PROCEEDINGS
of the
FORTY-FIRST ANNUAL MEETING

of the
UTAH MOSQUITO ABATEMENT ASSOCIATION

Held at the
UNIVERSITY PARK HOTEL
Salt Lake City, Utah

September 25-27, 1988

Edited by
SAMMIE DICKSON
and
ROBERT E. ELBEL

UTAH MOSQUITO ABATEMENT ASSOCIATION
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RESOLUTIONS - 1988

WHEREAS, the Utah Mosquito Abatement Association (UMAA) has held its 41st annual meeting at the University Park Hotel, Salt Lake City, Utah, September 25-27, 1988, and

WHEREAS, Davis Mosquito Abatement District, Rex Passey, Manager, has served as the host organization, and

WHEREAS, the local arrangements and program committees have done an excellent job,

THEREFORE, be it resolved that the UMAA extends sincere appreciation to the Davis Mosquito Abatement District, its manager, board of directors, and to all others concerned with the success of this convention.

WHEREAS, the papers presented by the speakers have been of excellent quality and highly informative to those who attended, and

WHEREAS, many of the participants in this conference came considerable distances to take part in the conference,

THEREFORE, be it resolved that the UMAA extends its thanks and appreciation to all speakers, and especially to those who came from out of state.

WHEREAS, Sammie Dickson has served with distinction and devotion to the UMAA as its president for 1987-88,

THEREFORE, be it resolved that the UMAA extends appreciation to him for his excellent service to the Association.

WHEREAS, the University Park Hotel, Salt Lake City, Utah, has provided fine facilities, excellent food and services, and

WHEREAS, the banquet was of outstanding qualify,

THEREFORE, be it resolved that the UMAA express appreciation to the University Park Hotel for contributing to the success of the 1988 meetings.

WHEREAS, the contributing members have provided financial support and information about their products and services, as well as displays,

THEREFORE, be it resolved that the UMAA express its appreciation to those organizations for the support and services they have provided to further mosquito control throughout the State.

RESOLUTIONS COMMITTEE
Elmer Kingsford, Chairman

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DR. DON M. REES
MEMORIAL AWARD

This award was created in 1987 by the Utah Mosquito Abatement Association to acknowledge exceptional contributions to mosquito control in Utah. The award honors **Dr. Don Merrill Rees, 1901-1976**, who was often referred to as the "Father of Mosquito Abatement in Utah."

The 1988 recipient of the second **Dr. Don Merrill Rees Memorial Award** is Lewis T. Nielsen, Ph.D. Dr. Nielsen began his interest in mosquitoes and their control while working for the Salt Lake City Mosquito Abatement District as a field employee in the summers between his years as an undergraduate student at the University of Utah (1937 - 1941). He earned both B. S. (1941) and M. S. (1947) degrees in zoology at the University of Utah. In 1955 he received his doctorate in entomology from that same institution under the guidance of his major professor, Dr. Don Merrill Rees.

Dr. Nielsen served as president of the UMAA in 1957-58, and editor of the Association's proceedings 1961-1968. He was the president of the American Mosquito Control Association in 1977-78 and received that organization's Medal of Honor Award in 1988.

As an instructor and professor at the University of Utah since 1946, Dr. Nielsen has published more than 60 scientific papers on mosquito identification, systematics, behavior, ecology and control. In 1961, Dr's Nielsen and Rees jointly published *"An Identification Guide to the Mosquitoes of Utah"* which is still the most useful and comprehensive work of its kind in Utah. During his tenure at the University of Utah, he has had 12 graduate students earn masters and 11 doctorates under his direction.

Dr. Lewis T. Nielsen is nationally respected for his work with mosquitoes. Having been involved with mosquito research and control for over 41 years, as well as a personal friend and colleague of Dr. Don Merrill Rees for that same time, the UMAA was honored to award Dr. Lewis T. Nielsen with its highest award, the **Dr. Don Merrill Rees Memorial Award**.

REMARKS FROM THE PRESIDENT OF THE AMERICAN MOSQUITO CONTROL ASSOCIATION

BRUCE F. ELDRIDGE

Dept. of Entomology, U.C. Davis
Davis, CA 95616

On behalf of the American Mosquito Control Association (AMCA), I extend my best wishes to you and the Utah Mosquito Abatement Association for an exciting and eventful 1988 meeting in Salt Lake City. I very much regret not being able to be there with you and also, that you will be unable to attend the AMCA Interim Board meeting and the meeting of the Ohio Mosquito Control Association in Columbus.

Current developments in the United States and elsewhere continue to occupy the attention of the AMCA and to emphasize the important role all of us in the mosquito abatement business have to play in protecting the health of the public and helping insure a reliable food supply while affording maximum protection to the environment. Some examples:

1. *Aedes albopictus* is neither gone nor forgotten in the United States (at least not by us!) and new infestation records continue to come in.

2. I am happy to report that the Environmental Protection Agency (EPA) is currently working closely with AMCA to insure that EPA's evolving pesticide label restriction plan, to be implemented in conjunction with the Endangered Species Act, will not have an adverse effect on our ability to protect public health.

3. There are many pieces of legislation pending in the U.S. Congress which will have a direct effect on our ability to conduct mosquito abatement. Because it is difficult to keep track of this legislation, AMCA will employ a firm to keep us informed in this area. I hope to see this accomplished by the end of the Columbus meeting. Some State organizations may wish to share in this service in some way.

4. The AMCA Central Office continues to improve its services to members. A new IBM computer system that includes desktop publishing capability has been purchased. This will make database maintenance much easier than in the past and will improve our ability to produce quality fliers, newsletters and similar materials at minimum expense.

5. A new Annual Meetings Committee is working hard on proposed new guidelines for the selection of meeting sites for AMCA. We have never had a firm policy on rotation of regions, selection time frames, and related factors, and this has led to some confusion. I hope that if nothing else comes out of this, it will avoid meeting date conflicts so that I can attend UMAA meetings in the future.

Future meetings for AMCA will be:

1989. Boston, MA

1990. Lexington, KY

1991. New Orleans, LA

1992. Corpus Cristi, TX

1993. Fort Meyers, FL

Again, please accept my greetings to all of your members and my thanks for your strong support of AMCA.

WHY SHOULD YOU CONTINUE TO BE CONCERNED ABOUT WESTERN EQUINE ENCEPHALITIS?

WILLIAM C. REEVES

Department of Biomedical & Environmental Health Science
School of Public Health
University of California
Berkeley, CA 94720

When Glen Collett asked me to meet with your Association, I welcomed the opportunity as I felt that California and Utah share many problems regarding mosquito-borne diseases and their control. I know something of your problems as I spent a fair amount of time in Utah visiting Don Rees and other close friends in earlier years. For many years, I annually reviewed the CDC programs that were located in Salt lake City and Logan, and on several occasions, I was asked to consult on the U. S. Army-University of Utah collaborative project in the Bonneville Basin. Incidentally, I also took this occasion as an excuse to reread some 12 papers by Rees, Graham, Collett, Crane, Elbel, Smart, Hill, Jenkins and Francy on their studies in Utah.

In his invitation, Glen asked me to concentrate this talk on Western Equine Encephalitis (WEE), to review its basic cycles, to examine the concept that threshold levels of vector populations are necessary for virus maintenance and to explain the problems encountered in interpretation of encephalitis surveillance data. In doing so, I shall present some past and current field studies in California, and I believe you will come to realize, as I have, that these data are very applicable to your problems in Utah.

Now for the past: In 1952, you reported 249 cases of encephalitis from Utah. Your last major outbreak of WEE in humans and horses was in 1958 when 36 of 172 reported cases in humans were confirmed as WEE. By 1961, the number of cases was down to zero. In 1978, some 60 cases of WEE were reported but few were confirmed. In the past 10 years, you have not reported a single case in humans or horses, and we have had a very similar picture in California. What is the easy answer to this pattern of disease occurrence? We would all like to say that "mosquito control is wonderful and that the problem has been solved." Unfortunately, the answer is not that simple. The disease problem has largely gone away, but the virus has not. WEE virus is still here in its invisible cycle between *Culex tarsalis* and wildlife in much of the same area where it occurred in epidemics historically. I don't believe any of you think there has been or ever will be an effective *Cx. tarsalis* control program in every area where the virus and vector are known to occur; yet, clinical cases of WEE are few each year in the western United States. I believe there are many reasons why the disease has decreased including mosquito control, vaccination of horses, the widespread use of insecticides on agricultural crops, changes in agricultural practices and changes in the habits of society. However, I believe that we may experience epidemics again in the future, and you should continue to be concerned. Genetic resistance to almost all insecticides is now widespread in *Cx. tarsalis* and more and more legal and social restrictions are being put on mosquito control practices. It is almost inevitable that *Cx. tarsalis* populations are going to increase as they already have in some areas.

The basic cycle of WEE as we conceived it in 1945 is amazingly similar to what we know today. We have elevated wild birds to a central spot in the cycle and now consider chickens to be incidental hosts that man introduced into the cycle. There is no question that the bird-mosquito-bird cycle is central to virus maintenance, and I shall call this the silent cycle in that we do not see it as it usually does not produce disease in the birds or vectors. Man and horse, while clinically susceptible, are accidental hosts that contribute nothing to the maintenance of infection; they do not have a viremia adequate to infect a vector. It is the silent cycle that is still occurring in much of the area depicted in the old epidemic maps.

Let me turn now to the subject of a surveillance program for WEE. An active surveillance program can include the following types of information which a mosquito control agency has at hand and takes for granted. Water is necessary to produce *Cx. tarsalis* and an excess of uncontrolled water from natural flooding or from agricultural or urban sources potentially means more *Cx. tarsalis* or other vectors. Temperature data are in the news each day, and you know that temperature controls the rate of mosquito development and virus multiplication in the vector. You also know what you have each year in the way of a budget to control vectors and what your limitations are in being able to effectively reduce larval or adult populations. You obtain data routinely on vector population levels by New Jersey light trap (NJLT) or CDC trap collections of adults, and you monitor larval populations although these mosquitoes may or may not become adults. You can focus your attention and program on *Cx. tarsalis* if you wish. Data on virus infection in vectors may be obtained by tests of field populations of mosquitoes collected from CDC traps. However, this is an expensive and labor intensive program, and one which you do not include in your current program in Utah. I shall discuss some values and limitations of this method shortly. Sentinel chicken flocks can be maintained as you are currently doing. *Cx. tarsalis* feeds on your 20 some groups of birds each night, and tests on the chicken flocks will detect virus transmission in its silent cycle. Data on clinical cases must be obtained by veterinarians or physicians. The question is, what can you do with the above surveillance data, and what are its limitations?

As a vector population builds up, virus activity can be detected in the vector or in sentinel birds. These events will precede the occurrence of cases in horses and humans. Virus activity will occur when summer temperatures are rising or have occurred. You want to use the surveillance system to anticipate an epidemic and prevent it. You want to intensify and establish control before human cases have occurred. Once human cases are occurring, you can be sure that additional people are already infected and, in the incubation period some such individuals probably will become cases. At this point, it is too late to intervene effectively with larval control. You must shift control to infected adult vectors. Adult control is expensive and may be ineffective unless it can be established over a large area and continued for at least 10 days. This is the period necessary to interrupt the continuity of virus transmission between birds and mosquitoes.

Let us turn now to establishing an understanding of some of the additional basic information you can get from a surveillance system and how to interpret it. In Kern County, 45 sites were the source of data on mosquito population and infection rates in mosquito pools and sentinel chickens. The 18 stations where bait trap indices of female *Cx. tarsalis* were less than one per trap night, we had little or no virus activity. A NJLT index would provide about the same information. It would be difficult to measure virus at such sites by tests on pools of mosquitoes as you couldn't collect a pool of 50 specimens where light trap indices were so low. Yet, one sentinel chicken converted, so we knew virus was present. At sites where there were more *Cx. tarsalis*, it was easy to detect virus in both vectors and sentinel birds. You can see why there was a need to reduce vectors at such sites to below an average of ten per trap night, which would minimize virus activity.

When an intensive control program successfully reduced *Cx. tarsalis*, virus remained but was at a very low level. These findings led to the concept that we should determine the threshold levels of vector populations below which virus transmission is markedly reduced or even stopped. While it may not be practical to stop virus transmission, it can be reduced to levels so low that there is very little chance that virus infection will occur in people or in horses.

To pursue this further, you must realize that the detection of virus in a mosquito pool does not mean that the infected mosquito in a pool will transmit infection if it bites. The mosquito may not have completed incubation, the virus may not be in the salivary glands. To learn this, we exposed susceptible chickens in bait cans for only 1 night and then tested the mosquitoes and chickens for WEE virus infection. Only 1 in 4 infected mosquitoes could transmit infection.

