PROCEEDINGS AND PAPERS

of the

THIRTY—FIFTH ANNUAL MEETING

of the

UTAH MOSQUITO ABATEMENT ASSOCIATION

held at

Rustler Lodge

Alta, Utah

October 4 - 5, 1982

Edited by

BETTINA ROSAY

and

GLEN C. COLLETT

UTAH MOSQUITO ABATEMENT ASSOCIATION

463 North Redwood Road

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RESOLUTIONS

WHEREAS, the Utah Mosquito Abatement Association has held its 35th Annual Meeting at Rustler Lodge, Alta, Utah, October 4-5, 1982

WHEREAS, Uintah County Mosquito Abatement District, Dr. Steven Romney, Manager, has served as the host organization, and,

WHEREAS, the Program Committee with Robert Brand as Chairman, has done an outstanding job,

THEREFORE, be it resolved that members of the UMAA extend sincere appreciation to the Uintah County Mosquito Abatement District and all others concerned with the preparation and arrangements for this excellent convention.

WHEREAS, the papers presented by the speakers have been of high quality with much valuable information for those in attendance, and,

WHEREAS, many of the speakers came considerable distances to participate in these meetings,

THEREFORE, be it resolved that the Association extend its appreciation to all speakers and give special thanks to those who came from out of state including Thomas D. Mulhern, Executive Director, American Mosquito Control Association, and Embree G. Mezger, President, California Mosquito and Vector Control Association.

WHEREAS, Rustler Lodge has provided excellent facilities and services and,

WHEREAS, the banquet and entertainment was of excellent quality,

THEREFORE, be it resolved that the Utah Association express appreciation to the personnel of Rustler Lodge who contributed greatly to the success of these meetings.

WHEREAS, the Contributing Members have provided contributions and interesting displays of their products,

THEREFORE, be it resolved that the Utah Association extend its appreciation to these organizations for the support and services they have provided to further mosquito control throughout the State.

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Thomas D. Mulhern .... Fresno, CA
W. Donald Murray, PhD .... Visalia, CA
Richard F. Peters .... Danville, CA

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THE ENTOMOLOGIST AND MOSQUITO CONTROL

Thomas D. Mulhern, Executive Director — AMCA
Fresno, CA

Mosquitoes have fascinated entomologists from the earliest beginnings of entomology — and rightly so! What other insect has evolved into so many distinct species? What other insect has directly attacked humans in so many parts of the world — with such dire consequences to life, comfort, and economic progress? Of course the answer is no other insect! Even today, malaria is the most prevalent disease through much of the world and causes more illness and deaths than any other specific disease — and encephalitis offers a constant threat to health and even life in these highly developed United States of America.

It is strange indeed that with all of the early interest in mosquitoes, coupled with identification and classification plus investigation of bionomics, there is no good record of a comprehensive plan to protect man from mosquitoes earlier than the 1890 "LAMBORN PRIZE ESSAYS" entitled "DRAGONFLIES VS MOSQUITOES: CAN THE MOSQUITO PEST BE MITIGATED?", with a subtitle "Studies in the Life History of Irritating Insects, their Natural Enemies, and Artificial Checks, by working entomologists". Strangely enough, these essays were prepared in response to a nation wide contest, sponsored by an engineer, Robert H. Lamborn, Ph.D., who offered a prize of $200 for the best essay on the subject to be judged by the personnel of the American Museum of Natural History. The invitation was addressed to "The Working Entomologists" and was widely publicized in the press of the time. The submissions judged to be the most meaningful were published in a book of 202 pages and were sent in by Mrs. C.B. Aaron, Mr. Archibald C. Weeks, Wm. Beutenmuller, and Henry C. McCook, D.D., together with a letter from Capt. C.N.B. Macauley.

Taken together, these comprise what we could now call "recommendations for an integrated approach to mosquito control".

There is much other early literature reporting upon older approaches that can once again be applied — using our modern equipment and technology.

By rare good fortune I just happened to come along in time to meet and know personally and be inspired by a number of the extraordinary, perceptive, early workers who gave us the principles we still follow; such greats of mosquito control as L.O. Howard, Robert Matheson, Joseph A. LePrince of yellow fever/malaria fame, L.L. Williams of USPHS, George Bradley of USDA and USPHS, F.C. Bishopp, and wonderful Harry H. Stage, William B. Herms, Stanley Freeborn, and the incomparable Harold F. Gray, and perhaps the greatest mosquito control teacher and entomologist of them all, Thomas J. Headlee, with whom I was greatly privileged to work closely for many years when my appreciation of the many approaches to mosquito control was being elucidated! Strangely, your own revered Don Rees was much like Headlee in manner and inspiring, demanding teaching.

Others, less well-known but still persons, from New Jersey, who impacted by committment to life-long mosquito control included Robert F. Engle, Carl Haag, and Steve Johnson of Ocean County, O.W. Lafferty and Richard Reeves of Cape May, Fred Reiley of Atlantic County, Harry Vannote of Monmouth, Les Smith of Middlesex, Bob Vannote of Morris, Jack Peterson and Jesse B. Leslie of Bergen, L.D. McCarter and Jim Brennan of Hudson, James E. Brooks of Essex, gentle Jack Flynn and particularly William H. Dillistin of Passaic, and last but certainly not least David Jenkins of Sussex County. All of these great people contributed in a variety of ways to my knowledge and appreciation of mosquito control! Naturally I could name a great many more among the still-actives — but I'd like to bring back recollections of these great people, however briefly. They and their associates have given us the enormous body of mosquito control technology that today we take for granted! I often wonder if we are doing full justice to the heritage they left us. Or if we ever can?

When we look at the broad scope of mosquito control through IPM, it is apparent that a number of professional disciplines are involved: entomology, biology, ecology, insecticidal chemistry, physics and mechanics of insecticide dispersal and application, engineering, personnel direction, teaching and leadership, public relations, finance, and management. A manager/entomologist must have many hats!

The need for entomology and the entomologist is self-evident and needs no further explanation here. But what of all the other specialties that are part of a well-rounded program, with all of the ramifications indicated by Table 1?

Let us look next at management. Certainly it is not disadvantageous for a manager to be a professional entomologist — and I have known many that were and are excellent managers. But I also know excellent managers who are not entomologists. If you examine the background training of these highly successful individuals, usually you will find that they had to acquire the varied skills that they must exercise daily in some way other than their specific training in entomology! Often by serving first as an assistant manager; sometimes by post graduate learning; and perhaps sometimes by doing, at times unfortunately by making important mistakes on the job when trying to "double in brass" without the needed technical training. In California, various seminars are organized for managers and technical specialists, whatever their basic training, with specific orientation to the problems of mosquito control. These seminars present down-to-earth training, based upon actual problems that have surfaced, and upon solutions that have proved to be successful. However helpful these seminars may be, they cannot replace the training in depth that is offered in the other specialties. However, the seminars can enhance appreciation of the other needs and also can indicate where other specialty services can be obtained, whether on a cooperative basis or for a fee, and whether from the universities, the land and water development agencies, the state and federal health departments, the U.S. Department of Agriculture, or from neighboring local agencies.

It is unfortunate that an entomologist may have to largely forsake practicing the profession for which he is specifically trained and devote most of his efforts to the peripheral activities, but it appears to be a fact of life that in local mosquito control agencies, if he is to receive full acknowledgement and adequate fiscal reward, he must aspire to management as an ongoing career. If this be a correct assumption, then should we not try to influence some of the training centers that produce outstanding young entomologists to include among their elective courses some that will be useful to the recipients as their careers develop? And some that will help them to make progress in the less-practiced arts of mosquito control!

We have lived through a period when great emphasis was placed upon chemical control of mosquitoes — often to the exclusion of other approaches — and fortunately, entomologists usually have some courses in chemistry in their training. But often we have seen the sprayers or other instruments of chemical control operated out of adjustment, or with improper dispensing heads, or without regard to limiting meteorological factors, all conditions that an agricultural engineer would immediately recognize. Now we have seen resistance to chemicals develop to the point where chemical control by itself is no longer enough.

