PROCEEDINGS AND PAPERS

of the

THIRTY—SIXTH ANNUAL MEETING

of the

UTAH MOSQUITO ABATEMENT ASSOCIATION

held at

Eccles Conference Center

Utah State University

Logan, Utah

October 3-4, 1983

Edited by

BETTINA ROSAY

and

GLEN C. COLLETT

UTAH MOSQUITO ABATEMENT ASSOCIATION

463 North Redwood Road

Salt Lake City, UT 84116

Published--April-1984

1983 OFFICERS

President .... Robert Brand

President - Elect .... Steven Romney

Vice President .... James Nielsen

Secretary - Treasurer .... Bettina Rosay

Past - President .... Elmer Kingsford

DIRECTORS

Box Elder County District .... J. Lawrence Nielsen
53 South 600 West
Brigham City, UT 84302

Davis County District .... Rex Passey
85 North 600 West
Kaysville, UT 84037

Duchesne County District .... Russell Snaith
Box 1951
Roosevelt, UT 84066

Emery County District .... E. James Nielsen
Castle Dale, UT 84513

Logan City District .... Elmer Kingsford
61 West 100 North
Logan, UT 84321

Magna District .... Evan R. Lusty
2611 South 9085 West
Magna, UT 84044

Salt Lake City District .... Glen C. Collett
463 North Redwood Road
Salt Lake City, UT 84116

South Salt Lake County District .... Jay E. Graham
7150 South 600 West
Midvale, UT 84047

Tooele Valley District .... Robert Brand
1535 Sunset Road
Lake Point, UT 84047

Uintah County District .... Steven V. Romney
1336 East Hiway 40
Vernal, UT 84078

Utah County Department .... Dennis Hunter
1111 West 100 South
Provo, UT 84601

Weber County District .... Dallas Nelson
505 West 12th Street
Ogden, UT 84404

RESOLUTIONS

WHEREAS, the Utah Mosquito Abatement Association has held its 36th annual meeting at the Eccles Conference Center, Utah State University, Logan, Utah, October 3-4, 1983 and,

WHEREAS, the Logan City Mosquito Abatement District, Elmer Kingsford, Manager, has served as the host organization, and,

WHEREAS, the Utah State University Cooperative Extension Service, Reed Roberts, Extension Entomologist, has served as co-chairman for local arrangements, and,

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

THEREFORE, be it resolved that the UMAA extend sincere appreciation to the Logan City Mosquito Abatement District, its manager, Board of Directors, and to Utah State University Cooperative Extension Service 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 extend its thanks and appreciation to all speakers and especially to those who came from out of state.

WHEREAS, Robert Brand has served with distinction and devotion to the UMAA as its president for 1982-83,

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

WHEREAS, the Eccles Conference Center, Utah State University, Logan, Utah, has provided nice facilities and excellent food and services, and,

WHEREAS, the banquet was of outstanding quality,

THEREFORE, let it be resolved that the UMAA express appreciation to the Eccles Conference Center for contributing to the success of the 1983 meetings.

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

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

RESOLUTIONS COMMITTEE
Dennis Hunter, Chairman
Douglas Brown
Verl Peterson

CONTRIBUTING MEMBERS

Agricultural Chemical Group (FMC Corp.) .... Fresno, CA
Biochem Products .... Davis, CA
BioQuip Products, Inc. .... Santa Monica, CA
Crop Protection, Division of Sandoz, Inc. .... Dallas, TX
Lowndes Engineering Co., Inc. - LECO .... Valdosta, GA
Peterson Equipment Company, Inc. .... Logan, UT
Public Health Equipment & Supply Co., Inc. .... San Antonio, TX
Rubber Supply Co., Inc. - Surety Safety Supply .... Salt Lake City, UT
Sherex Chemical Company, Inc. .... Dublin, OH
Steve Regan Company .... Salt Lake City, UT

INDIVIDUAL MEMBERS

Steve Burk .... Tooele, UT
Roy Ellis, PhD .... Winnipeg, CANADA
Howard R. Greenfield .... Salinas, CA
Eric Hamrin .... White City, OR
Judy A. Hansen .... Cape May Court House, NJ
Richard C. Hicks .... Las Vegas, NV
Carter Knowles .... Bakersfield, CA
Jay Linam, PhD .... Pueblo, CO
Lewis T. Nielson, PhD .... Salt Lake City, UT
Reed S. Roberts .... Logan, UT
Helen Sollers - Reidel .... Washington, DC
Luis Vargas, PhD .... Mexico City, MEXICO
Tim Williams .... Malad City, ID

HONORARY MEMBERS

William E. Dunn .... Salt Lake City, UT
Lewis E. Fronk .... Ogden, UT
Thomas D. Mulhern .... Fresno, CA
W. Donald Murray, PhD .... Visalia, CA
Richard F. Peters .... Danville, CA

TABLE OF CONTENTS

REPORT FROM THE AMERICAN MOSQUITO CONTROL ASSOCIATION

Jimmy K. Olson, PhD, President
Texas A & M University
College Station, TX

Greetings from the Officers and Regional Directors of the American Mosquito Control Association and *apologies* for our not being able to participate more actively in this year's meeting of the UMAA. Prior to our knowing when the UMAA meetings would be held this year, it was decided that AMCA should accept the invitation of the Illinois Mosquito Control Association to hold the interim meeting of the Board of Directors in conjunction with the annual meeting of the IMCA, which unfortunately falls on the same dates as those of your association's meetings. Due to this conflict, I have asked Dr. Lew Nielsen to officially represent AMCA at your meetings this year in his capacity as a Past President of AMCA, and, otherwise, as a person who continues to be very active in the affairs of the Association. In his capacity as our "Official Representative", I have further asked Lew to read this letter to you so that you might be more aware of current status and ongoing activities of the American Mosquito Control Association.

As far as the "current status" of AMCA is concerned, I am pleased to state that, in my opinion, the Association is alive and doing very well. During the past year, AMCA entered the "computer age" with the purchase and installation of a Radio Shack® TRS-80 Model 16 computer system at its Central Office in Fresno, CA. Tommy Mulhern, Executive Director of AMCA, Linda Shields-Raiche, AMCA Business Manager, and the rest of the Central Office staff have been very busy adapting the software associated with this computer system over to the business and administrative needs of AMCA. The membership mailing list of the Association is now fully computerized; the financial records of the Association are in the process of being placed onto the computer; and, most recently, the computer was used in the production of the AMCA Newsletter.

The ways that this computer system can aid AMCA in monitoring its business affairs, and executing its services seem to be boundless . . . and, most importantly, the computer system affords AMCA a means by which it can serve to the various needs of the Association and its members in a more efficient and cost-effective manner. In this regard, Tommy Mulhern and the Central Office Staff just recently completed an inventory of the back issues of *Mosquito News* and other publications that are being stored for sale at the Fresno office. This inventory has been placed on the computer so that the value of the inventory and its current status may be more efficiently and accurately monitored. I should mention here that the current combined value of the AMCA publications inventory is in excess of $110,000 and the Board of Directors, under the advisement of Tommy Mulhern, is seeking ways to market these publications. Some "good deals" may be in the offering for certain of these publications; so, you may want to watch future issues of the AMCA Newsletter for various sales on AMCA publications.

As for "on-going activities" of AMCA, the agenda for the interim meeting of the Association's Board of Directors gives indication that a great deal has been "ongoing". Ron Ward and several others report that the "new look" of *Mosquito News* with its 7"X10" format and blue cover has been very well received. The first 3 issues of *Mosquito News* for 1983 will contain 500 pages as compared to 577 pages for the same period during 1982. Actually, however, the 1983 figure represents a 4% increase in total words printed since the pagination in the new format of MN is 20% larger than that of previous issues. This then heralds a *stop* to the downward trend in total pagination which MN has been experiencing in recent years. I should also note here that, for the period January 1 - August 1983 there has been a 25% increase in the number of papers received for publication in MN during 1983 as compared to the number of papers received during the same period last year (i.e., 114 papers received in 1983 vs. 91 papers last year). Lew Nielsen, in his capacity as Editor of *Mosquito Systematics*, can fill you in on the similar good news regarding this particular publication of AMCA.

Carl Rathburn continues to be pushing his committee towards completing the revision of AMCA Bulletin No. 2 ("Ground Equipment and Methods for the Control of Mosquitoes"), which AMCA hopes to have out by sometime in the middle of 1984; and Harold Chapman assures that Bulletin No. 6 ("Biological Control of Mosquitoes") is back on its feet with considerable progress being made towards the completion of the text for this bulletin by early 1984. Of course, AMCA's Bulletin No. 1 on "The Use of Aircraft in the Control of Mosquitoes", originally published in 1948, was completely revised in 1982 and may now be purchased for $10 per copy from the AMCA Central Office.

The AMCA Public Information Committee reports that the final script for the movie on "Mosquito Control" is complete and awaiting the acquisition of funds for the ultimate production of the 20-27 minute film. A market survey designed to determine the level of interest in such a film among mosquito control agencies was completed in September 1983 by the PI Committee. The survey indicated a high interest among mosquito control agencies in purchasing the film once it was available. The BOD of AMCA will be considering a number of proposals as to how the Association may go about acquiring the funds needed to produce this film at its Interim meeting this week. The target date presently set for the completion of this film is November-December 1984, provided the necessary funds to cover production costs ($27,000) can be secured. The exact purchase price of the film has yet to be set although AMCA would like to keep the price *well below* the going rate of $400 per copy that similar films are being sold for at this time.

While we are on the subject of "cost and savings," I would like to mention that the AMCA Board (under the advisement of the Association's Finance Committee, Publications Committee and the Editors and Editorial Boards of the various periodicals of the Association) is taking a hard look at ways to further reduce the costs associated with the printing of its various journals, bulletins and other publications. In this regard, the BOD will be reviewing the Publication Committee's first attempt at developing a more formal competitive bidding procedure to be followed in the future by AMCA in securing a printer for the publication of *Mosquito News* and other publications of the Association. The BOD is also reviewing recommendations regarding the content and needs being satisfied by the Bibliography Section of MN and by *"The Annual Review of Mosquitoes and Diseases"* in an effort to find ways to cut costs and reduce the workload on Helen Sollers-Riedel in the production of these two items. Ways to reduce the costs associated with the publication of reprints of articles published in MN are also being considered.

On a broader issue regarding the content of AMCA publications, the BOD is also looking into ways that its system of quarterly publications may better serve to the informational and communicational.needs of the various interest groups that collectively comprise the membership of the Association. At its interim meeting in Illinois, the BOD will be considering a recommendation by the Association's Publications Committee that a *new* journal be created which would answer better to the needs of the research-oriented arm of AMCA and that the Newsletter of AMCA be expanded to contain certain of the items which are presently included in MN and which are of interest to the AMCA membership. It is further suggested that some new sections be added to the Newsletter which would answer better to the communicational needs of the operational-oriented arm of the Association.

The BOD, in its deliberations and ultimate recommendations to the AMCA membership on this matter, in no way wants to rekindle the controversy that resulted 10 years ago when it was suggested that the name of *"Mosquito News"* be changed. However, in an association with a membership as diverse as is AMCA's membership, it is not surprising that various groups comprising the membership require different emphasis in the publications of the Association. During my tenure as member of the BOD, I have received complaints from *both* research-oriented members and operational-oriented members alike that MN in its present form is not entirely satisfying their particular informational and communicational needs. In this regard, I agree with Tommy Mulhern that, when the needs of any segment of the membership are not being satisfied (by the services being provided) it is incumbent upon AMCA to seek adjustments which will be acceptable to all and which will, otherwise, preserve and enhance the unity and strength of the Association. It is with these objectives in mind that the BOD will be reviewing and making decisions on the recommendations put forth by the Publications Committee and others regarding the future publications of AMCA.

Another "in house" item that will take up a considerable amount of the Board's time at its interim meeting is its review of the first draft of the suggested revisions to the AMCA Bylaws put forth by the Association's Bylaws Committee. The ultimate goal of this revision process is to bring the Bylaws up-to-date and more in line with what AMCA is today and more reflective of how the Association administers to its affairs. It is doubtful that this revision will be completed in time for consideration by the general AMCA membership of AMCA this year; but, it should be ready for your review and approval by the end of 1984.

On the national scene, AMCA, through its Scientific and Regulatory Liaison Committee, has entered into negotiation with the U.S. Environmental Protection Agency regarding the development of a procedure whereby AMCA will be a formal part of the "Pesticides User Network" being set up by EPA's Office of Pesticides and Toxic Substances. The "User Network" is being set up by EPA to obviate the concerns expressed by several public and private groups regarding the efficacy waiver on pesticides and EPA's commitment to assure satisfactory product performance in the future. In addition to securing information on product effectiveness, EPA proposes to use the "Network" to seek 1) use and exposure information; 2) information on common vector control practices; 3) label improvement suggestions; and 4) information on integrated pest management practices. EPA considers AMCA through its membership to be a potentially important source of this kind of information and has asked that the Association become formally involved. *This* AMCA intends to do, provided that the details of the procedure for AMCA involvement can be worked out and, most importantly, provided EPA can supply AMCA with the funds needed to support the Association's activities on this project. I do hope the Association's activities on this project comes to pass; for another important aspect of the User's Network will be to provide vector control specialists such as yourselves, more direct access to EPA where your concerns and suggestions will be taken into account in regulatory procedures.

Internationally-speaking, AMCA is continuing its efforts to establish mechanisms to strengthen the Association's image on a world-wide basis and to better serve its members living and working "overseas". One such "mechanism" being considered by the Board of Directors is the establishment of a series of International Directors (or "IDs") which would serve as advisors to the BOD representing various areas of the world where AMCA does not have a strong image or sufficient membership to warrent a Regional Director at this time. In their capacity as International Directors, these people would be asked to represent AMCA's interests and otherwise advise and assist AMCA in strengthening its image and increasing its membership in their respective areas. An International Director (as presently envisioned) would *not* be a voting member of the BOD. However, at sometime in the future, and with the approval of the general AMCA membership, a petition procedure might be considered whereby IDs could become voting Regional Directors.

On a negative note, one AMCA activity, the AMCA-CDC Mosquito Control Training Course scheduled to be given in St. Paul-Minneapolis during August, had to be cancelled due to the threat of an outbreak of Western

Encephalitis in that region of the United States during late July-early August. Bob Sjogren and the rest of his staff at Metropolitan Mosquito Control District in St. Paul were too busy fighting mosquitoes to host the course, and it was decided finally to reschedule the course at some other location during the early spring of 1984.

AMCA has a number of other activities which should be referred to in this letter but, I imagine by now, Lew is tired of reading and you are tired of listening. I, therefore, urge you to read subsequent issues of the AMCA Newsletter for other items of interest regarding the Association and its activites; and, otherwise, please make plans to attend the annual meeting of the Association which will be held jointly with the Ontario Mosquito Control Association in Toronto on 18-21 March 1984. In the interim, if you have any questions, concerns or comments regarding AMCA, please feel free to express them directly to me or through your Regional AMCA Director, Bill Rapp.