Clearly, detection of virus in a mosquito pool or in a sentinel chicken is a very sensitive measure of virus activity if sampling is intensive enough and covers a sizeable area. You also must realize that detection of virus activity at a site usually doesn't mean that you have found the one hot spot in your area and must rush to that site to stamp it out. What it means is that virus probably is active over a fairly large area and larval control should be intensified.

Let me explain further some factors that control the effectiveness of the maintenance cycle of WEE and discuss the feeding habits of *Cx. tarsalis*. There is variation in host selection by different mosquito species and within a species and region in host feeding patterns. The areas with the highest feeding rates on birds are those with the highest levels of WEE virus activity. It turns out that these differences are controlled in a large part by the size of the vector population and the species of hosts available in the area. To illustrate the importance of the abundance of mosquito population, we exposed three-week old chicks in bait cans and examined the mosquitoes attracted. As the number of mosquitoes attracted increased, the proportion of individuals that fed decreased. If we didn't let the chick fight off the mosquitoes, they all fed. This phenomenon was illustrated further when we looked at seasonal patterns of feeding on different hosts in several states. Let me interpret this further, as it is related to the concept that there are threshold levels of vector populations that are required for effective virus transmission. At low population densities, *Cx. tarsalis* will feed on its preferred host (birds), and birds are a good source of virus infection. As the vector population increases, the birds react and chase some *Cx. tarsalis* away so they are forced to go to alternative hosts such as mammals. Most species of mammals are not a good source of virus infection. This shift in hosts can decrease the effectiveness of a virus cycle - even interrupt it. At times I have warned mosquito control operators not to go into an area where NJLT indices are in the hundreds of female *Cx. tarsalis* per trap night in the hopes of reducing that population to just half that number. If they did, it could increase the effectiveness of virus transmission. You must go to low population numbers quickly.

Let me turn now to illustrate how fragile the WEE virus transmission cycle can be. Up to 90% of *Cx. tarsalis* females are autogenous. That is, they may lay their first eggs without a blood meal. Autogeny can delay the first blood meal and possible contact with virus for a period of 4 days. Even if a female is not autogenous, she will not feed for up to 2 days after hatching. The first blood meal may or may not contain virus, and the female will oviposit after 4 days in the summer and refeed, but she cannot transmit virus at this time as incubation of the virus is not complete. There usually will be an interval of one day after oviposition before a second blood meal and again it will require 4 days for oviposition. As you can see, a female will be about 8-10 days old when she finally takes a third blood meal and can possibly transmit virus. If autogenous, she may be 10-12 days of age or older.

You probably wondered if I would ever stop going around that cycle, but I wanted you to realize how long a mosquito must live to transmit infection and why only 1 in 4 of infected mosquitoes can transmit infection. Most females will die in this interval. We have studied this by marking, releasing, and recapturing female *Cx. tarsalis*. We find that in the summer 10 to 35% of a population will die per day and very few females will survive to take 3 or more blood meals. If the first blood meal is not on a good source of virus infection, there is very little chance of virus persistence. You must know this to interpret data from a surveillance program and should realize that an adult control program that reduces adult survival can have an immediate effect on virus transmission.

Let me turn briefly to a largely unstudied aspect of WEE virus transmission, the role of *Aedes* mosquitoes as vectors. In California, *Aedes melanimon* becomes involved as a secondary vector of WEE virus when *Cx. tarsalis* spreads infection to jackrabbits. We suspect that when *Aedes* species become infected, they can be a very efficient source for spread of infection to people and horses. *Aedes dorsalis* could play a similar role in Utah. I should also mention the importance of *Ae. dorsalis* and *Culiseta inornata* as vectors of California encephalitis (CE) and Jamestown Canyon (JC) viruses. CE complex viruses, such as La Crosse and JC viruses, are important causes of encephalitis in northern and eastern sectors of the United States and CE and JC viruses are known to be common in vectors and wildlife in the Bonneville Basin of Utah. Fortunately, CE and JC viruses are not known to be important causes of clinical disease in the western United States. The reservoir of infection for CE group viruses is transovarial transmission from female vectors to their progeny, and this is a very effective mechanism to maintain virus infection.

You must remember that the absence of diagnosed cases of WEE in recent years in Utah does not mean that infections are not occurring. All clinical cases are not reported, and, in addition, we know that most people who are infected do not become ill. Indeed, hundreds of people have an inapparent infection for each clinical case that is diagnosed. We do not know what proportion of the population in Utah has been infected and are not immune as this would be a very costly addition to your surveillance program.

To finalize this discussion, I would remind you that in 1940 we had 3 questions to answer when research on WEE began. How are these viruses transmitted? If vector-borne, where do vectors get infected? Is there a promising method for control? All 3 of these questions were answered before the period when most of you became involved in mosquito control. You have learned how to control *Cx. tarsalis*, but is has been increasingly difficult as they became resistant to almost all available insecticides. You are rapidly learning that you cannot put all of your hopes on *Bacillus thuringensis*, biological control, or some new miracle insecticide. The cost of controlling epidemics is very high, and frankly, I am not certain we can control a large population of *Cx. tarsalis* adults that are transmitting virus over a large area. I believe we must depend on larval control beginning early each summer to minimize adult populations in the June - August period. Other alternatives to control epidemics are not attractive.

My final comment is that I do not believe that WEE and other mosquito-borne viruses will go away, and I hope you feel it is necessary to continue to be as concerned in Utah as we are in California.

EFFECTS OF PROPOSITION 13 IN CALIFORNIA ON MOSQUITO CONTROL

JOHN C. COMBS

Delta Vector Control District
Visalia, California 93291

The primary purpose of a mosquito abatement district (MAD) is to protect the public, and this cannot be overemphasized. In order to provide an adequate program, a district must be able to develop short- and long-term goals. This means that the district must have control of its fiscal matters which includes obtaining the necessary revenue. It must be able to prepare budgets that will fund the needed program(s).

In California, most of the districts were very conservative. Trustees, in general, would adopt budgets reflecting the current needs. Depending upon the amount of funds needed for capital projects, the Boards could raise the funds in one year by a Special Tax rate, each district having its own rate.

There were 2 basic reasons for the birth of Proposition 13 in California-- a large state surplus and a continued increase in county property taxes. Californians had been trying to get a message to their legislators that something had to be done to reduce the state surplus and reduce, or at least hold, current property taxes, but the legislators did not act. Jarvis, who was originally from Utah, teamed up with Gann and developed Proposition 13, which was not targeted at vector control, but he thought the impact on mosquito abatement districts would not be negative. The final effect on the districts was about a 50% decrease in property tax revenue and the establishing of future tax revenues upon the 1978 tax rates, which was 3 mils for the Los Angeles County West Mosquito Abatement District (LACWMAD).

Some examples of how districts coped with the reduced tax revenue:

- Cut permanent and/or seasonal staff
- Reorganized their staff
- Cut back on program
- Controlled only major sources
- Self-insured for workmans compensation, auto, liability, property, health, etc.
- Did not replace equipment

Some special districts, such as water districts, that had a built-in rate structure were able to cope with the reduced property tax revenue by simply adjusting their rates. Since legislators realized Proposition 13 had a negative impact on some districts, almost immediately they made some bail-out money available. This was followed by the Special Districts Augmentation Fund (SDAF) which was applied to each county and required special districts to contribute. The SDAF is administered by the Board of Supervisors. State law establishes the amount of funds to be raised, but the Supervisors determine the amount of funds to be raised from each district. They are required to hold a public hearing on the disbursement of the funds and then allocate the SDAF. In actual practice, the MADs contribute money into the fund and receive a larger amount in return.

Legislation was introduced by Millow and Roos, amending the MAD Act, Health and Safety Code, to permit a Benefit Assessment. This requires a 2/3 vote of those voting. The ballot proposition is not to exceed a given amount, for example, $3.00 per parcel. At the budget hearing the Board of Trustees can set any amount up to $3.00 per parcel. If the $3.00 is to be exceeded, it must be placed on the ballot. Since district funds cannot be used in publicity for a ballot measure, funds must come from private sources. A number of districts have been successful in getting such a proposition passed by the voters. The LACWMAD encompassing 400 sq. miles, with 11 cities and a large unincorporated area, could only obtain a little more than a 62% vote in favor.

In 1984, Corkindale sponsored a bill which amended the Health and Safety Code to permit a . . . "Levy, by resolution or ordinance, a service charge against any or all parcels of land within the district to pay for the cost of vector surveillance and control." The schedule of charges would be made, reviewed, and adopted annually after notice and hearing. The board would classify parcels of property according to use in relation to the cost of vector surveillance and control. This charge would not be deemed a tax of any kind. The LACWMAD adopted this method of obtaining necessary funds, followed by the

Southeast and the Compton Creek MADs. During the 4 years that the LACWMAD has used the service charge, there have been no protests about it.

Fiscal Year	Amount per Parcel
1985-86	$0.62
1986-87	2.49
1987-88	4.19
1988-89	4.05

The reason for the increase in 1987-88 and 1988-89 was to raise funds for property and a building. The district chose to have one service charge applicable to all parcels, but it need not be that way. However, the methodology used must be justified.

It has been necessary to work with the Tax Division of the County Auditor-Controller office to settle the service charge on condominiums and in cases where 2 parcels are occupied by one house or one business.

There is a need to develop a long-range public relations program so that the public knows that there is a MAD. It may be necessary to buy space in newspapers to get a message to the public. Often, when a district seeks public support on an issue, we learn that the public really does not know who we are and what we do.

It is necessary to have the support of the governing body of the district. The success of getting the service charge for the LACWMAD is attributed to the support and direction given the manager by the Board of Trustees.

REPORT OF THE CALIFORNIA MOSQUITO AND VECTOR CONTROL ASSOCIATION

NORMAN F. HAURET

L. A. County West Mosquito Abatement District
Culver City, CA 90230

Thank you for the invitation to speak concerning the activities of the California Mosquito and Vector Control Association (CMVCA). Our Associations have much in common, and it was a distinct pleasure to present your Executive Director, Glen Collett, with an honorary membership in CMVCA at our last conference. Glen is an Ambassador of Good Will for not only Utah and California, but for American Mosquito Control in general. I bring you greetings from our 48 member districts and extend to you an invitation to attend our 57th annual CMVCA Conference,which will be January 29 through February 1, 1989.

My recollection of the early days of CMVCA is that the managers tried to do everything. They were the lobbyists, printers, auditors, secretaries, and offered each other sage legal counsel. At Board of Directors meetings, everyone had an idea how issues should be addressed. It rapidly became difficult to distinguish between Board members, members-at-large, trustees, and guests. Discussions could drag on interminably, and the more heated the issue the longer became its resolution. Meetings were animated and more fun, provided one was proximate to, but not in the midst of, the argument. Issues were generally less immediate, less threatening, and largely of our own making.

Today, things are quite different. Professionalism is being imposed upon our Association. Our most severe problems are from external pressures, and adapting to these forces of change is quite a challenge. We have a very capable Executive Director, John Combs, who divides his time between being manager of the Delta Vector Control District and CMVCA. We have a professional legislative analyst, Ralph Heim, who serves in a similar capacity to the California Special Districts Association to which 18 of our vector control districts also belong. A legal counsel, Mr. Dale Bacigalupi of Fresno, California, has also been retained. Their activities are coordinated by the Executive Director.

The organization has standing committees with specified charges and ad hoc committees to address special, unassigned problems. Committee memberships include representatives from each of CMVCA's 5 regions. At regional meetings, committee items of concern are discussed. Thus, when a committee submits recommendations for the consideration of the Board of Directors, the Board members are able to represent the interests of their region's districts.

Legislation recently sponsored by CMVCA mandates a program of continuing education subject to the requirements of the Environmental Management Branch (EMB), State Department of Health Services, for all certified vector control technicians. An annual $25 fee per certificate holder to the EMB helps to defray the costs of this program.

CMVCA has regional programs of continuing education plus several workshops that are video-taped and utilized for training purposes.

The districts are supporting various local research projects: such as riverine malaria, SLE, and the behavior of mosquitoes in urban areas. The Station Viral and Rickettsial Disease Laboratory in Berkeley receives supplemental CMVCA funding. The state wide program of mosquito control research administered through the University of California (UC) is in great need of supplemental funding so that alternative technology to the use of correctional pesticides can be achieved. John Combs, Chairman, CMVCA's Research Funding Committee, in a letter to Lowell Lewis, Associate Vice President, University of California, summarized the concern of CMVCA:

> "I am constantly reminded of how closely the activities of our local public health programs are linked to agriculture: from alien migrant workers who might introduce malaria, to visiting suburbanites who might contract it from drip irrigation to major water reclamation projects. I am reminded that there is a rapidly approaching crises in vector control protection due to loss of pesticides, expanded concern for non-target and endangered species, and such

mundane matters as prohibitive insurance costs. By 'crisis' I mean that our control options are so narrowed that bioethically sound programs are becoming extremely difficult to maintain. This summer's outbreak of malaria, the rapid spreading of dog heartworm, and the lack of effective adulticides to control the arthropod-borne encephalitides are very serious symptomatic warnings that are control programs are becoming inadequate. Additionally, there is increasing involvement in the control of other vectors: tick-borne lyme disease is of increasing national concern, as are flies, rats, midges, Africanized bees, plague, relapsing fever, and many more."