The alternative of source reduction is now claiming more attention, but do we have the trained personnel to take full advantage? How many of you know how to calculate the size of drainage channels to drain a mosquito source of a given size? Or what grade and slope to employ to avoid excessive deterioration with first rains? What kind of an excavator will give you the most service if you acquire one? When should you employ underground drains and when open drains? How can you best integrate your program with other land and water management functions? What can you ask the management of such projects to do for you that will be reasonable?

Aside from engineering approaches, is your public relations program fully satisfactory? Do you have good media coverage of your work? Do you have full support of your fiscal needs by the local government budgeting unit? Does your public relations program motivate the people to do all the things they can to help out?

As a mosquito control consultant to local programs and to entomologists throughout a long life in mosquito control, I learned long ago that the consultant who asks questions of you is not nearly as effective as the one who contrives to get you to ask questions of yourself — if you will but ask yourself whether your program is sufficiently diversified — whether you are making full use of all resources that could be available to you — if you are prepared to follow the give-and-take that is necessary to obtain cooperation — then probably you will find avenues of improvement that you did not know existed! Usually a consultant does not provide answers — he only inspires you to bring out the latent answers that you and only you can provide for your own problems! He may suggest sources of information, or methods, but you must make the decisions!

Many local agencies in California and elsewhere are feeling the crunch of inflation and cut budgets, and in some areas there simply are not enough funds to maintain the former, carefully worked-out programs. So something has to give.

This might be a good time to flash back to an earlier time, and think for a moment about what was available for our predecessors to work with:

And let us remember that *Anopheles gambiae* was eliminated from South America mainly by a mixture of Paris green and road dust cast by hand on the breeding places!

One current program comes to mind which had a reasonably complete program similar to its neighbors but less funds and more problems, so it usually was not able to maintain quite so complete control. Since the budget cuts, funds are not sufficient. The Board of Trustees looked for all possible economies — even terminated the District's subscription to MOSQUITO NEWS! (Certainly a $35.00 saving will make little difference in funding — in fact, careful reading might have given that agency a clue to better ways to use the limited resources available). This is where the entomologist/manager who is fully aware of all potential approaches, and who has sufficient originality and ingenuity, may be able to put together a substitute program that will yield a fair measure of control to the people. A real challenge! I can give no sure prescription for a solution — but I am also sure that the district in question should call in the specialists available to it from state, federal, and university sources, and from the neighboring districts, for consultation on measures that might be substituted for the current inadequate program. Probably a substantially different program would be proposed — which if satisfactory to the local Board of Trustees might be implemented! This is a great challenge for any entomologist/manager but one that should be taken up.

In my opinion, the entomologist is essential, the future status of the entomologist is secure, but in many agencies, the program must be further diversified. The entomologist/manager must seek input from other specialists, and by adopting a fully exploited IPM program, much of the lost ground can be reclaimed. Not an easy task, but one that can be accomplished.

How your state or regional mosquito control association can help is difficult to define for its role is mainly facilitating the exchange of information from those who have it to those in need. And back of your state or regional association is AMCA, serving in like manner countrywide and worldwide. I hope each and everyone of you is a participating member. AMCA needs your participation — and you need or will need what it has to offer!

Table 1. Elements of comprehensive mosquito control performed by mosquito control agencies.

COMPREHENSIVE CONTROL — Inclusive of all known control methodology as applicable

INTEGRATED APPLICATION

NATURALISTIC CONTROL — Abets natural limitation through selective use of biological and physical factors similar to those found in the natural environment

TEMPORARY CONTROL

A. Natural Population Limitation

Biological factors:

Predators	Pathogens	Food productivity
Parasites	Detrimental plants	Competitors

Abiotic factors: (physico-chemical factors of the environment affecting mosquitoes, their enemies, or habitat)

Rainfall and runoff	Temperature	Sunlight and shade
Percolation	Salinity	Turbulence, currents, waves
Humidity	Alkalinity	Nature of soils substrate
Evaporation	Acidity	

B. Biologically Oriented Control

Manipulation of living organisms to destroy or limit mosquitoes at all stages
Environmental practices aiding populations of mosquito enemies or increasing their effectiveness
Genetic manipulation

C. Physical Control (Source Reduction) — Elimination or Modification of Breeding Places

Water Management
- Drainage
- Impoundment
- Contour design
- Reuse
- Organic solids removal

Regulation
- Circulation
- Flow and exchange rates

Levels and depth

Land preparation and management
- Filling
- Grading
- Drainage

Crop selection and management

Weed control

D. Chemical Control

Ovicides (not usually practicable)
Larvicides (small areas treated to protect large affected areas)
Pupicides (infrequently applied)
Adulticides (particularly useful in emergencies and in areas of chemical resistance by larvae)
Repellents
Growth regulators, physiological inhibitors
Attractants (with other procedures)
Weed Control

E. Mechanical Barriers

Screening of buildings
Temporary barriers as bed nets and mosquito-proof clothing

F. Landholder Motivation to Cooperate

Public information and education
Individual persuasion and cooperative efforts
Legal action and enforcement
Interagency cooperation

FROM: Training Manual for California Mosquito Control
DEVELOPED BY: Vector Control Section, California Department of Health
PUBLISHED BY: CMCA Press, 1737 West Houston Avenue, Visalia, California 93277

THIRTY—TWO YEARS OF MOSQUITO CONTROL

Howard R. Greenfield, Entomologist
Salinas, CA

I am here before you, not because I requested a place on the program, but because I inadvertently made a phone call to Glen Collett to tell him I was planning to attend the Utah Conference as a private citizen and would he be so kind as to confirm my intentions with the conference center. Thus, please lay the blame on Glen for being so very persuasive and persistent if I fail to measure-up to the high standards set by your program committee.

Nonetheless, I am pleased and honored to be here and to share with you my observations of the highlights of some thirty-two years of mosquito control in California.

I began my career in 1948, when upon graduating from San Jose State College with a degree in Biological Science and a specialty in Entomology, I went to work for the California State Health Department's Bureau of Vector Control, a newly formed bureau (1947) to provide the people of California protection from vector-borne diseases. I believe it was my early association with the Bureau of Vector Control that provided me with the opportunity to develop my own philosophy of mosquito control.

Early on, I had the great fortune to become personally acquainted with such world-renowned figures as your own Don Rees, California's Harold Gray, Professor Herms, Karl Meyer, and Lewis Hackett.

And there are those who are still making contributions to the field of vector control, such as Edgar Smith, Richard Peters, Lew Nielsen, Archie Hess, Lewis Ogden, your own Glen Collett, and lastly, a man who has dedicated his entire adult life to promoting mosquito control, Tommy Mulhern.

These people had, in my judgement, one basic philosophy about controlling mosquitoes and that was to know as much as possible about the ecology of the mosquitoes you control and the environment they occupy.

Unfortunately, the wise and learned counsel of these men went unheeded with the release of the miracle insecticide D.D.T. All we needed to do was to find appropriate instruments for the dispersal of this new miracle insecticide in the environment and our problems would be solved.

I recall in Merced County in one year, we applied D.D.T. by air to over 250 thousand acres at .5 lb. per acre. That's over 62½ tons of toxicant in Merced County alone!

Well, as you know, D.D.T. proved not to be the cure for mosquito control, and because of its failure, as with subsequent insecticides, we were forced to think again about the need for a better understanding of the ecology of mosquitoes. So back to the drawing board to rethink in terms of source reduction, water quality, drainage, and weed control.

At this point, I want to mention one benefit D.D.T. provided California that might not have occurred for a long period of time, and that was the promise of mosquito control for all people at a low economical cost.

Let me explain. From 1915 to 1946 (a period of thirty years), there were only 39 districts in California covering 4,645 square miles. Today, 30 years later, there are 63 districts providing mosquito control to nearly 16 million people in over 50,000 square miles.

Now, I would like to touch very briefly on the highlights of mosquito control in the past thirty-two years.

