Proceedings of the

Fiftieth Annual Meeting

of the

Utah Mosquito Abatement Association

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Ogden, Utah

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Edited by

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Dr. Don Merrill Rees Memorial Award

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

Glen C. Collett	1987
Dr. Lewis T. Nielsen	1988
Reed S. Roberts	1989
Dr. Bruce Francy	1990
Dr. Fred Harmston	1994
Ted Davis	1996

Meritorious Service Award

This award is presented to individuals who have distinguished themselves in administrative or technical service to mosquito control in Utah.

T. A. Schoenfeld	1970
Dr. Don M. Rees	1970
Evan K. Jeremy	1975
Wilford Egbert	1975
Reed S. Roberts	1976
Dr. Bettina Rosay	1976
William H. Wright	1978
Merrill L. Miner	1978
Dr. Jessop B. Low	1978
Dr. F. James Schoenfield	1979
William E. Dunn	1981
Lewis E. Fronk	1981
Thomas D. Mulhern	1981
Dr. W. Donald Murray	1981
Richard F. Peters	1981
Dr. Carl D. Clark	1985
W. G. Larson	1985
Dr. Robert E. Elbel	1988
Lynn Thatcher	1990
Rex Passey	1991
J. Lawrence Nielsen	1995
Dr. Howard M. Deer	1997
Monty Eggett	1997
H. B. Munns	1997
Verl L. Petersen	1997

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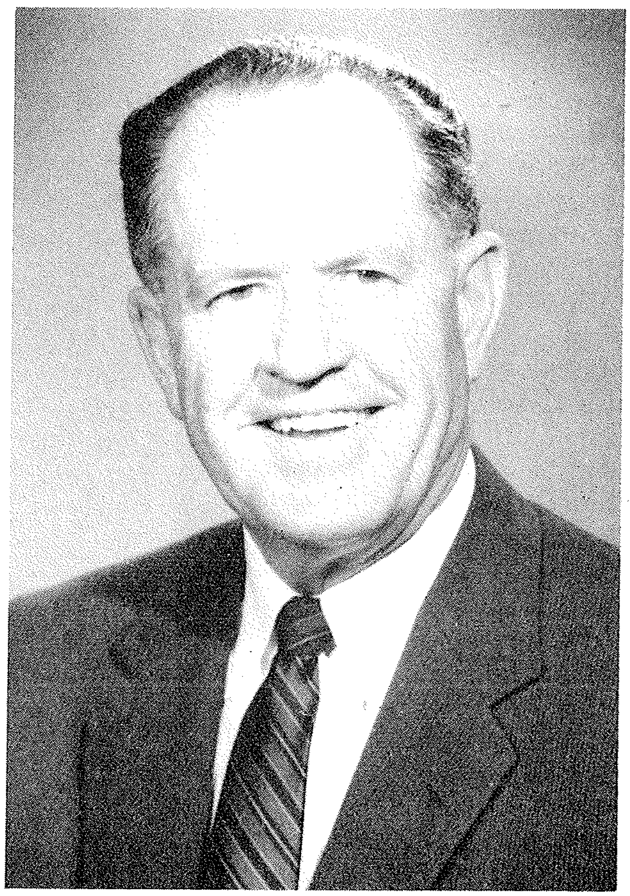
Dr. Don M. Rees	1948-1951, 1975
O. Whitney Young	1952
T. A. Schoenfeld	1953
O. C. Finley	1954
Howard Widdison	1955
De Lore Nichols	1956
Jay E. Graham	1957
Dr. Lewis T. Nielsen	1958, 1990
Lewis E. Fronk	1959, 1965-66 *
Karl L. Josephson	1960, 1969
Morris Swapp	1961
Glen C. Collett	1962
George F. Knowlton	1963
D. Elden Beck	1964
J. Lawrence Nielsen	1967, 1977
Kendall Sedgewick	1968
William H. Wright	1970
Reed S. Roberts	1971
Lee P. Kay	1972
Wilford Egbert	1973
Dr. Carl D. Clark	1974
E. Jenne	1976
Evan Lusty	1978, 1994
Keith Wagstaff	1979, 1993
Wanless Southwick	1980
Dennis Hunter	1981
Elmer Kingsford	1982
Robert J Brand	1983
Dr. Steven V. Romney	1984, 1996
E. James Nielsen	1985
Lewis A. Marrott	1986
Kenneth L. Minson	1987
Dr. Sammie L. Dickson	1988
Kay Weight	1989
Doug Brown	1991
John Jaussi	1992
Bruce Bennett	1995
Gary L. Hatch	1997

* Presidents serve from one annual meeting to the next annual meeting. From 1948 through 1965, annual meetings were held in the spring. However, from 1966 to the present, annual meetings are held in the fall. The second term of Lewis Fronk is listed as 1965-66 but was actually only 18 months.

DR. DON MERRILL REES
1901-1976



Founder of the Utah Mosquito Abatement Association 1948

DON MERRILL REES, 1901-1976
A TRIBUTE TO THE FOUNDER OF THE UTAH MOSQUITO ABATEMENT ASSOCIATION

LEWIS T. NIELSEN
Emeritus Professor
University of Utah
Salt Lake City, Utah 84112

Don Merrill Rees was born September 9, 1901, in Wales, Utah, to Thomas Davis and Elizabeth Rees. He grew up in this small community in Sanpete County. His father was a farmer and stockman. His early education culminated in a High School diploma at Snow College in Ephraim, Utah in 1919. On April 30, 1924, he married Norma Josephine Anderson of Ephraim. He continued his education at the University of Utah, receiving a B.S. degree in 1926 and an M.S. degree in 1929. He concluded his formal education with a Ph.D. at Stanford University in 1937. His interest in mosquitoes began in the late twenties when as a graduate student in zoology he conducted a survey of the species of the Salt Lake Valley and the Wasatch Front. Later that was to include the whole state, resulting in his publication "The Mosquitoes of Utah" in 1943. He joined the staff as an Instructor in the Zoology Department at the University of Utah in 1930 and, during the period from 1930-1937, he also served as the Supervisor of the Salt Lake City Mosquito Abatement District during the summer months. He continued to serve with the District as a member of the Board of Trustees from 1938 to the time of his death, much of the time as its President.

He received his full Professorship at the University of Utah in 1942. He served as Head of the Department of Invertebrate Zoology, 1948-1954; Head of the Department of Zoology and Entomology, 1954-1963; Chairman of the Division of Biological Sciences, 1951-1965; and Director of Ecological and Epizoological Research, University of Utah at Dugway, Utah, 1956-1961. While on the faculty of the University of Utah he served on numerous academic and administrative committees. He was President of the University Chapter of the Utah Education Association and elected President of the University Chapter of the American Association of University Professors.

He has often been referred to as the "Father of Mosquito Abatement in Utah." He was directly responsible for the establishment of the Utah Mosquito Abatement Association in 1948, and served as its president from 1948-1951, and again during 1974-1975. His influence, knowledge and leadership were instrumental in maintaining the splendid cooperation between Mosquito Abatement Districts and other state agencies directly or indirectly concerned with the affects of mosquito control. He was elected an Honorary Member of the Utah Mosquito Abatement Association in 1970.

His influence outside the state of Utah was great. He was one of the organizers of the American Mosquito Control Association. He served on its Executive Committee during 1947-1948, and as the Chairman of the Interim National Board in 1949, when the American Mosquito Control Association organized its Constitution and Bylaws. He served as its President in 1952. His many services to the cause of mosquito control were recognized when he received the coveted Medal of Honor Award from the American Mosquito Control Association in 1974 for "Distinguished Contributions to Mosquito Control."

In 1979, he was the Honoree of the first Memorial Lecture. This lecture is now given annually at American Mosquito Control Association meetings to honor the memory of deceased individuals who have made outstanding contributions in mosquito science and control.

He was a leader in developing and stressing means of control of mosquitoes by other than chemical methods and was a recognized national authority in the field of water management and mosquito control. He was also an expert on mosquito-borne diseases. In 1947, he served as a Medical Entomologist Consultant to the Surgeon General in a study of the control of viruses and rickettsial diseases in the Orient. He was a consultant to the U.S. Public Health Service from 1948-1952, and in 1964 was a consultant in the Canal Zone where he was asked by the U.S. Army and Canal Zone Government to evaluate and recommend improvements in mosquito control practices. He was a visiting professor at the University of Indonesia Medical School in Djakarta in 1957-1958, and helped reorganize their program in Medical Entomology. He also served as Chairman of the Utah Committee on Fish and Wildlife - Mosquito Control for several years beginning in 1964.

He organized the Institute of Environmental Biological Research at the University of Utah and served as its Director from 1960-1966. During this time he obtained grants from the National Institutes of Health which made it possible for the construction of a new Biology Building with facilities that greatly expanded the research capabilities in environmental and biological research.

In 1965, he received the "Distinguished Service Award" from the Utah Academy of Sciences, Arts and Letters for outstanding achievement in the biological sciences.

In 1987, the Utah Mosquito Abatement Association further honored Dr. Rees by establishing the Don M. Rees Award to recognize individuals who have made significant contributions to mosquito control in Utah and elsewhere.

Dr. Rees was the author of over 200 scientific publications in entomology, most of which dealt with multiple phases of mosquito control activities. He was listed in Who's Who in the West, American Men of Science and other directories. He was a fellow of the American Association for the Advancement of Science, a member of Sigma Xi, the American Mosquito Control Association, the American Public Health Association, the Entomological Society of America and many other professional organizations. He also belonged to the Honor Society Phi Kappa Phi.

One of the greatest contributions of Don Rees was his influence on his many students. While a Professor at the University of Utah, he produced almost 100 graduate students with Masters or Ph.D. degrees in entomology, many involving mosquitoes and insects of medical importance. He was noted as a fine teacher whose lectures were outlined and so well organized that failing one of his classes would have been difficult.

The great majority of his students have become highly productive teachers and scientists in universities and in state and federal agencies throughout the country. He was very proud of them and often stated that their achievements gave him greater satisfaction than his own. A source of particular pride to him was that four of his students had been elected to serve as President of the American Mosquito Control Association. All later received the AMCA's highest award, The Medal of Honor.

Don Merrill Rees died suddenly of a heart attack, April 5, 1976. He died while enjoying an active retirement and apparent good health.

Don Rees was a remarkable man with remarkable achievements. He was also a warm, friendly, unselfish human being and a devoted husband and father.

Besides being an outstanding scientist and teacher, he was an outdoors man. He loved to hunt and fish, especially with his close friend, Dr. Steven Durrant. Nothing suited him better than spending a day on the marsh hunting ducks or fishing along a mountain stream. He excelled at both of these hobbies. He also loved music of all kinds and on field trips and outings he often led group sing-alongs.

Those of us who were lucky enough to be close friends and students of Don Rees will always miss him and be grateful for his influence in our lives.

He is survived by his two sons, Dr. Thomas Dee Rees and Dr. Joseph Richard Rees, seven grandchildren, and two great grandchildren. His wife, Norma, died in October, 1991. She was his loving companion and his strong supporter for more than 50 years.

50 YEARS OF THE UMAA
HISTORICAL HIGHLIGHTS AND BENEFITS

GLEN C. COLLETT
Executive Director, Utah Mosquito Abatement Association
Salt Lake City, Utah

It is a privilege for me to present this brief history and benefits of the Utah Mosquito Abatement Association (UMAA) on this the fifty-year anniversary. Reviewing proceedings from annual meetings, minutes of board meetings, resolutions adopted, and committee reports related to the past fifty years, it is obvious that only highlights can be mentioned in this presentation.

Having spent many hours during the past month reading much of the material in these reports, I find the achievements of the UMAA remarkable. The first meeting of the mosquito control agencies in Utah was held in the Salt Lake Tribune Auditorium, Saturday, March 20, 1948. This meeting was arranged by Dr. Don M. Rees and resulted in the organization of the UMAA. Five papers were presented. Reports were given by the four districts that were established prior to this meeting.

Our four pioneering districts were:

Salt Lake City MAD, organized in 1924; twenty-one years later Box Elder County MAD was organized in 1945; followed by Magna MAD in 1946, and Weber County MAD in 1947.

In the June 1948 issue of *AMCA Mosquito News* Dr. Rees submitted a brief report in the News & Notes section on the organization of UMAA with the following officers elected:

Don M. Rees, President
Robert Wilkins, Supervisor of the Salt Lake City MAD, Vice President
Roy Tygesen, Board of Trustees of Magna MAD, Secretary-Treasurer

The remainder of the Executive Committee consisted of the Presidents of the four mosquito abatement districts. Dr. Rees stated the organization would function informally until a Constitution and By-laws were prepared and accepted by the Association.

A letter dated August 11, 1948, prepared for circulation to various agencies by the officers of the Association stated:

"The Utah Mosquito Abatement Association was organized in March of this year to promote close cooperation among those directly and indirectly concerned with, or interested in, mosquito control and related work; to increase the knowledge of mosquito abatement; and to advance the cause of mosquito abatement in the state of Utah."

This statement still applies fifty years later.

Dr. Rees served as President for the next three years.

The second annual meeting was a two-day meeting held March 18-19, 1949, at the University of Utah. Twenty-five papers were presented along with reports from the original four mosquito abatement districts.

This second annual meeting had an impressive program which began a tradition of having out-of-state speakers take part in annual meetings.

Five speakers were from California and included Harold Grey, President of AMCA; as well as Ed Washburn, President of the California Mosquito Control Association. Fred Harmston of the U.S. Public Health Service also spoke. The U.S. Public Health Service has participated in most of the meetings since that time.

From the initial four districts of 1948, the UMAA has grown to 17 districts.

We have had experts, world renowned in their fields, take part in these meetings. The Association has given graduate students the opportunity to present papers on their research related to mosquitoes, other vectors, and other aspects of control. Many have gone on to make major contributions in mosquito control and related areas.

Untold benefits resulted from exhibitor participation in these meetings. These exhibitors presented information on the development of new materials and equipment. Exhibitor support made a great contribution to the meetings. In a survey of District managers on benefits received from UMAA membership, the majority said up-to-date information gained at the annual meetings and the opportunity to meet in informal discussions with other members were the most valuable benefits.

An average of thirty papers have been presented at each annual meeting. During our fifty-year history over 1,500 papers have been presented. An additional 500 papers have been given at the four AMCA meetings which were held in Utah.

Papers from many states have made up the fifteen hundred presentations. It is worth mentioning that there have been approximately 175 presented from California. This indicates the great support given to the Association from California since that 2nd Annual Meeting.

Approximately 2/3 of the papers presented at annual meetings have been published in the Proceedings. The Proceedings serve as an archive of the development that has taken place in mosquito control in Utah and other regions of the country the past fifty years.

The Association has hosted four AMCA meetings. The first was 1952 when Dr. Rees was President of the National Association. The next was 1959, again in 1980, and this past March, 1997. This past March's meeting was one of the largest in attendance and was the most financially successful of any previous AMCA meeting.

