromaculis* constituted ninety-seven percent of the total collection. During the following two days severe thunderstorms and winds brought the entire field operation to a stand still. The precipitation over the two day period was recorded at one and one fourth inches. The following night (August 20) was cool with gentle breezes, and in a one and one half hour collecting period sixty-six mosquitoes were taken. The number of *Aedes nigromaculis* was reduced by fifty-six, and the number of *Culex tarsalis* was reduced by nearly sixty-eight percent, while the overall reduction in adults was sixty-five percent. These figures suggest that *Aedes nigromaculis* might be somewhat more hardy than *Culex tarsalis*, but the difference may be due to other factors. The figures also indicate that severe summer storms seem to have a definite, but limited effect on the adult population, as we have no way of knowing how many of the mosquitoes taken in the second count emerged after the storm.

*An Example of the Value of Biting Counts in the Evaluation of Fogging*

On August 27 and August 28 a carnival was held in the Plain City Park, and prior to fogging on the twenty-seventh, people were leaving the park because of the annoyance caused by mosquitoes. We also fogged the night of the twenty-eighth, and after the fog had lifted the area was entered and a bite count taken for a one and one half hour period. During this time a total of only eight mosquitoes were taken although the weather conditions and bright lights seemed to favor mosquito activity. This along with several similar incidents, which were not connected with formal bite counts, demonstrate the local effectiveness of adulticiding.

*A Comparison of Light Trap and Bite Count Collections*

Eight light traps were operated every night during the four months in which the bite counts were taken. The species collected are listed in the order of prevalence, and the percent of the total light trap collection represented by each is as follows: *Culex tarsalis* 66.4% ; *Culiseta inornata* 22.5% ; *Aedes dorsalis* 5.4% ; *Aedes nigromaculis* 3.2% ; other species inclusive of specimens damaged beyond recognition 1.6% ; *Culex pipiens* .5% ; *Anopheles freeborni* .16% ; *Aedes vexans* .13%. These results coincide with results obtained for the bite counts with respect to the most abundant, fourth most abundant and seventh most abundant species, but differs with respect to the rest. All the biting collections used as a comparison were not made in the vicinity of light traps, but the results of the two methods were compared as a matter of general interest. It is recognized that different locations and hours of collection can cause a difference deviation in the results of the two collecting systems. The relative degrees of positive phototropism for the different species as well as the population density affects the species and numbers of each found in the light traps. Another reason for the different results of the two methods is that the light trap collections were broken down into seven abundant species with an eighth group referred to as called others, while all specimens taken in biting collections were identified resulting in eleven species being reported. When the bite counts are considered alone, each species represents the following percentage of the total number collected: *Culex tarsalis* 33.3% ; *Aedes dorsalis* 21.1% ; *Aedes increpitus* 20.8% ; *Aedes nigromaculis* 9.6% ; *Culiseta inornata* 8.4% ; *Aedes vexans* 2.8% ; *Anopheles freeborni* 2.4% ; *Culex erythrothorax* .7% ; *Culex pipiens* .4% ; *Aedes campestris* .1% ; *Culiseta incidens* .05%. The percents for each species from the two collecting methods was added together and divided by two and the quotient thus derived represents the relative abundance according to an amalgamation of the two systems. The figures thus arrived at are: *Culex tarsalis* 49.8% ; *Culiseta inornata* 15.4% ; *Aedes dorsalis* 13.2% ; *Aedes increpitus* 10.4% ; *Aedes nigromaculis* 6.4% ; *Aedes vexans* 1.5% ; *Anopheles freeborni* 1.3% ; others .8% ; *Culex pipiens* .45% ; *Culex erythrothorax* .35% ; *Aedes campestris* .05% ; *Culiseta incidens* .02%.

On nine occasions, a bite count was taken simultaneously with a light trap collection, and within from five to sixty feet of the light trap. The results of the two methods of collection were then compared. These collections were made between July 15 and August 29. The number of mosquitoes collected by each method was totaled up for the nine nights, with the result that indicated there were 1.84 times as many mosquitoes collected through bite counts as in light traps. Eight species were represented, but ninety-five percent of them belonged to four of the species. When the species are singled out, arranged in order of abundance, and the number collected in light traps compared with the bite counts, the results are as follows: *Culex tarsalis* bite count twice as high as light trap collection; *Culiseta inornata* bite count 1.26 times the number collected in light traps; *Aedes nigromaculis* bite count six and one half times the light trap count; *Aedes dorsalis* bite count twenty-two times the light trap count; *Anopheles freeborni* bite counts were 1.28 times the light trap counts; *Culex pipiens* bite counts were only one fourth as large as the light trap counts; *Culex erythrothorax* bite counts were one third as large as the light trap counts; *Aedes vexans* were not found in these light traps but two were taken in the biting collections.

## SUMMARY

1. One hundred and two collections were made, of which twenty-one were zero counts.
2. Seventeen biting collections were made answering complaints.

3. Sixty-eight percent of the collections were made in urban or suburban areas, and thirty-two percent in rural areas. The species and numbers of each collected are affected accordingly.

4. The collections were made between June 2 and September 29, and most began within from one half to one hour after sunset.