First of all is image: As the entomologist of the early days was viewed to be a nut with a butterfly net in hand chasing bugs and butterflies, so was the mosquito control man viewed — a nut chasing mosquitoes with a shovel in hand and a hand-can filled with oil on his back.

His headquarters usually was a tin shed behind the County corporation yard. Records (if kept) could be found stuffed in an old orange crate.

This is no longer true. Districts now have office facilities that reflect, appropriately, their place in the government community. Thus, I believe, the public now perceives and accepts mosquito and/or vector control programs as a permanent ongoing activity of government. In the early days this was not always true.

Another major improvement in our image has occurred in our field workers. No longer are they looked upon as common laborers who were told how and where to spray, and at the end of summer, laid off until the next campaign began.

Today they are truly competent technicians, certified by the State Health Department as being knowledgeable about the chemicals used, the environmental factors, and the biology of the mosquito being controlled. A number of mosquito control technicians hold B.S. degrees in biology and many others have A.A. degrees. The future, I suspect, will see this trend continuing.

Rachel Carson's Silent Spring, viewed by many as the beginnings of the environmental crusade in America, has in my opinion, aided mosquito control programs. One — it forced managers to evaluate programs in relation to environmental needs. In so doing, it became quickly recognized that other scientific disciplines had been brought into the planning process.

No longer could we do it our way. Yes, we lost some control over programs such as response time of control techniques. We lost control over cost efficient aspects because of the need to meet certain regulatory laws and regulatory agencies. But — and I believe, this is important, that we as district managers are now having to become involved with the complete planning process. No land use plan is started until it is approved by the local mosquito control district. No subdivision can be developed without the district's input. Anything that has to do with water usage now generally requires a statement from the local mosquito control district as to what potential vector problems might be involved.

Also, a close liaison between agencies such as Fish and Game, U.S. Department of Agriculture, U.S. Fish and Wildlife Services, Parks and Recreation, University of California and, of course, our State Department of Health Services, are now being maintained and strengthened.

And, finally, I must mention computers. I know Jay Graham probably was the first to use computer programs in his district, but since Jay pointed the way toward computers, 14 districts in California now own them and incorporate them into their programs in California.

Lastly, in Northern Salinas Valley, under Don Grant's direction, water quality studies are being pursued. Measurements are routinely being made at 14 sites which provide a base for more detailed studies affecting the biota. We believe, that in so doing, we will enhance our reliability and predictability in making recommendations for source modifications and water management for mosquito and vector control.

RECENT DEVELOPMENTS IN MOSQUITO CONTROL IN CALIFORNIA

Embree C. Mezger, President, CMVCA
Manager, Solano County MAD
Suisun, CA

The most spectacular developments affecting mosquito control in California recently can be categorized as political, administrative, and financial.

Politically, five MAD's held elections to increase their tax rates, E.P.A. proposed new guidelines for the labeling of pesticides and devices, and the California legislature considered a bill to eliminate smog control devices on MAD vehicles and a bill to establish a reserve fund within each District.

Five MAD's held special elections to increase their revenue by means of a tax increase. Income of MAD's had been reduced rather drastically by the passage in 1978 of tax limitations contained in Proposition 13. Passage of a tax increase for the MAD's requires a favorable vote of at least two-thirds of the votes cast. Although the mood of people now is unfavorable toward increased taxes and, even in the face of a two-thirds vote requirement, the first four MAD's to hold special elections, Alameda, Glenn, San Joaquin, and Turlock, won their tax increase. The fifth, Burney Basin, reversed this trend with a voter rejection of the increase. San Mateo MAD is currently preparing for an election in November.

The guidelines that have been proposed by E.P.A. were reviewed by our Association, and our Board of Directors approved and submitted suggested changes. We recommended: 1. That the mass of the guidelines be reduced and the wording clarified; 2. That old requirements for labeling of products for health protection use, such as mosquito control, should be changed; 3. That drift is sometimes a necessary and important adjunct to the more traditional methods of mosquito control; and 4. That manufacturers should be discouraged from adding restrictive language to their labels which prevents users from making specific adaptations for mosquito control. Suggested wording for manufacturers is: "It is illegal to use this product in a manner inconsistent with its labeling." Additionally, the Board of Directors of our Association felt that comments made by Dr. William E. Hazeltine with regard to residue tolerance were pertinent and endorsed them. These comments recommended dispensation for MAD's in precautionary statements on labels, in mosquito control operator decisions, and in clarification of labeling regarding special purpose usage, target pests, and application limitation. The American Mosquito Control Association, Inc. also submitted comments to E.P.A. and to Vice-President Bush's Task Force on Regulatory Relief and received communications from the Task Force acknowledging receipt of the comments.

The two bills considered by the legislature dealt with removal of smog control devices from District vehicles and establishment of a reserve fund. Assembly Bill 65 (Boatwright) passed and was signed into law by the governor. It exempts MAD's and certain emergency vehicles from the requirements of California law for motor vehicle pollution control devices. Senate Bill 1477 (Marks) originally provided for emergency funds for MAD's along with several other provisions for other agencies. The benefits for MAD's were removed from the bill at the insistence of the Farm Bureau Federation. However, this is a new concept of a vehicle for assistance, and it has opened the door to a new approach for state assistance.

Administratively, the Association has reorganized the central office. The office was moved from Visalia to Sacramento. This necessitated a change of office personnel, and we suffered through a series of temporary office managers until we were able to secure the services of our present permanent manager, Mrs. Linda Sandoval. We apologize for possible lapses of communication with other associations in the recent past; we believe that we have now overhauled procedures and look forward rather optimistically to smoother functioning of the Association office.

After years of discussion as to whether or not the Association should have an executive director, we decided this year to take that step. We have hired Marvin C. Kramer, who had retired previously from the California Department of Health Services and who had also had experience as manager of a mosquito abatement district. The position was established effective July 1, 1982, and is ostensibly part-time.

Financially, the tax limitation measure passed in 1978, Proposition 13, drastically reduced the revenues of the Districts. Budget reductions in individual Districts ranged from 1.5 to 69.9 per cent.[1] These reductions in revenue have forced the Districts to eliminate or curtail such supportive programs as mosquito prevention and applied research and to lay off or arrange early retirement for control personnel.

Measures employed by the MAD's to bolster revenues have been discussed. Two mosquito control programs that are not MAD's, El Dorado County Service Area No. 3 and Santa Clara County Health Department, are governed by the Board of Supervisors. The Supervisors in El Dorado County met the need for additional revenue there by establishing a special fee that is paid by motel and hotel owners within the service area. El Dorado County Service Area No. 3 covers the South Lake Tahoe area. Rivalry and some provincialism between the staid county seat in the foothills, Placerville, and the glamorous, scenic playground at Lake Tahoe have occasionally prevented increases in service in the Lake Tahoe area, but in this case the service is paid for by the people who will benefit, so the proposal did not elicit resistance from representatives of other regions of the county. Landowners throughout other areas of the county do not pay for the services. For many of the actions by Supervisors this is not true; people throughout the county may be required to pay even though some of them may not benefit directly. Examples are flood control taxes for owners of land on hilltops and school taxes for bachelors.

In Santa Clara County the Supervisors had decided to eliminate the mosquito control program but, upon the urging of the manager and the California Department of Health Services, relented and agreed to keep a skeleton force. A substantial portion of the funds for continued operation will be supplied by the cities that are serviced.

In summary, in the continuing saga of the lives of employees of mosquito control programs, problems continue to plague us. The nature of the problems changes from year to year, but unfortunately the severity and number do not diminish. Perhaps we can turn adversity to advantage if we heed the poet and diplomat, James Russell Lowell. He said: "Mishaps are like knives, that either serve us or cut us, as we grasp them by the blade or the handle."

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[1]Ghormley, P.B. 1979. The Effects of Proposition 13 on Mosquito Abatement Districts in California. Proc. Calif. Mosq. Vector Control Assoc. 47:119.