Again, I apologize for my not being able to attend this year's meeting of your Association. On behalf of all the Officers, Directors and other officials of AMCA, I wish you a very informative and productive meeting.

COOPERATIVE ROLES OF THE UTAH DEPARTMENT OF HEALTH AND THE MOSQUITO ABATMENT DISTRICTS

James O. Mason, M.D., Dr. P.H., Executive Director
Utah State Department of Health
Salt Lake City, UT

Mosquito control has long been recognized as a fundamental public health concern. It was through pioneering work during the first part of this century which confirmed mosquitoes as more than a pest and nuisance, but as real threat to people's health.

Prevention has long been recognized as the most effective means of dealing with mosquitoes. In fact, prevention in this area was one of the early preventative efforts of public health workers. It is interesting to read early accounts of such prevention activites. The 1913 public health textbook, The People's Health, notes the following suggestions:

> "The common mosquitoes probably do not fly over half a mile if not driven by hard winds or smoke; hence a household can obtain relief for a time by stopping the breeding of mosquitoes near them. One stray tomato can may breed enough mosquitoes to make a whole neighborhood miserable. Do not wait for the mosquito brigade, but do your share for the public's good by pouring petroleum on any stagnant pools near your home; also fasten wire net between two hoops and keep it on the rain barrel. See that the cistern is tightly screened, and that the gutter is not choked and holding water. Cut holes in tin cans, bury ink bottles, etc.
>
> "What are the breeding places of mosquitoes as revealed by the sanitary survey? The smothering of wigglers (the early stage of the mosquito) by oiling the water destroys fish and other natural enemies, and unless the oil is applied every ten days or oftener, if it rains, the mosquitoes, will become worse than they have ever been. The use of kerosene should be only a makeshift for the time. The mosquito can only be exterminated by general cooperation in destroying their breeding places."

Our technology has improved, abatement districts have replaced " mosquito brigades" and our approach has been refined during the past 70 years, but our goals remain constant. The author of this text notes that "The mosquito can only be exterminated by general cooperation in destroying their breeding places."

Historically in Utah we have had a good cooperation and working relationship between the Utah Department of Health and the mosquito abatement districts. There has been some funding through our Division of Community Health Services of abatement districts. In the past this money has been rather small in comparison to the needs, and I feel we should look at our level of financial assistance in future budgeting.

Largely through the work of the mosquito abatement districts and state local health departments, Utah has been very fortunate to have an extremely low rate of encephalitis. In fact, in the past ten years, we have had only two cases of encephalitis in humans — and both of these individuals contracted the disease outside of Utah. This success is due on large measure to the work of the districts and the "early warning" reporting requirements through the Department of Health.

This year saw increased pressure on the abatement districts and on state and local health departments to meet the potential of a larger than normal mosquito population because of the flooding. 1983 saw extraordinary conditions and a renewed appreciation of the mutual needs and support of the health departments and the abatement districts.

I was impressed with the willingness of the districts this spring as we strengthened our cooperative work in light of the flooding. As I worked more with the districts, it was impressed upon me the need for renewed closer ties between the Utah Department of Health and the mosquito abatement districts.

This spring brought on increased demands for us to work closer together. On June 24th a meeting was held at the State Capitol with representatives from the abatement districts and the Department of Health and Department of Agriculture. This was our first formal meeting of sitting down together to plan our approach for the hot months ahead. It was agreed to apply for a FEMA grant to augment state resources and I assigned one of our staff full time to working with the abatement districts and in making the grant application.

On July 1st a follow-up meeting was held at the Department of Health. Further details of assignments and responsibilities were worked out and the Department agreed to immediately order 20 additional New Jersey light traps and 24 CDC light traps for use in the districts and other areas of the state. We also agreed on the assignment of laboratory services and coordinated between the State Veterinarian and veterinarians around the state.

On July 5th Dr. J. Hal Arnell started work as a consultant to the state.

On July 6-8 the additional light traps were set out in the state, including central Utah.

On July 8th the proposed FEMA budget request was presented to the UMAA Board. It amounted to a federal share of $33,000.

On July 15th the Department of Health issued one of several press releases about the mosquito abatement efforts and we announced the receipt of the FEMA grant for $33,149. This money was to bolster ongoing surveillance work and to begin surveillance in areas which did not have an abatement district. (To date we have spent approximately $18,000 of this grant.)

During the course of the summer, Department of Health representatives attended the UMAA board meetings and provided a closer working relationship between the Department and the districts.

Throughout the summer the sentinel chicken flocks were monitored and we did not have any positive results from the bleedings, that is until September 6th. At that time we had three positives. This was confirmed on the 12th. It is at this point — positive confirmations — that we must have commonly recognized protocols defining responsibilities of principal players, i.e., Communicable Disease Control, local health department, mosquito abatement district and appropriate others.

I feel good about the cooperative work we have had this year. We have made good progress and have learned from each other. But most importantly we have set the stage for increased cooperation between the districts and the Department of Health.

I hope that the increased cooperation we have seen this year with the various groups will become standard for future years. We must begin now to strengthen our ties and lines of communication.

Let me outline for you some recommendations for the direction which I would like to see the UMAA and the Utah Department of Health take during the coming months:

1) Formalize our relationship with regard to encephalitis surveillance. I suggest having a representative from the Department of Health's Division of Community Health Services be on your Encephalitis Surveillance Committee.

2) I realize the mosquito abatement districts do not have the financial resources to do all they would like to do and that the Department of Health's contribution in the past has been a modest $500. As we enter our budgeting process, I will investigate the possibility of increasing our assistance for your work.

3) We need to strengthen our lines of communication, especially on encephalitis surveillance. The lines of communication outlined in your 1981 report are a good step in that direction. I feel this needs to be enhanced with a call-down listing of specific individuals to be notified and a timeline as to when the notification is to be complete. This needs to include the Bureau of Communicable Disease Control, the State Health Laboratory, local health departments, and the Department of Agriculture.

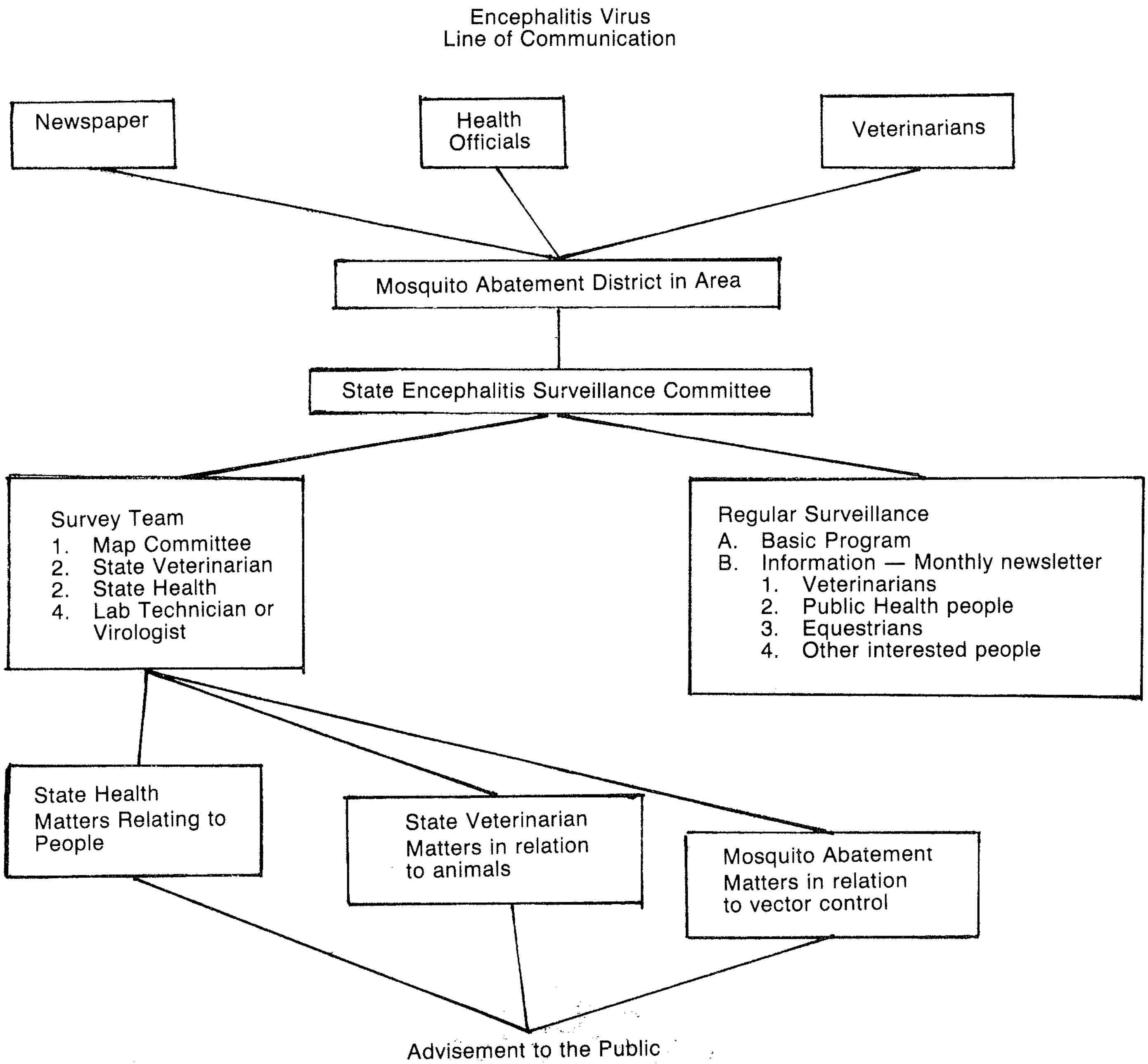
4) It would be good to look at increasing the number of sentinel chicken flocks, especially in central Utah.

5) Your association may look at the formation of other mosquito abatement districts which are not now served, such as the Sanpete/Sevier County area.

With a normal amount of precipitation this fall and winter added to the leftover flood waters of this past year, we may very well see an increase in the mosquito population next summer. We need to lay the groundwork for the potentialities of next summer. This year we were very fortunate: we organized quickly, had a cool spring, a shorter than normal hot spell in the summer and a lot of luck.

I have been extremely impressed with the work of the abatement districts and the professional employees in your association. I hope we will be able to strengthen our ties between public health and mosquito control in the future.

Figure 1. State of Utah Plan of Action



ENCEPHALITIS SURVEILLANCE IN CENTRAL UTAH, 1983[1]

J. Hal Arnell[2] and Frank C. Jackson
Utah State Department of Health
Bureau of General Sanitation
Salt Lake City, UT

ABSTRACT

A surveillance program for *Culex tarsalis* and WEE and SLE was carried out in July and August 1983 by the State of Utah Department of Health on the Sevier River drainage in central Utah, due to unusually heavy precipitation the previous fall, winter and spring and flooding along many sections of the Sevier River. The program was funded by the Federal Emergency Management Agency and the State Department of Health. Surveys of *Cx. tarsalis* populations were made in Sevier, Millard and Sanpete Counties by New Jersey light traps and live *Cx. tarsalis* were collected by CO_2-baited traps in Sevier and West Millard Counties and sent to CDC for virus testing. Some bird bloods were also obtained and tested. No WEE or SLE virus was found. It is recommended that this surveillance program continue, preferably with the establishment of mosquito abatement districts in these areas.

INTRODUCTION

The potential for an unusually large mosquito population during the 1983 season in Utah probably began in September of 1982 with a large storm on the 26th of that month that broke three rainfall records (Salt Lake Tribune, 27 Sept. 1982). From that date on, through the fall, winter and spring, Utah experienced one of its wettest years on record.

Some of the more significant events of this unusual weather year include the April landslide in Spanish Fork Canyon that created Thistle Lake, and 11 May, 8-inch snowfall that covered most of the state, late May slides in Farmington and Bountiful that damaged and destroyed numerous homes, the conversion of major downtown streets in Salt Lake City to canals to handle floodwaters, and the failure of the DMAD Dam above Delta in late June, flooding the town of Deseret with up to 5 feet of water. In mid-June, the Utah Department of Agriculture estimated damage to over 274,000 acres of crop and pasture land, including 12,000 acres around Utah Lake and 15,000 acres in Weber County. The Great Salt Lake was reaching high levels not experienced for decades. By 20 June, 22 of 29 Utah counties, 60% of the State's land area, had been declared eligible for disaster assistance. On 16 June, the Federal Emergency Management Agency (FEMA) directed the Center for Disease Control (CDC) to provide support and assistance on public health matters pertaining to the disaster.

State and local health officials and mosquito abatement districts (MADs) were aware early of the potential for unusually high mosquito populations in the State during the summer of 1983 and had special concern about *Culex tarsalis*, the primary vector in the western U.S. of Western Equine Encephalitis (WEE). On 20 June, Dr. Bruce Francy and Dr. Donald Eliason of CDC in Ft. Collins visited Utah to make preliminary field investigations. Extensive flooding was observed by aerial overflight in Utah County along the margins of Utah Lake, the Sevier River from near Levan to Richfield, Sanpete County, the Duchesne and Green River drainage in eastern Utah and the Jordan River and the southeastern and eastern margins of Great Salt Lake. Those areas had the potential for a WEE outbreak, although the *Cx. tarsalis* populations were slow in developing because of the cool spring but were expected to rise rapidly with the onset of hot summer temperatures. Their recommendations included the continued assessment of *Cx. tarsalis* populations in areas where mosquito abatement districts exist with extension into areas where MADs do not exist, the weekly collection of *Cx. tarsalis* samples for virus testing at Ft. Collins in MAD and non-MAD areas, and the testing of in-place sentinel chicken flocks every two weeks, all of this work being best done using temporary workers under supervision of the State Health Department and the Utah Mosquito Abatement Association. Contingency plans should be made to provide large area mosquito adulticiding should virus transmission be documented. (Pers. Comm. Francy & Eliason to David P. Greer, FEMA, Provo, UT, 28 June 1983.)

On 24 June, representatives from the mosquito abatement districts and the State Department of Health met to establish contingency plans for control of a potential mosquito-borne encephalitis outbreak. Application for financial support would be made to FEMA with monies to be used primarily in areas of the state with no established MADs. MADs would use routine surveillance and control methods and request assistance only if necessary. In non-MAD areas, local health department personnel were to be used as much as possible with one objective being to encourage these areas to develop permanent mosquito control programs. Frank C. Jackson of the State Department of Health was charged with formulating a budget, preparing a FEMA application and supervising the program for the Department of Health. Hal Arnell was hired shortly thereafter by the Department of Health as Entomologist.