Bruce Eldridge, UC Director of Mosquito Control Research is working very closely and effectively with CMVCA in securing funds for needed research. An attempt is being made to obtain increased funding either through the UC budget or legislative action, the latter being more difficult.

The training manual, which has served as an integral part of the Certification Program, is being rewritten by CMVCA and EMB. This manual will include mosquitoes, other insects and terrestrial vertebrates. It will be a comprehensive test for both educational and reference purposes. The Association is also financially assisting EMB in production of an excellent, professionally done video series with study materials that will provide information necessary for passage of the certification examinations.

A new computer, hardware and software, has been obtained for the central office. This has been a real asset to Linda Sandoval, CMVCA's full-time secretary.

Lastly, we are assessing when we shall need a full-time Executive Director to coordinate CMVCA's many activities.

Doug White, Manager Merced County Mosquito Abatement, serves on the Board of Directors of the California Special District Association which now has a full-time Executive Director so a closer working relationship is expected between the Associations.

This year CMVCA had half-day workshops on the day preceding the quarterly Board of Directors meetings. These workshops were on pesticide usage, legal responsibilities of districts, videotape techniques, and vectors of public health concern other than mosquitoes.

CMVCA is vigorously attempting to meet the challenge of vector control in the 21st Century and in developing and utilizing such alternative technologies as may become available.

THE ROLE OF A TRUSTEE OF A MAD BOARD

HERBERT J. MARSH

Trustee, Turlock MAD
Turlock, CA 95380

A trustee of a Mosquito Abatement District (MAD) Board is usually appointed by a governmental agency, or is elected to a governmental body and assigned to an MAD. In either aspect, the role is the same.

A Board is composed of many types of individuals with different ethnic, religious and occupational backgrounds, but they all come together for the same purpose, to protect the health and welfare of citizens and animal population.

Since an MAD is a tax-supported public agency, one of the first requirements of a board is to judiciously appropriate funds necessary for the mission of the district. Thus, the board has a sacred trust or obligation to approve funds for the District that are reasonable and prudent and to carefully analyze each month's bills and wages as well as the annual audit.

In this modern complex world, the hiring of a manager is of prime importance. The Board must be aware of his competencies in vector control, finances and budgeting, public relations, and management skills. If hired, the Board must then support him. He is a human being, not immortal, so work with him. If there is criticism, let it be positive and in private.

The Board sets and reviews personnel policies that are consistent with current personnel practices and those that are nondiscriminatory. Also, the Board sets and reviews policies and practices that will lead to an efficient operation of the district. This means clear, concise, and open communication with the manager.

The Board receives a monthly report as to the activities of the District and consults with the manager as to the immediate and future plans for control, source reduction, etc.

A trustee serves as judge and jury on matters dealing with complaints from the public and hears appeals from abatement orders.

A trustee serves on the various committees of the Board, such as negotiations, budgeting, legal, personnel, etc.

A trustee must attend meetings. If a member is absent, he:

a. does not participate in the program

b. prevents others from serving

c. may subsequently ask at the meeting, "Why didn't you do this at the last meeting?"

Each trustee on an MAD board must have mutual respect for each other whether that individual is a board member, manager, operator, or office personnel. The attitude of "divide and conquer" has no place in the operation or servicing of an MAD.

A TRUSTEE AS A MEMBER OF A COMMUNITY OR AREA.

Since a trustee represents a specific governmental board or agency, he must be aware of the conditions in the geographical area that he represents. Although a trustee does not tell the manager how to run the operations of his particular area, it is nevertheless, important for the trustee to visit areas that are sources of infestation or problems. A first hand knowledge of the problems facing the district or an operator can be helpful in public relations.

Last week I went with our manager to our city sewer farm. It was a brief tour, but now I can speak with factual information when I give my annual report to the mayor and city council as to the type of season the district is having and answer questions about the activities of the District. I do not try to answer all of the questions about an MAD, but sometimes a simple answer will prevent a call to the district. If a person asks about mosquito sources, I refer them to the District.

A trustee, when asked by the manager, helps coordinate the program of the District with the community, schools, and service clubs. After all, as a trustee, you have an obligation to the community. Especially if you are trying to pass a tax override or to increase the revenues of the District through a service or user fee.

A trustee must give an annual report to his governmental agency of his stewardship.

A trustee informs the public of their representation usually by the local newspaper.

A trustee ought to compliment the MAD operator whenever possible. Just a word, "We appreciate your work" will build strong morale.

A TRUSTEE AS A MEMBER OF A REGION

California is divided into 5 geographical regions. I belong to the northern San Joaquin region. We are a small region composed of 4 districts in contrast to southern California with about 23 districts.

It is important that each Board appoint a representative to the Regional Council which these Trustees attend and report back to the local Board.

Problems that are unique to that region are discussed at the regional meeting as well as problems that affect the State. Action taken at the regional meeting is referred back to the local Boards for further action or is reported to the State organization for action.

Each region elects a Trustee to represent the region on the statewide Corporate Board, and this representative must be in constant contact with the local boards for opinions, decisions and action.

A trustee must be willing to serve on regional committees and, if he has personal contact with any governmental official, he must be willing to utilize that contact for the betterment of the vector control operations whether for legislation, finances, or approval of projects.

A TRUSTEE AS A MEMBER OF A STATEWIDE ORGANIZATION

A Trustee needs to know that his District as a Corporate Board member of a statewide organization is entitled to membership in the California Mosquito and Vector Control Association and the Trustee Corporate Board.

Although most MADs select their manager to represent the District in activities of the CMVCA, each trustee belongs to the Corporate Board and should participate in its activities.

A trustee has an obligation to keep abreast of what is happening throughout the State and how these conditions affect the District.

A trustee attends the annual business meeting of the Corporate Board and quarterly Board meetings, if appropriate.

A trustee serves on statewide committees in the areas of his expertise. In California the CMVCA depends on the work of the various committees to meet the challenges posed by today's changing world and concepts. Trustees come from many fields of endeavor, and so it is important that they utilize that broad range of experience for the betterment of the agency. There are many college professors, management people, professional personnel, scientific technicians, and media personnel that can contribute to a specific phase of the operation.

A trustee is aware of the need for legislative contacts. As pieces of legislation are prepared, discussed in various legislative committees, presented for vote by the respective houses or presented to the governor for his signature or veto, each trustee needs to communicate with his legislator. It has been the consensus of most pollsters that the individual letter, preferably handwritten, will have more influence on a legislator or governmental official than a mass mailing of a form letter or a multiplicity of orchestrated phone calls. A simple phone call, "Jack, I would seriously like to have you consider this piece of legislation," will often produce results.

Lastly, a trustee answers questionnaires that are sent by the local, regional, or statewide Board or Committee; after all, without information, any organization perishes. Somebody once said only informed people are free, and only free people may be informed.

SOCIETY FOR VECTOR ECOLOGY

MINOO B. MADON

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I thank Glen Collett, Sammie Dickson, and the Utah Mosquito Abatement Association for giving me the opportunity to say a few words about the Society for Vector Ecology (SOVE). Since many of you are already SOVE members, I shall not burden you with past history, but I do have to backtrack briefly for the benefit of non-members and potential members.

In early 1968, a small group of professionals involved in vector ecology and control got together during a luncheon engagement in southern California and emphasized the need to establish a professional society in vector ecology, research and control. During early stages of formation, membership consisted of professionals with diverse training, entomologists, mammalogists, parasitologists, general biologists and engineers, all sharing similar dedication and goals. In August 1968, we incorporated as the Society of Vector Ecologists, but in order to obtain a tax-exempt status as a non-profit organization, we renamed outselves this year the Society for Vector Ecology. The overall objectives were revised to enhance the professional aspects of the <u>field of vector ecology</u>.

In April 1988, SOVE completed its 20th year. We have about 630 members worldwide. This includes 90 members from 16 European countries, plus 40 members from 22 other countries. The By-Laws committee has just proposed new Regional boundaries (at the request of members in the Eastern and North Central regions) which will be similar to those in the American Mosquito Control Association (AMCA). The Intermountain Region may also be renamed as the Northwestern Region (if approved by ballot of the general membership). This region will include the states of Oregon, Washington, Montana, Idaho, Wyoming, Colorado, and Utah. This current Regional Director is Steven V. Romney. Other notable SOVE members from Utah are Jay Graham, past President - 1984; Glen Collett, nominee for President - 1990; Lewis Nielsen, and Ken Minson, all of whom have been active SOVE members.

SOVE publishes 2 issues of the Bulletin and 4 issues of the Newsletter per year. Current annual dues are $25.00, which includes the Bulletin and Newsletter.

This year has been a productive one for meetings organized by SOVE, providing an opportunity for greater membership participation. We have 3 joint meetings, the first in mid-March with the New Jersey Mosquito Control Association, organized by Wayne Crans; the second, in mid-August with the Society for Invertebrate Pathology in San Diego, organized by Mir Mulla; and finally, this one with the Utah Mosquito Abatement Association (UMAA).

The European Region has also been very active. Meetings were held first in France, in 1986; second in Heidelberg, W. Germany, in 1987; and third in Cambridge, England, in 1988. Yugoslavia has offered to host the fourth European region meeting, and Sweden will follow in 1990. I really believe that these joint meetings in the U. S. and Europe are beneficial to those members who are unable to attend the Annual SOVE conferences which are usually held in California. The first Annual SOVE conference outside of California was in October 1984, held jointly with the 37th annual meeting of the UMAA in Salt Lake City, Utah. The University of Oklahoma, Norman, Oklahoma, will be the host for the 1989 Annual SOVE conference, organized by Cluff Hopla.

In closing, I hope to see many of you at the 20th Annual SOVE conference in Palm Springs, California, November 15 - 18, 1988, at the International Hotel Resort.

PUBLIC HEALTH PESTICIDES AND THE ENDANGERED SPECIES ACT

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The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) requires the Environmental Protection Agency (EPA) to weigh the risks and benefits of pesticides with regard to regulatory actions. It is the responsibility in the Biological & Economic Analysis Division of the Office of Pesticide Programs to ascertain benefits. Current accurate information on pesticide use and efficacy as well as when, where and how these pesticides are used is essential in order to make reasonable projections as to the biologic and economic impact of proposed regulatory actions including those having to do with the Endangered Species Protection Program. The importance of such information can hardly be overemphasized, especially for public health uses of pesticides where human lives may be at stake.

I. THE MOSQUITO/VECTOR CONTROL INFORMATION NETWORK (VCIN)

The American Mosquito Control Association (AMCA) with support from EPA developed the VCIN which had, as a primary objective, the acquisition of mosquito/vector control data from those agencies in the U. S. and Canada directly involved in such work. The survey questionnaire covered the 1984, 1985 and 1986 control seasons and was designed to elicit information in general areas of mosquito/vector control, viz. operational, biological and chemical. Some preliminary chemical data are presented here.

II. THE ENDANGERED SPECIES PROTECTION PROGRAM (ESPP)

The Endangered Species Act was passed in 1973. Following its passage, the EPA's consultations with the U. S. Department of Interior Fish and Wildlife Service (FWS) to determine jeopardy and, when appropriate, devise "reasonable and prudent alternatives," concerned only those pesticides undergoing review in the registration process. This approach was slow and did not consider the older, often more toxic pesticides. Because of these disadvantages, EPA developed a "cluster" approach in which pesticides registered for the same use patterns were evaluated. EPA has completed 4 clusters of which mosquito larvicide use is one.

Implementation of the ESPP is currently undergoing review. The Federal Register Notice published in March 1988 elicited comments on EPA's implementation plans; and, as a result, other approaches such as a species approach or a chemical approach are being considered. Regardless of the approach finally adopted, the biological opinions developed in the 4 consultations are still valid and should provide a basis for implementation. While there may be changes in the list of endangered species and pesticides in the 4 clusters, they are basically accurate, and expectations are that the lists will remain more or less intact.

III. THE ENDANGERED SPECIES PROTECTION PROGRAM AND MOSQUITO CONTROL

There is a perception among some mosquito/vector control workers that the ESPP will involve all mosquito control agencies and that it will be seriously disruptive of their activities. Some perspective of the potential interaction between ESPP and mosquito/vector control can be gained from information derived from the VCIN.

A. Pesticides

Larvicides most commonly used for mosquito control, as reported in the VCIN survey, are *Bacillus thuringiensis israelensis* (Bti) and oils. Among the other larvicides reported were: chlorpyrifos (Dursban), methoprene (Altosid), pyrethrins, temephos

(Abate), fenthion (Baytex), m-parathion, parathion, diflubenzeron (Dimilin), Arosurf, DDVP and methoxychlor, in approximate descending order of use.