In addition to hosting four AMCA meetings, the annual meeting in 1984 in Salt Lake was held jointly with the Society for Vector Ecology. This 16th Annual Conference of SOVE was the first time the meeting was held outside of California.

In 1987 a joint meeting with the West Central Mosquito and Vector Control Association was held in Park City. In 1994 a joint meeting with the Nevada Mosquito Control Districts was held in Wendover, NV.

Many training courses for district personnel have been held since the organization of the UMAA. Dr. Harry Pratt, Chief of the Insect and Rodent Control Training Branch of CDC, Atlanta, on two occasions came to Utah to conduct training sessions.

The first training course was held at the CDC Logan Field Station in 1955. The second was held in Farmington, Utah, February 4-8, 1958.

In 1989, American Cyanamid's public relations firm from New Jersey came to Salt Lake and presented training for district managers on how to handle TV interviews. Each manager was interviewed and video taped. The Video was then shown to the group and critiqued. A year later the public relations team returned and repeated the training.

Committees have consistently played a major role in carrying out the goals and benefits of the Association. For the past seventeen years, the Spring Workshop Committee, with Dr. Lewis T. Nielsen as chairman, has organized training for district employees. Topics were chosen to teach needed skills to new and returning seasonal employees.

The following are examples of topics that have been presented: Responsibilities of Mosquito Abatement Employees; Bti, what is it?; Pesticides and Their Safe Use in Mosquito Control; Utah's Important Pest Mosquitoes; Liability Management; It Can Happen to You, Safety Video; Guidelines for ULV Adulticiding; Importance of Accurate Record Keeping; Proper Dipping for Mosquito Larvae; Mosquito Habitats; Too Much and Too Little (pesticide); and Public Relations. The average yearly employee attendance for these workshops is 105.

Over the past years, the Pesticide Committee has arranged mosquito resistance tests on five different occasions. This Committee has drawn up product specifications and compiled quantities of pesticides needed by the districts for the joint purchase of these materials.

The legislative Committee's major responsibility over the years has been to monitor potential legislation. Many bills that would have had a detrimental impact on mosquito abatements were modified or killed as a result of the efforts of our committee.

The UMAA joined the Utah Association of Special Districts when it was organized in 1990. Robert J Brand was the UMAA Representative for 1990-91. As chairman of the UMAA Legislative Committee, Kenneth Minson has been our representative with this group for the past six years. Ken has spent untold hours and has done an outstanding service for the mosquito control districts in the state.

The Utah Mosquito Control/Fish and Wildlife Committee was established in 1962 to deal with conflicts that may arise between these two agencies.

Since the mid 1960s the Encephalitis Surveillance Committee has set the budget and arranged for laboratory work on blood samples from the sentinel chicken flocks. The data is used by districts to monitor mosquito-borne viruses.

It is obvious that the UMAA during the past fifty years has been a strength to the districts in the state. Regardless of district size, all have greatly benefited by working together as an Association.

GLOBAL STRATEGY FOR THE PREVENTION AND CONTROL OF DENGUE AND DENGUE HAEMORRHAGIC FEVER

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Introduction

The World Health Report (1996) stated, "The re-emergence of infectious diseases is a warning that progress achieved so far towards global security in health and prosperity may be wasted." The report further indicated that "Infectious diseases range from those occurring in tropical areas (such as malaria and dengue haemorrhagic fever, which are most common in developing countries) to diseases found worldwide (such as hepatitis and sexually transmitted diseases, including HIV/AIDS) and food-borne illnesses that affect large numbers of people in both the richer and the poorer nations."

Dr. George F. Lumley, a medical officer at the School of Public Health and Tropical Medicine, University of Sydney, Australia, observed (Lumley and Taylor 1943), "It is regrettable that endemic dengue normally excites but little interest, and this is especially true in Australia. Only when it extends into, even descends as a plague upon, non-endemic areas does it produce sufficient alarm and the sequela of appropriate prevention health measures."

Dengue today is still mainly viewed as a silent, orphan-like disease, circulating in the form of classical dengue which is of more significance to adults, due to associated joint and muscle pains, hence the name "break-bone fever." In children primary dengue infections are quite benign.

Since 1975, dengue has surfaced in significant outbreaks in more than 100 countries. It is epidemic in five of the six WHO regions (see Figure 1), Europe being the exception, however, imported dengue is reported from many countries in the absence of indigenous transmission. The more insidious form, dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS) with frank internal bleeding and shock are frightening manifestations of the darker side of dengue which mainly affects children under the age of 15, and about 5% of the cases result in death. In the 1970's only nine countries had experienced DHF outbreaks, to date 44 countries have been confronted by cases or DHF epidemics (Table 1).

Annually, it is estimated that there are 20 million cases, of which 500,000 require hospitalization, resulting in around 24,000 deaths. The global population at risk is estimated to range from 2.5 to 3.0 thousand million individuals, based mainly on urban populations in tropical and sub-tropical areas of the globe. However, dengue formerly thought to be mainly an urban problem now is recognized as being a significant problem in rural areas of China, India, Thailand, Malaysia, Indonesia and elsewhere in South-east Asia, placing an even greater population at risk. There are four different dengue serotypes for which there is no cross immunity which means that an individual who has recovered from one remains susceptible to the other three serotypes. The haemorrhagic form of dengue (DHF) most often occurs in individuals who have previously had an infection but are infected again with a different virus type, although DHF occasionally occurs as primary infections.

Dengue flourishes in conditions of poor housing, overcrowding, and inadequate sanitation, especially in cities in tropical and sub-tropical regions of the Americas, Asia, Africa, the Eastern Mediterranean and the Western Pacific, and in communities where solid waste accumulates, especially commonly discarded 20th Century household containers, and tyres where the peridomestic *Aedes* mosquitoes breed.

The rapid spread of dengue fever and DHF is causing great concern to public health specialists and WHO. Annex I is an overview of the importance of dengue surveillance by WHO region. Annex II presents information from a few sources, concerning the economic burden of dengue and DHF.

Dengue epidemics are increasing due to:

1. Growing urban populations;
2. Expanding mosquito breeding sites;
3. Rapid transportation which involves both the movement of infected people and the spread of dengue-carrying mosquitoes;
4. Circulation of multiple serotypes;
5. Changes in climate as related to El-Nino and the Southern Cone Oscillation resulting in increased rainfall;
6. Improved rural water supply (resulting from the decade of water);
7. Poor water storage practices;
8. Lack of political will;
9. Ineffective vector and disease surveillance; and
10. Inadequate public health programs.

Current status of dengue its vector mosquitoes:

The two principal or potential *Aedes* vector species are *Aedes aegypti* and *Ae. Albopictus* (see Figures 2 and 3 for distribution maps). *Aedes aegypti*, the principal vector is restricted in its distribution by the global 10°C isotherm. However, *Ae. Albopictus*, the secondary vector, has no such limits, but its distribution is related to photo periodicity, temperature, rainfall and humidity. North of 30° latitude, it appears that the species is seasonally affected by day length and the 10°C January isotherm and the 20°C July isotherm, delineating areas at risk for supporting established populations. It has exhibited a distinct overwintering capacity by going through diapause in temperate climates. An annual rainfall of 50 cm or more is sufficient to provide this species with a variety of rain-water dependent breeding habitat.

Progress toward implementation of the dengue resolution:

I. WHO resolution on dengue prevention and control

As a result of an initiative taken by WHO, and some Member States, a resolution on dengue prevention and control was brought before the Executive Board in January 1993, which resulted in its approval by the 46th World Health Assembly in May 1993. That resolution (WHA46.31) confirmed that dengue prevention and control should be among the priorities of WHO. Among other things requested that:

(a) Strategies be developed to contain the spread and increasing incidence of dengue, DHF and DSS in a manner sustainable by countries;
(b) Community health education be improved;
(c) Health promotion be encouraged;
(d) Research be strengthened;
(e) Surveillance be expanded;
(f) Guidance be given in vector control; and
(g) Mobilization of external resources for disease prevention.

Activities within WHO aimed at the implementation of aspects of the resolution include:

- Development of a 14 page, colored fact sheet "Preventing dengue and dengue haemorrhagic fever - a fact sheet for municipal and community leaders" (in four languages);

- Creation in 1996 of a world-wide web (WWW) dengue page on the Internet which features the above brochure in English and Portuguese which can be read through Acrobat Reader software. The direct URL address is http://www.who.ch/ act/dengprev.htm

- Production in 1993 of a 12-minute video, "Dengue, A Sinister Dawning," in four languages;

- Convening of an informal consultation in 1995 on "Key issues in dengue vector control toward the operationalization of a global strategy" resulting in the formulation of a global strategy on dengue and DHF;

- Support in 1995 for a regional meeting in SEARO during which a regional strategy on the prevention and control of dengue and DHF was adopted;
- Funding in 1994 of a consultant within SEARO to assist three Member States (India, Myanmar and Thailand) in the development of national strategies for the prevention and control of dengue and DHF;

- Identification of resources in 1994 which supported in part a research project on the "Social and economic impact of dengue haemorrhagic fever in Thailand," resulting in a report, and in 1995, funding of a similar study in Puerto Rico;

- Development in 1996 of a 12 MB interactive computer training program with a grant from AUSAID;

- Participation in a number of international congresses and meetings to increase awareness of the continuing rise and spread of dengue, DHF, and its vector mosquito species;

- Co-authoring with Dr. Norman Gratz (former Director of the Former WHO Division of Vector Biology and Control) of a 200-page document, "The Rise and Spread of Dengue, Dengue Haemorrhagic Fever and its Vectors - A Historical Review (up to 1995)," and

II. Global Strategy:

The WHO global strategy for the prevention and control of dengue and DHF recommends the following as guidelines for dengue-endemic countries:

(a) Selective, integrated vector control with community and intersectoral participation.
(b) Active surveillance based on a strong health information system;
(c) Emergency preparedness;
(d) Capacity building and training; and
(e) Research on vector control.

III. Regional Guidelines and Strategies:

In addition to the global strategy for the prevention and control of dengue, three WHO regionals have developed guidelines or strategies as well.

The Americas - American Regional Office/Pan American Health Organization

In 1994, the Pan American Health Organization (PAHO) published Scientific Publication No. 548, entitled, "Dengue and Dengue Haemorrhagic Fever in the Americas: Guidelines for Prevention and Control," a 98-page document which contains the regional strategy for the prevention and control of dengue and DHF. In early 1996, a PAHO Technical Task Force was established to study the feasibility, timeliness, and appropriateness of drawing up a hemispheric plan for the eradication of *Aedes aegypti* as an effective means of controlling dengue and urban yellow fever in the Americas (PAHO 1996).

At the XXXIX Meeting of the Directing Council of the PAHO in September 1996, a resolution (CD39.R11) on *Aedes aegypti* was approved which urged Member Governments "to collaborate in the definition of the general guidelines for a hemispheric plan to expand and intensify efforts to combat *Aedes aegypti* with a view to its eventual eradication in the

Americas through persistent country-level efforts."

The Western Pacific - Western Pacific Regional Office:

In 1995 the WHO Regional Office for the Western Pacific published the Western Pacific Education in Action Series No. 8, entitled, "Guidelines for Dengue Surveillance and Mosquito Control," a 104-page document that provides practical information on the steps for preventing and controlling outbreaks of dengue haemorrhagic fever. The guide's main emphasis is placed upon vector surveillance and control with a priority given to simple environmental measures individuals and communities can take to eliminate *Aedes spp.* larval breeding habitats.

South-East Asia - South-East Asia Regional Office:

In 1993, the WHO Regional Office for South-East Asia published the Regional Publication, SEARO No. 22, entitled, "Monograph on Dengue/Dengue Haemorrhagic Fever." The publication contains information on vector control and ecology, dengue viruses, pathophysiology, pathology and pathogenesis of DHF, management of dengue, clinical manifestations and epidemiology of DHF and development of DHF vaccines. In 1996, SEARO produced a report of a WHO Regional Consultation (WHO Project: ICP CTD 001) entitled, "Prevention and Control of Dengue/Dengue Haemorrhagic Fever in South-East Asia Region," consisting of 27 pages.

The report contained the strategy and plan of action for prevention and control of dengue/DHF. The basic elements of the regional strategy are to:

- Establish an effective disease and vector surveillance system based on reliable laboratory and health information systems;
- Undertake disease prevention through selective, stratified, and integrated vector control with community and intersectoral participation;
- Establish emergency preparedness capacity to control outbreaks with appropriate contingency plans for vector control, hospitalization, education and adequate logistics;
- Ensure prompt case management of DHF/DSS, including early recognition of the signs and symptoms to prevent case mortality; and
- Strengthen capacity building and promote training, health education, and research on surveillance, vector control, laboratory diagnosis, and case management, and development (field trials) of dengue vaccine.

IV. Conclusion

Today, dengue and DHF/DSS are considered to be the most important arthropod-borne viral diseases, ranking high among the new and newly emerging infectious diseases. Since the adoption of the dengue resolution, there has been progress in increasing awareness of the importance of dengue and DHF, at the political, decision making, national and community levels. In addition to the global strategy for dengue prevention and control, the Americas and the Western Pacific Regions have developed regional guidelines to assist Member States in prevention and control. In South-East Asia, a regional strategy has been adopted and at least four Member States are preparing national strategies.

Now, more than four years after the adoption of the dengue resolution, despite considerable progress made, *Aedes aegypti* and related vector species continue to spread dengue into new tropical and sub-tropical areas of the world, bringing misery and death, without respect for one's station in life, socioeconomic level, age, gender, social status, etc. Lumley in Australia was correct that there is a certain malaise about dengue which is only shaken off when massive epidemics occur.

While progress is being made on some fronts, dengue and DHF/DSS continue to spread, as related to increases in urban population growth, poor sanitation and availability of vector breeding sites, expanded air travel, and the circulation of multiple dengue serotypes, affecting susceptible persons. A global effort is required to stop this disease with closely developed collaboration between regional, national, and community health authorities, other concerned sectors, and the donor community.

ANNEX I: SURVEILLANCE

One of the major pillars of the global strategy is to increase active and accurate surveillance of dengue/DHF and its vectors. In most endemic countries in the world, dengue is not a notifiable disease and reporting is haphazard. The following are examples of recently reported outbreaks of dengue and/or DHF around the globe.

Africa: In Africa, dengue has been reported from seventeen countries those experiencing recent epidemics include Comores where in 1993 there were an estimated 84,000 cases of dengue. During 1976-77, the Seychelles experienced a dengue epidemic in the absence of *Ae. aegypit*, with only *Ae. Albopictus* present. For the most part in Africa, although serotypes are present, no outbreak to date has confirmed the simultaneous circulation of multiple serotypes or DHF.