A second meeting of MAD and Health Department personnel was held on 1 July, at which time decisions were made to purchase New Jersey light traps for mosquito population assessment and CO_2-baited mosquito traps for collecting live *Cx. tarsalis*. Horse bloods would be tested for virus at state laboratories, chicken and other bird bloods would be tested under the direction of Dr. Brent Johnson of the Department of Microbiology at Brigham Young University and live female *Cx. tarsalis* would be sent on dry ice to CDC at Ft. Collins. The State Department of Health would limit its surveillance efforts to counties that had been declared disaster areas, had no organized mosquito abatement program, and had population centers threatened by areas of high mosquito production. Therefore, the primary surveillance area would be on the Sevier River drainage in Sanpete, Sevier and Millard Counties. The formal application to FEMA was made on 7 July for $44,199, of which $33,149 would be FEMA funds, the remainder State funds. The grant (FEMA 680 DR) was approved 21 July, although actual surveillance began on 12 July.

METHODS

Eleven New Jersey light traps were put in place on 12-14 July. The criteria used in choosing trap sites were: 1) placing traps near areas of potentially high *Cx. tarsalis* breeding, primarily flooded areas adjacent to the Sevier River and tributaries; 2) having adequate coverage of municipalities threatened by high *Cx. tarsalis* populations; and 3) surrounding as much as possible the larger municipalities of Richfield and Delta.

Cooperation was required of local citizens in the municipalities chosen to supply power for the traps and to turn the power on and off at the required times. No persons asked to provide trap sites refused and most cooperated enthusiastically. Local sanitarians, Robert Lowe in Richfield, Jerald Finlinson in Delta, and George Johansen in Mt. Pleasant were asked to monitor the traps, collect material following each trap night, and ship the material to Dr. Arnell in Salt Lake City for identification. Traps were placed in the following localities: Austin, Annabella, Venice, Salina, and Redmond in Sevier County, run from 15 July to 31 Aug, except for the Venice trap which was retrieved 8 Aug and the Salina trap which was retrieved 19 Aug; Sutherland, Hinckley, Deseret and Oasis in West Millard County, run from 15 July to 29 Aug, except for the Deseret trap which was placed 22 July and the Sutherland and Deseret traps which were retrieved on 10 Aug; Mt. Pleasant and Chester in Sanpete County, run from 18 July to 29 July, These sites are shown in Fig. 1. Traps were retrieved early when low mosquito populations or low *Cx. tarsalis* populations no longer justified their use. All traps were run three nights per week, Sunday, Tuesday and Thursday, which facilitated collection and shipment by the sanitarians on Monday, Wednesday and Friday mornings.

Based on the *Cx. tarsalis* populations as determined from the New Jersey traps, collection of live mosquitoes commenced in the Richfield area on 3 Aug and in the Delta area on 10 Aug. Traps used were twelve CO_2-baited traps developed by the California Department of Health, Bureau of Vector Control. One to two pounds of dry ice is placed in an insulated gallon can perforated at the bottom, which is secured directly above a 4500 RPM fan powered by three "D" battery cells. The catch bag is closed at the bottom by a spring clip and at the top by another clip when removed from the fan assembly. A plastic disc spreads the catch bag during operation. A miniature lamp is optional. Four CO_2 traps were placed at each site and run for two consecutive nights. Because no 120V power source is required for these traps, much more flexibility in placement is available, although for the most part they were placed in the vicinity of the New Jersey traps.

Traps were run on 3-4 Aug, 17-18 Aug, and 31 Aug-1 Sept in the Richfield area, and 10-11 Aug and 24-25 Aug in the Delta area. Collections were kept alive until they could be identified and separated. Female *Cx. tarsalis* were pooled and placed on dry ice in shell vials and shipped as soon as possible to CDC in Ft. Collins for virus isolation. The remaining mosquitoes were saved when circumstances permitted for future identification.

Several attempts to collect chicken blood for testing were made with limited success due to difficulty in locating and capturing sufficient numbers of birds. On 3 Aug, four chickens and one duck were bled at Venice, Glenwood and Austin, and on Aug, nine chickens were bled at Deseret.

RESULTS

A total of 22,094 females of all species were captured in all traps, both New Jersey and CO_2-baited, from 15 July to 1 Sept. 1983. Of this total, 8336 were *Cx. tarsalis,* 3257 being captured in New Jersey traps over 148 trap nights for an average of 22.0 per trap night, and 5079 being captured in CO_2-baited traps over 152 trap nights for an average of 33.4 per trap night.

Fig. 2 lists the location of all traps and the species and numbers of each that were captured and identified during 1983. The 3370 *Cx. tarsalis* captured in CO_2 traps in the Richfield area on 3, 4 Aug and the Delta area 10, 11 Aug were not included in Fig. 2 because time did not permit the counting and identification of non-*Cx. tarsalis* species. Inclusion in the chart would have biased the number of *Cx. tarsalis* in relation to other species collected in the same traps.

Fig. 3 lists by species the total males and females captured in New Jersey traps, the females by species captured in CO_2-baited traps and the totals of all traps (less the 3370 *Cx. tarsalis* mentioned above).

Fig. 4 shows the average number of *Cx. tarsalis* females captured in New Jersey traps for each night that any New Jersey traps were run. We hesitate to draw any conclusions from these numbers because of several uncontrollable variables. Not all traps were run every night, winds and rain affected some traps and not others on any single night, and later in the summer fewer traps were being run. However, we observed a distinct decline in *Cx. tarsalis* in both areas, Sevier County and West Millard County over the last half of August in both New Jersey and CO_2 traps. Populations of other species, especially *Ae. dorsalis* and *Ae. vexans* remained high, even increasing late in August, probably due to local irrigation practices.

As stated above, 5079 *Cx. tarsalis* were captured in CO_2 traps. These were placed into 110 pools of approximately 50 mosquitoes each. All but the 6 pools (averaging 27 moquitoes/pool) captured 31 Aug and 1 Sept in the Richfield area were sent to CDC in Ft. Collins for WEE testing. All test results were negative.

The 3 Aug bloods from 4 chickens and 1 duck near Richfield, and the 10 Aug bloods from 9 chickens at Deseret were all negative for WEE and SLE virus.

CONCLUSIONS AND RECOMMENDATIONS

Our surveillance sites along the Sevier River were in an area of the State where little mosquito collecting has been done. There are no species lists or population density records extant. Even though 1983 was a year of unusually high precipitation and flooding along much of the Sevier River, the data obtained will be valuable in future years as a foundation with which to compare population trends.

In view of predicted excessively wet years in the immediate future, we strongly recommend that a program of WEE surveillance, and control if necessary, continue in the Sevier River area. Our specific recommendations include starting the surveillance in the early season to identify areas of potentially high *Cx. tarsalis* populations, later abandoning areas of no threat and concentrating efforts in areas of concern. Several sentinel chicken flocks should be placed early in the season in areas of high WEE transmission potential and bled regularly to augment live *Cx. tarsalis* collections, which should be made as conditions dictate.

We also strongly recommend the establishment of mosquito abatement districts in Sevier County and northwest Millard County. These areas are now conducting mosquito control by relatively ineffective means, that of adulticiding in and around municipalities in Sevier County and a hit and miss larvaciding of irrigation canals around Delta. At present, local political and health officials are ill-prepared to go beyond these methods especially from a financial standpoint. Generally, the local populace is unwilling to do more from both a financial and cultural standpoint, and in some areas strong opposition to adulticiding has been experienced. Although the establishment of MADs may be difficult, we feel that this is the only sound way to finance and carry out WEE surveillance over the long term, with the added benefit of control of extremely pestiferous mosquitoes such as *Ae. dorsalis, Ae. vexans* and *Ae. nigromaculis*. It may take a serious WEE outbreak among equines and/or humans in these areas to stimulate action in this matter.

In the meantime, the state may have to be prepared to assume financial and logistical responsibility for WEE surveillance in localized areas of the state for limited periods of time.

---

[1]This project was partially supported through the Federal Disaster Assistance Program, administered by the Federal Emergency Management Agency (FEMA 680 DR)

[2]Present address: 1722 Herbert Av., Salt Lake City, UT. 84108

Fig. 1: Locations of New Jersey light traps along Sevier River in central Utah (small symbols)

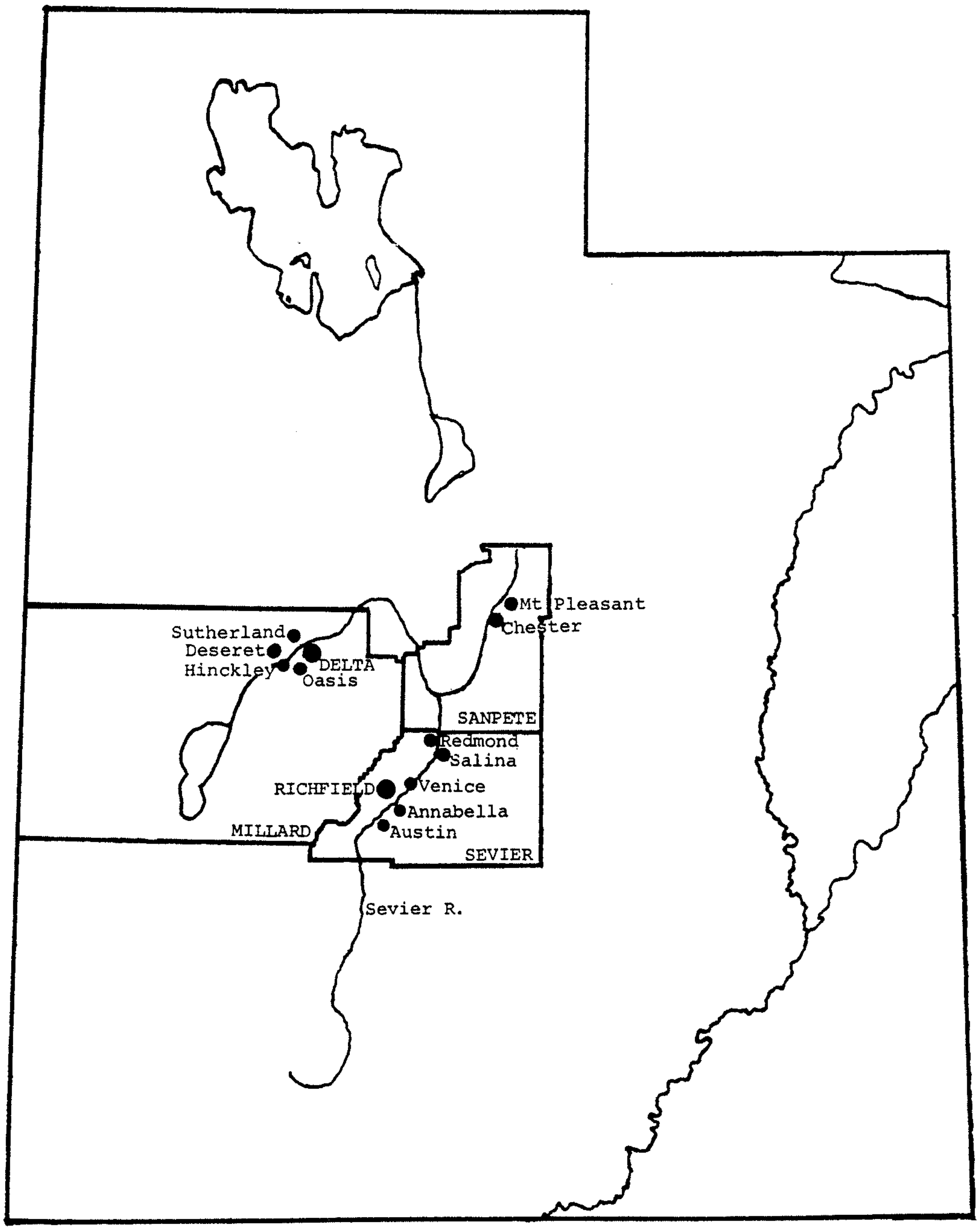


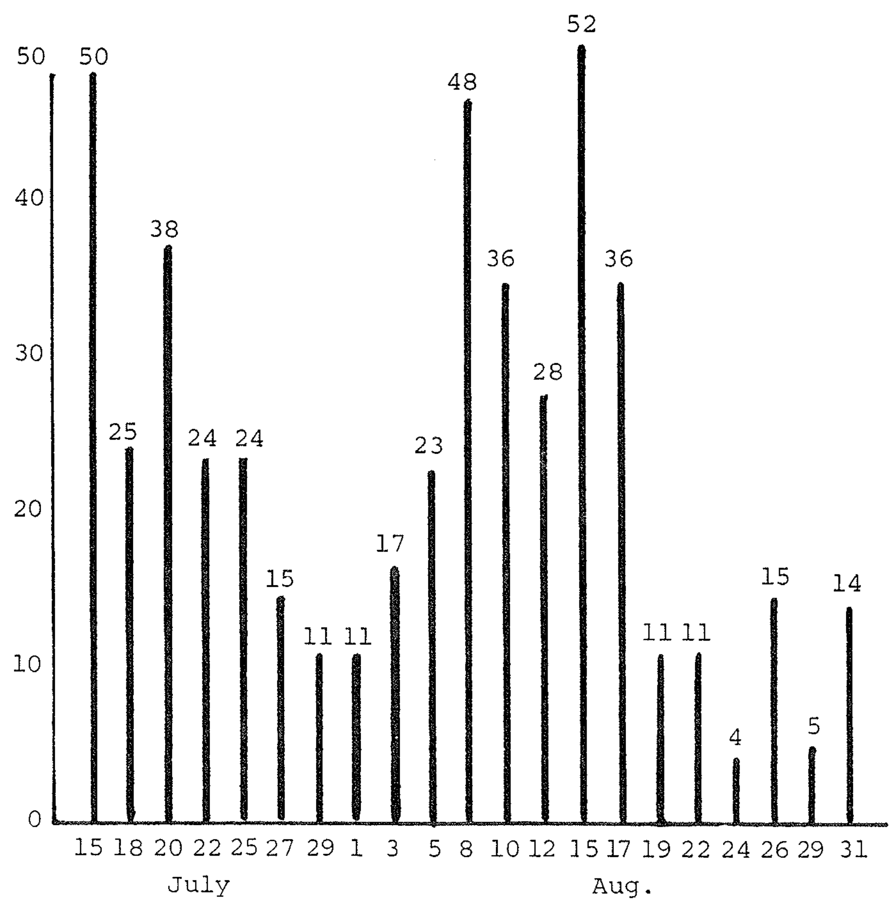
Fig 2: Females collected all traps 15 July — 1 Sept 1983
(3370 *Cx. tarsalis* collected Richfield area 3, 4 Aug and Delta
area 10, 11 Aug not included).