Nine of these 13 larvicides (Dursban, Altosid, Pyrethrins, Abate, Baytex, m-parathion, parathion, DDVP, and methoxychlor) are listed as jeopardizing to certain endangered species for which they pose a threat.

B. Endangered Species Habitats

Among some 3,080 counties in the U. S., 298 (10%) are currently listed as harboring one or more endangered species in the mosquito larvicide cluster, but 19 states have no endangered species currently listed in this cluster.

Of the 31 states that harbor endangered species, the number of "endangered species counties" for representative western states is shown in Table 1. The table also indicates the numbers of such counties reported to have organized control agencies which use larvicides. Most of these counties are in California and Florida, but, in any case, it is important to recognize that because district boundaries usually do not coincide with county lines, endangered species habitats (which by definition are limited in size and often remote) will frequently lie outside the jurisdiction of control agencies.

IV. SUMMARY

When placed in perspective, the impact of the ESPP on mosquito/vector control activities, so far as larvicides are concerned, appears to be far less than initially suspected. While this may be true, it is important to recognize the responsibility of mosquito/vector control agencies to protect endangered and threatened species to the fullest extent possible by avoiding the use of pesticides which may adversely affect those species and/or the environment.

Grateful acknowledgement is hereby made to the AMCA/VCIN for pesticide use data (James R. Caton, Project Director, and John C. Combs, Principal Investigator).

Table 1. Representative Western States that have endangered species listed in the mosquito larvicide cluster.*

State	Counties in State	No. of Counties** ES	No. of Counties** ES+LAR
California	58	29	27
Arizona	15	8	1
Nevada	16 + 1 City	4	1
Idaho	44	3	2
New Mexico	33	3	2
Utah	29	2	1
Wyoming	23	2	0
Oregon	36	1	0
TOTALS	254	52	34

* These states/counties harbor one or more endangered species each of which is vulnerable to one or more of 9 listed mosquito larvicides.

** ES = harboring endangered species, ES+LAR = ES counties which also practice mosquito control by larvicides somewhere within their borders.

LYME DISEASE

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History

Lyme disease was first recognized 13 years ago when 51 people in the town of Lyme, CT, came down with the same mysterious arthritis-like ailment. Lyme disease is now the most common tick-transmitted illness in the USA and has been reported in 32 states. However, 90 percent of all reported cases have occurred in just eight states: California, Connecticut, Massachusetts, Minnesota, New Jersey, New York, Rhode Island, and Wisconsin. Isolated cases have been reported from North Carolina, Georgia and Arkansas. Utah had one case in 1983. Elsewhere, it occurs on all other continents except Antarctica (Anon. 1988). According to the Centers for Disease Control, over 5,600 cases of Lyme disease have been reported nationwide since monitoring began in 1980. However, it is probably substantially underreported.

Infectious Agent

The infectious agent, first identified in 1982, is the spirochete *Borrelia burgdorferi* which is transmitted by Ixodid ticks. Distribution of cases coincides with the distribution of *Ixodes dammini* ticks in eastern and midwestern USA, with the distribution of *I. pacificus* in the western USA and with the distribution of *I. ricinus* ticks in Europe (Benenson 1985).

Reservoir/Transmission

In the northeastern United States, where most Lyme disease cases occur, an unlikely trio is responsible; the deer tick, the white-footed mouse, and the white-tailed deer. Adult ticks feed and mate on the deer, then drop to lay eggs, which hatch into tiny larvae. These larvae contract the infection by feeding on the mouse, the primary carrier of the Lyme-disease spirochete. The larvae eventually molt into infected nymphs, an adolescent stage that poses the chief threat to humans.

Nymphs are active in late spring and summer. They are also much smaller than adult ticks, making it harder to spot them on clothing or skin. From 70-90 percent of people who contract Lyme disease have been bitten by nymphs, which readily latch onto ground-feeding birds as well. This may be how the disease spreads to distant areas.

White-tailed deer also help to spread infected ticks to new areas. Some experts trace the appearance of Lyme disease to the nation's resurgent deer population--from about half a million at the turn of the century to 15 million today. Deer thrive where the lawns of suburbia intersect woodlands or open fields. Though the deer do not graze on suburban lawns, fields near these lawns provide browsing areas and the woods provide shelter--it's an environment conducive to Lyme disease. Displaced ticks may also settle on dogs and horses, both of which can become lame from the disease as well as bring ticks closer to home. Infected ticks have been found not only in wooded areas, but also on well maintained lawns (Anon. 1988).

Lyme "season" runs from April to November, although one is most likely to be bitten between May and August.

In Lyme disease, the spirochete may be injected into the bloodstream through the saliva of the tick (Steere et al. 1980) or it may be deposited in fecal material on the skin (Burgdorfer et al. 1982). From there, the organism may invade the skin or blood and migrate to the nervous system, where it has been recovered 10 weeks later when neurologic symptoms were present (Steere et al. 1983).

Clinical

Lyme disease has 3 clinical stages that can overlap or occur alone:

Stage 1 --(early disease). Symptoms may include profound fatigue, stiff neck, headache, chills, fever and muscle aches. Since tick bites don't always produce a rash, these symptoms alone may warrant a medical exam for possible infection. Without treatment, the spirochetes usually multiply and the disease progressively worsens.

Stage 2 -- (occurs within weeks to months after the bite and may affect the heart and nervous systems). Some 20 percent of untreated people develop acute neurological or cardiac symptoms. A common second-stage symptom is similar to Bell's palsy, a paralysis of the muscles on one or both sides of the face. Other symptoms include severe headache, encephalitis or meningitis. Cardiac problems arise mainly from the blockage of electrical pathways within the heart. Symptoms include palpitations, light-headedness, and shortness of breath. Cardiac symptoms generally last only a week or 2, but may sometimes be prolonged.

Stage 3 --(arthritis and chronic neurological syndromes). About half of untreated patients develop arthritis, most commonly in the knees. Episodes usually are cyclical: they last for several weeks or months, then diminish, and then recur. In about 10 percent of these cases, the arthritis becomes chronic, leading to erosion of the cartilage and bone (Steere et al. 1983).

Diagnosis depends on a history of potential exposure to the ticks in an endemic area, particularly during the warm months, and recognition of characteristic clinical features.

Rash Description

The characteristic rash appears at the bite location from two days to a few weeks after the bite. It usually starts as a small red spot that expands as the spirochetes spread beyond the bite. Most commonly, the rash develops into a reddish circle or oval about 2-3 inches in diameter. It fades with or without treatment after a few weeks. Much larger rashes, anywhere from 6 to 20 inches in diameter, may also occur, especially on the back. Other variants include a rash with a red perimeter and a clear center, and the so-called bull's-eye rash, which consists of several concentric red rings. Rashes may vary in shape, depending on where they occur on the body. Frequent sites are the groin, thigh and armpits.

Treatment

The drug of choice is tetracycline for adults and penicillin for children. Antibiotics help against all stages of the disease but are most effective when used early (Anon. 1988). It has been found that tetracycline or penicillin, when used early in the illness, shortened the duration of erythema chronicum migrans (ECM) and prevented or attenuated subsequent arthritis (Steere et al. 1980).

Prevention

1. Wear protective clothing (preferably light colors since ticks are easier to spot) with long sleeves, full-length pants, closed shoes--when in a wooded or grassy area or near a body of water.

2. Check yourself and your children after you return from a wooded or grassy area. Look especially at the hairline, eyes, ears, behind the knees.

3. Check your pets for tick exposure. Be sure they wear a flea collar or are sprayed with repellant. Ideally, it is best not to take pets into areas where tick exposure may occur.

4. Use an insect repellant labeled effective against ticks.

5. Keep your lawn mowed, since ticks are found in grass.

6. If you find a tick, remove carefully. Daub it with petroleum jelly and using a pair of tweezers, pull it out without squeezing or crushing the body, since fluids may contain the spirochete.

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NEW AND INVADING INSECTS TO UTAH

VAN BURGESS

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Salt Lake City, Utah 84116

I shall identify new insects in Utah, the impact they may have, survey and control programs, and answer any questions you may have. Let me draw your attention to 4 insects, make a brief comment about each of them and close with the gypsy moth program in Utah.

1. Apple Maggot and Cherry Fruit Fly

   With the discovery of these flies in native host material, Utah fruit districts were under quarantine for out-of-state shipments for the past 3 years. When requirements of the permit are met, we can market our fruits under a certification program.

2. Cereal Leaf Beetle

   The first report of the beetle in the western United States was in Utah's Morgan County 3 years ago. It has now spread to Weber, Davis, Cache, and Summit Counties. The Utah Department of Agriculture has introduced parasite releases at insectary sites and plans to do additional survey work next spring.

3. Russian Wheat Aphids

   The aphids were found in San Juan County 2 years ago. There are new records in Utah County and Salt Lake County this year. An "Aphid Biological Control Project" during 1989 cooperative endeavor between USDA-APHID, State Department of Agriculture, and Universities is underway.

4. Gypsy Moth

   The initial record was July 21, 1988. Six traps were placed around the University of Utah campus. Trap placement started June 23, 1988. Trap density increased to 24 traps per square mile, at 1,000-foot intervals. Traps were also placed at local R.V. camps, parks, etc.

   Additional records: 12 additional male moths were caught in Red Butte Canyon, Pioneer State Park Area, and 100 South 900 East, Salt Lake City, Utah. On August 10, 1988, a male moth was caught in the Holladay area; on August 12, 1988, 10 additional moths were caught; and on August 15, 1988, one trap site at Mill Creek Canyon contained more than 30 moths. One male moth was found in Utah County.

   Epicenter: Traps located in the Olympus Cove area, Salt Lake County, produced 10-20 moths. Numerous egg masses and other life stages were found on oak brush. Serious infestation was confirmed along the east bench area of Salt Lake County. By September 5, 1988, flight within the valley floor appeared to be over. Flight continued in the higher elevations.

   As additional moths were trapped, the population shifted to the Mill Creek Canyon and Olympus Cove areas. Heavy trapping was done in Mill Creek Canyon, Little Cottonwood, Big Cottonwood, Holladay, and Neffs Canyon. By September 16, 1988, traps were placed at 1723 sites; 1283 were caught, and multiple catches were made at 114 sites.

The Utah Department of Agriculture will conduct an egg mass survey during October 1988. Egg masses will be caged and data used when enforcement and control measures are applied in the spring of 1989. Quarantine, predators and chemical use will be areas under consideration as the program is evaluated.

Thank you for your attention and questions.

DEAD COW! WHAT NOW?

NORMAN T. EREKSON

Utah State Department of Agriculture
Salt Lake City, Utah 84116

Thanks! for the opportunity to be here. I hope I can help you avoid some pit falls and reduce the anxiety you feel when you get a call from an irate farmer blaming you for poisoning his best cow (it's always his best or favorite one).

Hopefully you have already prepared for this kind of confrontation so a calm, scientifically correct response can be given from a position of confidence.

Confidence because you know your actions haven't caused his problem and you have records to prove it. In other words your home work has already been done: 1) You followed proper procedures with doses and applications; 2) Where, what, when, how, and under what conditions with proper maps has all been documented and recorded.

Because you know all this, you can remain calm and cool as you try to indicate a concern but at the same time accept no blame. Next, ask him if he has had the animal examined by a veterinarian to get a diagnosis as to the actual cause of death with a proper description of the symptoms the animal had and the pathology found on post mortem examination. This puts the ball back in his court, and you can see what response is made and act accordingly. Notify your supervisor and our office and make copies of all records you have. Most of the time another cause of death will be identified and appropriate steps can be taken to help the farmer reach a proper conclusion to this problem.

We feel your services are needed for several very good reasons:

1. Reduce the mosquito population to reduce discomfort and the risks of insect-borne zoonoses.

2. Help monitor the types of insects and thus the types of diseases we may have to deal with.

3. Usually diseases such as Lyme Disease and equine encephalomyelitis show up in animal populations before they begin in humans, so we have an early warning system to help us institute public health measures before the epidemic fact rather than after it.

Dead cow! What now?

1. Accept no blame and try to calm his fears. Collect as many facts as possible.

2. Notify your immediate supervisor.

3. Notify the State Veterinarian's office.

4. Make copies of all pertinent data: Where, when, what, how, etc.

5. Make sure a proper diagnosis has been obtained.

Dr. Marshall and myself will be happy to collaborate with you his private practitioner and other interest parties to help resolve any problems that arise.

We like to be involved early in problems as sometimes we can help avoid frustrating public education situations that we all face from time to time.

BLACK FLIES, BOULDERS AND BTI

KENNETH L. MINSON

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Since running water is the environment for producing *Simulium* black flies, the Jordan River in Salt Lake County is a major producer. This river headwaters at Utah Lake which has an average depth of only 8 feet and little bottom vegetation to stabilize silt. With a prevailing south wind, the Jordan River starts its journey to the Great Salt Lake heavily laden with suspended solids. In the Jordan Narrows at the south end of the Salt Lake Valley, the river is shunted into 7 canal systems leaving only a trickle of water. This area of the river where ground water, springs and returning irrigation are the new sources of water is the region discussed in this paper.