MINERS + WOODCUTTERS = *AEDES SIERRENSIS*

C. Eric Hamrin, Manager
Jackson County Vector Control District
White City, OR

Gold was discovered in Jackson County during 1850 in the Klamath Mountains which are located in the southwestern area of the county. Miners worked the streams by panning, sluicing, and dredging for gold.

They preferred madrone (California laurel) for firewood which, when green, is easily cut and split. The wood also readily burns when only partially dried. After the trees were cut, limbs branched out from the stump in several directions causing a basin. These basins retained leaves which turned into organic material, and when combined with rain water, created ideal *Aedes sierrensis* habitat.

As the years went by, people continued to cut madrone for firewood, extending up the creek bottoms wherever horse drawn wagons or vehicles could travel. Roads were built on federal land and private property for timber and traveling purposes. The woodcutters would follow along these roads cutting firewood. As the years passed, these roads were used for access to building sites placing the people in the vicinity of ideal *Aedes sierrensis* habitat.

The 1981 mosquito season was not conducive to the production of *Aedes sierrensis*. Only 17 service requests were received during the entire year. However in this year, 1982, 293 service requests were recorded. Precipitation patterns for both years will be graphed to determine what caused the 17-fold increase during 1982.

Next spring there will be total of 668 households involved in our search-and-spray *Aedes sierrensis* control program.

A slide show was presented to demonstrate the number of residences that have been established in woodland areas containing ideal *Aedes sierrensis* habitat.

SWARMING AND MATING IN *AEDES NIPHADOPSIS* Dyar and Knab[1]

Sammie Lee Dickson
Department of Biology, University of Utah
Salt Lake City, UT

There are many references to the sexual behavior of mosquitoes in the literature (Downes 1969). Only a few of these works have been complete behavioral studies. Previously, only two papers, Rees (1943) and Rees and Collett (1954), have discussed swarming in *Aedes niphadopsis.* They briefly described a swarm of males of *Ae. niphadopsis* over *Artemesia* along foothills adjacent to larger mountains.

During 1980-82 I observed and recorded environmental conditions for the first swarms of the season until males could no longer be found. Observations were made along the eastern foothills of the Stansbury Mountains, 5.5 km north of Grantsville, Tooele County, Utah. Throughout this study, as did Rees and Collett (1954), swarming was observed along the foothills at least 2.5 km from the nearest larval habitat. Furthermore, swarming was never found at or near the larval habitat which was in vernal pools with emergent *Distichlis spicata* (saltgrass) and *Salicornia* (pickleweed).

SWARM MARKERS

Swarms were found in the foothills where groups of *Juniperus* were intermixed with dominant *Artemesia. Juniperus, Artemesia,* and contrasting areas of light and dark soil, plants or rock served as markers over which the all-male swarms occurred. *Juniperus* was the most common marker, with the largest swarms being found over trees of 1 - 2.5 m tall. When the trees occurred very close together, swarms were usually not present. The dark green junipers formed a sharp contrast to the silvery-green sagebrush, especially when the trees were a few meters apart. Thus, single trees with surrounding sagebrush stood out more than clumped trees and served as a recognizable marker. The same markers were used all three seasons by the successive generations of mosquitoes.

SHAPE AND SIZE OF SWARMS

Swarms over inanimate objects and sagebrush were always in the form of an upright ellipse (Fig. 2). The bottom of the swarm ranged from 0.5 - 1.0 m above a marker. The height of the ellipse ranged from 0.5 - 3.0 m with a diameter of 0.3 - 1.3 m. These swarms had from 1 to 150 males.

The more prevalent swarms over *Juniperus* consisted of two separate groups of males (Fig. 1). On the leeward side, level with the top of the tree, was a sphere. It ranged from 0.15 - 0.5 m in diameter with from 1 to 25 males. Directly over the juniper was a tall ellipse, 0.3 to 1.0 m above the tree. The elliptic portions usually had 3 to 5 times as many males as were present in the sphere. The ellipse and sphere were usually found over the same tree about 0.2 - 0.3 m apart. In some instances an ellipse was present without a sphere or vice versa.

FLIGHT WITHIN SWARMS

The movement of males within a swarm over markers other than *Juniperus* was the same as the elliptic portion of a swarm over a juniper (Fig. 2). Males always flew in a vertical plane facing into the wind. When moving upwards males made a repeated 'Z' pattern covering the entire width of the swarm. The downward flight was somewhat faster with the 'Z' pattern compressed into the middle of the swarm. However, some individuals flew only in a portion of the swarm. The sphere portion of the swarm over *Juniperus* had movement along a horizontal plane also facing into the wind (Fig. 1). Males in the sphere flew from the leeward to windward edges with the wind aiding the movement back to the leeward edge. Occasionally some males moved from the sphere to the ellipse or from the ellipse to the sphere. As wind directions changed, the sphere oriented to the leeward side of the juniper.

ENVIRONMENTAL INFLUENCES

Three environmental factors were found that must be suitable if swarming occurred on any night. These factors were temperature, light, and wind velocity. Swarming was never observed at temperatures below 7°C (Table 1). Since *Ae. niphadopsis* emerges in early spring, temperature inhibited swarming on many mornings and evenings. The second factor was light intensities. A swarm did not form in full sunlight. Swarming took place in morning twilight, dusk, and when clouds cast large shadows over swarm markers. Light intensities were measured, but wavelengths and intensity of light that the mosquitoes were responding to were not determined. Wind was the last factor. Swarms never formed when constant wind velocities were greater than 0.8 meter/second. Once a swarm was formed, wind also had direct effects on it. At 0 - 0.8 m/s, a swarm was only moderately affected with little or no disorganization. When wind velocities reached 0.9 - 1.5 m/s, there was a marked disturbance with flight patterns increasing in speed and with some males leaving the swarm. Wind velocities of 1.6 - 2.0 m/s caused individuals to stop vertical flight in the ellipse. The sphere and ellipse combined into a sphere close to the top of the juniper. Matings were never observed at these or greater wind velocities. Above 2.5 m/s, the wind dispersed all swarming. When the wind subsided, swarming again resumed.

All three environmental factors had to be within acceptable ranges before swarming took place. Relative humidities did not seem to be critical since swarming was observed with humidities ranging between 28 and 100%. Low voices, thunder, and gunshots disturbed the swarms temporarily as did gusting winds.

FORMATION OF A SWARM

Swarms of *Ae. niphadopsis* occurred during a 4- to 6-week period between mid-April and the middle to later part of May. Swarm formation was stimulated by a reduced amount of light. During daylight hours swarms were seen over swarm markers which had been covered by the shadow of a cloud. Swarm size was usually small under daylight/cloudy conditions. Before sunrise swarms also occurred. However, because of the low temperatures, they were unpredictable, smaller, and no mating was observed. The largest and most active swarms occurred at dusk. Before a shadow was cast on a swarm marker no swarm formed. As a shadow fell on the base of a marker, a male flew into either the sphere or elliptic area over a marker. As a shadow continued to be cast upon a marker, the number of males increased with individuals entering every few seconds. When a shadow completely covered a marker the swarm reached its maximum size. Males continued to enter but also to leave the swarm. As light diminished to less than 50 foot-candles, males ceased to enter the swarm while those in the swarm left. By the time light intensities were reduced to zero foot-candles all but a few of the males had left the swarm. With favorable weather conditions swarms lasted 1¼ to 1½ hours.

MATING

Matings observed in the field were associated with swarming males. Females either entered a swarm or flew very near it before being grasped by a male. Upon entering a swarm, the female flew rapidly in a circle two or three times within the confines of the swarm. During this period the swarm appeared disorganized except for the cloud of males following the female. Males were seen grasping other males for a few seconds before returning to the swarm. A mating pair left the swarm immediately after a female was grasped. They remained *in copulo* while flying for 5-30 seconds. Mating was usually completed while in flight. Males were not observed returning to a swarm after mating.