	Cx. tarsalis	*Cx. pipiens*	*Cx. erythrothorax*	*Cs. inornata*	*Cs. incidens*	*Ae. dorsalis*	*Ae. vexans*	*Ae. melanimon*	*Ae. spencerii*	*Ae. fitchii*	*An. freeborni*	*Ae. nigromaculis*	Total
Mt. Pleasant NJ	34			698		10							
Chester NJ	54			200		144							
	88			898		154							1140
Redmond NJ	362	6	2	128		176	259	1241				6	
Salina NJ	423		5	296		184	139	31				231	
Venice NJ	127	3		61		7	2						
Annabella NJ	917	4	1	133		82	41	6				7	
Austin NJ	877	10	1	809	1	59	316	103		7	1	9	
Redmond CO_2	130		19	9		75	93	1				78	
Salina CO_2	182			7		69	328	5				79	
Hwy 119 CO_2	26			2		950	12						
Sevier R. CO_2	31			1		2820	226					1	
Annabella CO_2	428					762	65	1		3		5	
Austin CO_2	238			3		266	310	5		7		3	
	3748	23	28	1449	1	5450	1791	1393		17	1	419	14320
Deseret NJ	61		1	12		115	1						
Oasis NJ	190		3	46		613	4						
Sutherland NJ	74			31		15		1					
Hinckley NJ	131			20		54	1						
Oasis CO_2	214			9		264							
Deseret CO_2	257			2		288							
SW Delta CO_2	112		3	1		299	1					4	
N Delta CO_2	91		1	1		65	8		127			22	
	1130		8	122		1713	15	1	127			26	3142
TOTAL	4966	23	36	2469	1	7317	1806	1394	127	17	1	445	18602
%	26.7	0.1	0.2	13.3	—	39.9	9.7	7.5	0.7	0.1	—	2.4	

Fig. 3: Numbers and species captured by New Jersey and CO_2 traps 15 July — 1 Sept 1983 (3370 *Cx. tarsalis* collected Richfield area 3, 4 Aug and Delta area 10, 11 Aug not included).

MALES & FEMALES NEW JERSEY TRAPS		FEMALES CO_2 TRAPS		TOTALS ALL TRAPS		%
Cx. tarsalis	7476	*Ae. dorsalis*	5858	*Cx. tarsalis*	9185	37.8
Cs. inornata	2793	*Cx. tarsalis*	1709	*Ae. dorsalis*	7807	32.2
Ae. dorsalis	1949	*Ae. vexans*	545	*Cs. inornata*	2825	11.6
Ae. nigromaculis	1534	*An. freeborni*	190	*Ae. vexans*	2217	9.1
Ae. vexans	1672	*Ae. melanimon*	127	*Ae. nigromaculis*	1541	6.3
An. freeborni	290	*Cs. inornata*	32	*An. freeborni*	480	2.0
Cx. pipiens	36	*Cx. erythrothorax*	23	*Ae. melanimon*	127	0.5
Ae. spencerii	16	*Ae. nigromaculis*	7	*Cx. erythrothorax*	37	0.2
Cx. erythrothorax	14	*Ae. spencerii*	2	*Cx. pipiens*	36	0.1
Ae. fitchii	1			*Ae. spencerii*	18	0.1
Cs. incidens	1			*Ae. fitchii*	1	0.0
				Cs. incidens	1	0.0
	15782		8493		24275	

Fig. 4: Avg. no. *Cx. tarsalis* females per New Jersey trap in 11 locations.



SOME VECTOR—BORNE VIRUS DISEASES IN ANIMALS

F. James Schoenfeld
Utah State Veterinarian
Department of Agriculture
Salt Lake City, UT

The epidemiology of diseases deals with three factors: Seed, Sower, and Soil. The Seed is the animal reservoir; the Sower can be direct, indirect, or vector-borne; the Soil is the animal host in which the disease organism grows.

Periodical and seasonal prevalence are two characteristic features of most viral diseases.

It is often difficult to detect virus in carriers or in materials or in hosts suspected of serving as sources of infection. A method of finding an indigenous infection is to observe the clinical infection in an indicator host. Two examples are bovine malignant catarrhal fever where cattle are the indicator host of a virus carried by the wildebeest and probably by sheep, and East African swine fever in which the warthog is the healthy reservoir of a virus that is fatal to domestic swine. The means of communication are uncertain.

A direct method of transmission is seen when rabies virus is transferred from a rabid animal by traumatic or lacerative procedures to one that is not afflicted.

It is possible that insect vectors could be an essential part of a disease transmittal chain in cows and goats if the virus is spread to man by the milk. This is an indirect vector-borne disease.

In Utah there are a number of vector-borne virus diseases that concern livestock and, aside from economic losses, are a potential hazard to man.

Equine encephalomyelitis has been verified as WEE and EEE. In the insect-transmitted encephalitides, mosquitoes are generally conceded to be the immediate vector. The sources in nature are birds, rodents, and possibly reptiles. There is some question about the bird-mosquito, human-animal relationships. A presumptive diagnosis may be based upon clinical signs, history, and seasonal occurrence. Diagnostic support is obtained from the results of positive virus neutralization or hemagglutination-inhibition tests on the acute phase and convalescent sera.

Equine infectious anemia (swamp fever) is an acute or chronic disease of horses. It persists in blood leukocytes of infected horses for life. Transmission is by transfer of blood cells, possibly by biting insects, from ill horses to healthy horses.

Vesicular stomatitis, a disease closely resembling foot-and-mouth disease, occurs in cattle, horses, swine, and a wide range of wild animals. It is usually evident during the warm, moist season of the year, and other than direct contact, it is believed to be spread by biting insects.

Bovine leukosis, affecting cattle and sheep, is one etiologic factor in the adult form of lymphosarcoma. There has been a increase in the number of serological cases in Utah. Studies are in progress on the relationship to various forms of human leukemia and cancer.

Pseudorabies is an acute infection of the central nervous system found in nearly all subhuman mammals although it is primarily associated with swine. It is possible that birds play a part in the transmission of the disease.

Bluetongue is a noncontagious disease of sheep, cattle, goats, and wild ruminants. The principal biological transmitting agent is the midge, Culicoides. Its presence coincides with the seasonal occurrence of the disease.

Anaplasmosis, caused by a protozoan rather than a virus, is a peracute to chronic infectious disease of ruminants characterized by anemia, icterus, and fever. It is spread by surgical procedures or by bites of ticks, horseflies, stable flies, and mosquitoes.

THE VESICULAR STOMATITIS DILEMMA

R. Thair Carver
Veterinary Medical Officer
USDA, APHIS, Veterinary Services
Logan, UT

I don't know why I was asked to give this presentation on Vesicular Stomatitis by the Mosquito Abatement Association, and I have been in a dilemma since being asked. So I have entitled my subject as The Vesicular Stomatitis Dilemma--and it has been that until right now, and from here on out it now becomes your dilemma.

I am sure that insect vectors are responsible for the transmission of this disease, but probably not the most important and would not control it if the insects were brought under control. During the 1982 outbreak, we kept telling ourselves as quick as it freezes the outbreak will stop. It is pretty hard to convince the people in Idaho who had outbreaks during Christmas that insects played any part of the transmission of the disease to them.

Vesicular Stomatitis is a viral disease of horses, cattle and swine. Macules, vesicles and erosions appear successively in the mucous membranes of the mouth or on the skin of the teats or the foot. Mortality or serious sequelae are rare.

The causal agent is a virus belonging to the Rhabdoviridae family, of the Vesiculovirus genus. It is sensitive to changes in pH, especially acid. Serologically, the VS virus has two distinct serotypes, New Jersey and Indiana, with the latter being made up of three subtypes, Indiana I, Indiana II (Cocal) and Indiana III (Alagoas). Even though the NJ and Indiana serotypes are serologically and immunologically distinct, the infections are clinically indistinguishable.

This disease closely resembles Foot and Mouth Disease and other viral mucosal diseases. Confirmation of these diseases all require laboratory tests.

The words Vesicular Stomatitis mean blisters in the mouth. Other names and synonyms for this disease are sore mouth of cattle and horses, erosive stomatitis, stomatitis contagiosa of horses, and aphthous stomatitis of cattle and swine.

History of Vesicular Stomatitis

1864 — sore mouth in horses during Civil War
1904 — vesicular disease in cattle
1915 — recognized in horses sent to France
1916 — extensive outbreaks from Utah to Virginia
1925 — virus isolated from vesicles from cattle at Richmond, Indiana (prototype Indiana VS)
1926 — Cotton, W.E. The causal agent of Vesicular Stomatitis proved to be filter-passing virus. JAVMA 70: 168-181. 1926
1932 — isolate from vesicular lesions of cattle in New Jersey became prototype strain NJ VS
1939 — horses and cattle in Argentina
1941 — Venezuela, included swine
1942 — Indiana VS in Colorado
1943 — New Jersey VS in Colorado, swine in Columbia, VS was enzootic and most severe during dry months when flies are most abundant.
1944 — Colorado, included 3 human cases with NJ V S
1945 — cattle and horses in California, NJ VS
1946 — FMD outbreak in Mexico, farmers thought it was VS
1947 — Indiana VS isolated in Mexico, VS occurs throughout the year with peak during the rainy season
1949 — extensive NJ VS throughout US to Manitoba, Canada
1952 — VE outbreak increased concern for differential diagnosis (Vesicular Exanthema in swine)
1952 — 1956 — reduced VS acitivity
1957 — high incident in Oklahoma of NJ VS
1959 — Texas, NJ VS
1963 — Georgia and Alabama, NJ VS
1964 — Texas, Oklahoma, Colorado, Arkansas, and Missouri, Indiana VS
1965 — Colorado and New Mexico, Indiana VS
1966 — Texas, Colorado, and New Mexico, NJ and Indiana VS
1967 — 1971 — limited activity, 1 to 13 cases per year, NJ VS, subclinical infection detected by serological survey
1972 — 19 cases NJ VS, New Mexico, Louisiana, Colorado, horses and cattle, VI and Tissue CF
1973 — 4 cases, NJ VS, Louisiana, Tissue CF only
1974 —1 case, NJ VS, North Carolina, Serum CF only
1977 — 1980 — Ossabaw Island, very limited serologic positives
1981 — 1 case, Texas, NJ VS
1982 — New Mexico, Arizona, Colorado, Utah, Wyoming, and eventually involved 14 states, NJ VS extensive outbreak

Transmission of the Disease

The ecology of the Vesicular Stomatitis virus is still not very well understood. There are many questions as to where and how the virus is maintained in nature, how it is transmitted from one animal to another, and how it is introduced into herds free of infection. The Indiana and New Jersey viruses may have different cycles. The agent has been isolated from mites, tropical sand flies, and from mosquitoes. Sand flies can transmit the infection transovarially to its progeny and to susceptible animals by biting them. These facts plus the fact that the disease occurs most frequently when arthropods are most abundant suggest that, at least for the Indiana virus, there may be a transmission cycle between wild animals and arthropods. However, several objections to this hypothesis have been raised. Viremia induced in various animals is insufficient to infect biting arthropods. Moreover, the capricious distribution of the disease during outbreaks, which sometimes leaves contiguous farms unaffected, is difficult to explain. Also, there have been epizootics during which it has not been possible to isolate the virus from arthopods. Other hypotheses suggest that the virus is in the soil or pasture and that the animals become infected by inoculation, either through the skin or oral mucosa, or that the reservoir of the virus could be a plant or insect, with vertebrates being only accidental hosts. The replication of the NJ virus in arthropods after feeding on a natural host has so far not been confirmed.

Man contracts the infection by contact with domestic animals, either through the nasopharyngeal route, through abrasions in the skin, or by aerosols. The direct sources of infection may be saliva, the exudate or epithelium of open vesicles, or the virus itself when handled in laboratories.

During the 1982 outbreak, I was asked to do an epidemiological survey in Uintah and Duchesne counties of Utah. I have some slides showing Vesicular Stomatitis lesions in goats, horses, and cattle from the Colorado outbreaks and an infected dairy herd from Kuna, Idaho that will give you an idea of what we saw from this disease. Our big concern with this disease is that it resembles so closely that of Foot and Mouth Disease that, just as happened in Mexico in 1946, we will be dealing with Foot and Mouth Disease and treating it as Vesicular Stomatitis. Foot and Mouth Disease could spread nation-wide before we knew what we had. I am, therefore, including some slides on Foot and Mouth Disease, Rinderpest, Malignant Catarrhal Fever and Swine Vesicular Disease so you can see that these diseases cannot be distinquished by looking at them.

The slide presentation illustrated the Colorado outbreak in goats, horses, dairy and beef cattle; Kuna, Idaho, dairyherd outbreak; and Plum Island Animal Disease Center of experimental foreign animal diseases.

During the survey in the Basin area of Vernal, Roosevelt and Duchesne, it was felt early in the outbreak that insects played a very important part. We kept saying as quick as it freezes the outbreak will stop. Horses kept in stables, handled daily and given some type of vector treatment seem to escape the disease, while horses down on the river and out in the open contacted the disease. Cattle using insecticide type ear tags appeared to have protection, while cattle not so treated, did not. Dairy cattle that became infected involved greater numbers than did beef herds. A reason for this might be the limitations of dairy cattle to use insecticides because of milk production. However, transmission would fit better into contaminated feed, water, and equipment. Certainly animal transmission as indicated by outbreaks due to cattle movements was evident.

This disease seems to run in long cycles. For example, the 1949 outbreak in Utah and then the long period in between before the 1982 outbreak. There is a lot we need yet to learn about this disease and its unusual cycles. Our big concern is still this disease being confused with foreign animal diseases that someday will gain entrance into the United States. We don't say "if" the disease comes but "when".

UNIVERSITY OF CALIFORNIA MOSQUITO RESEARCH PROGRAM

Russell E. Fontaine, ScD
Extension Entomologist
University of California
Davis, CA

The main purpose of the University of California program is to meet the needs of California mosquito control and the public for improved mosquito control materials, equipment, techniques, methods and strategies.

The research program was not created overnight, but evolved gradually over a period of about five years from 1965-1970. Until 1965, the California State Health Department, Vector Control Branch, was conducting research with state funds and doing a good job. But state policy decreed that research supported by state funds was a University function and therefore, should be assumed by the University. The fact is University scientists had been involved in mosquito research ever since the beginning of the century, but not within the framework of a program. Researchers carried out their studies on an individual basis supported with grant funds from various federal and state agencies, industry, foundations and other sources.

The concept of a goal-oriented program organized within the University system of nine campuses was something quite different from the usual approach to University research. It evolved because of a statewide crisis in mosquito control in the mid-1960's due to widespread mosquito resistance to synthetic insecticides (the organochlorines, the organophosphates, the carbamates). The resistance problem emerged from overdependence and the overuse of synthetic insecticides by MADs for virtually every kind of mosquito problem. It wasn't that insecticides were bad. On the contrary they were and are still essential for mosquito control. It was their excessive use without sufficient integration of other methods and strategies that needed correction. Moreover, the possibility of a resurgence of mosquito-borne diseases without adequate measures for prevention threatened public health.

This was the scenerio that led the University to organize a University-wide mosquito research program. With the support of the CMVCA and a legislative appropriation of state funds specifically designated for mosquito control research, the program was implemented in 1971-72.

The objective was to pursue a comprehensive program of pure and applied research, with emphasis on applied. Pure or basic research is designed to expand our base of scientific knowledge rather than to achieve some specific predetermined, applied objective.

The program has several unique features that set it apart from traditional research in the University.