The Americas: In 1995, the worst dengue epidemic in Latin America and the Caribbean for fifteen years struck 32 of the countries in the region causing more than 275,000 cases of dengue, 7,715 cases of DHF and more than 100 deaths. In Venezuela in 1996, as of August, there had been 5,098 cases of dengue reported. Training has been provided in the clinical diagnosis and treatment of DHF in nine countries, vector control in three countries, social participation in two countries, and laboratory diagnosis in 25 countries. Bolivia has increased in dengue surveillance in 1996 as a dengue outbreak is ongoing in the country.

Eastern Mediterranean: A dengue outbreak occurred in Djibouti in 1992 with an estimated 12,000 cases. Only Saudi Arabia has reported a small number of DHF cases with mortality.

South-East Asia: Dengue and DHF is an important emerging health problem in the region. In Indonesia in 1996 there was an outbreak of dengue/DHF in eleven provinces, which had been going for five months. By the end of May there had been 4,544 cases reported with 113 deaths. During the period of late August to mid November in Delhi, India a significant DHF epidemic occurred during which 8,777 hospitalized cases were reported with 354 deaths. Dengue 2 serotype was isolated from a small number of cases.

Western Pacific: In 1995, an epidemic of DHF was reported in Cambodia. Responding to a call from the Prime Minister, WHO set up an emergency dengue control team which moved quickly to work with national control program. The government launched an integrated intervention campaign with information dissemination, insecticide spraying, and larvicide distribution, supported by WHO, UNICEF, and some NGOs. In French Polynesia, following a long inter-epidemic period involving low-level transmission of dengue type 4, two back-to-back epidemics of dengue type 1 and 3 took place during 1988-89. Many DHF and dengue shock syndrome (DSS) cases occurred during the later outbreak, causing fatalities. Dengue 3 continues to be transmitted sporadically with sever cases, as seen by two deaths in 1992.

An outbreak of dengue types 3 and 4 occurred in American and Western Samoa in the later part of 1995 and early 1996 with several hundred cases reported, one death attributed to DHF. In Malaysia in 1995, there were 2,906 cases with 195 DHF cases. In

1996, by early October, 10,479 cases were reported with 419 cases of DHF and 26 deaths (Lam and George, 1996).

In the Philippines, as of the middle of July 1996, there were 1,485 suspect cases of dengue/DHF with 26 deaths reported. In Vietnam' as of September 1996, a dengue/DHF epidemic had already caused more than 100 deaths in the southern and central parts of the country.

ANNEX II: ECONOMIC ASPECTS OF DENGUE AND DHF

The following are examples of published or reported costs related to outbreaks of dengue or DHF epidemics from selected countries. Collectively, it is estimated that the dengue epidemic costs the American Region hundreds of millions of dollars annually.

The Americas

Jamaica: From the 1977 dengue type 1 (DEN-1) epidemic in Jamaica, it is estimated that about 400,000 people were affected, with at least 105,000 cases in the Kingston Corporate area alone. Costing was not available (Moody *et al*, 1979).

New Providence, Bahamas: Giglioli (1979) reported that 1,100 cases of DEN-1 occurred in the Bahamas and that timely aerial application covering 24,000 acres at a cost of US $50,000 halted the epidemic.

Puerto Rico: The economic impact of repeated outbreaks of dengue and DHF is considerable. For example, the 1977 dengue epidemic caused by DEN-2 and DEN-3 is estimated to have case approximately US $10.3 million (Morens, *et al*, 1986) in medical services and lost work time and other direct and indirect costs, with no way of measuring the impact upon tourism.

Chiriboga, *et al*, (1979) reported that the 1977-78 epidemic was estimated to have cost in the range of US $6 million (based on a 6.1% attack rate), to US $15.5 million (based on a 18.1% attack rate). The economic impact exclusively from dengue-induced morbidity and attendant costs of medical treatment, along with epidemic control costs (both "direct cost") on the one hand and on the other, morbidity-related absenteeism from work, including lost wages and reduced output of sick persons and parents of sick children ("indirect cost"). No costing was made for loss of tourism.

Cuba: During the 1981 epidemic of dengue/DHF, 344,203 cases of dengue were reported and 10,312 cases of DHF with 158 deaths. The cost was estimated to be US $103 million, including medical care, hospitalization,, emergency rooms, lost salaries for patients and cost of lost production. Direct costs of *Aedes aegypti* control was estimated at US $43 million (Kouri *et al*, 1989).

South-East Asia

Thailand: The cost of the 1980 epidemic of DHF/DSS in Thailand were estimated at US $6.5 million. This amount takes into account mosquito abatement and hospitalization costs, almost entirely for children (Matsurapas 1981).

In the study on the social and economic impact of DHF in Thailand, conducted by Santasiri Sornmani, Kamolnetr Okanurak and Kaemthong Idaratna (1995) of the Mahidol and Chulalongkorn Universities, Bangkok, the following findings were reported. In 1994, there were a total of 51,688 DHF patients hospitalized in Thailand. Estimated morbidity and mortality as well as prevention and control costs totaled 334 million Baht (US $13.36 million), excluding potential income loss, and life disruption and psychological effects. The economic burden of DHF on Thailand and its people based upon an average attack rate of 85:100,000 was estimated to be 788.06 million Baht (US $31.48 million) per year.

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Fig. 1. THE GENERAL DISTRIBUTION OF DENGUE AND/OR DENGUE HAEMORRHAGIC FEVER, 1975–1996

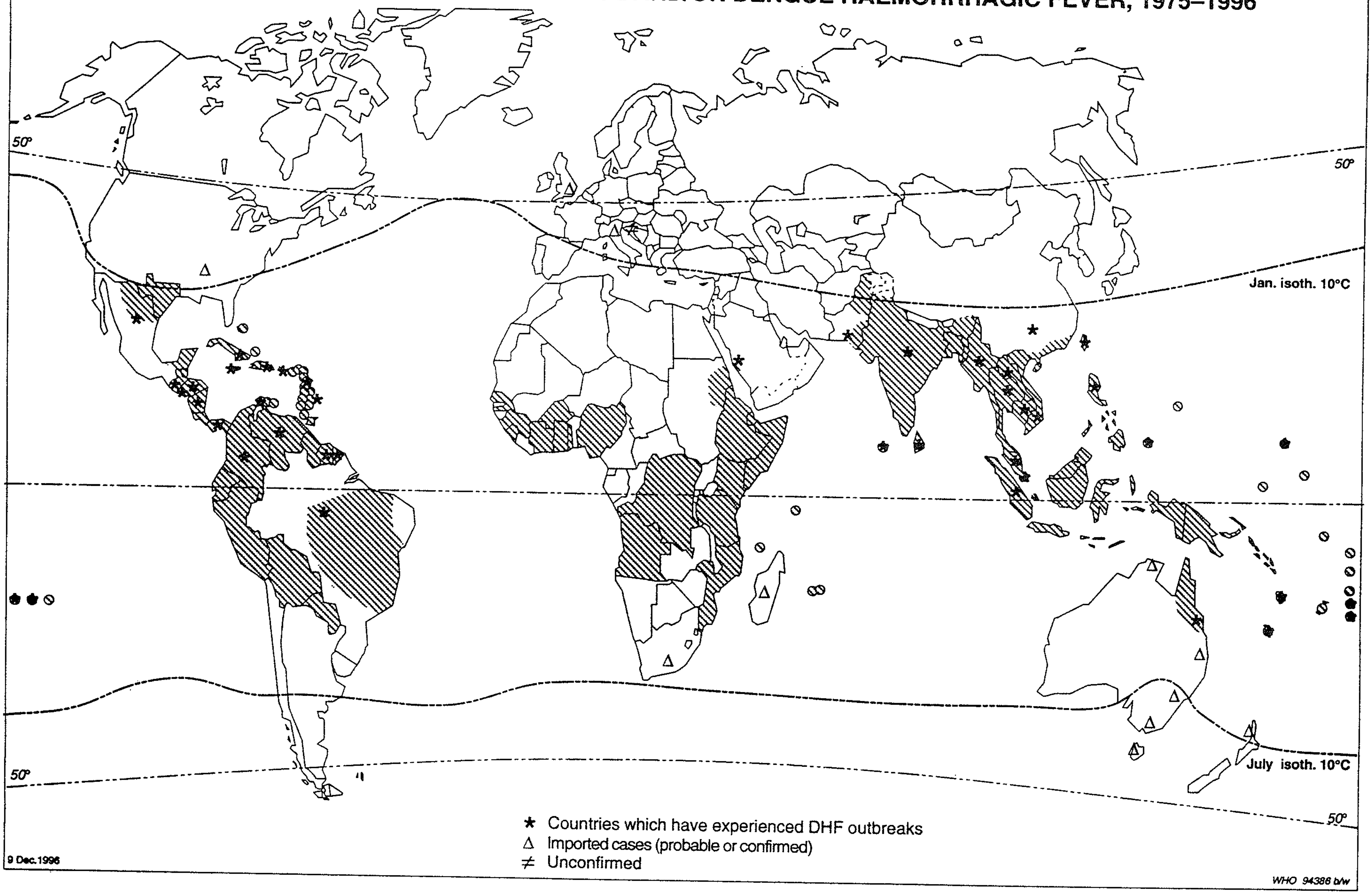
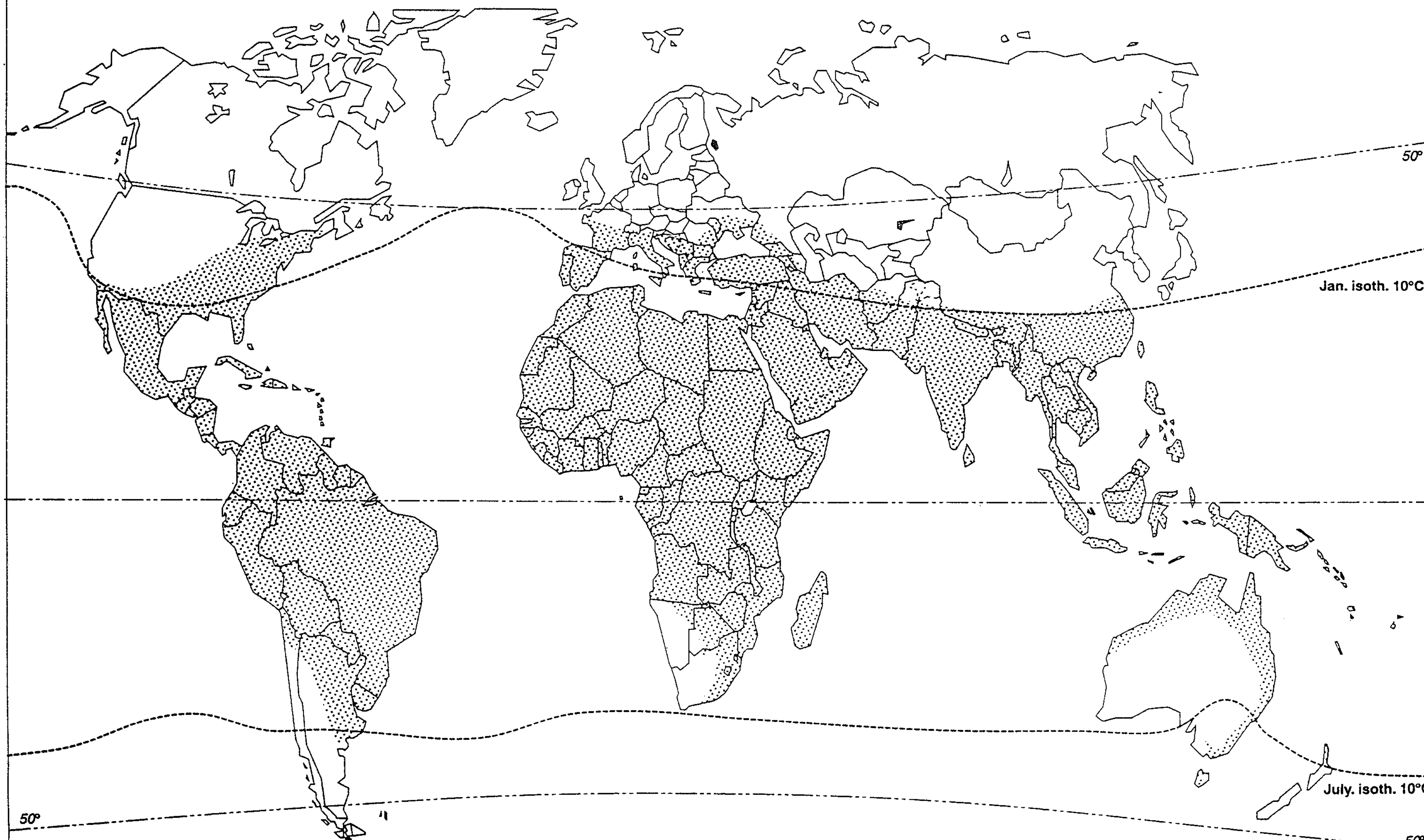


Fig. 2. ACTUAL AND POTENTIAL DISTRIBUTION OF AEDES AEGYPTI, 1995



The designations employed and the presentation of material on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines represent approximate border lines for which there may not yet be full agreement.