To kill black fly larvae, sufficient pesticide must be introduced into the water to provide enough particles of poison to be selected along with all other indiscriminate suspended material that the larvae ingest. With a high silt load, the black fly ingestion of silt, etc. is facilitated rapidly and then seems to shut down feeding for a short period of time (Colbo and Wotton, 1981). Kurtak (1978) suggests the individual black fly larva catches only 1-10% by weight of the material passing over its fans. Kurtak further points out that high turbidity can increase the effects of an insecticide. He also points out the increased concentration of particles on the fan surface beyond 200 particles/fan area/second for small particles reduces efficiency of ingestion. This problem of high concentrations of silt, etc. suspended in the water column may cause black fly larvae to feed sporadically (shut down due to overload for periods of time) reducing further the available pesticide with which to effect control.

Bacillus thuringiensis var. *israelensis* (BTI) was tested in the heavy silt-laden environment of the South Jordan Canal in 1986 under the direction of Mitch Rohifs, a research specialist with Abbott Laboratories. The South Salt Lake County Mosquito Abatement District conducted tests along a 1.5 mile stretch of this canal using black plastic straps 0.5 x 18 inches that were submerged 1-6 inches deep in the water (the depth varied as the canal fluctuated). The actual test was conducted when the monitors achieved 100-200 larvae/strap. The dosage rate of BTI was 10 ppm trickled into the canal via a carboy for 10 minutes. Three monitors were located at 0.25 mile intervals downstream from the treatment site. Monitors read 24 hours later indicated less than a 20% kill. Dr. Rohlfs concluded that the silt load was too heavy to permit larvae a sufficient chance at enough toxic crystals to effect a reasonable kill.

In spite of this evidence, BTI was the insecticide of choice for the Jordan River because of its fisheries potential. With water flows ranging from less than 5 cfs up to 100 cfs, the very rocky bottom of the river was exposed and provided excellent habitat for black fly larval attachment as did vegetation along the banks that trailed into the water. Very gradually the river stairsteps its way to the north end of the valley. These stairsteps or trickle areas provide sufficient water velocity to encourage large numbers of black flies to lay their eggs along these sites. In between the trickle areas are stretches of almost calm water (less than 1 fs) extending 100-200 yards long. These calm water areas seem to be the bane of the treatment program along with the heavy silt load in this area of the river.

Simulium vittatum Zetterstedt is the only species found in the Jordan River in current collecting. Kurtak (1978) has pointed out that *S. vittatum* functions better in slower moving streams of 30 cm/s as opposed to *Simulium pictipes*, Hagen which inhabits water at the 50 to 70 cm/s level. *S. vittatum* has short microtrichia (mouth fans) of 7 microns compared to the longer heavier microtrichia of *S. pictipes* which are 15 microns long. Slow water dwellers have fans that are smaller and more delicate. Since only 1-10% of particles by weight passing over their fans are captured, *S. vittatum* larvae may need to be exposed to large quantities of crystals to effect sufficient control to satisfy the program and the taxpayers.

Treatment by the black fly crew has been modified to take into account the trickle area and calm-water area in this 2-3 mile stretch of the Jordan River. Two men work in tandem and slug-treat this area just above each trickle area using 30 ppm of BTI (Vectobac-12AS). These treatments may occur every 100-200 yards depending on the distance of the calm-water area. Previous sampling of areas of black fly production below areas treated upstream that included both trickle areas and calm water areas showed little, if any, reduction of larvae. These dead pockets of river water plus large rocks and dense vegetation have made treatment extremely difficult for black fly workers trying to walk in or along the stream itself.

The above method of treatment did produce satisfactory kills downstream for distances up to 3 miles, but the time and effort expended must be modified to be economically feasible. The stress and strain on the crew is also of considerable importance and needs to be addressed.

The black fly program in South Salt Lake County is in a constant state of flux as water needs vary and the respective canals and the River vacillate so dramatically throughout the season. Stringent environmental requirements necessitate a constant need to upgrade treatment procedures. Every effort is being made to meet these criteria.

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NEW DISTRIBUTION OF *Culex erythrothorax* DYAR IN COLORADO, WITH A REPORT OF VIRUS ISOLATIONS FROM THIS AND OTHER MOSQUITO SPECIES

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Collaborative investigations between the Colorado Department of Health and the Division of Vector-Borne Viral Diseases (DVBVD) Centers for Disease Control (CDC) were undertaken in 1987 to assess arboviral activity along the Front Range of the Rocky Mountains. These studies included collections by one of the authors (TD) in a high plains area of southeastern Colorado, approximately 120 km east of the Rockies. The collection contained a significant number of a *Culex* (*Culex*) species which appeared distinct from all species known to occur in the area and could not be definitively identified since no males were recovered. These specimens remained unknown despite discussions with and the examination of voucher specimens by colleagues at the Walter Reed Biosystematics Unit (WRBU), Smithsonian Institution, Washington, D.C.

Additional collections at the site were made by the authors on August 2-3, 1988. Again, although more than 2000 females of the unknown *Culex sp.* were caught, no males were found in collections. Immatures reared from an adjacent small seepage area densely vegetated with sedge (*Carex*) yielded a single female of this species and numerous *Cx. tarsalis* adults. Further collections by the authors on August 16-17 yielded more than 6000 females of the unknown species and, fortunately, 6 males.

This paper reports identification of this species and an extension of its range; data is presented on arbovirus isolations from mosquitoes in southeastern Colorado.

Materials and Methods

The high plains of southeastern Colorado, in which the collections were made (Fig. 1), is an intensively irrigated agricultural region. The collection site was located outside the town of Las Animas, along the Purgatory River drainage near its confluence with the Arkansas River. Alfalfa, corn and grains are the major crops; pastures and small cattle feed lots are also common. Marshes abound along both river basins with cattail and tule the predominant vegetation.

All adult mosquito collections were made with CDC miniature light traps supplemented with dry ice. The specimens were put in vials and transported on dry ice to the DVBVD in Fort Collins, Co. where mosquitoes were identified and pooled on refrigerated chill tables to prevent loss of virus.

Pooled mosquitoes were triturated in 1.6 ml of diluent composed of 1% bovine albumin in pH 7.6 Tris-buffered saline containing antibiotics. Suspensions were clarified by high-speed centrifugation and the supernatant fluids were stored at -65℃ for later testing. Two-tenths milliliter of each mosquito suspension was inoculated onto monolayer cultures of a continuous line of African green monkey kidney (Vero) cultures grown at 37℃ in 6 well cell culture plates. After absorption of inocula for 1 hr., cultures were overlaid with a nutrient agar (Hayes et al. 1976). Cultures were observed daily for plaques and cell harvested for passage when plaques appeared. Recovered virus strains were identified by indirect FA tests using mouse immune ascitic fluid.

Approximately 60 live females and 1 male of the unknown *Culex* were aspirated from the light-trap bags of August 17 and brought to DVBVD for colonization attempts. Adults were initially offered a blood meal on the arm of the senior author (10 fed to repletion) and thereafter were allowed to feed on restrained baby chicks. Immatures were reared from egg rafts by standard insectary procedures; pupae were reared individually to adults in darkness. Emerged adults were frozen at -65℃, lyophilized and pinned as reference specimens. Egg rafts were also supplied to colleagues at the WRBU, Smithsonian Institution for their own rearing of associated specimens.

The terminal abdominal segments were snipped from field-collected males for clearing and dissection of the genitalia by previously described methods (Jakob, et al. 1979).

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Results

The genitalia of the *Culex* sp. males from the 1988 collections and the reared males were compatible with that depicted for *Cx. erythrothorax* (Carpenter and LaCasse, 1955) and with specimens recovered from collections along the lower Colorado River following the release of water from lakes along the California-Arizona border, which was necessitated by excessive spring runoff in 1983 (CDC, unpubl. data). Adult males reared at the WRBU were also determined to be *Cx. erythrothorax* (E. L. Peyton, pers. commun.).

Virus isolation studies with the 1987 collection (Table 1) yielded virus strains only from *Cx. tarsalis*, the known enzootic and major epidemic vector of western equine encephalitis (WEE). Though not all *Cx. erythrothorax* were pooled for virus studies, it was the most abundantly collected species, but no virus was isolated from this species in 1987.

Testing of the 1988 collections (Table 2) yielded 30 arbovirus strains with 4 WEE isolations from both *Cx. tarsalis* and *Cx. erythrothorax* and a single WEE strain from *Aedes vexans*. In addition, 20 Hart Park virus strains were obtained from *Cx. tarsalis* and *Cx. erythrothorax*. A single bunyumwera group virus was obtained from *Anopheles quadrimaculatus*. *Cx. erythrothorax* was again the most prevalent mosquito in the collections.

Discussion

Prior to these studies, *Cx. erythrothorax* was found in Colorado only from the Grand Junction, Mesa County area which is located on the western edge of the state. Thus, the finding of this species on the plains of southeastern Colorado represents a significant extension of its range, particularly since the great natural barrier, the Rocky Mountains, lies between these areas. Compared to the discovery of relatively low numbers of this species in Texas in 1953-54 (Menzies et al. 1955) and in New Mexico from September 1963 - September 1964 (Sublette and Sublette, 1970), great numbers of *Cx. erythrothorax* were taken in 1987 in Las Animas, Colorado, even though trapping was done only for a single night (August 5) with 6 traps. Collections in 1988 on 4 nights (24 trap nights) yielded >8000 *Cx. erythrothorax* even though no measur-able rainfall had fallen in the area for 3 months. Thus, the species appears to be well established in the area.

In California *Cx. erythrothorax* occurs mainly in the coastal and foothills areas. Larvae are found in the tule margins of lakes and ponds (Bohart and Washino, 1978).

The riverine ecology of this species in the Imperial Valley is described (Walters and Smith, 1980). In Utah, this species is most frequently found in large permanent swamps containing considerable vegetation (Nielsen & Rees, 1961).

Feeding preferences for *Cx. erythrothorax* are variable, depending on the geographic area of study. Nearly all the feedings were on mammals in Kern County, California, but on birds in Salt Lake County, Utah (Tempelis 1970). Approximately equal feeding occurred on mammals and birds near the Salton Sea in California (Gunstream et al., 1971). The species appears to be an opportunistic feeder, utilizing whatever hosts are most abundant in the area.

WEE, St. Louis Encephalitis, and Turlock viruses have all been isolated from *Cx. erythrothorax* in California and SLE virus was from specimens collected in Yuma, Arizona. From collections made in southeastern Colorado in 1988, 4 WEE virus strains each were recovered from *Cx. erythrothorax* and *Cx. tarsalis* although the MIR in the latter species (2.1) was 4 times that of *Cx. erythrothorax* (0.5) (Table 2). These findings suggest that this species may play a role, albeit a secondary one, in the enzootic maintenance of WEE virus. No unusual WEE activity in horses or man was noted in the area in 1987 or 1988. Six strains of Hart Park virus were also isolated from *Cx. erythrothorax*, although the MIR (0.7) was tenfold less than that for *Cx. tarsalis* (7.3).

Acknowledgements

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Appreciation is also extended to Mr. Larry Kirk and Ms. Christine Happ for the laboratory testing of mosquitoes and identification of the virus isolates. Mr. E. L. Payton, WRBU, provided fruitful discussions and encouragement.

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Table 1. Virus Isolations from Mosquitoes Collected August 5, 1987, in Las Animas, Colorado.

		Virus Isolations			
Species	No. Mosq. (pools)	WEE*	SLE*	TUR*	HP*
Ae. vexans	273 (6)				
Aedes spp[a]	49 (6)				
An. quadrimaculatus	133 (3)				
Cx. erythrothorax	1690 (34)				
Cx. tarsalis	613 (21)	2(3.3)[b]	1(1.6)	1(1.6)	1(1.6)
Cs. inornata	3 (1)				

[a]Includes *dorsalis*, *melanimon*, *trivittatus* and unidentifiable *Aedes*.

[b]MIR - minimum infection rate/1000 mosquitoes (no. positive pools/total mosquitoes).

*WEE = Western Equine Encephalitis, SLE = St. Louis Encephalitis; TUR = Turlock, HP = Hart Park

Table 2. Virus Isolations from Mosquitoes Collected in August 1988 in Las Animas, Colorado.