1. It includes the entire University system of nine campuses and the schools of public health and the Cooperative Extension Service. Any scientist in the system is eligible to submit a research proposal and to receive an award providing his or her proposal meets the approval of the research committees. There are three committees in the review process: The California Mosquito Vector Control Association research committee, the Mosquito Research Technical committee, and the University-wide Mosquito Research Advisory committee.

2. The committees evaluate the progress of the research by the impact made on solving mosquito problems affecting the control effort in the state and not by the number of research papers published by participating researchers. This is not to imply the program opposes papers. It supports the cost of publications, but the emphasis is on the relevance of the research to the needs of California mosquito control.

3. An outstanding feature that has greatly strengthened the program is the close collaboration between mosquito abatement districts and University researchers in the implementation of field research projects. About 60% of the projects involve participation with MADs. The value of the MAD participation is estimated at $100,000 annually. Incidentally, the total funding for mosquito research from all sources, federal, international and private was over $2 million in 1982.

With this background of the program, let's look at some highlights of the research in 1983.

The University program groups the research according to categories as follows:

Categories of mosquito Research	No. of studies 1982-83
Vector Disease Control	3
Biology, Ecology, and Ethology	9
Genetic Control	2
Biological Control	13
Chemical Control	8
Physical and Cultural Control	3
Application Equipment	1
Integrated control	3
	42 studies

This breakdown shows the comprehensive coverage of the research. Altogether it adds up to integrated mosquito control.

Vector Disease Control.

The Professor Reeves' team, UC Berkeley, School of Public Health, is continuing their regular research activities on basic studies on: (1) The competence of different strains and species of vector mosquitoes to transmit viral infection, (2) on the biology and genetics of *Culex tarsalis*, (3) on statewide epidemiological surveillance of WEE and SLE in participation with State Health and MADs. Last year and this year mosquito pools continue to reveal much viral activity but very few human cases reported. Only eight were confirmed in 1983.

Evaluation of aerial ULV application for control of *Culex tarsalis*. Field trials on adult *Culex tarsalis* control using ULV aerial spraying was given high priority last summer and this summer because we don't have an effective adult control system to fall back on in the event of an epidemic of WEE or SLE.

Aerial spray trials in Kern County last summer, 1982, showed low mortality of natural mosquito populations using Dursban and Ficam. Failure was attributed to mosquito resistance and to the flight and biting activity of *Culex tarsalis* being asynchronous with the timing of spray application.

Aerial spraying trials this summer indicated much better results using Baygon (propoxur) applied by helicopter and fixed-winged aircraft.

Dog Heartworm Disease. Our research on this disease has shown an endemic distribution in northern California and in parts of southern California. Research has confirmed that at least four species of mosquitoes are capable of transmitting the disease. The principal vector is the treehole mosquito, *Aedes sierrensis*, but *Aedes vexans, Anopheles punctipennis* and *Anopheles freeborni* are also competent vectors. The disease is widely distributed throughout the State in residential and recreational areas. Although infections are confined to canines, occasional self-limiting human infections are detected appearing as coin lesions resembling a T.B. spot in lung x-rays.

Genetic Control

In genetic control, our genetics researcher, Sr. Monica Asman, has run into fundamental problems with the sterile male technique. She found that colony-reared *Cx. tarsalis* sterile males are poorly competitive against wild males. On the other hand, irradiated, sterile, wild males are fully competitive. Therefore, the loss of competitiveness stems from the rearing process. So, further field research has been suspended until such time as the rearing problem can be sorted out.

In another sterile male experiment to control treehole mosquito (*Aedes sierrensis*) populations in a small woodlot, Professor John Anderson from UCB found that colony-reared, irradiated, sterilized males were fully competitive with wild males. This would indicate that a mating-competitive problem with one mosquito species does not necessarily apply to another.

Mosquito Biology, Ecology, and Ethology

Many mosquito workers tend to "poo poo" this line of research as impractical but this is not the case. The aim is to enrich the knowledge about the behavior, habits, survival rates, host preferences and other characteristics of pest and vector mosquitoes. We consider ecological knowledge of mosquito species as a basis for effective planning and efficient execution of control measures.

We have recovered some interesting information from nine projects but nothing spectacular that would constitute a breakthrough. It's the kind of research which produces items of information that may eventually add up to breakthroughs.

Biological Control

After much research we find that biological control offers no panacea for mosquito problems. It's just another approach to complement other control methods in a balanced integrated program. Most researchers regard biological control a fascinating but difficult line of research because of complex interactions between multiplicity of predators, parasites, and pathogens in most mosquito breeding habitats. In many situations, the interactions between organisms boggles the scientific mind to try to sort out all the variables about who is doing what to whom!

In 1982-83, we had 13 studies in progress dealing with mosquitofish, nematodes, bacteria, and fungi.

Mosquitofish research is heavily supported because it is the principal bioagent used by MADs. Virtually every control agency employs fish in routine operations. At this juncture in our fish program, we have reached an impasse in the research on mass rearing fish. The MADs have a big shortfall in fish production meeting only about 20% of the need in the rice-growing areas of the state. Learning from errors of previous research attempts, we have launched another pilot project fish production unit under the direction of Jim Hoy, UCB, working in collaboration with Dr. Chuck Beesley, Manager, Contra Costa MAD. We are hoping for a breakthrough this time, but we are keeping our fingers crossed.

Fungi: The fungi, *Coelomomyces* and *Lagenidium,* have been extensively studied for the program but there is no evidence that they are ready for use on a practical scale in mosquito control.

Bacteria: If we asked to select something in this program that approached a breakthrough we would say B.t.i. without hesitation. This spore-forming bacterium is one of many strains of B.t.i. toxic to insects, some of which are sold commercially for control of cabbage loopers, hornworms, and other chewing insects.

Although B.t.i. was discovered in Israel, 1976, most of the developmental work which led to its registration in 1982 was a product of the UC research program between 1978 and 1981.

The beauty of B.t.i. is its selectivity to mosquito larvae and its safety to warm-blooded animals and many non-target organisms. For years entomologists have been searching for a mosquito-selective larvicide harmless to beneficial organisms in the aquatic habitat. B.t.i. fulfills this need. The only animals affected thus far, other than mosquito larvae, are certain non-biting and biting gnats in the families Dixidae, Simulidae and Chironomidae. Currently it is the principal larvicide used for the control of Simulid vectors of Onchocerciases in W. Africa.

In California many mosquito abatement districts are using the product for mosquito control in a variety of habitats—from rice fields to waste water lagoons.

B.t.i. does not recycle and therefore must be reapplied to breeding places like a chemical insecticide. This disadvantage is partially overcome by its non-injurious effects on mosquito predators, parasites, and pathogens which play an important role in suppressing mosquito populations.

B. sphaericus: This microbial shows good potential for mosquito control and is being extensively tested in the laboratory and field. It is quite specific and active against *Culex* and *Anopheles* mosquitoes but less so against *Aedes* mosquitoes. Unlike B.t.i. it shows some evidence of recycling. However, under practical conditions it still must be reapplied like an insecticide for effective results.

Like B.t.i. it is harmless to non-target organisms and totally safe to use in environmentally sensitive situations.

The nematode parasites *Romanomermis culicivorax* is being successfully reared but for control of mosquito larvae in the field it has not been effective to date.

Chemical Control

Research on chemical control in 1982-83 has focused evaluation of mono-layer films, insect growth regulators, botanical insecticides, and ovipositional attractants and repellents. Our program gives high priority to researching environmentally safe insecticides.

Professor Mulla and Dr. Schaefer research teams reported poor to good results with the mono-layer films in different mosquito habitats. The details are reported in our 1982 annual report and more will be forthcoming in the 1983 report.

Some IGRs tested were effective but apparently impact on non-target organisms at high dosage rates.

We are supporting research by the Mulla team on alleochemicals of plant origin toxic to mosquitoes on ovipositional attractants and repellents and cuticular lipids of mosquitoes. Again details are given in the 1982 report.

Studies of mosquito resistance to chemicals is continuing under G. P. Georghiou at UC Riverside. Based on resistance testing of B.t.i., we should be optimistic about its continuing effectiveness in the future.

Reduction in Insecticide Usage

One of the objectives of the research program was to help alleviate overdependence and overuse of the synthetic organophosphorous and carbamate compounds by the MADs. Since the program was founded in 1971, these insecticides have been reduced 65% from 134,000 pounds of a.i. in 1971 to 48,000 pounds in 1981.

Physical and Cultural Control

California faces increasing mosquito problems from the proliferation of mosquito problems associated with waste water disposal, reclamation and reuse activities throughout the state. One important problem is urban waste water drainage systems. Through lack of maintenance, numerous mosquito problems are being created in our big cities. For example, the Los Angeles basin is traversed by huge, open and underground storm drains that create numerous mosquito breeding places throughout the system. The failure of the cities to maintain the drains and clear them out routinely is the basic cause of the problem.

There is much more to say about the UC research program. We just skimmed the surface. However, the 1982 Annual Report of the program tells most of the story and we can send you copies at your request.

We find that mosquito problems in California are dynamic and subject to change influenced by developments in agriculture, industry, urbanization, and recreation. So research will have plenty of challenges to work on in the future. And finally, the mosquito problems are not likely to be solved by dramatic breakthroughs but more realistically by the gradual application of new knowledge obtained from a continuing program of comprehensive, integrated research.

VECTOR CONTROL IN CLARK COUNTY — AN UPDATE

Richard C. Hicks
Chief of Vector Control
Department of Public Works
Clark County Vector Control
Las Vegas, NV

I appreciate this opportunity to provide an update of vector control in Clark County, Nevada. Since I presented a paper at the UMAA Meetings in 1976 (Hicks, 1976), some changes have occurred in our organization and program that I would like to share with you.

In 1979 Clark County Vector Control became a separate division within the Department of Public Works. Prior to this, Animal and Vector Control were combined with one division head. Both divisions still share a common office staff and are housed in the same building.

Biological and Chemical Control

Our most commonly used and most successful method of mosquito abatement in Clark County has been the use of the mosquitofish, *Gambusia affinis* (Baird and Girard). We have increased our use of *G. affinis* extensively over the last six years.

In 1979 we used 52,000 mosquitofish, whereas in 1982 we relocated 121,000 fish. Concurrently we decreased our use of Baytex 2%, a granular larvicide, by 80%. Forty-five hundred pounds of larvicide were used in all of Clark County in 1976 as compared to 875 pounds in 1982. In the Las Vegas Valley itself, excluding the farming valleys north of Las Vegas, there was a 94% decrease in the amount of larvicide applied, 2150 pounds compared to 130 pounds.

Part of the reduction in the amount of larvicide used is due to the elimination of some breeding sources through land development and the removal of locations from our treatment list because of their distance from populated areas.

We have placed *G. affinis* in essentially all mosquito breeding locations where there has been enough water to support them, even if only on a temporary basis. The fish have been placed in roadside ditches, flood channels, and other locations where in the past we would have applied larvicide.

On August 2nd of this year 5,000 mosquitofish were delivered to Mohave County, Arizona, in a cooperative effort to abate mosquitoes in areas recently flooded by the Colorado River.

Fish Trapping

Gee's wire minnow traps have been placed in flood channels and drainage ditches to trap *G. affinis*. Styrofoam floats have been placed on some of the traps so that the entrance remains at the surface of the water, providing the fish easier access to the trap. No significant difference has been noted in the results of our trapping whether we bait with oatmeal, dog food or use no bait at all; therefore the traps are not baited.

The mosquitofish are collected periodically March through October from 15 traps. During an 8-hour day, 700-1000 fish are trapped. The traps are left in position 2-3 hours before the fish are gathered and placed where needed. They are transported either in a 5-gallon bucket or in a Duracraft "pickup" model aluminum hauling tank if the fish need to be held overnight or transported out of the city. A metal holding cage has been placed in a flood channel to provide temporary storage of the fish when it is necessary to hold them for 1-3 days before being placed.

Fish Electroshocker

In an attempt to increase the number of *G. affinis* collected and reduce the time required to trap them, inquiries were made into the feasibility of using a fish electroshocker. In checking with Nevada Fish and Wildlife personnel and some mosquito abatement districts in California, it appeared that there really wasn't too much known about what effect an electroshocker would have on mosquitofish.

In 1980 in consultation with Coffelt Electronics Company, Inc., Englewood, Colorado, we purchased a Variable Voltage Pulsator, Model No. VVP-3E, Electroshocker, a unit designed to have application in hard water conditions typical in the drainage channels in the Las Vegas area. A 240V 2750W gas powered Homelite Generator was used to run the electrofisher. Two 5-foot electrode handles and 100 feet of cable completed the unit. The electroshocker was placed in the bed of a 3/4 ton pickup truck.

We were able to stun *G. affinis* and net them at the water's surface when the electrodes were spaced 1-5 feet apart. Two hundred fifty DC volts and 8 amperes were needed to shock the fish. The results were variable. The small size of the fish as well as the alkaline condition of the water apparently attributed to the inconsistent results obtained with the shocker.

We found the electroshocker impractical for our intended use. At least three men were needed to run the unit, and there was always a serious hazard associated with the use of the electrodes when the agents were standing in the water. For the time spent in equipment setup, manpower needed, safety hazards, and the inconsistent collection results, we decided to return to our conventional, proven method of fish trapping.

A backpack electroshocker unit would be the most convenient to use, but one was not recommended that would give satisfactory results in hard water. The unit would be safer, too, if it were practical to use in a boat.

Midge Control — Bullheads and Carp

In addition to the widespread use of *G. affinis* for mosquito control, we have introduced other fish species for the biological control of chironomid midges. The Nevada Fish and Wildlife Department has made available to us black bullheads, *Ictalurus melas* (Rafinesque), of the catfish family and carp, *Cyprinus carpio* Linnaeus. The first collection, in March 1977, consisting of 850 bullheads (6-8 inches long) and 170 carp of various sizes, was seined from a pond on the Overton Game Refuge, 50 miles NE of Las Vegas.

The fish were first transported to Las Vegas in 30-gallon plastic garbage cans containing blocks of ice. Subsequent collections were transported in the Duracraft fish tank.

The fish were placed in the major drainages of the Las Vegas Valley and in some recreational park ponds. The bullheads established themselves in some areas to the extent that trophy-size fish have been caught by fishermen. The largest fish reported has been a 13-inch long bullhead weighing 1 pound 5 ounces. It was caught in June 1978, 15 months after being planted.

Not many of the carp have survived because avid youngsters have netted and fished them out of the channels. The bullheads are not as noticeable as the carp and are less easily caught in large numbers because they bury themselves in the sediment and are nocturnal feeders.

No studies have been conducted to determine if the bullheads and carp are depleting the midge populations, but fewer midge complaints from area residents may be an indication that the fish are helping.

Flooding in mid-August of this year has deposited silt in some of these channels to the extent that locations where bullheads were abundant have now been filled in completely. These areas will be monitored to determine what effect this flooding has had on the bullhead population.