WHO 93484

Fig. 3. Countries where *Aedes albopictus* is reported to be present, 1996

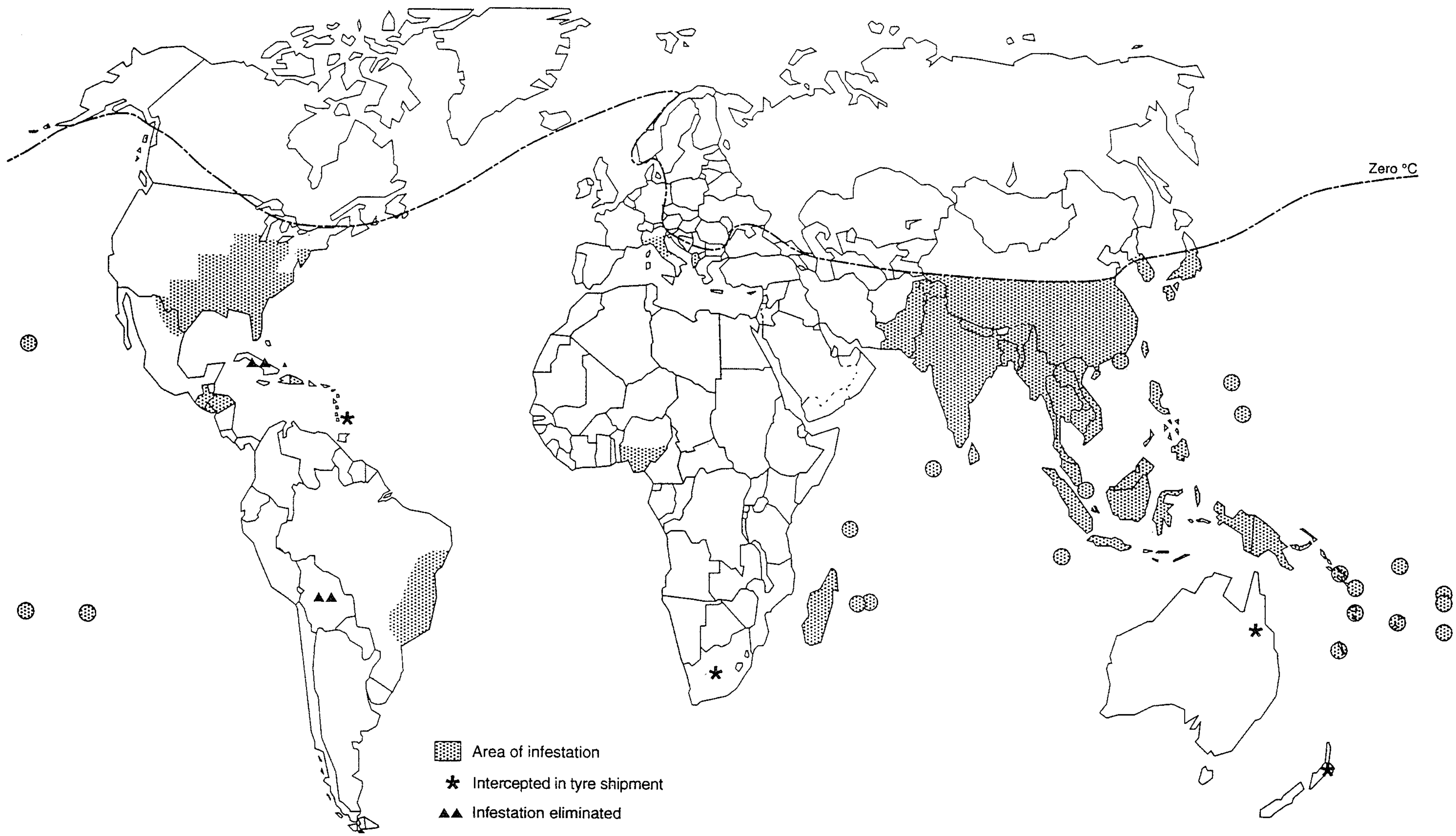


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Table 1. Dengue Haemorrhagic Fever (DHF) outbreaks by country and by year.

	COUNTRY	FIRST CASE	FIRST EPIDEMIC
1	Thailand	1950	1958
2	Philippines	1953	1953
3	Malaysia	1962	1962
4	Singapore	1962	1962
5	Vietnam	1963	1972
6	India	1963	1988
7	Sri Lanka	1965	1989
8	Myanmar	1965	1970
9	Indonesia	1968	1973
10	Cambodia	1970's	1983
11	Tahiti	1971	1990
12	Niue Island	1972	1972
13	New Caledonia	1972	1972
14	Tonga	1975	1975
15	Puerto Rico	1975, 1985	1986
16	Peoples Republic of China	1980	1985
17	Laos	1980	1985
18	Taiwan	1981	1988
19	Cuba	1981	1981
20	Suriname	1982	1993
21	Mexico	1984	1995
22	Maldives	1985	1985
23	Nicaragua	1985	1994
24	Aruba	1985	-
25	Dominican Republic	1986	1995
26	Columbia	1986	1993
27	El Salvador	1987	1995
28	Honduras	1987	1995
29	St. Lucia	1988	-
30	Palau	1988	-
31	Venezuela	1989	1989
32	Vanuatu	1989	-
33	Marshall Islands	1989	-
34	Brazil	1990	1993
35	French Guiana	1991	-
36	Cook Islands	1991	-
37	Australia	1993	-
38	Saudi Arabia	1994	-
39	Pakistan	1994	1994
40	Panama	1995	1995
41	Guadalupe	1995	1995
42	Guatemala	1995	-
43	Jamaica	1995	1995
44	Barbados	1995	-

SPECIAL DISTRICTS AND THE LAW

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After such a marvelously successful season at the Legislature concerning the passage of all of our proposed legislation, the Utah Association of Special Districts (UASD) felt somewhat secure for this upcoming session. We could have not been more wrong. In the summer of 1996, the State and Local Committee of the State Legislature proposed that the section of the State Code that referenced the Special Districts be recodified. This recodification was to reflect a better method of understanding the concepts surrounding Special Districts and to put together in the same area of the Code similar statutes that govern similar districts. The immensity of this project caused the project to be postponed until this year. The interim committee of the State and Local was divided into two committees this summer. The Political Subdivisions Interim Committee took the responsibility to continue the Special District project and has been the group the UASD has been dealing with since the end of the 1997 legislative session. The areas and concepts the legislators are struggling with are as follows:

- Uniformity— The statute should provide for a higher degree of uniformity among the various types of independent special districts. Provisions relating to creation, dissolution, withdrawal, and annexation should be uniform.

- General Purpose Government Priority— Before a new special district is created, a general purpose government should have the **first right of refusal** in providing services to its citizens. General purpose governments should have the right to provide a service already provided by a special district. There should be a mechanism for a general purpose government to reclaim its right to provide the service to its citizens. When changing who provides the service, there should be an equitable distribution of assets and liabilities between the general purpose government and the special district (single purpose government).

- Voter/Property Owner Approval to Create— Voter/property owner approval must be obtained before a special district is created, if the special district would have eminent domain powers, bonding authority, taxing authority, or authority to spend taxpayers' money.

- Elected Board— All board members of independent special districts should be elected by the citizens residing within the special district and/or the property owners owning property within the special district. Board members of dependent special districts should be appointed by the entity upon which the special district is dependent.

- Reporting— When a new special district is created, the Office of the State Auditor should be notified of the creation. Either through the annual audit process or some other appropriate process, all independent special districts should be required to provide proof of having liability insurance.

- Public Notice of Fee Increase— Notification of any proposed fee increase should be broadly publicized providing ample opportunity for citizens residing within the special district to be aware of the proposed fee increase. A public hearing must be held on the proposed fee increase.

- Change in the Tax Code to Provide Flexibility to General Purpose Governments— Provide a way to give general purpose government the method to service a need in a restricted area where a need is perceived. This could come from a differentiation tax of some sort.

With these concerns on the table, the first problem that needs to be addressed is general purpose government vs. Single purpose government. Can and/or should your cities and towns be the entity to provide all services, especially to limited areas of need? Should the opportunity to be given to the citizenry to choose a single purpose government where the focus is restricted to the need(s) of the local entity? This is a crucial question that many in the municipal or general purpose government arena would eliminate or make extremely difficult to achieve. Single purpose government has proven time and again that a single focus mentality is so important in providing meaningful service when faced with a critical need.

The problem with special districts or single purpose government is the perception that there is no accountability from appointed boards because they are not able to be taken out by the voter in case of mismanagement or malfecience in office. The UASD has indicated at many meetings where testimony was allowed that this perception is just not a valid reason to upset a system that is not broken. Some feelings expressed indicate that the American way must include elected officials. Go figure!!! The UASD's position is that appointed or elected, board members or trustees are as good as the individuals involved. Training and honest updating from both sides will keep many problems at a minimum.

At the same time at the State level, the Constitutional Revision Committee has undertaken the task to look at local government practices pertaining to the Constitution that might need changing, additions, or deletions that would enhance the law. They opted to look at special districts because the legislature was and there were some individuals that seem to have a personal agenda. The UASD has been asked to testify and present our story to the Commission. This has been very helpful in stopping a definite move to rewrite the Utah State Constitution in a way that would have put serious restrictions on the forming and managing of districts. Types of districts allowed were discussed and verbiage to change the language in the Constitution was put forth that would have been very onerous to member districts. This Commission has an interesting mix of members including attorneys, legislators, professors, and community people.

Hundreds of hours have been put forth to make sure these legislators, particularly the leadership where possible, understand the facts and benefits of special districts to the citizenry of this State. It needs to be realized that wherever taxes or fees are levied by any government entity, there is a very hard look given by the legislators who make the laws that govern these various units. This review will be to see that the tightest monetary oversights possible are in place. Where it appears otherwise, they will do everything in their power to make sure that these statutes will be changed to reflect their wishes. Many of the suggestions proffered by the committee members are already on the books and they just don't understand the total picture. This ignorance of the law as it pertains to special districts has given the UASD many opportunities to visit, teach, and inform the committee members. We feel that we have been very successful in providing the answers to numerous questions and have volunteered to provide any additional information that is needed to make meaningful judgments.

Any time a district takes it upon itself to act outside the prescribed parameters of the law, every district in the State suffers to some degree. Using the handout provided, please take a look at your own district program and see if you are following the guidelines that are stated in your own bylaws and your policies and procedures manuals.

If we don't stand together in the law, that same law will definitely hang us. There are too many examples out in the real world to indicate that the powers that be are not going to be satisfied by the status quo. Changes will continue to be suggested, laws written and passed, and we will still be no better than the people who run the programs. We must continue to be positive, above board in our dealings with the public sector and above all, provide the kind of a program we are all charged with doing.

MALARIA ERADICATION IN THAILAND: A GOOD IDEA THAT DIDN'T WORK[1]

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Malaria is a deadly disease that still threatens the health of people in underdeveloped tropical regions (Giglioli 1982). In 1955 the goal of global malaria eradication as defined by the World Health Organization (WHO) was to break the cycle, end transmission, eliminate sources of infection and prevent reintroduction. At the Eighth World Health Assembly, a resolution placed the program under the supervision of WHO and the United States Agency for International Development (USAID). WHO also established a special account for funds that were to be donated by United Nations (UN) members to help defray additional costs for the eradication campaign (USGAO 1982). In 1960 these actions led to the establishment of an eradication campaign in Thailand which was operated by the Division of Malaria Control, Ministry of Public Health, with cooperation from USAID.

Malaria has always been Thailand's most important public health problem and with international support, Thailand has spent much of the last 50 years working to control malaria with striking success but repeatedly, a too-rapid withdrawal of DDT house spraying caused a resurgence of malaria (Elbel 1963). An effective malaria eradication program requires scientific, financial, political and administrative measures (Giglioli 1982). This paper attempts to answer the question as to which of these factors led to the failure of malaria eradication in Thailand.

Scientific Factors

Resistance developed in the vector mosquito, ***Anopheles minimus***, to DDT and in ***Plasmodium*** parasites to chloroquine and other antimalarial drugs; also, the behavioral change in the vector allowed it to rest on outside vegetation after a blood meal rather than on DDT-sprayed walls (Wirth & Cattani 1997). This was complicated by the evolution of a new vector, ***An. balabacensis*** (Hinman 1966).

There were 3 phases in the malaria eradication campaign in Thailand (Elbel 1963):

1. **The Preparatory Phase** consisted of:

   a. Training microscopists.

   b. Geographical reconnaissance in which all malarious villages were mapped to determine the number and location of all houses, the estimated spray surface and the population to be protected (Fig. 1). Village maps were used by spray and survey teams to insure that widely scattered houses were not missed. In 1960 Avery-Jones of WHO found a missed-house rate of 10% in DDT-sprayed areas of South Thailand; this rate was attributed to the scattering of houses, owner refusals and the construction of new houses. A house not sprayed becomes a focus of infection.

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[1]Part of a paper submitted by Ratnapradipa in partial fulfillment for the degree of Master of Public Administration at the University of Utah, Salt Lake City, Utah.

c. Malaria survey (Fig. 2) which emphasized the need for eradication if the blood-parasite rate was above 2%.

d. House-to-house case detection which was used where houses were never sprayed or were removed from the DDT-spray program after 1-7 years because the blood-parasite rate was below 2%; eradication was still indicated if this rate was above 0.05%.

2. **The Attack Phase** included:

a. Training temporary spraymen (Fig. 3).

b. Total coverage with DDT (Fig. 4); all houses in all malarious areas were sprayed thoroughly in contrast to malaria control that treated only the highest endemic areas.

c. Post-spray survey to check malaria incidence during each month of the interspray period; when the blood-parasite rate was below 2%, house-to-house case detection was started.

3. **The Consolidation Phase** used:

House-to-house case detection which continued until 10 monthly rounds in one year showed that the blood parasite rate was below 0.05%.

Financial and Political Factors

In 1968 as a result of the high cost of the Vietnamese War, the US Congress cut off funds for malaria eradication in Southeast Asia. Without finance, supplies and personnel from the US, Thailand could not continue malaria eradication (Smith 1982).

The years of battle had resulted not in overcoming malaria but in war-weary countries and eradication staffers (Harrison 1978). War weary, discouraged, beaten and financially stressed, many governments questioned the value of continuing to support costly eradication campaigns. Almost everywhere the economic strain was highly unpopular. Eradication was sold as a once-and-for-all effort: spend now and save later but vigilance proved nearly as costly as war and much harder for its proponents to continue to justify politically.

Administrative Factors

During the 1960s, the goal of the Jamaica Malaria Eradication Training Center was to train all technical advisors and all regional medical directors and assistants in malaria programs worldwide for one month in Jamaica and 2 weeks field experience in Mexico. The training was very thorough including all phases of malaria eradication and details for writing the plan of operation for each region of the country involved but the training center was closed in 1968 when the US Congress cut off funds for malaria eradication. The loss of training and high-quality technical assistance which were absolutely critical elements of USAID strategies was one of the most serious causes of the international decline in malaria eradication programs (Shuler 1985).

In Thailand there were too many temporary eradication workers with too little supervision. Also, WHO experts thought that USAID's malaria staffing in Washington D.C. and in the field was inadequate in numbers of personnel and in their technical capacity to discharge responsibilities (Hinman 1966). At the peak of US support for malaria eradication, full-time Jamaica-trained advisors assisted programs in many countries. However, the ability of USAID to provide such assistance declined significantly and in 1965 program administration was transferred from USAID to the US Centers for Disease Control (CDC) to make better use of health resources located elsewhere in the government. Concurrently, a presidential directive to limit the number of US employees overseas, balance-of-payment concerns and reduced foreign assistance appropriations negatively affected eradication programs. The program called for 65 US advisors to work on overseas projects but USAID could supply only 39 advisors and a staff of 22 people to provide technical assistance, training, evaluation, research and procurement services (USGAO 1982).

Supervision and inspection were exacting tasks that required intelligence, devotion and skill in handling people (Hinman 1966). Similar to India's failed eradication efforts, Thailand's administrative problems were in part related to the people and the culture. In both countries, shortages of workers were chronic. Of those who could be persuaded to take jobs, many were not the type of people who were comfortable with assuming, using or delegating authority. In India, workers were inclined to neglect or falsify reports (Harrison 1978) and in Thailand, the zone chief who stole and attempted to sell 15 drums of DDT and then disappeared with $2,650 was not found (Elbel 1963).

Discussion

There are many elements involved in the conduct of a successful malaria eradication program. Becoming cognizant of these factors would help understand the causes for failure of the Thai program. In order to know how to implement such a program, one must understand three of its elements:

1. The donors who provided funding: WHO, USAID, UN, and CDC.
2. The difficulties of conducting a foreign-financed project in a Third World country as Thailand where malaria poses a significant enough health threat to be a concern to the global community.
3. The recipients were the Thai people and project consideration had to be given to coordinating, accommodating, and interpreting cultural differences which with language often caused misunderstanding and failed communication. Asian thinking, logic and perspectives often differ significantly from those of the Western World.