Matings usually took place during light intensities of 40 -80 foot-candles. Light of this intensity occurred for approximately a 30-minute period each evening. Matings were also limited seasonally. Although seasonal swarming lasted for 4 to 6 weeks, it was only during the peak emergence of 2 to 3 weeks that large swarms (greater than 75 males) occurred. Matings usually occurred only in these large swarms. Few, if any, matings took place in the first and last two weeks of swarming. During one evening following a period of peak emergence, I observed 48 matings in a 26-minute period in a swarm of 250 males. This would account for almost 20% of the males having mated in one evening. Only on a few occasions was mating observed at this high rate.

Out of 30 females taken while *in copulo* all were in the earliest stages of ovarian development and one was in the second gonotrophic cycle. This suggests that once having mated, females may re-enter a swarm.

Some mosquitoes in emergence cages in the field and in the laboratory mated where no swarm was possible.

FEEDING STATUS

Using the nectar detection method of van Handel (1972), 30 females and 40 males collected while *in copulo* were tested for the presence of fructose. Fourteen of the 30 females were positive, suggesting that they had fed at a nectar source in the previous 12 hours. It appears that many females took nectar before mating. None had any trace of blood in the gut. Thirty-six of the 40 males were negative for fructose. Another 67 males were taken from various swarms. Of these, 23 were positive for fructose. Five males caught as they were leaving a swarm were all negative for fructose. This suggests that males may feed on nectar daily but the activity of swarming depleted the energy rapidly.

SUMMARY AND CONCLUSIONS

Swarms of *Ae. niphadopsis* were found only along foothills adjacent to larger mountains at least 2.5 km from the nearest larval habitat. *Juniperus* was the primary swarm marker especially when separated by several meters from other trees of the same species. Swarms over *Juniperus* consisted of two distinct parts, a small sphere and a larger ellipse. The function of this unusual form of swarming is uncertain. Mating was observed from both portions of the swarm. Swarms over other markers lacked the spherical portion. Temperatures greater than 7°C, reduced light, and wind velocities of less than 0.9 m/s were required before swarming would occur. Matings usually occurred in swarms with more than 75 males and between 40 and 80 foot-candles of light. Thus, matings were constrained to approximately 30 minutes each evening for a period of about 2 or 3 weeks. Up to 20% of the males in a single swarm were observed mating during one evening. With this mating-rate potential and the period of time involved, swarm-matings could account for all mating in this species.

Nearly half the females caught while *in copulo* had nectar-fed in the previous 12 hours. However, 90% of the males captured while *in copulo* were negative for fructose. Because of the long flight from the larval habitat to a swarming site, females may be forced to nectar-feed before mating. Males were believed to have nectar-fed daily.

All biting females of the several hundred examined (data to be published elsewhere) were found to have already mated. This along with the fact that mating and swarming occurred only in the foothills helps explain why adults of this species are seldom found near the larval habitat.

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[1]Project partially funded by a Sigma Xi Grant-in-Aid.

Table 1. Observed environmental conditions with resulting swarming and mating.

Date	Percent Relative Humidity	Temperature °C	Wind[1]	Size of swarm[2]	Mating rate[3]
IV-12-80	39	7	moderate	large	none
IV-19-80	34	17½	slight	moderate	none
IV-20-80	--	29	moderate	small	none
IV-26-80	31	15-20	slight	large	many
IV-29-80	70	13½	moderate	moderate	few
V-05-80	59	15½-17½	slight	large	none
V-07-80	68	16½	slight	large	none
V-13-80	52	12-12½	moderate	small	none
V-17-80	72	11	strong	small	none
V-18-80	95	7	slight	none	none
V-21-80	28	24	slight	small	none
V-26-80	36	16½	moderate	small	none
IV-12-81	47	10-15½	slight	large	few
IV-16-81	55	13½	slight	large	many
IV-20-81	69	12-13½	slight	large	many
IV-22-81	49	11-13½	strong	moderate	none
IV-23-81	55	12-16½	moderate	large	many
IV-24-81	--	9½-10½	slight	moderate	none
IV-30-81	40	21-24½	slight	large	few
V-01-81	72	13½	slight	moderate	none
V-10-81	52	18½-21½	moderate	large	many
V-13-81	75	12½-16	slight	moderate	few
V-18-81	58	19½	moderate	small	none
V-26-81	100	19½	moderate	small	none
V-28-81	75	17-20	slight	small	none
IV-14-82	50	15	strong	small	none
IV-24-82	--	7	slight	small	none
IV-25-82	42	17	slight	large	none
IV-27-82	52	13-17	slight	large	many
V-01-82	95	8½-9½	slight	small	none
V-02-82	58	20-24½	moderate	large	few
V-04-82	70	10-11½	strong	moderate	none
V-06-82	49	10½-14	slight	large	many
V-11-82	73	9	slight	none	none
V-13-82	39	14-19	strong	moderate	many
V-17-82	42	--	strong	moderate	few

[1]Slight = undetectable, or not disturbing swarm activity; moderate = occasional gust disturbing swarm; strong = gusts frequently disturbing swarm.

[2]Small = 1 - 15 males in ellipse; moderate = 20 - 60 males in ellipse; large = more than 75 males in ellipse.

[3]None = no matings observed; few = less than ten matings; many = more than ten matings seen during the evening at a single swarm.

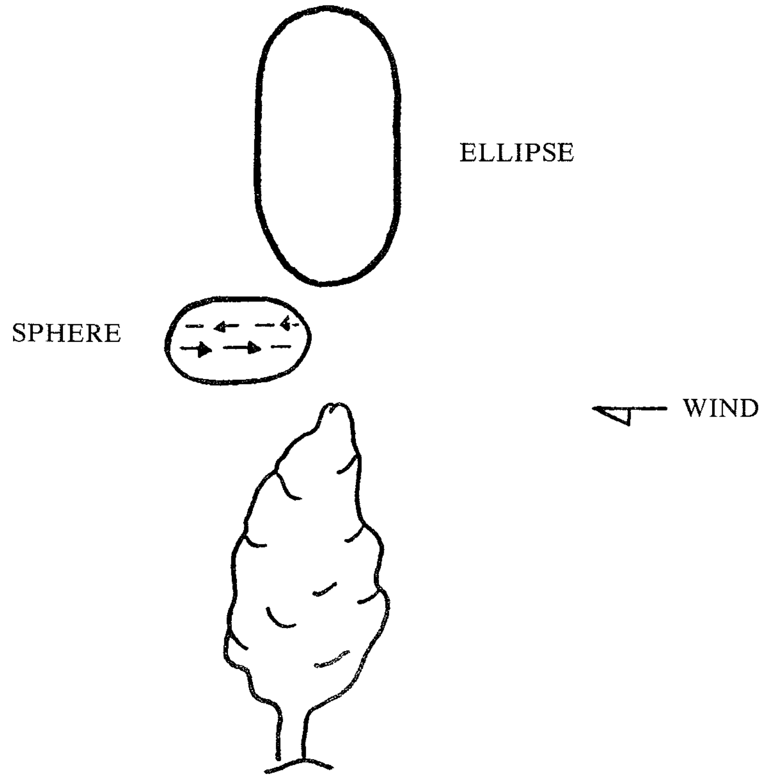

FIG. 1. Typical swarm of *Ae. niphadopsis* over *Juniperus.*

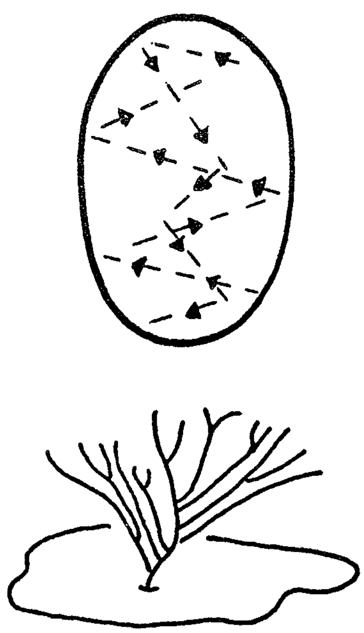

FIG. 2. Individual flight movements in a swarm over *Artemesia*. Wind would be oriented into the page.