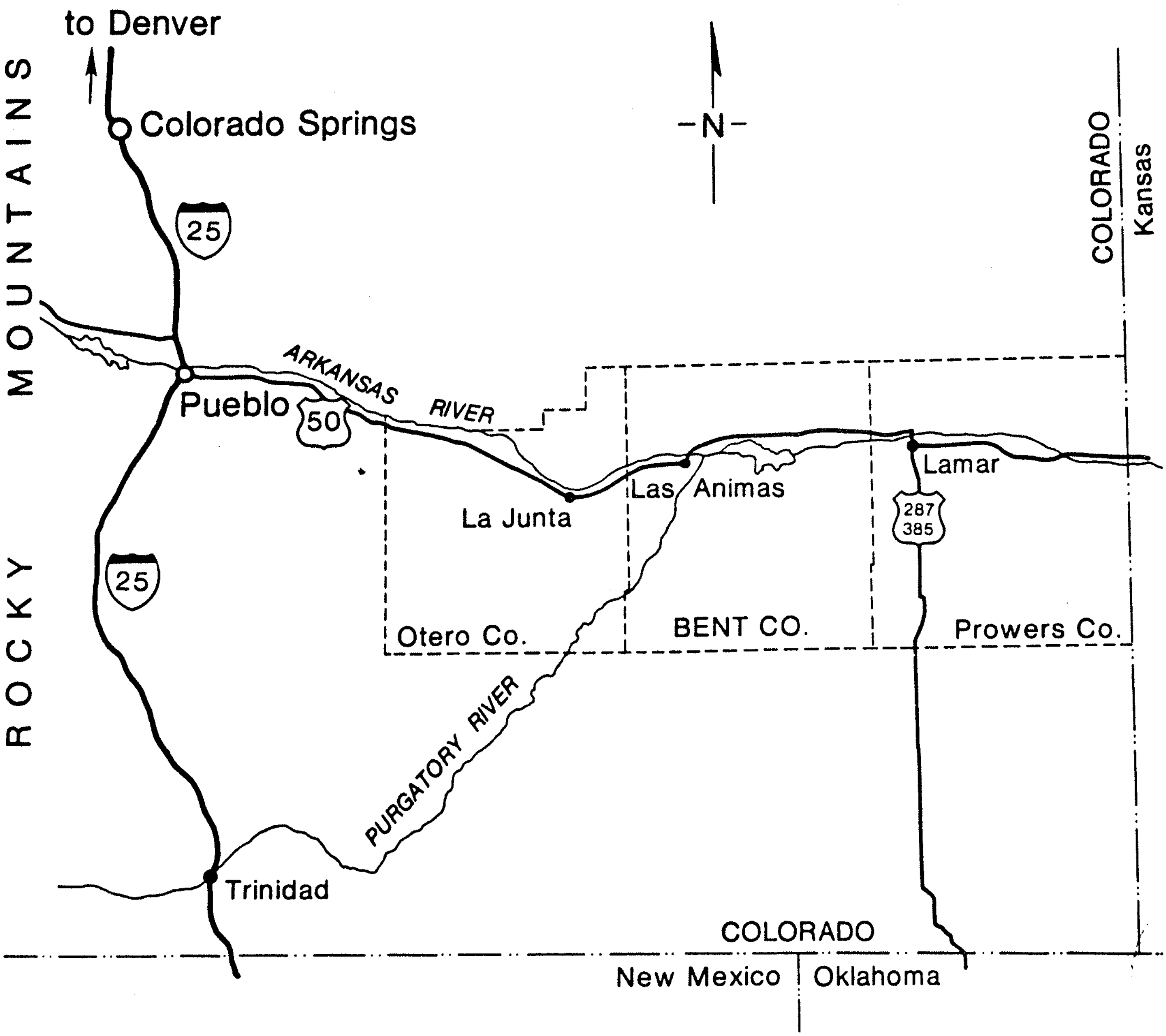
		Virus Isolations		
Species	No. Mosq. (pools)	WEE*	HP*	BUN*
Aedes spp[b]	256 (21)			
Ae. dorsalis	560 (14)			
Ae. vexans	3008 (44)	1(0.3)[a]		
An. quadrimaculatus	969 (17)			1(1.0)
Cq. perturban	1 (1)			
Cx. erythrothorax	8669 (126)	4(0.5)	6(0.7)	
Cx. tarsalis	1917 (32)	4(2.1)	14(7.3)	
Cx. restuans	1 (1)			
Cs. inornata	48 (10)			

[a]MIR - minimum infection rate/1000 mosquitoes. (no. positive pools/total mosquitoes).

[b]Includes *melanimon*, *nigromaculis*, *trivittatus* and unidentifiable *Aedes* spp.

*WEE = Western Equine Encephalitis; HP = Hart Park; BUN = Bunyamwera

Figure 1. Area of southeast Colorado where *Cx. erythrothorax* was found.



UMAA COOPERATIVE ENCEPHALITIS SURVEILLANCE - 1988

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The last Western equine encephalitis (WEE) outbreak to occur in Utah that involved humans was in 1958 when there were 48 human cases, with 1 fatality. This occurred along the Wasatch Front where the population is the highest. The last WEE outbreak in horses occurred in 1978 in the Uintah Basin in eastern Utah. Since that time, only 2 human cases of WEE have been reported, and horse cases have been rare.

The outbreak of 1958 convinced mosquito abatement districts in Utah that larval and adult mosquito surveillance was not enough. Since 1959, some sort of viral surveillance, be it sentinel chicken flocks or mosquito pools, has been used in Utah. Surveillance using mosquito pools was coordinated by the UMAA in 1974 and continued until 1982. At that time it was decided that the processing of specimens was slow, and sufficient numbers of mosquito pools were not being tested to make the system effective.

In the fall of 1982, Utah began receiving record amounts of precipitation which continued through 1984. Thus, the years of 1982, 1983, and 1984 set all time records for the greatest amount of precipitation in each year. Neither 1985 nor 1986 had record precipitation, but it was well above average (National Oceanic and Atmospheric Administration climatological data, 1982-1986).

With the large amount of precipitation in the fall of 1982, mosquito abatement directors around Utah were concerned about possible flooding and the resultant standing water that would make good habitat for *Culex tarsalis* with a potential for an outbreak of WEE in 1983. Dr. Bruce Francy, Fort Collins, Colorado, Centers for Disease Control, was invited over to Salt Lake City to suggest a possible alternative to the mosquito pool WEE surveillance. He suggested the use of sentinel chickens because of: (1) results in 4-5 days after breeding, (2) early seroconversions may allow a Mosquito Abatement District (MAD) response time, and (3) cost of the program would not be prohibitive. Thus, in 1983, the UMAA, Utah State Department of Health, and the Utah State Department of Agriculture cooperatively began a sentinel chicken flock-encephalitis surveillance project. In 1983 the predicted floods did come, and Utah MAD workers were worried. However, the 11 sentinel chicken flocks each with 20 chickens had only 3 chickens with seroconversions for WEE, and this was not until the fall of 1983. By 1984 there were 21 chicken flocks in the project. However, there were no seroconversions in either 1984 or 1985. MADs in Utah got a scare in 1986 when 5 chickens, 2 from Emery County and 3 from Uintah County, seroconverted for St. Louis encephalitis (SLE); also, 3 chickens from Duchesne County and 2 from Uintah County converted to WEE. Fortunately, there were no associated cases of WEE in humans or horses. The seroconversions to SLE were the first ever in Utah. In 1987, precipitation was finally below average, and 5 chickens from Uintah County seroconverted to WEE.

That brings us to 1988 when there were 21 chicken flocks each with 20 white leg-horn hens. The first bleeding was made on May 19, and the sentinel flocks were placed throughout the State. Field bleedings began on June 13 and continued on a biweekly schedule through September 6. As of August 22 there have been no seroconversions.

During the surveillance projects of 6 years, over 17,000 bloods have been tested for both SLE and WEE antibodies. Only 18 seroconversions have been found; 5 for SLE and 13 for WEE. No human or horse cases have occurred in these 6 years. Thus, the project has shown that WEE and SLE viruses are active in our State.

In 1988, bleedings from several districts were at times slow arriving or did not arrive at all. Results of the bleedings are taking 3 to 4 weeks to complete. I believe that the cooperative agencies in this project need to revitalize this program to offer the citizens of this State the best surveillance and protection from these deadly viruses.

SIGNIFICANCE OF LARVAL CLASSIFICATION OF FLEAS (SIPHONAPTERA) AS RELATED TO THE ADULTS

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Larval classification is from Elbel (in press) who examined 52 of the 264 species of American flea larvae North of Mexico.

In the Pulicidae, the larva of *Echidnophaga gallinacea* is included with the Tunginae because the short setae on the first 12 body segments distinguish the Tunginae from all other larvae. The adult *E. gallinacea* is placed with *Pulex* in the Pulicinae but the female, in contrast to most other fleas, remains attached to the host as for the Tunginae.

Larval Pulicinae are divided into 2 groups, one with *Pulex* and the other with the Archaeopsyllini - Spilopsyllini - Xenopsyllini (dog and cat, rabbit and rat fleas); there are not enough differences in larval characters to suggest that the last 3 adult tribes represent more than one tribe.

The anal comb with a single row of setae distinguishes the Pulicinae from all other larvae including the Tunginae except *Ctenophthalmus* adults of which are hystrichopsyllids; for larval *Ctenophthalmus*, the posterior row on abdominal segments 8 and 9 has respectively 5 and 6 setae as in the ceratophyllids (Ceratophyllinae) rather than 6 and 7 or 7 and 8 setae as in the Pulicinae and Hystrichopsyllinae - Stenoponiinae. *Ctenophthalmus* and *Pulex* larvae are unique in possessing 3 large rounded teeth on the mandible. Larval *Ctenophthalmus* represent a distinct group between the pulicids and the ceratophyllids.

Adult Rhadinopsyllini are hystrichopsyllids but the larvae represent a distinct group.

Larval hystrichopsyllids of the subfamilies Hystrichopsyllinae and Stenoponiinae are grouped together because of similarities of larval characters. Larval *Mioctenopsylla* are included here because the posterior row on abdominal segments 8 and 9 has respectively 6 and 7 setae as in the Hystrichopsyllinae - Stenoponiinae rather than 5 and 6 setae as in the ceratophyllids (Ceratophyllinae) to which the adults belong. Larval *Mioctenopsylla* share with the Ceratophyllinae the narrow mandible rather than the broad mandible with single large tooth of Hystrichopsyllinae - Stenoponiinae; also, the anal comb with a double row, 2 setae in the anterior row, is shared with Ceratophyllinae rather than one setae in the anterior row of Hystrichopsyllinae - Stenoponiinae.

Adult *Anomiopsyllus* are hystrichopsyllids but the larvae represent a distinct group between the hystrichopsyllids and ceratophyllids.

Adult Phalacropsyllini are hystrichopsyllids but the larvae represent a distinct group between the hystrichopsyllids and leptopsyllids.

The arrangement of larval leptopsyllids (Leptopsyllinae) agrees with that of the adults but included here is the larva of *Conohinopsylla stanfordi* as the posterior row on abdominal segments 1-5 has the second seta 1/4 the length of the first and third seta as in the Leptosyllinae. *C. stanfordi* shares with the ceratophyllids (Ceratophyllinae) 5 short setae in the anterior row of abdominal segment 9 rather than 4 short setae in the Leptopsyllinae. The adult *C. stanfordi* is an hystrichopsyllid grouped with *Anomiopsyllus*.

The arrangement of larval rhopalopsyllids, ischnopsyllids and ceratophyllids agrees with that of the adults. Rhopalopsyllids belong between the pulicids and the hystrichopsyllids; ischnopsyllids belong before and ceratophyllids after the leptosyllids.

What does this mean for mosquito control and vector ecology? Fred Stehr is writing an epilogue on the significance of larval classification for his 2 volumes of IMMATURE INSECTS. While assembling data for Fred, Leif Hanson, University of Utah, laughed and said that mosquito workers fought the battle of larval verses adult classification over 70 years ago so I asked for references and copies of publications. He said immediately, Theobald's (1907) Mosquitoes of the World and came back with pertinent publications. Dyar and Knab (1906) achieved a natural grouping of mosquitoes by correlating larval characters and adult genitalic characters. In 1907 they criticized Theobald's (1907) Mosquitoes of the World because his classification based on scale characters was not confirmed by other adult or larval characters. Felt (1911) approved Theobald's classification but emphatically condemned the founding of species or of a classification based on larval characters. Dyar & Knab (1911) in rebuttal stated that certain species of mosquitoes could not be distinguished as adults but there were distinct differences in the larvae; this led to the founding of species on the larvae. Later study of the male genitalia showed corresponding differences so there are several species that are separable only on characters of larvae and male genitalia. They concluded that the study of larval characters produced a more exact and homogeneous concept of generic values. Initially, the most heterogeneous elements were placed in *Culex* and with those who work with the superficial characters of the adults alone, this is still the case. Theobald associated wholly unrelated forms in *Culex* but forms which should have been included were excluded on trifling differences in scales and scatter through the system. Dyar and Knab believed that an impartial and careful study of the mosquitoes would show that larval names were valid since larval characters are more positive and reliable and are of more evolutionary importance than those of the adults.