The failure of the Thai malaria eradication program was not inevitable and could have been avoided if the program was funded yearly until the malaria blood-parasite rate in all villages fell to 0.05%. However, success would have required a delicate and diligently attended balance of all program elements and a coordinated effort. There were different degrees of failure in the components of the Thai malaria eradication program including economic costs, inadequate government, public and financial support, inflexibility and a lack of consideration paid to local conditions and cultural peculiarities (Desowitz 1991). According to USAID, malaria-eradication activities required trained and experienced personnel at all levels of the health service to ensure long-term success of the program; the effectiveness of many national eradication programs was limited by insufficient qualified personnel (USGAO 1982).

Wirth and Cattani (1997) stated that despite its initial promise, the DDT campaign backfired. Programs in many malaria-endemic countries were unable to sustain the level of thoroughness and efficiency required to make residual insecticide spraying effective. The result was inadequate or erratic coverage. DDT was and still is the cheapest and most commonly used insecticide in malaria eradication (Roberts *et al*, 1997). They think that DDT is still needed since 21 countries in the Americas showed an increase in the malaria blood-parasite rate as DDT house spraying declined; only Ecuador, which increased DDT-house spraying from 1993-95, had a decrease in malaria.

The public's understanding of the program is important. For instance, one South Thai villager stated, "You can't spray my house until you get permission from my evil spirits." The spray chief responded, "I am spraying your house with DDT to get rid of mosquitos, malaria, and evil spirits." The villager answered, "If you can get rid of my evil spirits, you are welcome." In northeast Thailand, villagers were told to keep their trays of silkworms out of the house during DDT spraying and for 3 days thereafter and to keep them away from walls when returned to the house; accordingly, silkworms were not killed.

Future malaria eradication efforts in Thailand will require soliciting the public's active cooperation, participation and support of the program. The public must report mosquito infestation and occurrence of breeding locations, cooperate with DDT spraying, apply preventive measure as screening or using pyrethoid-dipped mosquito nets and support increases in taxes to fund efforts (Slooff 1987). Research is needed on vaccines. Vaccines alone will not overcome malaria. Vaccines may be only partially effective because malaria immunity is only partially effective. Vaccine is available for ***Plasmodium falciparum*** now but a vaccine cannot be developed for other ***Plasmodium*** (Wirth & Cattani 1997).

An alternative to insecticides is biological control. This remains a well-publicized but under-supported approach to control of mosquito-borne diseases. Among the biological agents under development for use against mosquito vectors is ***Bacillus sphearicus***. Mosquitoes have not yet shown resistance to this bacteria (Maramorosch 1985). According to Ratnapradipa (1990), ***B. sphearicus*** controls mosquitoes but has no adverse effects on other aquatic insects.

Conclusions

Although each factor was important in the failure of the Thai malaria eradication program, the crisis resulting from the US Congress terminating funds was the main reason for the campaign's failure. The battle to overcome malaria is important to the global community as well as to Thailand. A new program must be flexible, continuous, innovative and dynamic. The increased resistance of vectors to DDT, of parasites to chloroquine, the evolution of a new vector and the behavioral change of vectors to rest on vegetation rather than DDT-sprayed walls may motivate increased research of alternative measures and of continuing programs that use traditional eradication measures. The Thai government must establish strong positive channels of communication with donor organizations and with local communities. Education is important for garnering support and cooperation on the domestic and international levels. Children must be brought into the program by teaching mosquito biology, the malaria cycle, and malaria eradication procedures in the public schools so that children can bring information home to their parents. The program must include DDT house spraying, preventive measures, insecticide and biological control of larvae, modifying water flow to eliminate breeding and malaria-parasite control by vaccines. The combination of vaccines, antimalarial drugs, vector control and education will be necessary to effectively contain malaria.

Acknowledgment

Grateful appreciation is expressed to University of Utah Professors, J. Steven Ott, Director of the Public Administration Program, who contributed much information and direction to the study and Richard P. Simpson, Associate Dean of Continuing Education, who offered helpful criticism and suggestions.

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Figure 1. Geographical Reconnaissance (Photo - R.E. Elbel)

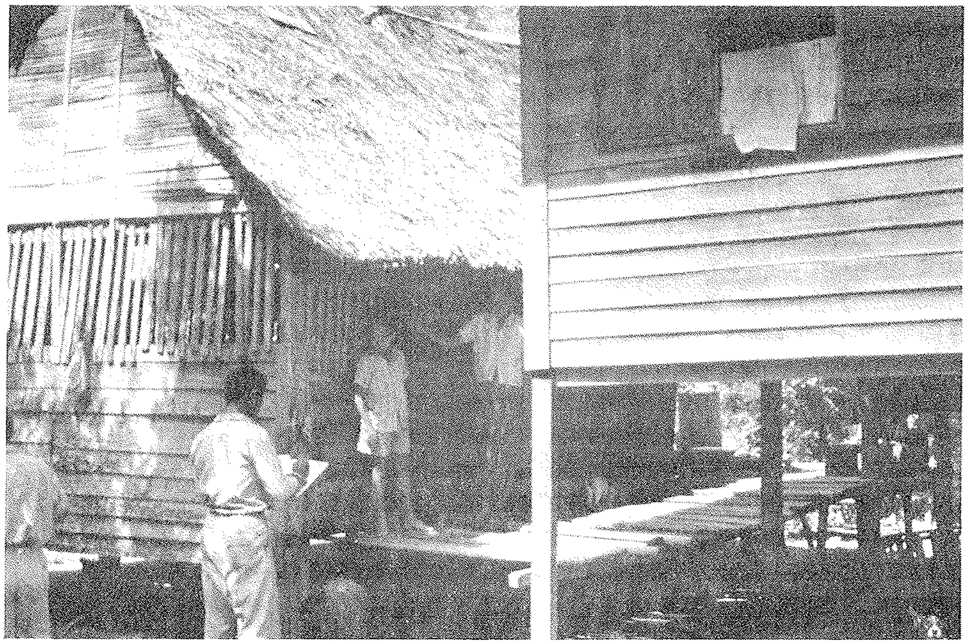

Figure 2. Malaria survey, malarious spleen (Photo - R.E. Elbel)

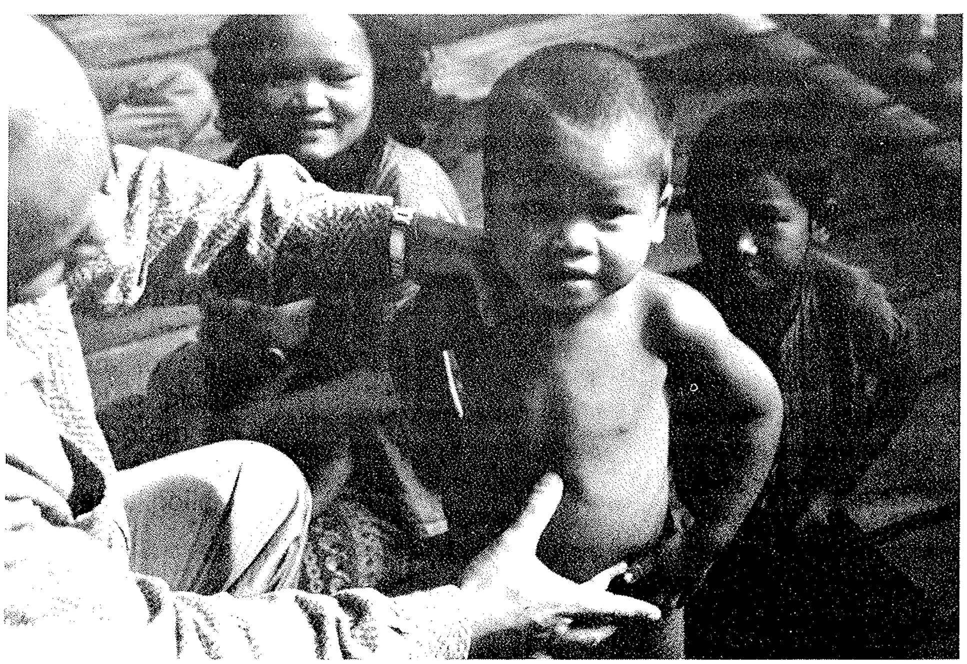

Figure 3. Training spray men using water (Photo - R.E. Elbel)

Figure 4. Preparing house for spraying (Photo - R.E. Elbel)

"HONEST, WARDEN! A BOBCAT® MADE THESE TRAILS"[2]

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Within the boundaries of the Consolidated Mosquito Abatement District (District) in the heart of California flow the Kings and San Joaquin Rivers. Along these two rivers, riparian areas form a greenbelt of diverse vegetation creating a source of natural beauty and providing a reservoir for wildlife. As with many California rivers, the adjacent riparian corridors have been greatly impacted and reduced. Historically, these corridors were wide expanses covering broad flood plains. Today the corridors are restricted to narrow bands along channeled, flood-controlled rivers. Agricultural and urban development encroach upon what remains. These remnants serve as valuable preserves for a diversity of plant an animal species.

Unfortunately, included in that faunal diversity is an abundance of mosquito species. Dense vegetative growth in seepage and overflow areas in the District provide ideal breeding sites and harborage for 17 species of mosquitoes. One of the most common mosquitoes found in these riparian areas is the encephalitis mosquito, *Culex tarsalis*. Also plentiful in this habitat are passerine birds that can serve as reservoirs for St. Louis encephalitis and western equine encephalomyelitis viruses. These viruses, which are vectored by mosquitoes, can cause serious illness in man and other animals. With the threat of disease and the continual increase in human population living directly adjacent to riparian areas, mosquito and virus surveillance and mosquito control in these areas is critical.

Access to mosquito breeding sources in riparian habitat is often difficult because of the dense vegetative growth. To address the problem, the District expanded its source reduction program to establish and maintain trails into riparian breeding sources along the Kings and San Joaquin Rivers. In doing so, however, the District discovered that approval to undertake such work was required from the California Department of Fish and Game (Fish and Game).

Authority to oversee human activity in riparian areas is codified in Sections 1600-1607 of the California Fish and Game Code (Code). These regulations affect all individuals, as well as state and local government agencies, whose activities or projects might substantially "divert, obstruct or change the natural flow or bed, channel or bank of any river, stream or lake. . . in which there is at any time an existing fish or wildlife resource or from which these resources derive benefit. . . " (Code Sec. 1601). Riparian habitat, by definition, occurs along banks of rivers and streams and wildlife, by nature, inhabitant and derive benefit from such habitat. Thus, any modification to riparian areas, such as establishment and maintenance of trails by District personnel, comes under the purview of Fish and Game for review and approval. The regulations also make provision for the negotiation of agreements or memoranda of understanding (MOU) to allow for approval of ongoing projects and routine maintenance activities without continual notification and review.

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In 1991, the District signed a current MOU with Fish and Game that allows the District to open access-ways to any river or stream within the District boundaries for the inspection and abatement of mosquitoes. It permits the clearing of vegetation and debris from access-ways using hand tools, including chain saws; but places stipulation of the size of trees that can be removed. With the MOU in hand, the District sent work crews into riparian areas to cut trails into and through mosquito breeding sources. Chain saws and machetes were used to clear willows, vines and bamboo thickets. The work resulted in better access to routinely treated mosquito sources and opened up areas previously inaccessible for surveillance and control. Major trail work was carried out during the winter off-season, but actual work time available was limited by the short off-season, bad weather, holidays and other projects. Also, cutting trails and pulling aside debris by hand proved to be an arduous and time consuming task. With the job of keeping established trails cleared each year, the process of developing new access-ways was slowed. In the fall of 1994, the District began to look for a more efficient means to establish and maintain trails. At this point came the idea of using a small skid steer loader.

A compact and highly maneuverable front end loader, the skid steer is widely used commercially for various jobs including swimming pool excavation and construction site work. Its value is enhanced in confined areas because of its short turning ability and responsiveness. To determine the utility of this type of machine in riparian areas, the District arranged for a field demonstration of a Bobcat® loader (Melroe Company). The test site chosen was densely vegetated and represented severe conditions, but performance of the Bobcat® exceeded expectations. The machine had plenty of power and pushed through the vegetation with relative ease. The local Fish and Game warden was also present to observe and evaluate the environmental impact of the Bobcat®. After watching the demonstration, the warden was satisfied with the Bobcat® and its intended use and wrote an addendum to the MOU allowing its use to be added under the existing agreement.

In January 1995, the District purchased a 763 Bobcat® loader with a 46 HP diesel engine and a 66 inch toothed bucket. Later, metal "Tire Crawler" tracks were purchased to install over the tires for added traction, especially in wet and muddy conditions. Also, several modifications were made to the Bobcat®. A heavy gauge metal, mesh door was placed on the front of the cab. Some areas of the cab frame were beefed up and protruding fixtures were removed. These changes were made to improve the safety and durability of the Bobcat® when crashing through heavily wooded vegetation.

The District now uses the Bobcat® for virtually all trail development and maintenance work. Currently, the program consists of the Bobcat® and operator supported by a one to two man crew, who helped direct the work, assist with chain saws and service the machine. Use of the Bobcat® allows smaller crews to clear more access-ways and will enable crews to maintain all sites every year. It has proven to be a versatile machine, as the District continues to discover new capabilities and uses.

As the environmental impact of the Bobcat® use is a critical issue, care is taken in clearing access-ways to minimize the reduction of vegetation and to insure access-ways are surrounded by sufficient vegetative cover. To accomplish this, the district maintains communication and cooperation with the local Fish and Game warden.

The Bobcat® is an integral part of the District's trail maintenance program. Also, importantly, it is accepted as an appropriate tool for creating access-ways to mosquito breeding sources in riparian areas, without significantly impacting the wildlife resource.

MONOMOLECULAR SURFACE FILMS, WHAT? WHY? WHEN?

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Monomolecular Surface Films (MMFs) can very successfully be used to control the larvae and pupae of many species of mosquitoes. They were tried many years ago, but left the market because of a very expensive manufacturing process. Since we expect a new MMF product to be available quite soon, I want to take a few minutes and just reacquaint you with this type of product.

MMFs are basically composed of ethoxylated isostearyl alcohol. This is a similar type of alcohol to what is widely used in cosmetics, such as facial creams and other cosmetics. The LD_{50} is over 20,000 mg/kg and in pesticides, 5,000 mg/kg and higher is usually considered to be quite safe.

Chemically it is a surfactant, which means it is a surface active agent, working at the water/air interface, and does not go down into the water column. It is biodegradable, meaning it will react with oxygen and other items to decompose. MMFs will decompose into products such as water and carbon dioxide in two weeks or less. They have little or no effects on non-target species or plant life.