MOSQUITO HOST BLOODMEAL IDENTIFICATION: METHODOLOGY AND DATA ANALYSIS

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ABSTRACT[1]

Various serological test procedures are applicable to arthropod bloodmeal identification. The precipitin test has been most consistently used because the equipment need is minimal and the test relatively simple to perform. The passive hemagglutination inhibiton (PHI), while more complex, has been used to identify bloodmeals to genus or species. Because of its specific sensitivity and the fact that it can be automated, the enzyme linked immunosorbent assay (ELISA) method offers considerable potential.

Host feeding or selection pattern is a product of numerous factors including host preference, host availability and host irritability. From results of bloodmeal identification studies, the following two host selection strategies appear to be involved: (1) fixed or active, and (2) passive or opportunistic. The extent and detection of mixed bloodmeals and multiple feeding have been the subject of some controversy. The haptoglobins (Hp) technique shows the best potential in estimating incidence of multiple cryptic meals taken from man.

Biases in sampling and assessment in bloodmeal identification studies are examined; the forage ratios, feeding index and the Human Blood Index are also discussed.

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[1]Full text to be published in Annual Review of Entomology with coauthor C.H. Tempelis.

HOW BOARDS OF TRUSTEES CAN HELP THE DISTRICT MANAGER

Verl Peterson, Trustee
Box Elder County Mosquito and Fly Abatement District
Brigham City, UT

When a district manager is hired, many of us feel our job is completed and we turn everything over to him. That is partially correct. He has the education, experience, and desire but he still needs a lot of other help. As board members we have the obligation to provide the following:

1. **Facilities**: Convenient control center, buildings for storage of equipment and supplies, fenced area for protection from theft and vandalism.
2. **Equipment**: Trucks, jeeps, tractors, spray machines and pumps, radio communications.
3. **Supplies**: Chemicals, biological control agents (mosquito fish, dragonfly naiads).
4. **Personnel**: Workers in quantity and quality who can efficiently carry out instructions and do the work required and who are personable and able to deal with the public.
5. **Cooperation**: Budget sufficient funds, set policies, give latitude for decision making.

All the conditions listed above are essential but perhaps the most important one is the last — cooperation, which means:

1. Attending board meetings.
2. Giving input to problems discussed.
3. Budgeting and paying salaries commensurate with the responsibility.
4. Furnishing sufficient insurance coverage.
5. Complimenting employees for accomplishments.
6. Offering constructive alternatives to problem areas.
7. Making further training opportunities available.
8. Letting the manager work out district problems with the board's help and consent.
9. Stopping by the district office to give encouragement.

CHLORINATED HYDROCARBON PESTICIDE RESIDUES IN THE ENVIRONMENT

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It is a great pleasure to be invited to address the Utah Mosquito Abatement Association. I would like to express my appreciation to the organizers and members for the very warm welcome extended to me. The choice of this beautiful mountain retreat has certainly provided a suitable place to reflect upon the use of chemicals in our modern world.

I have been most impressed with and appreciative of the expertise, energy and emphasis on sound chemical treatment techniques and integrated pest management practices described by the previous speakers. One of my functions as the toxicologist for the Enviromental Protection Agency — Region 8 is to advise people on the latest and most up-to-date pesticide practices. Thanks to you, I will be much more well-informed. I would like to take this opportunity to congratulate the members for your emphasis of real ecological and societal concerns in the practices you use to control mosquitoes. Your record is most impressive.

Compared to the emphasis on organophosphate and biological pesticides of this meeting, I have been asked to update this group on the use of several dinosaur chemicals used in pest control practices.

One of the early pesticides used in the Salt Lake Valley for mosquito control was lindane or hexachlorocyclohexane. This practice was not proven to be effective. However many uses for lindane still remain. The recent conclusion of an RPAR (Rebuttable Presumption Against Registration) has been completed and lindane returned to the registration process with only minor changes. I recently assisted the US Forest Service in a risk assessment process to determine if wood treated for pinebark beetle infestation with lindane would constitute a hazard from home fireplace or woodburning stove usage. The exposure potential calculated was much less than many of the approved uses for lindane.

A second chlorinated hydrocarbon pesticide that has made the news lately has been chlordane. Many, many problems have been recognized concerning this persistant, toxic, and potential mutagen or oncogen. Most of the registered uses have been cancelled. Chlordane is still used as a termite control agent and as such has been identified by the US Army as a contaminant in approximately 25% of the housing where this chemical had been used for termite control. Houses on slabs or with crawl spaces have been associated with contamination problems. Toxicologically few identifiable illnesses can be blamed on low level, chronic chlordane exposure. There are some indications that children are the most susceptible to the effects of chlordane.

Mr. Glen Collett had asked me earlier to up-date this group concerning the presence of endrin in the wildlife and migratory birds of Montana. As was reported extensively in the media, wildlife, waterfowl and upland game birds showed contamination of endrin the the State of Montana after the use of endrin to control a pale western and army cutworm infestation in 1981. Many samples were taken and levels of endrin detected were substantially above the FDA standards for poultry. These standards have been developed for a standard diet.

The consensus is that the limited dietary ingestion would minimize the risk. Any individual's consumption pattern would likely be within an acceptable margin of safety which would limit teratogenic or toxic manifestations. The Montana Fish, Wildlife and Parks Department did suggest handling and cooking practices which would further limit consumer ingestion of endrin.

The year 1982 brought an increased vigilance with an expanded monitoring program. Samples of waterfowl and upland game birds have shown presence of several chlorinated pesticides. Attachment 1, supplied by the Montana Department of Fish, Wildlife and Parks, shows the extensive array of chemicals present.

The upper concentration levels and the large number of chemicals raise a certain amount of toxicological concern. A perusal of the data indicates only a very few animals with elevated levels of two or more of these chemicals. One wonders how these few birds, all probably migrants, could manage to find that much contaminated feed and still migrate. The major contaminants besides endrin were heptachlor epoxide, hexachlorobenzene, PCBs and the DDT family.

In 1962, Rachel Carson published Silent Spring. She was one of the early flag raisers to address the consequences of widespread use of persistant chlorinated hydrocarbons which would result in the persistant contamination of the environment and food chains. Fortunately, we see that several of these chemical levels have been dropping with time. The changing use patterns of chemicals and the development of the integrated pest management practices may further limit the contamination of the environment with the persistant chlorinated hydrocarbons in the future.

Attachment 1. Results of 89 samples of waterfowl and upland game birds tested for chlorinated hydrocarbons (PPM) by the Montana Fish, Wildlife and Parks Department. 1982.

Compound	Detectable Levels Low — High	Number of Postive Results
Endrin	◄0.01 — 2.98	55
Heptachlor	◄0.01 — 0.24	1
Heptachlor Epoxide	◄0.01 — 33.6	55
Lindane	◄0.01 — 0.09	20
Benzene Hexachloride	all levels ◄0.01	0
Alpha BHC	0.04 — 0.32	5
Oxychlordane	◄0.01 — 2.36	29
Alpha Chlordane	0.10 — 1.17	3
Gamma Chlordane	0.06 — 1.17	4
Trans Nonachlor	◄0.01 — 1.25	15
Beta Nonachlor	◄0.01 — 0.27	11
Dieldrin	◄0.01 — 6.01	33
DDT	◄0.01 — 9.22	29
DDD	◄0.01 — 0.67	7
DDE	◄0.01 — 33.70	67
PCB	◄0.10 — 50.10	10
Hexachlorobenzene	◄0.01 — 24.8	33
Mirex	◄0.01 — 6.01	20

THE USE OF *BACILLUS THURINGIENSIS ISRAELENSIS* IN MOSQUITO CONTROL

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In recent years, mosquito control has been bothered by two particularly problematic situations. Most mosquito management agencies or organizations wrestle with these problems constantly, and until recently there were few solutions.