Encephalitis Survey

In the summer of 1980, a virus, thought to be arthropod-borne, was suspected of causing the hospitalization of at least 5 people and affecting 30 residents with encephalitis-type symptoms in Bunkerville and Mesquite, farming and ranching communities in Virgin Valley, 75 miles northeast of Las Vegas.

To determine the source of these illnesses, Dr. Telford H. Work of the UCLA School of Public Health was contracted by the Clark County Health District to conduct an arbovirus survey in these communities adjacent to the Virgin River. This area is a few miles south of where Elbel, et al. (1977) did an arbovirus study in 1972-75. It was determined to collect mosquitoes and bleed chickens as part of this arbovirus surveillance which began mid-August, 1980.

Six BVS miniature light traps and dry ice were used to collect mosquitoes on two consecutive nights. From these collections of 1494 mosquitoes, sorted into 52 pools consisting mainly of *Culex tarsalis* and *Cx. erythrothorax*, one isolate of Turlock Virus from one pool of *Cx. tarsalis* was recovered from isolation attempts in suckling mice.

Of 64 sera collected on 15 August from 3-year-old chickens, 5 were positive in hemagglutination inhibition (HI) tests for both Saint Louis encephalitis (SLE) and western equine encephalitis (WEE), and three sera were positive for California encephalitis (CEV).

Dr. Work concluded from the laboratory studies of mosquitoes, chicken bloods, and human stool specimens that the illnesses were not caused by an arthropod-borne virus but rather by an enterovirus, Coxsackie Type A9.

Summary

There has been an increased use of the mosquitofish, *G. affinis*, for the control of mosquitoes in Clark County, Nevada, with an attendant significant decrease in the amount of chemical larvicide used in the last six years. Other fish species, carp and bullhead catfish, have been used in an effort to control chironomid midges.

A fish electroshocker unit has not proven successful in capturing large numbers of mosquitofish; wire minnow traps are used instead.

An arbovirus study in 1980 determined that encephalitis-like illnesses in Bunkerville and Mesquite were caused by an enterovirus.

Literature Cited

Elbel, R.E., G.T. Crane and C.H. Calisher. 1977. Arbovirus isolations from southwestern Utah and northwestern Arizona insects, 1972-75. Mosq. News 37:497-507.

Hicks, R.C. 1976. Mosquito control activities in Clark County, Nevada. Proc. Utah Mosq. Abate. Assoc. 29: 7-9.

AROSURF® MSF: A NEW LARVICIDE AND PUPICIDE FOR MOSQUITO CONTROL

Richard C. Dodwell and Robert L. Harrison
Commercial Development
Sherex Chemical Co., Inc.
Dublin, OH

Sherex would like to express our appreciation to T. Wayne Miller, Jr., Director and Dr. Richard Levy of the Lee County Mosquito Control District in Fort Myers, Florida, for supplying the slides and much of the data used in this presentation.

Arosurf® MSF is an exciting new tool for use as a larvicide and pupicide in integrated mosquito control programs. Chemically, Arosurf® MSF is the two mole ethoxylate of isostearyl alcohol. It is a biodegradable, non-petroleum surface active oil that has been shown to be effective in controlling the larval and pupal stages of over 25 species of mosquitoes. When applied to a mosquito habitat in low dosages, Arosurf® MSF spontaneously and rapidly spreads over the surface of the water to form an ultra-thin film that is approximately one molecule in thickness, hence its classification as a "monomolecular surface film".

The film does not kill mosquitoes by toxic action characteristic of most other larvicides. Instead, it kills larvae and pupae by inhibiting their proper feeding, resting, breathing and molting orientation at the air-water interface and by increasing the wetting of the tracheal structures leading to drowning. Since the kill mechanism is physical in nature, resistance of mosquitoes to Arosurf® MSF is not expected to develop. The product can be used to entrap and drown female and male mosquitoes that oviposit or rest on the water surface. It can also wet, sink, and inhibit the eclosion of floating eggs and egg rafts and *Culex* and *Anopheles* species.

Sherex Chemical Company has manufactured this product for use as an emollient and emulsifier for personal care products such as bath oils and skin lotions for over 20 years under the trade name of Arosurf® 66-E2. Consequently, the two mole ethoxylate of isostearyl alcohol had a long history of safe use even before it was considered for use in mosquito control. It was not until 1976, that Arosurf® MSF was conceived as a potential mosquito control agent by the U.S. Navy as a spinoff from research on the containment of small oil spills by monomolecular surface films. Essentially, the use of this product for mosquito control remained a laboratory phenomenon from 1976 to 1979. In 1979, the Lee County Mosquito Control District in Fort Myers, Florida, initiated a cooperative project with the U.S. Naval Research Laboratory to determine if this material could be used effectively in operational mosquito control programs. Extensive laboratory and field studies with a large number of surface films indicated that of those tested, Arosurf® MSF was the most effective and efficient film-forming agent for controlling a broad spectrum of mosquitoes.

The results of toxicological testing indicates that Arosurf® MSF has a low order of toxicity. The acute rat oral LD_{50} is greater than 20,000 mg/kg, the acute dermal rabbit LD_{50} is in excess of 2,000 mg/kg and the product is nonmutagenic by the Ames test. Twenty-four hour occluded skin patch tests conducted on human subjects resulted in no evidence of skin irritation. While the product is mildly irritating to the eyes of rabbits, the effects were reversible within seven days. Chronic and carcinogenic studies conducted on closely related fatty acid and fatty alcohol ethoxylates have demonstrated no observed effects at high feeding levels and no evidence of carcinogenicity. Laboratory and field studies on a wide variety of non-target fish, crustaceans, mollusks, birds, insects, mammals and aquatic plants, at and well above the recommended application rates, have indicated that little or no adverse effects are to be expected. Studies have also demonstrated that the product is compatible with mosquito predators or parasites such as Gambusia, hydra, flatworms and nematodes. It should be noted that aquatic insects such as water striders, water measurers and certain aquatic beetles that are intimately associated with the air/water interface can be drowned in shallow semi-permanent habitats, particularly under strong wind conditions. However, the effect is usually minimal and recovery of the affected populations is rapid.

Arosurf® MSF is currently under review by the EPA for national registration as a mosquito larvicide and pupicide. Most recently, the EPA has exempted the two mole ethoxylate of isostearyl alcohol from the requirements of a tolerance for residues in or on fish, shellfish, irrigated crops, and other foods. It is expected that Arosurf® MSF will be fully registered by the EPA for operational mosquito control within the next few months. For the past year, the product has been used on a semi-operational basis by several mosquito control districts in Florida under an experimental use permit granted to the Office of Entomology by the Department of Environmental Regulation. Data from the Office of Entomology has indicated that this product is a safe and effective technique for use in Florida mosquito control programs.

Arosurf® MSF can be applied as technical material or as a water-based suspension by conventional ground and aerial techniques at application rates of 0.3 - 0.5 gal. per surface acre of habitat water. Control of larvae is usually achieved in most species of mosquitoes within 24-72 hours. Rates of 0.2 - 0.3 gal./acre can be used to control pupae and emerging adults within 24 hours after treatment. The product has been shown to persist in a variety of mosquito habitats and kill mosquitoes for up to 10 days at application rates of 0.2 - 0.5 gal./acre.

The technical film can be supplied by the following techniques:

— Small and inexpensive pump sprayers or compressed air sprayers. Since the product is applied at low treatment rates, larger areas can be controlled with Arosurf® MSF than with similar quantities of conventional larviciding oils.

— Helicopters equipped with slightly modified spray systems. Application by this technique is particularly effective for uncanopied habitats having little or no emergent or surface vegetation (e.g. *Psorophora* habitats).

— Truck mounted high pressure spray systems equipped with commercially available injection valves for application in roadside ditch larviciding.

Arosurf® MSF can also be applied as a milky water based suspension at up to 10 percent by weight of the product in water by:

— Truck mounted spray systems equipped with high sheer paddle agitation for application as a high pressure spray at volumes of 3-5 gal./acre.

— Helicopters equipped with raindrop nozzles for application of the pre-mixed water based suspension at a rate of 5-6 gal./acre. This technique has been shown to be effective for penetrating moderately vegetated canopies.

In order to maximize the performance available from the surface film approach to mosquito control, the application should take into account the following consideration:

— Application of Arosurf® MSF to habitats subjected to persistent unidirectional winds of 10 mph or greater, surface drainage, over-flow or run-off will result in displacement or removal of all or most of the surface film from the habitat.

— When spraying habitats where the water surface is highly obstructed (e.g. sewage treatment systems), application at a dosage of ca. 0.4 - 0.5 gal./acre is recommended. The higher dosage is expected to compensate for loss of film on vegetation or floating debris, therefore, assuring adequate coverage of the habitat.

— Expansion of the water surface of a mosquito habitat from rain or tidal fluxes after application of Arosurf® MSF can significantly reduce the initial surface dosage to below the effective level. It is recommended that, when habitat surface expansion is expected to occur within 24 hours after treatment, the habitat be treated with a dosage that is based on the expected water surface area. This will assure adequate film persistance and eliminate the need for retreatment of mosquito broods resulting from the new water.

— Arosurf® MSF does not form an oil sheen and is not visible on the surface of the water. Its presence can be determined by adding a drop of Adol® 85 oleyl alcohol from a plastic eye dropper bottle to the water surface at several locations. If the drop of oleyl alcohol beads on the surface of the water, the film is intact and effective for mosquito control. Spreading of the indicator oil means that the product is either absent from the zone tested due to wind or is not present in sufficient quantities for mosquito control. The use of indicator oil at various intervals after Arosurf® MSF application is an important operational tool for use in backchecking a mosquito habitat to determine if retreatment is necessary. Its use will insure the confidence of the applicator that material is present and will prevent unnecessary reapplications.

Arosurf® MSF resists oxidative decompostion, is non-volatile, and therefore should have an essentially unlimited shelf-life when stored at ambient temperatures typically encountered in indoor or out-of-door facilities. Technical or water base formulations exhibit a similar high degree of stability in spray tanks. Unused material can remain in a spray tank for weeks or longer providing that contaminants have not been introduced into the system.

Research on the development of activated formulations of the product are presently in progress. Certain solvent and amine systems have shown promise in enhancing the rate of larvicidal action. Experiments have shown that Arosurf® MSF formulations can be applied with intermittent drip-dispensing devices and commercial oilers to provide prolonged mosquito control in areas such as irrigation and sewage treatment systems. Formulations of Arosurf® MSF with BTI or Abate 4E can produce a combined rapid larvicidal and pupicidal effect that cannot be achieved with the individual formulation components while significantly enhancing field coverage. Sherex research has also indicated that the product can be formulated into several types of slow-release biodegradable matrices for obtaining prolonged mosquito control for 30-90 days in permanent and semi-permanent habitats. Laboratory and field trials with these formulations and release mechanisms are currently in progress.

In summary:

Arosurf® MSF has many advantages which make it an attractive product for control of mosquito larvae and pupae.

1) It is safe to use and non-hazardous to applicators and the environment.

2) The product is effective at low surface dosages.

3) Arosurf® MSF is rapidly biodegradable at recommended dosage levels.

4) It has a broad spectrum of activity.

5) Mosquito larvae and pupae are unlikely to develop resistance.

6) It is practical to apply by conventional techniques.

7) The product has good storage stability.

8) And it is useful against larvicide resistant populations.

We feel that Arosurf® MSF will become an important tool for use with other standard techniques used in integrated mosquito and vector control programs in the U.S. and overseas.

MOSQUITO CONTROL IN LARAMIE, WYOMING, INCLUDING USE OF *BACILLUS THURINGIENSIS*

Donald L. Forcum
City Sanitarian
Laramie, WY

Abundant mosquito breeding areas occur near the City of Laramie, elevation 7200 feet, due to spring runoff of melted snows in late May and June. This water causes flooding of the Laramie River and adjacent meadows resulting in great production of *Aedes* mosquitoes. Much of the runoff is used as flood water irrigation and may stand on the fields until early summer.

The mosquito abatement program, which is the largest in the state, was started in 1971 (Forcum 1972). It is financed by $1.50/quarter fee on each water meter hookup in the City, which provides about $35,000/year. Most of the population of Albany County lives in Laramie and in 1974, the Albany County Weed and Pest District officially declared the mosquito a nuisance that required control. Under a yearly contract, the City is repaid for the aerial spraying of about 9,000 acres/year at a cost of about $10,000. With the Weed and Pest District acting as our agent, the lowest bids can be obtained for insecticides and application. In 1977 joint bidding started with the City and the Big Laramie Mosquito Control Association, which is a group of private ranchers who raise their own funds and direct their own program. The results are dramatic cost saving for the City, since the Association treats 20-30,000 acres.

Our typical control efforts start in late May when the flood plain and irrigated pastures within 10 miles of the City are aerially treated for larvae using 1 qt./acre of diesel oil with 1 oz./acre of Baytex L.C.. Later in the season the City is adulticided with ULV malathion from truck units.

During 1982 and 1983, *Bacillus thuringiensis* was tested in habitats that included ponds with heavy vegetation, ponds with sandy bottoms, and one pond with sewage overflow.

Larval densities were judged by dipper counts with a minimum of 15-20 dips or up to 50 dips depending on the size of the area. Inspection was for first and second instar larvae. The total size of the area to be treated was estimated. Dosage rates were calculated according to label recommendations, the compounds mixed with water, and the ponds treated. Generally, assessment of the kill was made in 24 hours.

Formulations of materials were Bactimos wettable powder, flowable concentrate, briquets, and Teknar flowable concentrate. Application was by spray can, portable backpack spray unit, or 100-gal. tank with pump and hose mounted on a truck.

Evaluation

Bactimos briquets gave only 50% kill in 48 hours in one pond. They floated, were not tied down, and there was insufficient time for further testing.

Results of liquid formulations were considered to be very effective and are listed below.

	APPLICATION RATE	PERCENT KILL IN 24 HOURS
Bactimos wettable powder	2-7 oz./acre	90-100%
Bactimos flowable concentrate	1 pint/acre	60-90%
Teknar flowable concentrate	½-2 pints/acre	99-100%

The flowable concentrates were somewhat easier to work with than the powder. It was necessary that applications be uniform over the entire surface of the water. Some small areas not directly treated did not show good control. Unlike oil mixtures, the liquid formulations of BTI did not spread and treated water was hard to see. Water with fluctuating levels required retreatment. Timing was important in order to reach first and second instar larvae for adequate control. Mosquito control by BTI compounds was considered successful even under conditions of cold air and water temperatures.

Cost estimates, as shown below, indicate that for use in aerial larviciding, Teknar would be more expensive than Baytex (see Forcum and Cudzilo 1983).

	Baytex L.C. Actual Cost/Acre Laramie 1982	Teknar Estimated cost/acre
Larvicide	$0.56	$3.20
Diesel oil	0.32	— —
Application	0.98	2.00
	$1.86	$5.20

The use of Baytex presents some hazards to birds (DeWeese et al. 1983). The alternate choice of BTI formulations is currently limited by expense.