Levy et. al., (1981) reported that "monomolecular organic surface films cause little to no adverse effects to the environment . . . general observations indicated that there appeared to be no increased mortality of non-target organisms, when compared to untreated or control areas." We do know that since MMFs reduce the surface tension of the water, some non-target species that rely on the surface for air, such as beetle larvae, water striders or pupating midges may be affected. Also, it was reported that no adverse affects on foliage or plant life could be detected.

When a MMF is placed on the water, it very rapidly self spreads (almost faster than you can see) until it forms a layer/film on the water surface that is just one molecule thick. Sitting there, it changes the surface tension of the water surface. To try and explain what one molecule thick is, we have to use a scientific definition. A molecule is the smallest part of a substance that retains the integrity of the product itself. As an analogy, if we were to spread chicken soup on the surface of a table so that it is was one molecule thick, and then take a minute sample of it, i.e., the size of a pin point, and analysis would say it was chicken soup. If we spread it thinner than one molecule, since chicken soup is made up of water and flavorings, etc., our sample might just show hydrogen atoms, or atom particles of the flavoring, but it would not be identified as chicken soup.

Since it affects the surface tension of the water, the mosquito larvae and pupae cannot attach themselves to the surface to breath, i.e., they cannot maintain a breathing position, and eventually they will drown. Since this effect is strictly a physical, not a chemical phenomena, there is no possibility of resistance. Mortality will usually be achieved within 24 to 72 hours. Egg laying adults and even resting males will not be able to sit on the water surface and will drown.

When MMFs first came into the market, probably around the early 1980's, there were some initial application and use problems. Just as the industry was starting to get control of these, the product left the market. We might still expect some concerns today, so it is important to understand, it is not an oil. It is not foamy, and it does not leave any kind of an oil film or sheen on the water surface. That is becoming a major concern, environmentally today since many states are now passing laws that state nothing can be put on the water that causes a sheen.

Most larvicides only work in a small portion of the mosquito life cycle. MMFs can actually work on any part of the mosquito life cycle that is associated with water. They have a broad application window. MMFs will persist many days. When I go into a city or town with a mosquito control program, and there is a lot of

mosquito control done in the USA outside of organized districts, I have to be very careful about what I recommend. While there are certainly educated and intelligent people, they might be more concerned with city construction projects, and have no idea at what stage their mosquito brood is in, or when a hatch might come off. If I recommend a product (and I'm not picking on bti's here because bti's are a great product and we sell tons of it), that has a useful working life of say 24 hours, and they apply it a day or two early, or a day or two late, they have wasted their money. I certainly won't look like a hero in their eyes as their being eaten alive by mosquitoes. In cases like these, I really appreciate a product such as a MMF. It has a wide useful window so it can be applied early or late and still control all stages. Secondly, if an over application were to occur, it wouldn't create an environmental problem, as the label actually says you can dispose of this material, on site.

MMFs are believed by many to be good pupicides, but not good larvicides. That's wrong! Because of this misconception, many districts have put a drum of MMF in storage with the thought of using it if they ever have a hatch get away from them. The MMF would be used to get back in control. Well this certainly will work and will work very well, but they are really missing the boat. Because of the higher oxygen uptake, pupae will certainly go down faster than larvae. On larvae, MMF works more like an IGR. Don't come back in 20 minutes looking for dead larvae. Results on larvae can take anywhere from 24 hours to 72 hours. Much of this is dependent on the water temperature and other factors. MMF will last up to ten days. Unlike IGRs, MMFs will control all stages of larvae and pupae, whether they are in a feeding stage or not.

I think another reason users didn't think it would last over several days, is that they couldn't see it on the water surface. If you put oil on water, you can see the colorful film spread out over the water surface. With an MMF, you can't see it, but it is there. If you want to check to see if the MMF is present, you can put one drop of indicator oil on the surface of the water. It will either spread out and create a shiny colorful film like any petroleum product on water, or if it is present, the MMF will force it into a tight bead of oil. It is truly a biodegradable product. Once its useful life is over, it is gone.

Since the action is physical, it is highly effective on species that have acquired a resistance to chemical type products. Even continual use with successive generations will not build any chemical resistance.

MMFs spread according to surface area available. If you have a site that expands and contracts in proportion to rain or other events, you can apply an MMF for the maximum area expected, and the product will expand and contract in proportion to the area available.

MMFs are excellent cleaners. They remove gunk, rust and many other things. On more than one occasion, I heard of a sprayer or tank that didn't leak before the use of a MMF, but started to leak after using. What really happened was that the MMF cleaned out the rust layer that was keeping the tank from leaking and by golly, it did start to leak. To carry this further, all the gunk and rust that was cut loose, went to the nozzles and they plugged. So even though the product got blamed, it was really the previous maintenance, or really the lack of it, that was causing the problem.

In the presence of oil, MMFs will turn to a mayonnaise consistency. This is just one of the side effects of this molecule. Containers and spray tanks must be free of oil. I heard of one customer state that upon applying the product, the whole surface of the pond covered with "mayonnaise." Upon investigation, it was learned that it was somewhat of a windy day, and the customer first applied a larvicide oil, and then to be sure, also applied MMF. He got mayonnaise. An analogy to this might be that if you have an insecticide whereby the label says to dilute it with oil, and you decide to dilute it with water, you can fight the problem, or use the product as it was intended and not have a problem. Go purchase a few inexpensive plastic containers or sprayers and dedicate them to MMF. Problem resolved.

If you want to see how a MMF works and how fast it spreads, take a cake pan and put about ½ inch of water in it. Now lightly spread a little baby talcum powder on the surface of the water. In the middle of the pan, using an eyedropper, put in just one drop of a MMF. If you were looking at the eyedropper, the powder will be pushed off the entire surface and the effect will actually be over before you can move your eyes to the pan.

Many plants have natural oils in their stalk. It is the plant's method of keeping water out of their systemic system and drowning. Unfortunately, in some cases, when applying larvicide oils, these two oils will actually repel each other, something like two magnets aligned with like poles so that they repel each other. This can actually create an annular ring or a circular opening around the plant stalk, and it doesn't take long for the mosquito larvae to find this and go right on breathing. If we get too aggressive with larvicide oils, we may cause phytotoxicity. MMFs will do just the opposite. Actually they will sort of wick up the stalk somewhat, and you actually should take this into consideration, going to a higher application rate, when you are calculating your dosage.

MMFs are safe for use in recreational areas. It is probably one of the safest products available in mosquito control. It will be labeled for use on potable/drinking water supplies. Because MMFs are such an effective and environmentally attractive product, when previously introduced, the competition really went to war and created a lot of misunderstandings and misgivings about the product. Every once in a while, yet today, one of these old tales will pop up. An example is: there was a lot of concern that wind may blow it off the water. The wind actually can move the product to one side of a pond; however, it will respread itself rapidly when the wind dies down. If you know anything about mosquito biology and use a little common sense, you know that you are not going to have emergence, certainly not "living" emergence, going on when the wind is actually strong enough to blow product off the pond. Emergence requires extremely calm water. In waters quiet enough for the adult to emerge, a MMF will respread and the merging adult won't be able to stay on the surface and will drown.

In summary, hopefully you realize the MMFs are naturally effective. Control begins within 24 hours and can last up to ten days. Non-toxic and biodegradable. MMFs are probably the most environmentally friendly mosquito control product you can find. The LD_{50} of MMF is over 20,000 mg/kg. (5,000 is usually considered non-toxic).

MMFs are easy to use. Lasting up to ten days, it has a broad application window so that application a day or two early, or a day or two late, is still going to give excellent results.

MMFs may turn out to be one of the more environmentally friendly products we are going to have in our mosquito control arsenal. While no product is correct for every situation, the advantages of MMFs versus the very few disadvantages make it a desirable new product.

If you haven't tried MMFs or even if you tried the earlier ones without much success, I would encourage everyone to reevaluate this product from a fresh perspective. To close with just a little bit of product information, the new product I am discussing is ***Agnique MMF 5996.*** It is one of the many Agnique products manufactured by Henkel Corporation out of Cincinnati Ohio. As soon as final EPA registration is obtained, it will be marketed nationwide by VWR.

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NEW TRENDS AND RESULTS WITH ALTOSID®

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This paper introduces two new products in the Altosid® line that will be available for the 1998 mosquito season and will review a few unusual places for the use of Altosid® Pellets and Briquets.

The first new product is called **Altosid® XR-G**. It is a round, black, beebe sized granule that is uniformly shaped. It will give a nominal control of 21 days and will be able to go through the wet-dry cycles as the other solids. The application rates range from 5-10 pounds per acre for *Aedes* and *Anopheles* and 10-20 pounds per acre for *Culex* and *Culiseta*. It will be packaged in 40 lb bags. The advantages of Altosid® XR-G are the smaller size, which leads to a better coverage of difficult to control areas such as hoof prints in pastures. It will also be able to penetrate the vegetation very well and might be easier to apply with standard application equipment than Altosid® Pellets.

The other product is called **Biosid™ - Granular Larvicide with Altosid®.** This is not an entirely new product, it just used to be a do-it-yourself product. Biosid™ is Biodac will ALL (Altosid® Liquid Larvicide) already formulated on it. It has a size of 12-20 mesh and is virtually dust free. The application rates range from 7-13 pounds per acre, which equals three to four ounces of ALL per acre. The advantages of Biosid™ are that it is now a ready to use product, so there is no hassle with mixing equipment any more. Since it is a granule, it has a better penetration of vegetation than ALL. It is lighter than sand, which leads to higher payloads with an aircraft. And as all Altosid® Products, it gives you a better control of 3rd and 4th instars than *Bacillus thuringiensis* var. *israelensis* (Bti). Bob Brand (Tooele Co., UT) conducted a trial with the "homemade" Biosid™ and at an application rate of seven pounds per acre had five days of control. The manufactured Biosid™ will give you five to seven days of control. It will also be packaged in 40 pound bags.

Trial #1: Treating Gutters with Altosid® 30-day Briquets

A constant problem of may towns are the mosquitoes breeding in gutter and catch basins in residential neighborhoods. In the summer of 1996, Lewis Marrott (Utah Co., UT) and I treated several catch basins in 21 intersections in Provo and Spanish Fork with thirty day Briquets. They usually treat them with Vectobac or Dursban Granules once a week. Since the gutters are used for irrigation and the current can be fairly high, we were concerned about the Briquets being washed out of the gutters. Some Briquets were placed in little bags made of screen fabric. That seemed to work pretty well. To monitor the trial, we took dip counts and sampled pupae once a week. The pupae were placed in little paper cups in the lab and checked for emergence after two days. The percent control (=% Emergence Inhibition (%EI)) was evaluated with the following formula:

$$\%EI = (DP + DA)/(DP + DA + AA) \times 100$$

DP = Dead Pupae
DA = Dead Adults
AA = Live Adults

Most of the gutters in Provo still showed 80-100% of control after 31 days, whereas the control in Spanish Fork dropped under 50% after 24 days. One problem was, that we couldn't find any pupae when we checked, so the statistics are rather poor. Another explanation for the different results is that sometimes people would clean out the catch basins if they get too cluttered and might have taken the Briquets out will all of the other debris.

Although the monitoring was a little tricky, the complaints in the treated areas dropped down significantly. For routine use we will have to improve the bags for the Briquets, so they can be refilled quicker and easier.

In summary, we can say that this kind of situation is quite difficult to treat with any kind of chemicals.

Trail #2: Applying Altosid® Pellets to a Drainage Ditch with the ArroGun® Pistol

In April of 1997, I did a trial with Eldon Rowley (West Millard Co., UT). Altosid® Pellets were applied at a rate of three pounds per acre to a drainage ditch with the ArroGun® Pistol. We attached the ArroGun® to a Grizzly® fogger with a special manifold. West Millard County has a vast system of irrigation and drainage ditches. These drainage ditches form perfect habitats for mosquitoes. Eldon usually treats them once a week with liquid Bti, which of course is very labor intensive and time consuming. For the trial we treated a ditch that was 1/4 mile long and about ten feet wide. We measured one pound of pellets in the hopper and drove the truck at ten mph. One of Eldon's employees was sitting on the tailgate of the track pointing the pistol in the ditch and pulling the trigger. We got five weeks of control with this application rate. For routine use, the pistol could be operated by the driver of the truck, which would reduce the labor costs quite drastically.

Trial #3: Midge Control with Altosid® Pellets

This trial was conducted with Richard Hicks (Clark Co., NV) on the Palm Valley Golf Course in Las Vegas. Residents of the golf course were complaining about the huge number of midges that would swarm their patios in the evenings. Richard checked two ponds close to those houses and found a medium to high infestation of Chironomid larvae. Since we had no data for application rates for midge control, we went with a high rate and thought we could work our way down from there to find the optimum rate. At the time of the application, we estimated the ponds to be bigger than they actually were, so we ended up with application rates of eleven pounds per acre. We applied the pellets by hand from a boat as evenly as possible. To monitor the trial, we built a couple of emergence traps with buckets, funnel, catching container and an inflated tube to make it float. The idea is that the midges emerging under the trap fly towards the light and get trapped in the catching container. We put a little anti-freeze in it to kill and preserve the midges. Since we weren't sure how well those traps would work, we also put up a couple of New Jersey light traps. We caught hardly any Chironomids in the emergence traps, but had an average of 150/night in the New Jersey traps. After six weeks there was a drastic increase of midges to over 500/night. Since there were no pre-treatment counts of the midges, we also had to rely on the complaints of the residents. The residents called in a few days after the application to compliment Richard on his application. The complaints increased at the same time our trap counts went up, so we can make the conclusion that at a rate of eleven pounds per acre we got five to six weeks of control.

Trial #4: Treating Log Decks with Altosid® Pellets

My coworker, Bob Boggs, did a trial in Redding, CA with the Shasta Mosquito and Vector Control District. They have problems controlling mosquitoes that the Lumber Mill produces. Permanent sprinkling of the log decks result in excellent mosquito habitat, both in the recycling ponds and the little puddles between and under the logs. The ponds are used to recycle the water after it has been sprinkled on the logs. To check and control the ponds is relatively easy. The real challenge is the little pockets of water in the log decks. They have been treating it with Golden Bear and Bti for years with poor results. The light trap counts were still at about 3,000 to 3,500 per week. To apply the Altosid® Pellets they installed a Herd Seeder® to an A-frame. To be able to turn it on and off they modified a garage door opener and attached it to the Herd Seeder®. The A-frame was hooked to a crane (100' tall and 150' long), which is usually used to transport the logs. They applied 65 pounds of Pellets over eight acres by moving the crane with the Herd seeder over the log decks and controlling the seeder with the remote control. At an application rate of six pounds per acre they get 30-40 days of control and the trap counts dropped down to 50-150 per week.

As you can see, there are many possible areas where Altosid® can be successfully used. Sometimes you just have to be willing to experiment a little and have some unusual ideas to make it happen. With the XR Granule and Biosid, the number of possibilities is almost unlimited.