The first problem is the situation where adulticiding is heavily relied upon. This is generally akin to "closing the barn door after the horse got out". Besides not being very effective at comprehensive population control, the mosquito control agencies are placing themselves in a position of vulnerability to many complaints which may range from a ruined paint job on a car to a sick parakeet, and even more serious complaints where human health hazard is noted.

Most good mosquito control experts will readily admit that larviciding would be infinitely better at real management of mosquito problems if it could be done. Good larviciding is difficult and not as easy to do as driving up and down the alleys in response to complaints. Manpower is necessary to monitor mosquito populations before they become problems and prevent the maturation of the larvae into the blood-sucking adults.

A well-managed organization is essential if efficient larviciding is to be done.

The second problem situation arises out of the continued use of chemical control agents. There is a circular, self-defeating circumstance presented by continued heavy reliance on chemicals. The more you use, the more you'll need, and so on. One will lead to another, and the long-term net gain will be nothing.

With these problems in mind, a relatively new strategy for mosquito management can be considered. Microbial control of mosquitoes with a bacterial agent commonly called B.t.i. is available to the general public as TEKNAR™ and other proprietary names.

As far as mosquito control materials are concerned, B.t.i. is the new kid on the block, and it circumvents the two problems mentioned previously. It is a larvicide so it can be relied on for comprehensive control, and it is not a chemical so it is not susceptible to the many problems inherent in chemical control. Discovered in 1976, the microbial agent developed rapidly into a very successful product and was placed on the market in 1981. The results have been very good and TEKNAR is today a successful product being used by many abatement districts.

For those who are not familiar with TEKNAR, it is the H-14 serotype of *Bacillus thuringiensis*. It is a preparation of bacterial spores and a toxic compound called delta endotoxin. The mode of action is that of a stomach poison. Once ingested, the toxic component brings about the rapid cessation of normal function due to gut paralysis and eventually death.

There are several factors which influence the degree of effectiveness of the B.t.i.. The habitat is of primary importance because this determines actual mosquito species and the ecological ramifications of the control procedures, i.e. different species and behavior in stagnant pools vs. clear pasture puddles.

As far as the larvae are concerned, we know that the feeding activity per weight of larva is greater while smaller, and any natural protection to the larvae is also less when they are in early instars.

Any residual activity depends on several factors, each of which is important in its own regard. A higher rate of application means longer residual activity. A high population density means less residual. Lower water quality means shorter residual. Other elements affecting residual activity are habitats and whether the mosquito species is multivoltine or univoltine.

These considerations are not particularly vulnerabilities of TEKNAR. Rather, they should probably be considered when using any control procedure.

When TEKNAR is enrolled into an overall program of mosquito management, there are many advantages. It controls most species in any kind of water and is environmentally safe. It also has the potential for black fly control.

As a practical matter, TEKNAR has been available as a water-dispersible concentrate. This has been the most readily acceptable formulation, and it has been proven to be a good one. Very good results are common and are reported from all areas. In fact, there are even times when TEKNAR is used as a standard material to which others are compared. It has been used in some few instances where it served to clean up a population of mosquitoes that survived an application of chemicals.

There is one chink in the armor when it comes to TEKNAR'S formulation; and it's not just TEKNAR that has the problem. Just about any liquid preparation has difficulty penetrating a heavy canopy of vegetation. The prepared material, when applied over a dense canopy, has difficulty getting to the water and much is lost on the vegetation. So, Sandoz, Inc. has developed a granular formulation in an effort to combat the problem. It is presently under development and has been giving outstanding results.

FIELD OBSERVATIONS OF DURSBAN 2% GRANULES IN SALT LAKE COUNTY, UTAH

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Midvale, UT

After evaluating the 1981 larval control program, it was evident that changes needed to be made as light trap counts were higher than average and, more importantly, complaints had increased while numbers of larval breeding sources continued to decline.

Most mosquito larval sources in the South Salt Lake County Mosquito Abatement District are small [less than ¼ acre] and usually are effectively treated with parathion 2% granules on a limited basis and reported good results especially when used as a prehatch measure.

During 1982, Dursban 2% granules were used almost exclusively after the first of May as a larvicide. It is difficult to make conclusions on the effectiveness of Dursban after only one year's use, but some observations can be made. The 1982 season was wetter than normal and more sources were available for larval production. Even though pools with larvae have been declining the past few years, we projected 1982 would be more productive than the preceding year because of the above low. We think that Dursban was responsible for suppressing the number of pools positive for larvae during 1982.

Some sources were treated prior to flooding along Little Cottonwood Creek in the Holladay area. Past records showed that these pools produced large broods of *Aedes increpitus* each spring. During 1982 none of the pretreated sources yielded this or any other species. According to residents in the area, fewer mosquitoes were noticed than in other years.

A large source [approximately 20 acres] in West Valley City was treated with Dursban granules and effectively controlled. This source usually produced a brood of *Aedes dorsalis* whenever it was flooded. Subsequent to treatment, a canal overflowed, and the area more than doubled in size and remained flooded for five weeks but no larvae were found.

Even though Dursban 2% granules are more costly than parathion 2% granules, we feel the extra cost is justified because production of larvae is delayed in many sources, and it appears prehatch treatment is more effective than with parathion. The work load is decreased because of the residual action of the product. By keeping accurate records about the breeding habits of mosquito species in a District and applying Dursban 2% granules as a prehatch and/or routine treatment, benefits will far exceed the added cost.

Further study is needed to fully evaluate the effectiveness of Dursban 2% sand core granules as a control measure in Salt Lake County.

MEDFLIES, MOSQUITOES, AND MALATHION

Robert Stevens
American Cyanamid Company
Wylie, TX

I know that many of you have been watching the Medfly eradication program conducted in California by the USDA and the CDFA. I hope that each of you has been assessing the implications as applied to your own mosquito control program. As the supplier of malathion ULV, American Cyanamid has been watching the program very carefully, and we would like to share some of our observations with you. It is our hope that each of us has learned some valuable and beneficial lessons from this program.

To refresh your memory regarding the operations of the program, here is some background information. The USDA operates, on an ongoing basis, a tight inspection program designed to prevent the introduction of quarantined pests of economic importance into the United States. If such a pest becomes established, it is the responsibility of the USDA to institute appropriate control and/or eradication measures to protect US agriculture. The Medfly was first identified in Santa Clara County in the summer of 1980. The USDA, in cooperation with CDFA, instituted a biological control program based on sterile male release, supplemented by a limited ground pesticide application program.

When it became apparent in December of 1980 that the infestation was spreading, the USDA proposed the aerial application of malathion in a bait formulation over the infested area of 14 square miles at a proposed cost of less than $1 M. The aerial-applied malathion bait formulation was recommended because of previous success in Florida and Texas during earlier outbreaks. Malathion was the pesticide of choice because of its long history of usage spanning 28 years without showing adverse effects upon the pesticide which had taken place during that period of time by industry, independent research, and government sources.

It was at this point that the USDA discovered a number of facts that mosquito control directors have known for a long time. Fact number one was that most individuals and municipalities fear aerial pesticide application programs and, unless properly educated about the mechanics of the program, will continue to oppose such programs. Secondly, that politics often take precedence over good science. Third, that environmentalists and/or opposition groups are strongly organized, and fourth, that the media can be a major asset or a monumental deterrent to the continuance of a program.

A decision against aerial application of pesticide was made at that time as the State favored a program of fruit stripping, ground spraying, and expanded use of sterile male fly release. When early summer arrived, significant increases in adult wild flies were noted outside the core area, and as time progressed, additional satellite infestations were found. Based on quarantine pressure imposed by the USDA, a final decision on the aerial application of malathion bait was reached.

In anticipation of the need for aerial application, the California District of Health Services has reviewed all the available research on the safety of malathion. It issued a comprehensive report which concluded that the greatest hazard that could affect the general populace was the possibility of an aerial incident during the program. American Cyanamid, in strong support of malathion applied in area-wide programs, issued a booklet entitled, "Understanding Malathion and the Mediterranean Fruit Fly Program." At the local level, the president of the Santa Clara Medical Society, after meeting with State and other Society members, issued a letter to all Society members concluding that the widespread anxiety and overreaction based on fear and lack of appropriate information. The Society urged its members to provide their patients with reassurance and to be guided by the clinical and scientific assessment of risks provided by the State study.