Recommendations

A. Wyoming needs the ability to establish abatement districts. Rancher involvement has worked well but funding may not always be certain.

B. Future use of BTI compounds is preferable due to ecological considerations, but they are not yet cost-competitive on a large scale basis.

References

DeWeese, L.R., L.C. McEwen, L.A. Settimi, and R.D. Deblinger. 1983. Effects on birds of fenthion aerial application for mosquito control. J. Econ. Entom. 76:906-11.

Forcum, D.L. 1972. Mosquito control problems of Laramie, Wyoming. Proc. Utah Mosq. Abate. Assoc. 25: 20-1.

Forcum, D.L. 1982. Mosquito Control Report. City of Laramie, Wyoming.

Forcum, D.L. 1983. Mosquito Control Report. City of Laramie, Wyoming.

Forcum. D.L. and G.A. Cudzilo. 1983. Evaluation of Bactimos and Teknar for control of floodwater mosquitoes, Laramie, Wyoming. Proc. West Central Mosq. and Vect. Contr. Assoc. 8:24-9.

MOSQUITOES AND TARWEED — FIELD OBSERVATIONS AND LABORATORY EVALUATION

E.J. Kingsford[1], M.F. Balandrin[2], J.A. Klocke[2], and R. P. Adams[2, 3]

How often have you looked at two mosquito breeding sites and thought: They are so much alike, why aren't there larvae in both of them? A number of such observations were investigated at the Butte County MAD in California. The absence of mosquito larvae in some pools was determined to be due to the presence of various predatory organisms. However, there were sites that lacked predator populations and still did not produce mosquitoes. Further study of those sites exhibited one notable, but previously overlooked, difference between producing and non-producing sites. The predator-free, non-producing sites contained a plant that was not present in similar, producing sites.

The tarweed, *Hemizonia Fitchii* Gray (family Compositae), is a resinous plant common in some parts of California. When it was found in, or trailing in, pools formed by spring rains, mosquito production was very low to non-existent. Removal of the tarweed from the pools allowed mosquito production to occur.

Crude extracts of the plant were made for laboratory testing. A modified WHO bioassay was used with *Culex pipiens* as the test organism. The results of the tests indicated sufficient toxic activity to warrant additional study.

The Plant Resources Institute, Salt Lake City, was equipped to do chemical extractions from fresh plant material from Butte County. In bioassays, the oil fraction was the most active against *Cx. pipiens* larvae. Chemical isolations of the biologically active oil fraction led to the identification of five major components as well as several volatile fatty acids, alkanes p-coumarate derivatives, minor chromene derivatives, and a number of mono- and sesquiterpenoids. The major constituents isolated were monoterpenoid 1, 8-cineole; the chromene, encecalin; eupatoriochromene (desmethylencecalin); 6-vinyl-7-methoxy-2, 2-dimethylochromene; and desmethoxyencecalin.

The chromenes exhibited weak to moderate toxicity against *Cx. pipiens* larvae and nymphs of the milkweed bug, *Oncopeltus fasciatus*. No developmental effects were detected in survivors of either insect.

A full report of the work will be published in the Journal of Chemical Ecology.

[1]Formerly, Entomologist, Butte County MAD, Oroville, CA; Presently, Manager, Logan City Mosquito Control, Logan, UT.

[2]Plant Resources Institute, Salt Lake City, UT.

[3]Present address: Department of Botany, University of Texas, Austin, TX.

PESTICIDE LABELS CAN BE INTERESTING

Howard Deer
Extension Pesticide Specialist
Utah State University
Logan, UT

Most of us recognize Cythion as a pesticide, not because of its container or because of what's inside the container, but because of the name that's on it. The name is familiar to us as is the name of the manufacturer. We recognize products as being pesticides mostly because of the name that's on the label, not because they're in 5-gallon cans, boxes, or plastic jugs; names like Baytex or parathion or a company name like Ortho. The same is true for the types of products that we see advertised for sale in lawn and garden stores, hardware stores, and similar places. Again we see names that are familiar to us like Ortho, Lilly Miller, and Acme. The reason that all of these products are pesticides is because the Federal Insecticide, Fungicide and Rodenticide Act or FIFRA states "pesticides are any substance or mixture of substances intended for preventing, destroying,repelling or mitigating any pest." That's a very broad definition and interestingly enough it makes many household products pesticides as well, things like Lysol disinfectant, a root killer to take a root out of a sewer pipe, a product called Halt which the mailman uses to keep the dog from biting him on the leg, OFF mosquito repellent, No-Pest strips, flea collars for the cat or dog, moth-balls, Vanish toilet bowl sanitizer, chlorine that is put in the swimming pool to keep bacteria from being formed, humidifier additives that keep bacteria from forming in humidifier water, rose sprays, Comet cleanser, and even household bleach. Many types of consumer products are pesticides because they make a claim to prevent, destroy, repel, or mitigate some pest.

The Environmental Protection Agency says that about 1,625 different chemcials can be pesticides because they have biocidal activity. About 48,000 products are pesticides and about 8,000 different companies are registering these products for sale and use. In Utah we have a state registration law that says to sell a pesticide here you have to register it with the Utah Department of Agriculture. In 1982 Utah had 4,422 registered products by 482 different companies. The reason Utah didn't have the 48,000 is because Utah doesn't grow cotton, almonds, and several other crops and there is no reason then for those products to be registered here as they wouldn't by sold or used.

What does one get when buying a pesticide? Three things: the chemical, a container and a label. The chemical is going to do the job, but not just by itself. One needs to know more about it. The container is going to preserve the chemical so that we will be able to use it. But it's the label that's the key to getting the benefit out of that pesticide. On that label one finds general information, directions for use, information on container disposal, and cautions about what some of the dangers might be. It is to our benefit to preserve these labels and the way to do that is by having a good storage area that is clean, well ventilated, and dry.

Labels that are painted onto the can last much better than those labels that are paper-adhered to the surface of the can. A way to lose the benefit of a label is to transfer the pesticide from its original container with its warning and precautionary statements, and put it into a differently labeled container such as a food container that someone else associates with a different use.

By law a label must contain certain things: a name brand or trademark, net contents statement, EPA registration number, EPA establishment number, ingredient statement, the directions for use, a precautionary statement, the name and address of manufacturer; and if it is a restricted use pesticide, it has to have a classification statement saying that. Household pesticide products must meet these requirements also. An example of a chemical product label that is not a pesticide is on an ammonia bottle. It doesn't have anywhere near as good a label as pesticide products have. It tells us that it's ammonia. It tells us there's one fluid quart in it, and that it's poisonous. But we're not really sure if "clear" means clear ammonia or Clear is the name of the company that made it. It doesn't tell us where it was made or who manufactured it, it doesn't give us a name or address or somebody to call or write. There really are no directions for use. It does have a precautionary statement but it's brief.

Pesticide labels must have one of three signal words. The signal word that is reserved for the least toxic compounds is "caution." An example of the wording is "Harmful if swallowed, avoid inhalation, do not get on skin, on clothing, or in eyes, use in a well ventilated area." If it's more toxic it will have the word "warning" with example wording like "poisonous if swallowed, inhaled or absorbed through the skin." And if it is a very toxic compound, it will have the word "danger — poison" and the skull and crossbones, example wording like "may be fatal if swallowed, inhaled, or absorbed through the skin."

How does EPA determine which one of these signal words should be on the label? It is done through toxicity testing. To determine the dermal or skin toxicity the chemical is injected underneath an impermeable covering that is put around the shaved belly of a rabbit. Later the rabbit's skin is examined for reactions. For inhalation toxicity, animals are placed in a chamber and the chemical is pumped in it so they can determine what concentration it takes to kill the animals. For eye toxicity rabbits are used because the rabbit doesn't have a tearing mechanism so it's not able to wash the eyes with tears. In oral toxicity animals like rabbits, rats and dogs are used. The chemical in question is added to their food and by observation the toxicity can be determined.

The results of this testing leads to a term called the LD50 or the Lethal Dose of a chemical that will kill 50% of a population of test animals. Pesticides that have an

LD50 of 0 to 50 mg/kg are the most toxic and will have the signal word "danger". Those that have an LD50 of 50-500 mg/kg will have the signal word "warning" and those that have a toxicity above 500 mg/kg will have the signal word "caution." Let's look at some oral LD50s for some pesticides and other products. Parathion has an LD50 of 8 mg/kg. That doesn't mean a lot to the average person. There is a method that will allow you to convert these numbers into more meaningful terms. It would take on the average .024 ounces of parathion to kill 50% of 187-pound individuals. Nicotine at 10 mg/kg is not much behind parathion. Kerosene is also quite toxic at 50 mg/kg. Rotenone (83 mg/kg) derived from plant roots and diazinon (92 mg/kg) are well known insecticides, gasoline (150), caffeine (200), Sevin or carbaryl (675), 2,4-D (700), aspirin (750), malathion (1375), table salt (3320), and Simazine (5000) a herbicide that is considered relatively non-toxic.

How do we protect ourselves from these toxicities? We use types of protective clothing like head coverings, goggles, rubber gloves, rubber footwear, some type of rubber garment, and if needed, a respirator. Contaminated protective clothing may be worse than not having any protective clothing at all, so soak and wash protective clothing often. On cartridge respirators the cartridges thread out. Wash the "O" ring and the diaphragms thoroughly. Check the gloves for holes by putting water in and exerting pressure. Wash work clothes frequently, but separate from other wash clothes. Wash your hands frequently when working with pesticides, before you use the bathroom and before you eat or drink. At the end of the day take a shower and pay attention to ear canals, nostrils, under the fingernails, etc. Be aware the protective clothing has some limitations: it's got to be kept clean, respirator pads have to be changed, it gets awfully hot inside of rubber suits, and it is not adequate for hypersensitivity. Update your telephone list of emergency numbers frequently.

Pesticides have both benefits and risks. By reading and following label directions we can obtain the benefits and minimize the risks, so take time to read the pesticide label before using it.

SAFETY ATTITUDES

Leon Hunsaker
Extension Safety Specialist
Utah State University
Logan, UT

THE ACCIDENT SEQUENCE

In order to more vividly illustrate and discuss the factors involved in the accident sequence, we are going to use a modified version of Heinrich's domino theory. It represents a valuable teaching aid that has considerable merit in illustrating human characteristics involved in the causes of accidents.

Factors Involved in the Accident Sequence

HEREDITY

Hereditary characterisitics are characteristics an individual is born with, characteristics he can do little about. They consist of physical qualities such as a person's size, eyesight, hearing, etc.

BEHAVIOR

Behavioral characteristics are developed or acquired as a result of the living experience. A person may be a diligent worker or he may be a dawdler or day-dreamer.

UNSAFE CONDITION

The unsafe work condition is a physical condition or environment that is unsafe and likely to cause illness or injury. Comprehensive standards developed under the Occupational Safety and Health Act deal with the safety of the work environment.

UNSAFE ACT

The unsafe act of the employee is responsible for about 85 percent of all accidents. Unsafe work performance includes improper lifting, taking shortcuts, and lack of protective equipment. Unsafe acts do not always culminate in an accident, but when one does occur, we assume that the individual was just unlucky.

ACCIDENT

An unintended event that interrupts a normal procedure or practice and results in stoppage, damage to equipment or property, and/or personal injury.

INJURY

The last element in the chain of events or accident sequence is personal injury.

Barricades to the Accident Sequence

Can we stop this sequence from occurring? Let's reexamine each of the factors and discuss barricades that might be useful in preventing the completion of the sequence.

1. Proper Selection

Pick the right person for the job. Are you physically able to complete the task safely?

2. Proper Attitude

How do we shape and develop the proper attitude in ourselves and perhaps our employees?

3. Report Unsafe Conditions

How do we recognize that an unsafe condition exists? Once it is recognized, how do we get it corrected effectively?

4. Safe Work Practices

What is the missing link between the employee's assumed knowledge of his work rules and his occasional careless act that violates those rules?

5. Personal Protective Equipment

Some jobs are inherently dangerous, yet they need to be done. For these types of situations, the use of personal protective equipment is essential.

6. First Aid

How do you control the injury? What are the basic requirements to assure basic first aid coverage?

POLITICS OF MOSQUITO CONTROL IN NORTHWEST COLORADO

Sam Haslem
Routt County Extension Director
Colorado State University Extension Service
Steamboat Springs, CO

First, let me introduce myself. I grew up in the Uintah Basin on a ranch at Jensen, Utah, where the Green River went through our property. We wintered our cattle at Jensen and summered the cattle on Blue Mountain in western Moffat County, Colorado. I was fortunate in that I spent a lot of time in the high country with the cattle except for haying and irrigating when I had to come to the ranch and irrigate, put up hay and in general, fight mosquitoes.

Our main defense in those days was a Levi jumper, lots of repellent and try to get the work done before the sun got low on the horizon in the afternoon. About sundown the hay fields just appeared to be gray with mosquitoes and when milking a cow, one was hard pressed to keep from getting a dozen mosquitoes from floating on top of the milk bucket.

I came back to Northwest Colorado in 1970 as a professional extension worker in the position of Routt County Extension Director. One of the early items brought to my attention was the need for more mosquito work in the west end of Routt County in the community and near the community of Hayden. Mrs. Ruth Foster, one of the leaders in the community and a prime mover for mosquito control, briefed me on the work the ladies' club had done in Hayden in previous years. This included getting rid of mosquito habitat such as old tin cans, tires full of water, and swampy areas in town. She also told how the women's garden club had used motor oil-treated sawdust in and around the community as a larvacide.

We then started holding mosquito meetings to try to get the local power structure of the three northwest Colorado towns -Craig, Hayden and Steamboat Springs- more cognizant of the mosquito problem and willing to attempt ways to alleviate the problem.

One of the early meetings was held at the Hayden Legion Hall where 50 Hayden residents attended; four from Craig (19 miles away), and one from Steamboat Springs (25 miles away). Hayden people seemed much more concerned than those from the other two communities. Resource people at these meetings were Ted Davis of the Colorado Department of Health and Bill Hantsbarger, Extension Entomologist, Colorado State University in Fort Collins.

The primary program at Craig during those years was to use aircraft spraying Baytex about the time the largest amount of mosquitoes emerged. Flying was done over an area in and around the town of Craig. Steamboat Springs did some of the same type of program,in a knockdown effort, here again using aircraft and Baytex at about the time large numbers of mosquitoes were emerging. Hayden also did much of the same with the additional help of 4-H clubs, Boy Scouts and the Lions Club, using many pickup loads of oil-treated sawdust over the years. During the 70's there were a few, but very vocal people, who came to these communities and were very anti-chemical no matter what the chemical or what it was used for.

In 1978, the mosquitoes were unusually bad and a donation program took place in Hayden. A local aerial sprayer flew the town using Baytex. This sprayer had recently been spraying wheat with 2, 4-D and had not adequately cleaned his tanks of the 2, 4-D residues. The result of 2, 4-D damage on local gardens was devastating, and any use of aircraft in the future was severely impaired.