Robert Traub, University of Maryland, wrote me that, "the free-living flea larvae, as in other arthropods, have adopted their own ways of life and undergone their own lines of evolution, often independently of the parasitic adults." George Edmunds, University of Utah, said that, "there is one phylogeny and one classification for both larvae and adults." According to Emden (1957), larval and adult evolution in the Holometabola are influenced so much by differences in habitat that their salient characters must have developed in different directions but these diverging trends enhance the importance of larval characters and insure a truly independent means of checking the soundness of an existing classification based on adults. Edmunds and Allen (1966) stated that a knowledge of immature stages was essential in establishing the probable phylogeny and classification within the insect order Ephemeroptera where aquatic nymphs and aerial adults offer 2 different sets of characters for study. They noted that the validity of the species concept within a genus is greatly clarified when both nymphs and adults are known; all included species should be studied in both stages to gain a correct concept of the range of characters. Holland (1964) stated that flea larvae, "may not be especially helpful in elucidating higher taxa" but his opinion was based on Elbel (1951) who concluded that study of more flea larvae might show that some of the features used to separate the cat flea, *Ctenocephalides felis*, from 3 members of the Ceratophyllidae might prove to be family characters. In 1978 Elbel pointed out some of the differences in larval and adult classification of families of fleas. More is known now and Bob Pilgrim, University of Canterbury in New Zealand, has more examples than I do. Eventually, those working on adult classification may want to consider modifications of flea classification toward Edmund's goal of, "one phylogeny and one classification."

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FLEAS: THEIR MEDICAL IMPORTANCE

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Mosquito populations are limited by water in which to breed but fleas are limited mainly by the presence or absence of a population of their preferred host. However, the presence of the host does not guarantee that the fleas will be present because there are other factors involved. Utah is so arid that low humidity is the main limiting factor to the existence of fleas. The immature stages are particularly sensitive to dryness. Therefore, before discussing the importance of fleas, a review of their life history is in order. Flea life history is summarized from Elbel (in press); medical importance and host relationships are summarized from James and Harwood (1969) and Stark (1958).

Eggs are laid singly, the number laid at one time varying from 3 - 18. They are dry if laid in the fur of the host or sticky if laid in the nest. Larvae hatch in 3-10 days and feed on flea feces and other organic matter. They have chewing mouthparts and are eyeless and legless. There are 3 larval instars in most fleas. The larva eventually spins a silken cocoon in which it undergoes metamorphosis and the cocoon becomes covered with nest debris. The newly-emerged adult can seek its first meal when the host returns to the nest. Fleas can spend most of their time in the nest, feeding when the host is there or they can hitch a ride on the host. Unlike mosquitoes both sexes feed on blood. In arid Utah, these humidity-sensitive immature stages cannot survive except in the humid and temperature-stable nest or burrow of a host. The common Utah fleas are found on rodents but other fleas parasitize cavity-nesting birds, such as woodpeckers and swallows, as well as rabbits and mammals that occupy burrows. Fleas can exchange between hosts whenever there is physical contact between individual hosts, such as mating,but perhaps, the main place of flea exchange between individual rodents is the nest or burrow. Some fleas are more commonly found in the nest that on the host. Since fleas may feed on more than one individual host, there exists a potential for disease transmission. Most fleas are found usually on one or several closely related host species but some seem to have a broad range of hosts and naming the normal host species may not be possible. However, preferences usually exist.

Fleas are medically important in a number of ways. They can cause physical damage. Tungid fleas, one of which is commonly known as the sand flea, can cause such damage to a person. The tungid female embeds itself into the skin of the host until just the end of the abdomen is exposed. It swells to the size of a pea as its eggs develop. This may occur on the feet of people causing considerable irritation, sometimes ulceration and infection which may necessitate amputation of the affected part. Tungid fleas occur in tropical and subtropical regions of North and South America and have been introduced into Africa. The cosmopolitan "human" flea, *Pulex irritans*, and the cat flea, *Ctenocephalides felis*, can bite viciously and be very irritating. The cat flea has been recorded from Utah but does not persist because of our dry climate. The human flea is found on a broad range of hosts, including hogs and large carnivores, which are probably preferred hosts. Howell (1960) found *P. irritans* abundant in a kit fox den.

The primary medical importance of fleas is in plague transmission. They do transmit some other diseases such as murine typhus and perhaps tularemia but plague must be emphasized. Plague is an infectious disease of rodents which may be transmitted to humans and cause an epidemic. Historically, the black rat (*Rattus rattus*) and the Norway rat (*Rattus norvegicus*) and their fleas have been important in causing human outbreaks. To understand why plague is transmitted to man when the disease is rampant in a rodent population, let us look at a flea that fed on a plague-infected animal. The plague bacteria can reproduce in the infected flea's gut and form a block in the flea proventriculus. A completely blocked flea may be starving but no matter how much it tries to feed, blood that it does manage to suck up is squirted back into the bite wound by elastic recoil of the flea. Of course, that returned blood may carry an infectious dose of the bacteria. Since the flea is starving, it will bite repeatedly in a vain attempt to feed; thus, a blocked flea is very dangerous. This danger is compounded when the rats have died of plague and the fleas turn to biting people. Other ways of getting infected from a flea include scratching infected flea feces into the bite wound or eating the infected flea as many animals, including some primitive human cultures, do while grooming themselves and each other. The major way in which plague is spread among humans is through aerosol droplets produced when the infected person coughs; this is the most dangerous form of plague and is called pneumonic plague. In such a form, plague is spread like the common cold from person to person. In the great epidemics during the Middle Ages, person-to-person transmission in this way was responsible for most cases rather than each individual being bitten by a flea. Certainly, some infections were started by flea bites. The presence of plague-infected rats and their fleas near habitations simply got the ball rolling. If plague occurs, mosquito abatement personnel may find themselves involved in rat control.

Human cases of plague in Utah are uncommon and sporadic as shown by review of the Communicable Disease Newsletter (1970-1987). Most human plague in the West results from the bite of squirrels or their fleas (Isenberg, 1987). The rock squirrel, common in our local canyons and foothills, has been found naturally infected with plague as have their fleas. The rock squirrel is probably of more concern than other possible reservoirs of plague (barring the presence of domestic rats) because these squirrels often live in proximity to human habitations along the Wasatch Front. If the squirrel dies or abandons its burrow, fleas can survive months without feeding in the burrow environment. Therefore, control only of wild rodents may not be a practical short-term solution. In the past, the heavy gas, methyl bromide, has been used to fumigate rodent burrows because it is effective against both the rodent and the fleas That is the problem: the fleas remaining in the burrow. Controlling rats in urban areas is certainly effective. Buildings can be rat-proofed. Warfarin is the safest and most easily handled poison in rat control but it has to be used in combination with an insecticide to kill the fleas that remain after the rat dies (Gratz 1980).

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DESIGN OF A PESTICIDE AND HERBICIDE STORAGE AREA

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In 1980, when Emery County organized its mosquito and weed control department, the needed chemicals were stored in a tractor trailer, which had the wheels removed, on a county property on a hill overlooking the city of Castle Dale. The trailer was well built of wood and metal construction and had electric lights and heaters. At the time we considered the storage area adequate as it was secure and protected the chemicals from the heat and cold.

With the many demands of organizing, building and running a new department, little thought was given to a better storage facility until 1985 when 2 things happened: First, a representative of the Occupational, Safety, and Health Administration (OSHA) arrived; and second, our insurance company refused to renew coverage on a non-permanent structure. By this time the amount of chemicals to be stored was more than the trailer could hold, so an old van was also being used which was, according to OSHA, below safety standards for chemical storage. Obviously, our attention was now focused on the need to obtain a better storage facility.

At this point, the county commissioners asked me to present them with plans for a storage facility. Thinking that I had only to round up a few plans from somewhere, it didn't seem much of a task.

In an effort to find where I could obtain these plans, I checked with OSHA, Chemtric, Utah Department of Health, Utah Department of Agriculture, Industrial Commission of Utah, U. S. Environmental Protection Agency (EPA), Utah State University Extension, and other extension agencies in other states. Everyone, it seemed, could tell me some things, but no one could tell me how to build such a facility. Federal and State regulations, as well as information gleaned from individual chemical labels, also provided additional information on storage requirements. It was now apparent that there was little chance of finding ready-made plans, and that we would have to draw up our own.

As I began designing a facility, other things were also considered, such as safety, problems associated with hazardous waste disposal, optimal storage conditions to maximize shelf life of chemicals, accessibility to each chemical, and the most efficient use of the limited space in the county complex. In our situation, the general site of the structure was already determined; had this been a variable, other things would have to be considered. The area must be secure to prevent unauthorized entry and must be of sufficient size to physically separate insecticides and herbicides. There must be power, water and possibly sewer facilities available. Consideration should be given to the prevailing wind direction and structures located downwind from the storage area. The location should also be away from human and animal areas to minimize problems in the event of fire or other accidents. The site should be one where flooding and runoff would not occur to prevent possible ground and surface water contamination. Since Federal and State regulations prohibit the discharge of pesticide contaminated waters, room must be provided for a collecting sump, dikes, evaporative pool, and a washing pad with gravity drains.

Literature from Arthur W. Sellers, Extension Specialist, Agricultural Engineering, West Virginia University, while speaking on design considerations of a storage facility, indicates that a minimum facility should contain: pesticide storage area, mixing/wash area, equipment washdown/refill area, and room for safety equipment and materials. Other design considerations include construction with fire resistant materials, cement floors that slope to a drain, ventilation and temperature control (radiant heaters are the preferred heat source to eliminate the blowing of powder formulations). The floor drains should gravity flow to an evaporative pool or sump as should the wash pad drains. There must be a physical barrier to separate insecticides and herbicides and possibly an area set aside for the more toxic pesticides. Safety features should include fencing, fire extinguisher, eyewash/emergency shower, good lighting, loading and unloading areas at truck bed height to minimize lifting chemicals to eye level and to reduce chances of dropping a drum, power ventilation, security locks on all openings, appropriate warning and identification signs, air gap or anti-siphon device on tank loading hoses, and non-skid floor surface.

The storage area that was designed was basically 2 parallel 30' x 9' concrete boxes, each with a corrugated tin arched roof 8 1/2 feet high and a 4-foot wide door in one end. A common wall separates the 2 enclosures (bunkers), one being for insecticides, and the other for herbicides. This fireproof structure was built, then buried under 6 1/2 feet of dirt in the south side of the hill. The southern exposure aids in winter heating, and the 6 1/2 feet of cover effectively moderates seasonal temperature variations, producing near ideal temperatures of 42 to 74 degrees Fahrenheit.

Construction was as follows: After water lines, drains and footings were in place; four foot walls were poured. The front wall which would hold up the backfill was 10 inches thick and appropriately reinforced. The roofs of the structure consisted of a 9-foot diameter culvert cut in 2 lengthwise pieces and secured to the top of the walls. The upper part of the front and back walls were then framed in a way so as to have 2 1/2 inches of the corrugated tin roof extend into the cement. The washdown and loading pad, with a drain that ran to the evaporative sump, was constructed next to the sump, which had a southern exposure to facilitate evaporation, the sump was encircled with a chainlink fence, topped with three strands of barbed wire. The truck-bed-height dock at the front of the bunkers has 4 inch by 1 foot by 20 foot rubber bumper pads attached to it.

Chemicals are stored on both sides of each bunker with the walkway down the center. This allows easy access to any chemical, making inventory and stock rotation easier. An exhaust duct pulls fresh air through louvers at the bottom of the door in the front and vents out at the top in the rear of the bunker. The fan is activated from the outside when the light switch is turned on. A sink was built inside the front door of each bunker and safety data sheets, current inventory sheets and materials to neutralize and absorb any spills were placed near the sink. An emergency shower is very accessible between the bunkers and adjacent to the loading pipe. The loading pipe extends out over our tanks with a 1-foot air gap to prevent contact with chemically laden waters, thus preventing the siphoning of chemicals back into the water system.

This facility has been used for 2 years and meets our needs very well.

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TAX LIMITATION ON MOSQUITO ABATEMENT
A DIFFICULT TASK MADE IMPOSSIBLE IN BOX ELDER COUNTY

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Box Elder County covers an area of 3,580,000 acres and contains over 400,000 acres of highly potential mosquito producing sites. There are 83 private duck clubs, 5 state-managed water fowl hunting areas, and one federal refuge.

Box Elder County contains 17 cities and towns and over 1,000 square miles of the Great Salt Lake lies within its borders.

The District has been attempting to control mosquitoes in these large areas on a budget of less than $300,000 a year and, in most cases, has been fairly successful.