IMPORTANT FACTORS IN SUCCESSFUL DIBROM CONCENTRATE ULV AERIAL MOSQUITO ADULTICIDE APPLICATIONS

BILL SEWELL
Valent
765 Highbridge Lane
Danville, CA 94526

Dibrom is an effective, economical mosquito adulticide, when applied as labeled. When such a small amount of product (½ to 1 fluid ounce per acre) is utilized, proper application techniques must be followed to achieve the desired results. Atomization of product into droplets of from 30 to 80 microns in diameter is optimum for safety and efficacy (not over 5% above 80 microns is required to meet label instructions). Dibrom has a low vapor pressure so volatility is not a factor in efficacy. As volume medium diameter increases, the number of droplets decreases logarithmically, not arithmetically. This means large drops significantly reduce efficacy and can potentially cause automobile paint spotting. Dibrom has not had a paint spotting problem in actual commercial use since the early 1970's. Applications must be made when adult mosquitoes are airborne to archive maximum effectiveness.

Spray equipment must be corrosion resistant, as the Dibrom ULV manual describes. Flushing equipment with suitable solvents is recommended after each use. Dibrom is soluble in diesel fuel, HAN, Jet A and several other solvents.

Properly set up application equipment and pilot knowledge and skill are essential for maximum effectiveness. When properly done, the results of a Dibrom ULV air application are spectacular, even after over thirty years of use (USDA registered in 1962). At mosquito ULV rates, Dibrom has minimal environmental impact and little or no impact on humans or animals in treated areas. The label is broad and is currently registered for use in all states and with the Federal EPA.

TRUMPET
THE WATER RINSABLE FORM OF DIBROM

BLAINE OAKESON
Van Waters & Rogers
Salt Lake City, UT 84110

In 1997, Valent introduced a new formulation of Naled under the brand name Trumpet EC. It is registered in all states including California. Trumpet contains 10.9 pounds of technical Naled per gallon with an emulsifier. This is equivalent to a 78% product.

Trumpet is an adulticide, which controls the same pests as the Dibrom 14 concentrate that you are familiar with. The sites to be treated and uses are also the same. In most cases, our target is still the same.

Trumpet EC is labeled for ULV use (not thermal) and can be applied by ground or air. The ground application rate is 1.5 ounces per minute at 10 mpg, and aerial application rates are 0.6 to 1.2 ounces per acre by fixed wing aircraft, or rotary wing aircraft. Slower moving aircraft (less than 100 mph) should use a rotary atomizing nozzle to provide the correct droplet spectrum.

Although Trumpet contains an emulsifier, it is not intended for mixing with water. The emulsifier is the key to the product, unlike Dibrom 14, Trumpet can be simply flushed from the equipment or the system can be cleaned using water.

The recommendations are to use sufficient water to completely flush the system and then have the system as dry as possible before introduction of additional Trumpet, since water left in the formulation tank, etc., would dilute the product.

The following represents a partial listing of products that were tested for compatibility with Trumpet.

stainless steel	pvc	copper
rubber	bronze	teflon
fiberglass	viton	nylon

A sample of the product is placed in Trumpet for a minimum of four hours; then it is removed, rinsed, or flushed with water and throughly examined for any effects. Results have been extremely favorable. There was some slight discoloration on Bronze and Copper, and slight swelling of Rubber and Viton.

For running droplet size determinations use a spread factor of 0.7 for Trumpet. By ground, Valent recommends droplets in the 11 to 20 micron range; with an MMD not exceeding 15; and no droplets larger than 50 microns. Aerially, the recommendation is to position the nozzles 45 degrees into the wind and no more than 5% of the droplets should exceed 80 microns. While we are not ready to change Valent's nozzle position recommendation, I want to add that Dr. Jim Brown at Nave DEEVAC in Jacksonville, Florida has been working on nozzle positioning and has new data that may affect all aerial applicators. You might want to check with him.

Extensive tests have been run with Trumpet on paint finishes. It compares favorably with Dibrom 14 concentrate. The test labs commented that microscopically, Dibrom is no more damaging than what we might observe after washing and waxing a paint finish.

One comment concerns the flow rate. Trumpet is slightly more viscous (thicker) than Dibrom concentrate, and thus the flow rate using the same nozzles and pressure may be slightly slower. Be sure to check the Trumpet manual for flow rates with selected nozzles at various pressures.

For health and environmental effects, all of the Trumpet registration data is based off the Technical Naled data. You can refer to the Dibrom Concentrate manual. Keep in mind that since this data is based on the 93% material, Trumpet at 78% is actually a somewhat safer product, both LD_{50} and environmentally.

In summary, Valent has provided a new formulation for the mosquito control market that has all the advantages of the original Dibrom concentrate:

1. Broad label for use sites and pests,
2. Very low rates - as little as 0.6 ounces per acre,
3. Labeled for both ground and aerial application,
4. Very quick knockdown with very high efficacy,
5. Rapid degradation in the environment - controlled by environmental conditions,
6. Wide range of crop tolerances for additional safety,
7. Extremely price competitive on a cost per area basis, and
8. The added feature that you can clean/flush with water.

FYFANON® AND PYRETHRUM ULV FIELD TRIALS ON CAGED MOSQUITOES

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Introduction

In July 1997, the Salt Lake City Mosquito Abatement District (SLCMAD), in cooperation with Cheminova, did four ULV field trials using Fyfanon® and pyrethrum against caged ***Culex tarsalis*** mosquitoes. The three main goals for running these tests were:

1. To determine if the addition of pyrethrum and/or piperonyl butoxide (PBO) to Fyfanon® increases efficacy,
2. To determine if a quicker knockdown occurs with the addition of pyrethrum and PBO to Fyfanon®, and
3. To determine if Fyfanon® is an effective adulticide in the SLCMAD.

Finding an answer to this last goal was the most important reason for running these tests. The SLCMAD has had a long history of organo-phosphate use for both larval and adult mosquito control (Fig. 1). Previous organo-phosphate resistance tests done in the SLCMAD dealt with mosquitoes in the larval stage and not adults (Hart and Womeldorf 1976, Merrell and Wagstaff 1977, Wagstaff and Merrell 1978, Merrell and Rosay 1979, Fink and Thompson 1987). Those previous studies showed that there was resistance to organo-phosphate larvicides in certain species of mosquitoes in the SLCMAD. Malathion has been used as an adulticide in the SLCMAD for more than thirty years. There was concern that there might be resistance to malathion after so many years of its use.

Methods and Materials

A total of four tests were run using four different chemical formulations.

Test 1. Fyfanon®
Test 2. Fyfanon® + 0.25% pyrethrum +2.5% PBO
Test 3. Fyfanon® + 1.0% pyrethrum +10.0% PBO
Test 4. Fyfanon® 85.5% + 1.0% pyrethrum

The test area was a large field next to the Jordan River. The area was not only a good adult habitat, but it was close to the SLCMAD and big enough to accommodate the test plot which was approximately 400' x 400'. From the outer perimeter of the plot, rows of stakes were placed at 50', 100', 200', 300', and at the west end a 350' row was set up (Fig. 2). The stakes were numbered and fitted with a wire about three feet high to hold the mosquito test cages.

Three CDC traps baited with dry ice were placed along the river the nights before the tests. They were then picked up the next morning and brought to the SLCMAD lab. At the lab, the mosquitoes from the traps were transferred into the cages using aspirators. Most collections were approximately 95% *Cx. tarsalis* and 5% *Ae. dorsalis*. At least twenty mosquitoes were placed in each of the cages, however, some cages received nearly twice that number. The small cages were made of rolled up metal window screen, the ends covered with pint canning jar lid rims filled with screen. One of the lids was held by a rubber band far easy access. Once the cages were filled with mosquitoes, they were placed in a large portable cooler and transported to the test area. The cages were then placed onto the wires of the stakes just prior to the spraying of the test plot area. Once the chemical was applied to the test area, the cages were collected. As the cages were picked up, a piece of tape was placed on the top of each cage and the stake number written down. The cages were then transported back to the lab to await the one hour count. Control cages were placed at the test area upstream from the ULV spray. These were handled in the same fashion as the other cages. In between tests, chemical was changed and all previous chemical was flushed out of the ULV machine.

One hour after spraying each cage was carefully examined to determine the number of dead and living mosquitoes. Counts were made at 1, 2, 6, 8, 12, and 24 hours for each of the four tests.

The tests were done using a truck mounted Dynafog ULV machine driving on the upwind side of the test plot area. Wind direction and speed was determined immediately before application was made to insure coverage of the test plot. The conditions for the test were adequate. Test 1 had the best conditions with wind speeds from 0-1 mph, the spray drifted slowly, completely covering the area. Test 2, 3, and 4 conditions were not quite as favorable with wind speeds ranging from 3-6 mph, but the chemical was observed drifting over the entire test plot area.

Results

The results of all four tests are listed in table 1. Mosquitoes in cages further downwind had less mortality than those closest to the spray release point. The greater the amount of time post treatment, the higher the percent mortality. Controls generally had a low mortality through the first twelve hours. However, in all cases the mortality at twenty-four hours was sufficiently high to make the counts at that time meaningless.

At twelve hours post treatment the percent mortality varied greatly between the tests (Fig. 3). Fyfanon® 85.5% + 1% pyrethrum (test 4) had the best results with 87% mortality. Fyfanon® (test 1) had the poorest results with 44% mortality. Fyfanon® + 1.0% pyrethrum + 10% PBO had 65% mortality, and Fyfanon® + 0.25% pyrethrum + 2.5% PBO had 71% mortality.

Conclusions

These tests showed conclusively that Fyfanon® alone does not obtain a sufficient mortality against *Cx. tarsalis* to be used as a control agent at the SLCMAD. It is believed that the use of malathion by the SLCMAD for more than thirty years coupled with the use of other organo-phosphates as larvicides during much of that same period has resulted in a high degree of resistance to malathion as an adulticide, i.e., Fyfanon®. Further tests are needed to confirm resistance as the main factor for lack of kill in these tests.

The addition of pyrethrum to Fyfanon® definitely increased Fyfanon's® efficacy. Three out of the four formulations used in the test had pyrethrum added to the Fyfanon®. In each of the three cases the results were better than with straight Fyfanon®.

Two of the formulations used in the test had PBO as well as pyrethrum added to Fyfanon®. The results with these formulations were better than with the Fyfanon® alone, but in the formulation with only pyrethrum added to Fyfanon®, the best results were obtained. This showed that PBO did not play much of a part in the effectiveness of the formulations.

A quicker knockdown was obtained in the test when pyrethrum and PBO were added to Fyfanon®. The problem with concluding that this is always true, is that the test results with Fyfanon® were poor anyway. If these tests had been done in an area were Fyfanon® was more effective, Fyfanon® alone may have had just as quick of a knockdown as the other formulations.

The results of the caged mosquito tests were overall very informative. Fyfanon® alone does not control *Cx. tarsalis* very well in the SLCMAD. However, all *Ae. dorsalis* in every cage of all four tests had a 100% mortality. New alternatives will need to be found in an effort to control *Cx. tarsalis* at the SLCMAD.

Future tests both form the SLCMAD and other areas need to be performed and compared to see if the results of these tests are valid or an anomaly.

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Table 1. Results of percentage mortality of *Cx. tarsalis* adults by time post treatment and distance down wind. Refer to test for chemical formulas used in each test.

			% MORTALITY				
			(DISTANCE DOWNWIND)				
Hours Post-Treatment	Test #	Control	50 ft.	100 ft.	200 ft.	300 ft.	350 ft.
1 Hour	1	0	4.3	13	3.9	0	
2 Hours		8.9	21.7	18.7	16.7	10.4	
6 Hours		15.6	42.8	30.9	26.5	6.3	
8 Hours		22.2	47.1	43.9	29.4	21.9	
12 Hours		22.2	71.7	47.2	35.3	21.9	
24 Hours		51.1	81.2	69.9	50.0	63.5	
1 Hour	2	1.8	15.1	6.8	12.4	18.8	5.9
2 Hours		1.8	62.4	32.0	49.6	36.5	27.1
6 Hours		3.5	69.9	53.4	66.4	65.9	16.2
8 Hours		10.5	88.2	60.2	75.2	75.3	33.8
12 Hours		8.8	78.5	62.1	68.1	75.3	36.8
24 Hours		?	86.0	79.6	88.5	69.4	51.5
1 Hour	3	0	72.4	36.3	8.7	11.3	
2 Hours		3.5	100.0	67.4	37.4	21.1	
6 Hours		15.1	89.7	80.0	53	29.7	
8 Hours		15.5	89.7	80.0	53.9	29.7	
12 Hours		27.6	92.4	81.5	55.7	33.8	
24 Hours		32.8	97.9	91.1	71.3	42.9	
1 Hour	4	0	54.6	76.5	33.9	49.6	
2 Hours		10.5	84.1	84.0	53.2	77.8	
6 Hours		0	90.9	92.4	62.4	85.9	
8 Hours		5.3	87.9	88.2	64.2	82.2	
12 Hours		7.9	93.2	94.1	72.5	88.1	
24 Hours		36.8	100.0	95.8	75.2	90.4	

Fig. 1. History of organophosphate use at the SLCMAD.
(*Bti* added for comparison)

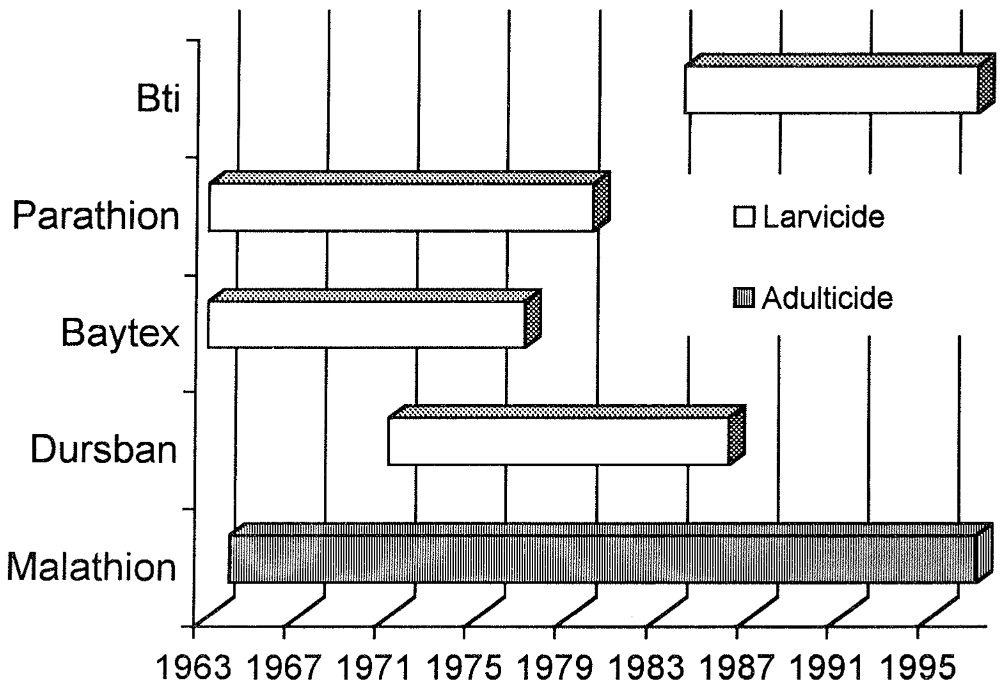


Fig. 2. Test plot arrangement of stakes holding cages of adult mosquitoes. (Numbers in box represent the identification of each location.)