By and large, physicians are usually a conservative lot in counselling their patients--and I, for one, want my doctor to be conservative. Thus, if asked by a patient, the common reaction by a physician is, "If you can avoid exposure to anything that is not going to help you, avoid it." You know how nervous people--and opponents of spray programs--can magnify such a caution. It quickly becomes, "Doctors are warning their patients to avoid exposure."

Yet no doctor wants to alarm his patients unnecessarily. In California, once the medical community was thoroughly informed, the "my doctor warned me syndrome" largely disappeared.

The public statements were extremely helpful by informing the media and alleviating public fear. After the aerial applications started, the general anxieties over the program subsided. Many residents hardly noticed the night time application of 2.4 fl. oz. of malathion mixed with 9.6 fl. oz. of protein bait applied at the rate of 12 fl. oz. per acre. As expected, non-target environmental effects were minimal. Initial and ongoing health surveys indicated no adverse health effects associated with the program. Several months after the aerial program began, the Medical Society reported that it was not aware of any serious complaints of side effects or toxicity from the spraying.

We think the California experience confirms the importance of the medical community as a positive influence upon mosquito control programs. While physicians are aware of the disease prevention benefits to be achieved by mosquito control, they probably are not aware of the vast amount of research that supports the safety of malathion if that is the product you use. We urge that, as you seek community support for your mosquito control programs, you assign the medical profession the highest priority for initial participation and suggestions.

As of May 1982, the California program has cost over $70 M, and it involved limited spraying another season before the fly was eradicated. It is unfortunate that the original Medfly finds were not handled in the same manner as they were in Florida. In Florida, the Lee County Anti-Mosquito District, because of their expertise in urban aerial application of pesticide, contracted with the Florida Department of Agriculture and the USDA for aerial application work. The Medfly was quickly eliminated. Both programs clearly identified the need for judicious use of pesticides in pest management programs.

All operations at this have ceased. Actual bait application this summer was limited to an area south and then east of the San Francisco area. The last fertile fly was found about 1 July, and since then there have been no major control programs in the area. We will certainly hope that the job has been completed and the Medfly eradicated in California.

REPORT OF THE UTAH MOSQUITO CONTROL — FISH AND WILDLIFE MANAGEMENT COORDINATING COMMITTEE

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The present membership of the Committee consists of the following, Al Regenthal, Rod Crey, Jerry Newell, Tim Provan (alternate), and Reed Roberts, Chairman.

By way of a brief introduction we would like to cite the objectives of this Committee as listed in the 1963 issue of the UMAA Proceedings. At that time the Committee consisted of J.B. Low, Leader, Utah Cooperative Wildlife Research Unit, Chairman; Don M. Rees, Division of Biological Sciences, University of Utah; and Donald M. Smith, Waterfowl Supervisor, Utah Department of Fish and Game.

The objectives of the 1963 Committee were listed as follows.

1. To work with the National Committee in further serving the aims and objectives of the National Committee on the state and local level.

2. Coordinate mosquito control and fish and wildlife management programs and policies on state and local levels.

3. Gather and disseminate relevent information and suggest standards on mosquito control techniques consistent with sound fish and wildlife management objectives.

4. Gather and disseminate relevant information and suggest standards on fish and wildlife management techniques consistent with sound mosquito control objectives.

5. Stimulate needed research and demonstration projects relating to mosquito control and fish and wildlife management practices.

6. Sponsor suitable meetings and cooperate with agencies, organizations and all others whose activities and interests may relate to those of this committee.

In his report to the Association in 1973 Jay E. Graham summarized the formation of, and the reasons for, the Utah Mosquito Control — Fish and Wildlife Management Coordination Committee. Following are comments from his report.

> The concept of a coordinating committee developed, as near as I can tell, from discussions between Bob Vannote of the Morris County Mosquito Extermination Committee and Paul Springer of the U. S. Fish and Wildlife Service. A national committee was appointed and certain objectives established. The first conference sponsored by the Committee was in 1960 in Washington, D.C. Later a meeting was held at Yosemite Park following which Glen Collett, Jay Graham and Dr. George F. Knowlton discussed the idea of a committee being established in Utah. Thus, the organization, which serves without authority or tenure by mutual interest and consent and without reporting responsibility except to their own groups and interests was formed.

The same Committee membership, namely Jessop B. Low, Chairman, Don M. Rees, and Albert Regenthal, was maintained since the time of appointment in 1963 to 1973, except the Division of Wildlife Resources personnel which was changed from Donald Smith to John Nagel then to Albert Regenthal.

In his 1973 report, Graham listed the goals of mosquito control and wildlife management as follows.

1. Learning more about the biology of mosquitoes and the weak links in their histories.
2. Appraising the effects of control measures on the whole environment.
3. Recognition of mosquito habitat by wildlife managers and the development of waterfowl habitat with features to discourage mosquito reproduction.
4. Coordination between the two groups to control mosquitoes and still perpetuate to the maximum the capacity of our marshes to produce wildlife (waterfowl, water birds, and other desirable wildlife) and to provide recreational opportunities to hunters, sightseers, photographers, hikers, picnickers, and others.

His report continued with a list of committee accomplishments and future plans. It is interesting to note that Graham stressed the need for additional research in his report, especially at the Bear River Migratory Bird Refuge. The role of sinkboxes in producing mosquitoes, the need for standards in mosquito control and the economic value of marshlands were some of the other subjects included in his reports.

The 1974 Committee report was prepared and presented by Albert Regenthal. He cited several cases where personnel from wildlife and mosquito control had become more aware of the programs and needs of the other. He cited the case of two of the waterfowl management superintendents who had, on their own initiative, undertaken measures to improve water distribution systems with one of the express purposes being better mosquito control.

One problem at that time which had come to the attention of the Committee was the mosquito problem in the Jensen area of Uintah County. This is a problem which has since been resolved by Dr. Steven V. Romney and the local representatives of the Utah Division of Natural Resources.

The 1976 report of the committee was given by Reed S. Roberts. At that time there were two committees interested in the working relationships between the mosquito abatement agencies and the state and federal agencies responsible for the preservation and propagation of fish and game animals. Within the UMAA there was the Wildlife Resource Committee which consisted of Reed S. Roberts, Chairman, Glen Collett, Lewis Fronk, Larry Nielsen, Rex Passey and Wiley Stewart. The second committee, the Utah Mosquito Control — Fish and Wildlife Management Coordination Committee consisted of three members, Jessop Low, Al Regenthal and Reed Roberts.

On August 1976 an on-site visit was made at Ouray by the Committee members, interested representatives from the Utah Division of Wildlife Resources and Steven V. Romney. Since that time considerable progress has been made at both Ouray and the Stewart Lake area.

Since 1977 the Committee's activities have been limited. However, in 1979 a new Federal Agency became involved when on September 5, 1979, U. S. Attorney General Benjamin Civiletti issued an opinion that the Administrator of the Environmental Protection Agency had the ultimate administrative responsibility of determining the jurisdictional scope of waters in the United States, including wetlands for the purposes of Section 404 of the Clean Water Act. The Civiletti opinion and a subsequent Memorandum of Understanding (MOU) between EPA and the U. S. Army Corps of Engineers resulted in agreement between the agencies regarding wetland delineation and the agency jurisdiction. The outcome was the establishment of a system geared to avoid the costly delays which occurred in the past.

The current role of the U. S. Army Corps of Engineers in the regulation of mosquito control activities is a major subject and too lengthy to include in this report. However, representatives of our Association have been in communication with the Army Corps of Engineers and there is every reason to believe that any problems which arise will be resolved by mutual consent.

The original objectives of the Utah Mosquito Control — Fish and Wildlife Management Coordinating Committee are every bit as valid today as they were in 1963.