My father, Joe Haslem, a conservative cattleman from Jensen, Utah, told me about the program Uintah County was carrying on in the late 1970's under the direction of Dr. Steve Romney. Even though my father had complained about high taxes for many years, he said the tax money spent on mosquito abatement in Uintah County was the best tax dollar he had ever spent, and for a change his livestock were not bothered by mosquitoes all summer. He was also able to spend time outside in the evenings without fighting mosquitoes.

As a result of this, I invited Dr. Romney to attend a highly publicized meeting in Hayden in July of 1979, as well as Ted Davis, of the Colorado Department of Health. This meeting was well attended by Hayden residents since we were in the height of the mosquito season. Dr. Romney did an exceptionally professional job describing mosquito ecology, telling the life cycles of mosquitoes and how the program worked in the Uintah Basin. He also pointed out how little damage was done to bees in the Uintah Basin, an area well-known for quality honey production.

Dr. Romney was not without his detractors. Those who offered so much opposition to the mosquito work the previous years found they were far outclassed by Dr. Romney, and some of those whose minds were made up learned considerably more about mosquitoes.

As a result of the meeting with Dr. Romney in Hayden, two college students were hired the summer of 1980, and a $10,000 budget was appropriated by the Town of Hayden. These two college students were well trained in science, with one of the students, Kelly Watson, having just finished a Bachelor's Degree in Entomology at Colorado State University, and the other student, Bethany Craighead, being in her senior year in Animal Science, also at Colorado State University.

I transported these two individuals to Vernal, Utah to spend a day working with Dr. Romney in their Uintah County program. These two individuals came back from a day in Uintah County highly motivated and with a somewhat basic knowledge of larvaciding and mapping of habitat.

Our next effort at Hayden was to fly over the area and since I have been a pilot for many years, this was relatively easy. Two cameras were used to help map the area and find habitat that was not easily visable from roadways or trails.

That summer of 1980 saw a tremendous change in the quality of mosquito control work done in northwest Colorado. During that period of time, Ted Davis of the Colorado Department of Health came out and spent field time working with the two people at Hayden, so by summer's end they were extremely well trained and had devoted many hours to larvaciding and mapping of habitat in and around the Hayden area.

Because of the excellent job done at Hayden, local newspapers and radios publicized the program highly. The following year, Moffat County and the community of Craig started larvaciding and taking people to Vernal, Utah, to spend time with the Uintah County abatement people. The same thing took place in Steamboat Springs and I transported a teacher from Steamboat Springs to Uintah County, along with a new Hayden town crew for 1981. The new Hayden crew consisted of two college students from the community of Hayden. They were highly motivated young people who did a very creditable job, following the guidelines established by the first crew of Hayden mosquito abatement personnel. That year Hayden purchased the first cold air fogger in northwest Colorado.

At the height of the mosquito season during 1981, the Steamboat Town Council asked me to present a 15-minute program covering the entire gamut of mosquito control, mosquito ecology and what could be done in and around Steamboat. I was only able to introduce the subject in 15 minutes, but it helped start the Steamboat Town Board on a control program. This probably would not have happened had it not been for many residents calling the Steamboat Town Hall asking why Hayden could do such a terrific job and Steamboat, with its much higher town budget, not be able to control mosquitoes.

During 1982 and 1983, I again transported mosquito abatement personnel from Steamboat Springs and Hayden to Uintah Basin to spend a day working with Uintah Basin abatement people. In 1983, the Hayden Town Manager also went to this session with the Uintah County people. It did take a fair amount of encouragement to get the Hayden Town Manager to attend this one-day session.

The Hayden Town Board had given the Hayden Town Manager the directive that mosquito abatement would be Number One priority during the summer of 1983. In the summer of 1983 there was a change in personnel working for the Town of Hayden. The individual who was in charge of mosquito abatement went on to a bigger and better job.

The Hayden Town Manager felt that mosquito abatement could take place on an every-other-week basis and, consequently, only had abatement people out every other week during the height of the mosquito season. In addition to this, approximately six people complained to the Hayden Town Board about the use of a cold air fogger in the Town of Hayden, and all fogging was terminated in Hayden.

Approximately ten days later at the next Town Board meeting, a full house objected to the off again — on again method of mosquito abatement and presented a petition to the Hayden Town Board supporting a stronger emphasis on mosquito control. Shortly after this incident, the Hayden Town Manager left by mutual consent with the Hayden Town Board. Members of the Hayden Town Board actually picked up and continued with the mosquito abatement program.

The result of not continuing with a strong abatement program was made painfully clear to the residents of Hayden, and in future years more effort must be done during the fall and winter months to be organized, to have well-trained people on hand, and be ready to carry out an effective mosquito abatement program when the mosquito season arrives. The effects of northwest Colorado towns having successful programs will be felt in the countryside and perhaps in the future an overall, concerted program may take place in the formation of a pest district at least in one county or even across county lines.

ETHICS IN MOSQUITO CONTROL

Jay E. Graham, Director
South Salt Lake County MAD
Midvale, UT

OBLIGATIONS OF THE MEMBERS OF THE GOVERNING BOARDS AND ADMINISTRATIVE OFFICERS

The obligation of the governing boards are:

1. To become cognizant of the nature, complexity, benefits and possible hazards of mosquito control operations.

2. To employ competent, properly trained professional personnel.

3. To require that professional personnel keep abreast of developing technology and provide the resources for them to do so.

4. To support and contribute their time and efforts to professional organizations that facilitates the exchange of information and promotes the welfare of mosquito control.

5. The governing board should delegate to the executive officer of their program adequate authority to organize and direct operations.

6. To evaluate the performance of the professional staff, require high levels of performance, and require necessary improvements or dismissals.

7. To provide funds through available sources, properly manage these monies and report to higher authorities and the general public on the use of these funds and the results obtained.

8. To cooperate with research organizations such as universities or government agencies and exchange data to promote the development of mosquito control technology.

CODE OF ETHICS
For Registered Professional Entomologists

Preamble

The profession of Entomology is increasingly important to the welfare and progress of human society. Professional Entomologists have the position and authority to render effective service to humanity, in keeping with high standards of ethical conduct. In order that the honor and dignity of the profession be advanced and maintained, the American Registry of Professional Entomologists has established the following code to define the professional conduct and ethics, binding on its members.

Obligations to Society

1.1 The Professional Entomologists's knowledge and skills will be used for the betterment of human welfare.

1.2 The Professional Entomologist will share in sustaining the laws, institutions, and burdens of the community.

Obligations to the Public

2.1 The Professional Entomologist will have proper regard for the safety, health, and welfare of the public in the performance of professional duties.

2.2 The Professional Entomologist will be honest and impartial, and will preface any one-sided statements, criticisms, or arguments by clearly indicating on whose behalf they are made.

2.3 The Professional Entomologist will express an opinion on an entomological subject only when it is founded on adequate knowledge and honest conviction; and will be factual in all estimates, reports, and testimony.

Obligations to the Profession

3.1 The Professional Entomologist will strive to advance the science and art of entomology, to guard and uphold its high standard of honor, and conform with the principles of professional conduct.

3.2 The Professional Entomologist will cooperate in upbuilding the profession by exchanging information with fellow entomologists, and by contributing to the work of technical societies and the technical press, where disclosure of such information does not conflict with the interests of clients and employers.

3.3 The Professional Entomologist will defend the prestige of the profession, and will report to the Registry any persons or organizations using the words entomologist, entomology, or derivatives thereof in a manner implying performance or supervision by a registered Entomologist when such is not true.

Obligations to Employers and Clients

4.1 The Professional Entomologist will act as a faithful agent or trustee for each employer or client, and will not knowingly engage in illegal work or cooperate with any person so engaged.

4.2 The Professional Entomologist will undertake only those entomological assignments for which the Entomologist is qualified. The Professional Entomologist will obtain or advise the employer or client to obtain the assistance of specialists whenever the employer's or client's interests are so served best, and will cooperate with the specialists.

4.3 The Professional Entomologist will indicate to the employer or client alternatives to recommended courses of action and the expected consequences of each recommended action and alternative.

4.4 The Professional Entomologist will inform the employer or client as to any financial interest the

Entomologist has in any person, material, device, or concept which is or might become involved in a project or work for the employer or client.

4.5 The Professional Entomologist will act fairly and justly toward vendors and contractors, selecting their products and services on the basis of merit and value.

4.6 The Professional Entomologist will not disclose information concerning the business affairs or technical processes of present or former employers or clients without their consent.

4.7 The Professional Entomologist will not accept compensation, financial or otherwise, from more than one party for the same service, or for other services pertaining to the same work, without the consent of all interested parties.

Obligations to Fellow Entomologists

5.1 The Professional Entomologist will give credit for entomological work to whom it is due.

5.2 The Professional Entomologist will promote solidarity and harmony with fellow entomologists, respect their judgement, and support them collectively and individually whenever possible against unjust claims and accusations.

5.3 The Professional Entomologist will not accept any engagement to review the professional work of a fellow entomologist (except in editing scientific papers and in litigation) without the knowledge of such entomologist, unless the entomologist's connection with the work has been terminated.

5.4 The Professional Entomologist will not injure intentionally the professional reputation, prospects, or practice of another entomologist. However, proof that another entomologist has been unethical, illegal, or unfair should be communicated to the Registry.

5.5 The Professional Entomologist will provide a prospective entomology employee with complete information on working conditions and the proposed status of employment, and during employment will keep the employee informed of any changes therein.

5.6 The Professional Entomologist who employs or supervises other entomologists will endeavor to provide opportunity for their professional development and advancement.

SOME POSSIBLE HOSTS OF MOSQUITOES

Robert E. Elbel, PhD
Department of Biology
University of Utah
Salt Lake City, UT

Slides were shown of 29 mammals and a few birds from western United States. The Black-tailed Jack Rabbit, *Lepus californicus,* is of particular interest since Crane et al (1983) showed that most feedings by mosquitoes (166) were on rabbits which also served as hosts for viruses. In addition they noted 3 mosquito feedings on deer, 11 on unidentified mammals and 2 on birds. Specimens shown were the Bighorn (*Ovis canadensis*) from Glacier National Park, Montana; Mule Deer (*Odocoileus hemionus*) from Glacier National Park; Pronghorn (*Antilocapra americana*) from western Utah; Kit Fox (*Vulpes macrotis*) from Dugway, Utah; Red Fox pups (*Vulpes fulva*) from Mount McKinley National Park, Alaska; Arctic Ground Squirrel (*Spermophilus parryi*) from Mount McKinley National Park; Least Chipmunk (*Eutamias minimus*) from Uinta Mountains, Utah; Golden-mantled Ground Squirrel (*Spermophilus lateralis*) from Rocky Mountain National Park, Colorado; Uinta Ground Squirrel (*Spermophilus armatus*) from Wasatch Range of Salt Lake County, Utah; Badger (*Taxidea taxus*) from western Utah; Spotted Skunk (*Spilogale putorius*) from Dugway; Chisel-toothed Kangaroo Rat (*Dipodomys microps*) from Dugway; Northern Grasshopper Mouse (*Onychomys leucogaster*) from Dugway; Desert Wood Rat (*Neotoma lepida*) from Dugway; Deer Mouse (*Peromyscus maniculatus*) from Dugway; Montane Vole (*Microtus montanus*) from western Utah; Bobcat kittens (*Lynx rufus*) from Dugway; Black Bears (*Ursus americanus*) from Yellowstone National Park, Wyoming; Bison (*Bison bison*) from Yellowstone National Park; Yellow-bellied Marmot (*Marmota flaviventris*) from Yellowstone National Park; Montana Hoary Marmot (*Marmota marmota*) from Glacier National Park; Coyote (*Canis latrans*) from Dugway; Wolf (*Canis lupus*) from Salt Lake Zoo; Black-tailed Jack Rabbit (*Lepus californicus*) from Salt Lake Zoo; Pika (*Ochotona princeps*) from western Utah; Pallid Bat (*Antrozous pallidus*) from southern Utah; Long-tailed Weasel (*Mustela frenata*) from western Utah; Moose (*Alces alces*) from Yellowstone National Park; Elk (*Cervus canadensis*) from Yellowstone National Park; Canada Goose (*Branta canadensis*) from Salt Lake Zoo; Clark's Nutcracker (*Nucifraga columbiana*) from Rocky Mountain National Park; Saw-whet Owl (*Aegolius acadicus*) from Dugway; Long-eared Owl (*Asio otus*) from Dugway; and Rough-legged Hawk (*Buteo lagopus*) from Dugway.

REFERENCE CITED

Crane, George T., Robert E. Elbel, D. Bruce Francy and Charles H. Calisher. 1983. Arboviruses from western Utah, USA, 1967-1976, J. Med. Ent. 20:294-300.

THE *ANOPHELES PSEUDOPUNCTIPENNIS* COMPLEX (SUMMARY)

Luis Vargas, PhD
Public Health Service
Mexico City, Mexico, D.F.

The irregular but extensive distribution of *Anopheles pseudopunctipennis* from the southern Nearctic to southern Neotropical regions implies the existence of variants with genetic barriers. Chromosome studies have not provided conclusive evidence of subspecies. However, taxonomic characters of larvae, pupae, adult females, and male genitalia permit separation of the forms into *An. p. pseudopunctipennis* Theobald, *An. p. franciscanus* McCracken, *An. p. boydi* Vargas, and *An. p. willardi* Vargas. Distinctive egg shapes have been found for each type. Further study of the eggs and colonization of diverse populations may help define the species' relationships.

TITLES PUBLISHED ONLY

"The Use of TEKNAR® (BTI) in Environmentally Sensitive Areas Such as Aspen, Colorado, Ft. Nelson, British Columbia, and Noahtak, Alaska." G.T. Bohmfalk, PhD, Manager, Industrial Division, Zoecon Industries, Dallas, TX.

"Arbovirus Activities in the U.S. in 1983." D. Bruce Francy, PhD, Chief, Arbovirus Ecology Branch, Vector-Borne Diseases Section, C.D.C., Ft. Collins, CO.

"Progress in the Development of VECTOBAC®, *Bacillus thuringiensis* Serotype H-14,Granular Formulations." Philip Grau, PhD, Western Regional Manager, Field Research and Development, Abbott Laboratories, Fresno, CA.

"The Ecology of Mosquitoes in Container Habitats in Central Oklahoma." Cluff E. Hopla, PhD, Department of Zoology, George Lynn Cross Research, Norman, OK.

"Larvicidal Activity of Two Spore-Forming Bacteria." Mir S. Mulla, PhD, Department of Entomology, University of California, Riverside, CA.

"The Relationship Between Pest Control Operations and Mosquito Control Districts." Bob Olsen, Wasatch Exterminators, Member of State Pesticide Advisory Committee, Salt Lake City, UT.

"Integrated Pest Management of an Urban Swamp." Frank W. Pelsue Jr., PhD, President CMVCA, Southeast MAD, South Gate, CA.

"Recent Field Trials with BACTIMOS® (BTI)." Becky Brown Westerdahl, PhD, Technical Representative, Biochem Products, Davis, CA.