During the past 2 years, I spent a great deal of time studying and evaluating the Box Elder County Control Program; many goals have been reached, and several thousand dollars were saved on operating costs. New ideas and plans were successfully completed, improving efficiency. This has been accomplished through better trained employees, more cost-efficient chemical applications, increased biological control, more effective and reasonable scheduling of employees and equipment, increased cooperation with private individuals and government agencies, and the effective use of 4-wheel all terrain vehicles. All of these things have helped us do a better job with a reasonable operating budget. We have continually strived to keep the same level of service for the people of Box Elder County. This is not going to be possible in future years if the tax limitations are passed in November since the yearly operating budget will be reduced by at least 24%. This reduction would amount to approximately $68,000.00 per year. It is obvious that District services would have to be reduced or, in some cases, eliminated completely, thereby increasing the chances of mosquito related diseases and other health related problems within the county.

The following changes would have to be made in the district program in order to operate within the reduced budget limitations:

1. At least one full-time position would be eliminated, resulting in an increased work load.

2. The seasonal staff would be reduced by at least 5 employees. This would reduce our coverage of county mosquito sites and inspections could only be made every 8-10 days instead of the present 5-6 day schedule.

3. Possible reduction in salaries would be considered.

Those of us involved in mosquito control management know what the obvious results would be. Increased adult mosquito activity throughout Box Elder County. A longer response time to answer complaints and suppress mosquito activity. Fewer experienced employees would return to work each year with the necessary reductions in benefits and heavier work loads for the remaining employees.

The District now budgets for at least one new vehicle per year. After 10 years of service in a mosquito control unit, the vehicle is turned over to the yard spray program where it is generally used for another 5 years or longer depending on vehicle condition. If tax limitations were realized, at least 3 years would be added to each vehicle's usage. The results would be greatly increased maintenance costs, decreased dependability, and increased delays due to downed vehicles.

Since chemicals are the third most expensive line item on our budget, limitations would have to be set on purchase and usage. Priorities would have to be set on what and what not to treat. This would depend on the species of mosquito and its flight range.

The western equine encephalitis (WEE) vector, *Culex tarsalis* would have top priority for treatment, followed by less-important species. Ultra-low volume (ULV) applications would be emphasized, and larviciding would generally be decreased as much as possible. The reason being that in Box Elder County, ULV applications are approximately $0.60 per acre plus chemical, while larviciding applications are $1.50 per acre plus chemical. Weather conditions play a critical factor in successful ULV applications, and there would be more complaints from the public if ULV applications were stopped because of weather. There would be increased pressure on the manager and the Board of Directors and very possibly increased disease transmission. Aircraft spraying would have to be reduced. The cost for air applications in Box Elder County for 1988 was $180.00/hour. This is a 34% increase over 1987. Liability insurance was a large factor in this increase. The District no longer carries liability insurance for aircraft. It is now the responsibility of the air sprayer and, in the long run, the District pays for it. Our own liability insurance has increased 35% in 2 years.

To summarize the Box Elder District has not had a tax increase since 1979, and a tax limitation now would greatly handicap the district's control program. At the present time, most mosquito abatement districts, including Box Elder, operate on a very reasonable and fair budget. A 24% reduction would make it impossible to keep adult mosquitoes at a tolerable level and chances for a WEE outbreak would most certainly increase.

REVISED CONSTITUTION OF THE UTAH MOSQUITO ABATEMENT ASSOCIATION

Adopted at the 8th Annual Meeting of the Association
Revised at the 13th Annual Meeting
Revised at the 25th Annual Meeting
Revised at the 28th Annual Meeting
Revised at the 30th Annual Meeting
Revised at the 41st Annual Meeting

ARTICLE 1. NAME

The name of the organization, an unincorporated association, shall be "UTAH MOSQUITO ABATEMENT ASSOCIATION," also known as "UMAA."

ARTICLE II. OBJECTIVES

The objectives and purposes of the Association shall be to promote close cooperation among those concerned with, or interested in mosquito control and related work, to increase the knowledge and advance the cause of mosquito abatement in an efficient and effective manner compatible with the goals of a sound environment. The Association may also encourage and undertake such other insect control problems as the Association may determine.

ARTICLE III. MEMBERSHIP

Section A. The membership of the Association shall consist of three classes: Members, Contributing Members, and Honorary Members.

Section B. Members shall consist of two categories: Agency Members and Individual Members.

1. Agency members shall be any active mosquito abatement program supported with an annual budget from public funds.

2. Individual members shall be any person interested in or concerned with mosquito abatement who desires affiliation with the Association.

Section C. Contributing members shall be any commercial or other organization which desires affiliation with the Association.

Section D. Honorary Members shall be any individual who has performed outstanding service in the interest of mosquito abatement and who has been elected to honorary membership for life by two-thirds majority vote of voting members present at the time of voting.

Section E. Approval of Membership. All applications for membership shall be subject to approval by a majority of the Board of Directors at any meeting of the Board of Directors at which a quorum is present.

Section F. Voting. All trustees, commissioners and designated permanent employees of agency members shall have one vote at Association meetings. All individual and honorary members shall have one vote. Contributing members shall have no vote.

ARTICLE IV. REVENUES

Section A. The revenue of the Association will be derived from dues paid by members, from the sale of publications, from donations and contributions, and from such other sources as may be approved by the Board of Directors.

Section B. The dues for members and date of payment shall be established annually by the Board of Directors of the Association. All mosquito abatement districts and organizations sponsoring members shall be notified by November 15th following the annual meeting of any changes in the amount of dues from those assessed the previous year and approved by the Board of Directors.

ARTICLE V. OFFICERS

Section A. The elective officers of the Association shall be President, President-Elect, Vice President, and a Secretary/Treasurer. The officers shall be elected at the annual business meeting by a majority vote, except for the President-Elect who automatically ascends to the office of President. A director shall be appointed by the governing body of each unit in Utah engaged in mosquito control and which is a member of the Association. The elective officers and the duly appointed directors shall constitute the Board of Directors.

Section B. The Board of Directors, at their discretion, shall appoint an Executive Director who will sit as a voting member of the board. The Executive Director's salary will be established by the Board of Directors.

ARTICLE VI. DUTIES OF OFFICERS

Section A. The President shall preside at all meetings of the Association, annual and special, and at all meetings of the Board of Directors. He shall maintain and exercise general supervision over the affairs of the Association, subject to the authority of the Board of Directors, and shall discharge such other duties as usually pertain to the office of President. He shall name members of the committee with consent and approval of the Board of Directors at their first meeting during his term of office. In the absence of the Secretary-Treasurer, the President may sign checks to pay for bills approved by the Board of Directors.

Section B. The President-Elect shall exercise the powers and perform the duties of the President in the absence or disability of the President. In case of a vacancy in the office of the President, the President-Elect becomes President for the balance of the term of the office. He shall function as Program Chairman for the Annual Meeting held during his term of office. The Board of Directors shall appoint by a majority vote an Acting President-Elect, when the office becomes vacant, to serve until the next election of officers by the Association.

Section C. The Vice President shall assist the President and the President-Elect with the duties of these offices as directed.

Section D. The Secretary-Treasurer shall keep full and correct minutes of all meetings of the Association and of the Board of Directors. He shall be responsible for the maintenance of all membership records, conduct the correspondence of the Association, and issue all notices of meetings. He shall collect and receipt for all dues, assessments and other income. He shall deposit promptly all funds of the Association in such depositories as shall be approved and designated by the Board of Directors. Checks in payment of obligations of the Association shall be signed by the Secretary-Treasurer. He shall, under the direction of the Board of Directors, pay all bills of the Association and make such other disbursements as are necessary and incidental to the operations of the Association. He shall, at the annual meeting of the Association, and if directed by the Board of Directors at special meetings, make full and true report of the financial condition of the Association. He shall perform such other duties as are usually incident to the office of Secretary-Treasurer and as may be assigned to him by the Board of Directors. The Secretary-Treasurer with the approval of the board of Directors and with the assistance of the Publications Committee, shall publish and distribute the proceedings and other publications of the Association. In the absence or disability of the Secretary-Treasurer, the Board of Directors shall appoint a member of the Association to serve in this capacity as required or until the next election of officers by the Association.

Section E. The Executive Director shall serve the association by duties which include:

(a) Coordinating the Annual Conference with the Program Chairman.

(b) Serving with the Local Arrangements Committee to facilitate hotel requirements, exhibit space, etc., associated with the Annual Conference.

(c) Aiding in the promotion of the Annual Conference and obtaining commercial exhibitor participation.

(d) Serving with Officers and Directors to promote the UMAA to various Local, State, and Federal agencies regarding environmental concerns and issues.

(e) Monitoring and working with the Legislative Committee on matters that impact mosquito control which come before the State Legislature.

(f) Coordinating bidding for chemicals for the Association.

(g) Representing the Association at the meeting of the American Mosquito Control Association and at any other meetings which the Board of Directors may deem necessary.

(h) Assisting in the development and coordination of the annual Work Shop.

(i) Publishing an Association Newsletter on a bi-monthly basis from April through October.

(j) Submitting an Annual Report during the Annual Conference Business meeting.

(k) Other such duties as the board may direct.

Section F. The Board of Directors shall meet upon the call of the President, or upon the request of three (3) or more members of the Board of Directors directed in writing to the Secretary-Treasurer. At least five (5) days prior notice in writing shall be given by the Secretary-Treasurer to any meetings of the Board of Directors: the time and place of such meetings shall be designated by the President. A majority of the members of the Board of Directors shall constitute a quorum for the transaction of business, and action by the Board of Directors shall be upon the vote of a majority of those members present at any meeting of the Board of Directors at which a quorum is present. The Board of Directors shall manage the affairs of the Association and shall have power:

(a) to fill any vacancy among the elected officers of the Association,

(b) to appoint the following standing committees each to consist of not less than three (3) members: Publications, Auditing, Program, and Nominating. Special procedures for the Nominating Committee are included in Article VII. The Secretary-Treasurer shall be an ex officio member of all committees,

(c) to appoint such other committees as it may deem to be necessary or useful in conducting the business of the Association,

(d) to prescribe the duties of officers of the Association not otherwise prescribed in the Bylaws of the Association,

(e) to prescribe rules and regulations for the conduct of the affairs of the Association, as are not inconsistent with the provisions of the Constitution of the Association,

(f) to determine the number and price of each publication which shall be distributed to the various members of the Association, and to others; to approve lists of nonmembers who may receive publications without charge, and

(g) to accept or reject applications for memberships in the Association, prescribe rules and procedure in relation thereto.

ARTICLE VII. NOMINATION AND ELECTION OF OFFICERS

Section A. At least 15 days prior to the annual meeting of the Association, the President shall appoint, subject to approval of the Board of Directors, a Nominating Committee consisting of five (5) members of the Association, naming one of the five to serve as Chairman.

Section B. The Nominating Committee shall determine its nominees for elective officers of the Association. It shall present the names of the nominees selected in the opening session of the annual meeting of the Association. It shall also present at this time, on request, any nominations made in writing and signed by three or more members of the Association. Election of officers will be conducted in a business meeting where nomination for officers may be made from the floor.

Section C. Officers of the Association shall be elected by majority vote at the annual meeting of the Association, and shall serve until the next annual meeting.

Section D. The Executive Director shall be appointed at the discretion of the UMAA Board of Directors by a simple majority vote. Term of office shall be one year subject to reappointment at the annual conference business meeting.

ARTICLE VIII. MEETINGS

Section A. There shall be an annual meeting of the Association, for the election of officers, the presentation of papers and discussions on mosquito abatement and related subjects, and such other business as may be properly considered. Such meetings shall be held at such times and places as the Board of Directors shall prescribe. At least 7 days prior notice shall be given to all members as to the time and place of the annual meeting.

Section B. Special meeting of the Association may be held whenever the Board of Directors deems such meetings necessary, or whenever ten or more Members shall make a written request thereof, presented to the Secretary-Treasurer. Such request shall be presented to the Board of Directors, which shall designate a time and place for such special meeting. The Secretary-Treasurer shall give written notice of all special meetings of the Association to all members at least seven (7) days prior to the date of such special meeting.

Section C. A simple majority of Members of this Association shall constitute a quorum for the transaction of business at any annual or special meeting and any actions taken at such meetings shall be by majority vote.

ARTICLE IX. REPORTS AND PUBLICATIONS

Section A. The Association shall publish an annual report. The report may contain the proceedings, papers, and business transacted at the annual meeting. It may also include any other matter deemed by the Board of Directors to be essential to the general welfare.

ARTICLE X. PARLIAMENTARY PROCEDURES

In the absence of rules in this Constitution of the Association, the proceedings of the Board of Directors' meetings as well as the Association meetings shall be conducted in accordance with established parliamentary procedure.

ARTICLE XI. AMENDMENTS

This Constitution may be amended at any regular business meeting of the Association at which there is a quorum, by a two-thirds vote of the members present, provided the Board of Directors has previously considered the merits of the amendment.

ARTICLE XII. FINANCIAL RESPONSIBILITY

Except by the specific direction of the Board of Directors under their personal individual financial responsibility, no debt or other financial obligation of this Association shall be incurred by this Association beyond the amount of the funds (over and above all liabilities) then in the hands of the Secretary-Treasurer.