5. The mosquitoes were taken from below the knees of the bare legs of the collector.

6. Eleven species of mosquitoes were collected.

7. The four dominant species according to bite counts are: *Culex tarsalis, Aedes dorsalis, Aedes increpitus*, and *Aedes nigromaculis.*

8. The four dominant species according to light trap counts are: *Culex tarsalis, Culiseta inornata, Aedes dorsalis*, and *Aedes nigromaculis.*

9. The four dominant species after combining the light trap percentages with those of the bite counts are: *Culex tarsalis, Culiseta inornata, Aedes dorsalis*, and *Aedes increpitus.*

10. When summed up, 1.84 times as many mosquitoes were collected in bite counts as by light traps in the same area and at the same time.

11. The average period of maximum biting activity was in the third half hour after sunset.

## REPORT FROM DAVIS COUNTY MOSQUITO ABATEMENT DISTRICT

Submitted by Morris F. Swapp, *Manager*

Gentlemen:

Once again I have the opportunity to give you the progress report of Davis County Mosquito Abatement District. Each year has its good features as well as adverse conditions. It is my experience that each year is different from the previous one in the fight against mosquitoes.

The year 1959 had its peculiarities, contrary to the predictions which were made one year ago, that we would have an infestation of mosquitoes and probably another out-break of encephalitis due to the lack of control of the *Culex tarsalis* mosquito; we are happy to report that the 1959 season was perhaps the most successful and mosquito free season since the Davis County Mosquito Abatement District was organized about ten years ago.

We believe there were several factors responsible for the successful year namely:

1. The addition of two more crewmen.
2. Additional permanent drainage from year to year.
3. Increased technical knowledge of crew members.
4. More efficient coverage through airplane spraying.
5. Pre-hatch spraying in some critical areas.
6. Better water management of the water fowl areas in Davis County.
7. A better educated public to help spot and report mosquito breeding areas.
8. Dry climatic conditions of the past summer.

In looking to the future in Davis County things are looking up in all respects. We are increasing our man power, and our ability to abate mosquitoes with more and better equipment, but at the same time we are gaining several thousand acres of mosquito producing area.

The State Fish and Game has established an additional 2,500 acres of mosquito producing area in the north end of the County by erecting additional shooting grounds at Howard Slough. In addition to this 3,500 acres of wild life refuge is being constructed adjoining Farmington Bay. The North Davis Sewer District has created another critical area in Syracuse.

To help combat the additional areas involved we are adding a new Dodge power wagon with a spray crew.

The time has arrived when the Davis County Mosquito District is becoming of age. This summer we will gather our equipment from all sections of the county to a central headquarters located in West Kaysville. With the advent of a central location we are expecting to do a much more complete job of record keeping, and of coordinating the program.

The Board of Directors of the Davis County Mosquito Abatement District are aware of the many needs confronting them and the crew members in our abatement work. As usual money is the limiting factor. The mill levy was raised this year from .75 to .85 of a mill in order to purchase a central headquarters. Our Board is aware of the tremendous acreage which is potential mosquito producing area in Davis County. They are also aware that these areas are situated within one mile of heavily populated districts.

In behalf of the Board of Directors from the Davis County Mosquito District we thank our County workers in the neighboring districts, particularly the Salt Lake and Weber Districts for their cooperation from year to year.

It is our hope in Davis County that we can be a credit to the state organization now and in the years to come.

## ECONOMIC POISONS AND MOSQUITO CONTROL

Jay E. Graham

Chemical control programs of mosquito abatement districts are generally designed with limits determined by available scientific information and legal restrictions. Some factors which must be considered in the design of chemical control programs are (1) concentrations required for effective mosquito control, (2) minimum concentrations which could be harmful to other organisms, (3) residues which might accumulate in milk or meat, (4) the areas where chemicals are to be applied, and (5) hazards to which the operator might be exposed in handling the insecticide. A detailed study of these factors and others has been conducted in Salt Lake County and the results published (Graham and Anderson, 1958). Such a study demonstrates conclusively that mosquito control can be accomplished by the proper application of chemicals without presenting any significant hazards to other animals, including man.

Chemical control programs for other pests in various parts of the world have caused some damage to wildlife, and accidents in handling poisons have resulted in some unnecessary deaths. In addition, certain insecticides accumulate in the tissues of mammals, including man, and could conceivably cause detrimental effects over a long period of time. For these and other reasons, responsible and reasonable people have felt a growing concern about the use of insecticides. Mosquito abatement districts have two primary obligations regarding their chemical control program. They must first develop an effective, safe program based on information obtained from pertinent scientific literature and then they must explain their program to the best of their ability to concerned, reasonable people.

Some facts that have proven helpful in explaining the chemical control program in the South Salt Lake County Mosquito Abatement District are:

1. Concenrations of insecticide used for mosquito control are much less than those used in agriculture.

2. Most poisons are applied to waste land that has no value as farm land or as a wildlife resource.

3. Insecticides that will accumulate in milk or meat are not used on forage crops.

4. An animal drinking water treated to destroy mosquito larvae would have to drink many times its weight in water in 24 hours to get a lethal dose.

5. Insecticides have been widely used for mosquito control in Utah for many years and there has never been an authentic case of a farm animal becoming sick or dying as a result of mosquito control.

### CONCLUSION

The proper application of chemical agents for the control of mosquito larvae and adults does not constitute a threat to the health or safety of farm animals or wildlife, and will not cause accumulation of insecticide in the milk or meat of cattle.

### LITERATURE CITED

Graham, Jay E. and R. D. Anderson
1958. The effects of mosquito larviciding on other organisms in Salt Lake County. Utah Acad. Sci., Arts and Letters. Proc. 35:42-48.