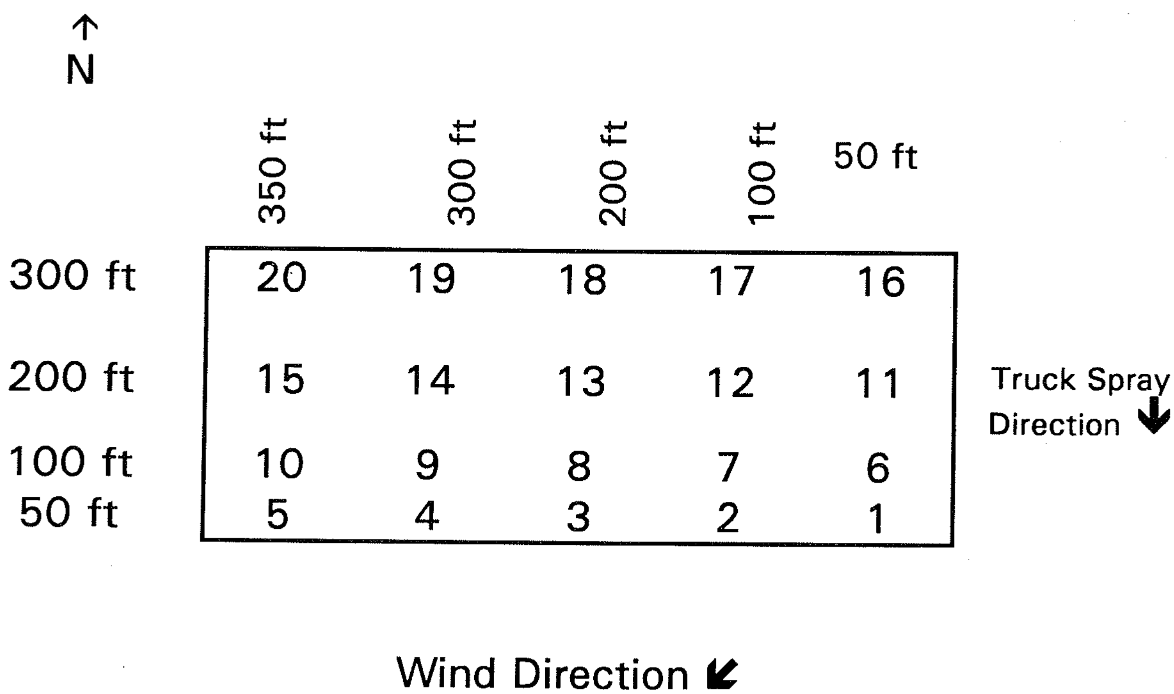
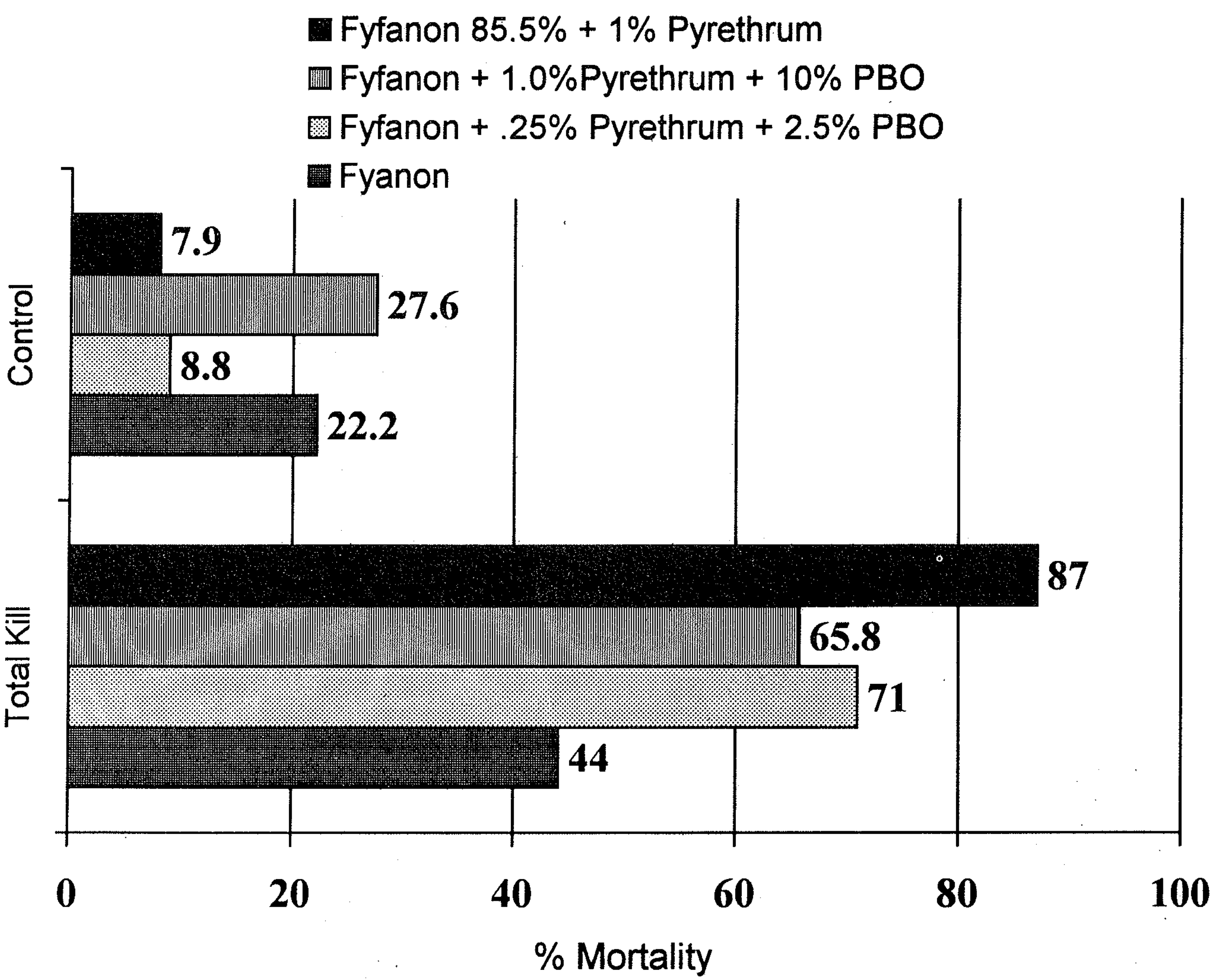
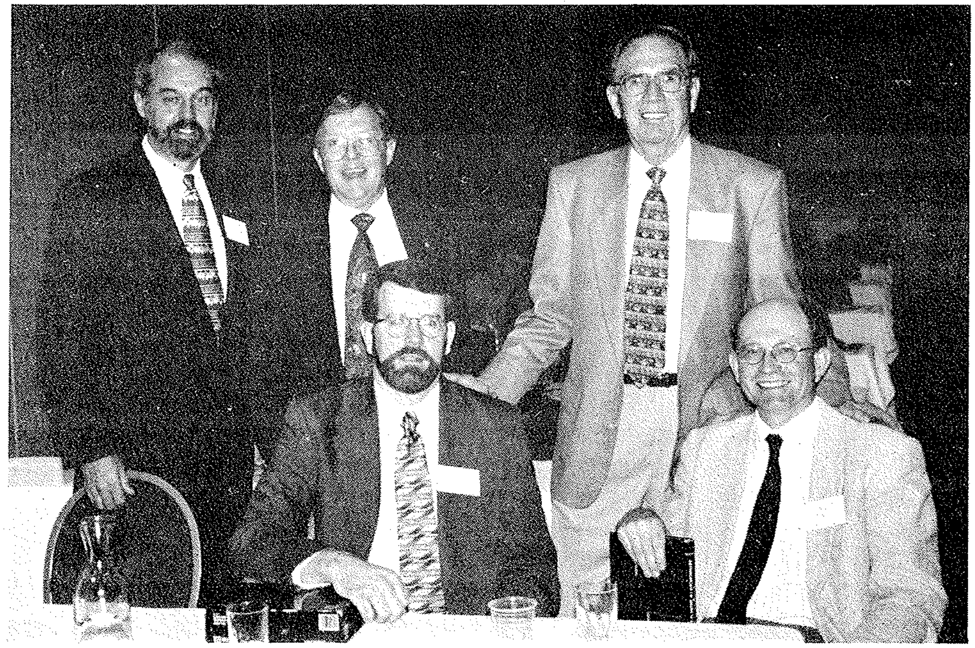


Fig. 3. Percent mortality at 12 hours post treatment.



Attendees of the 1997 UMAA 50th Annual Meeting



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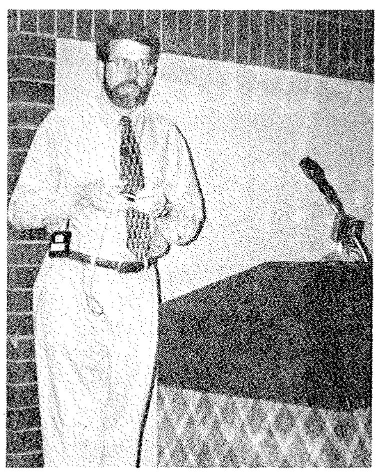

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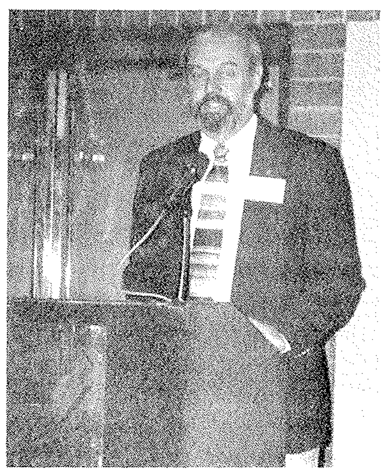

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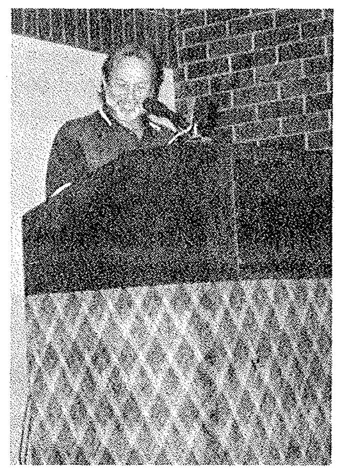

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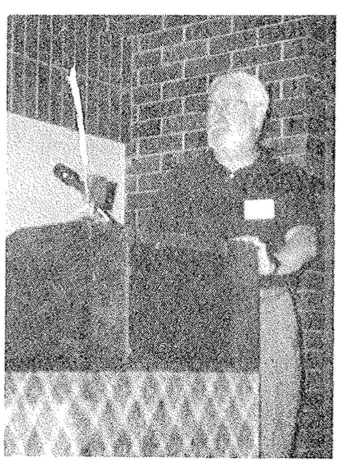

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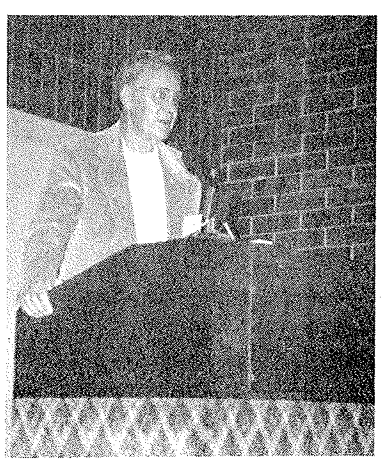

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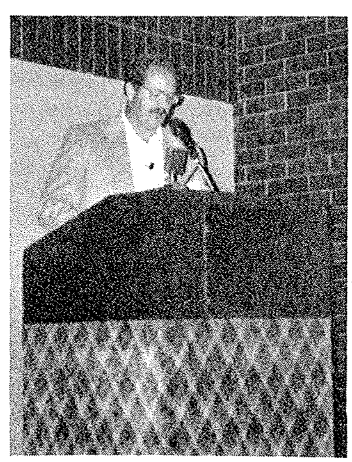

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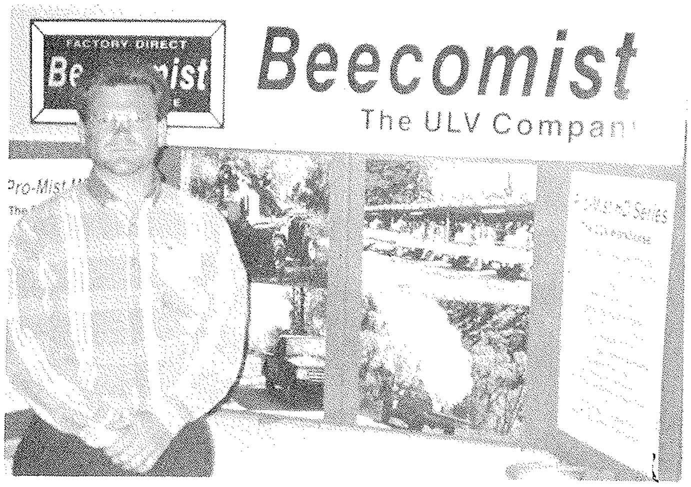

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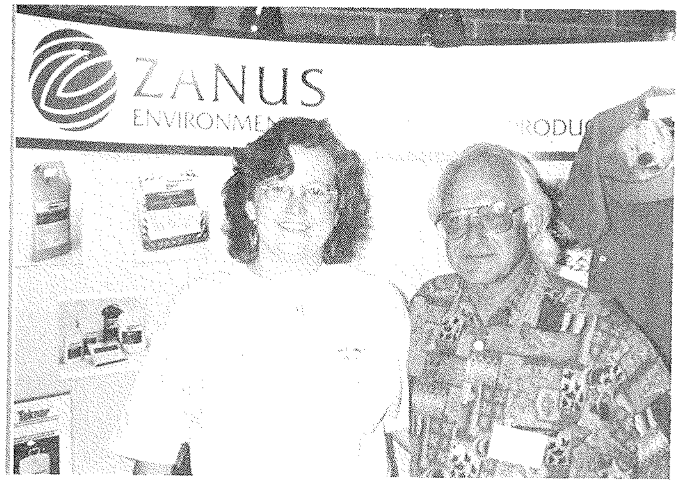

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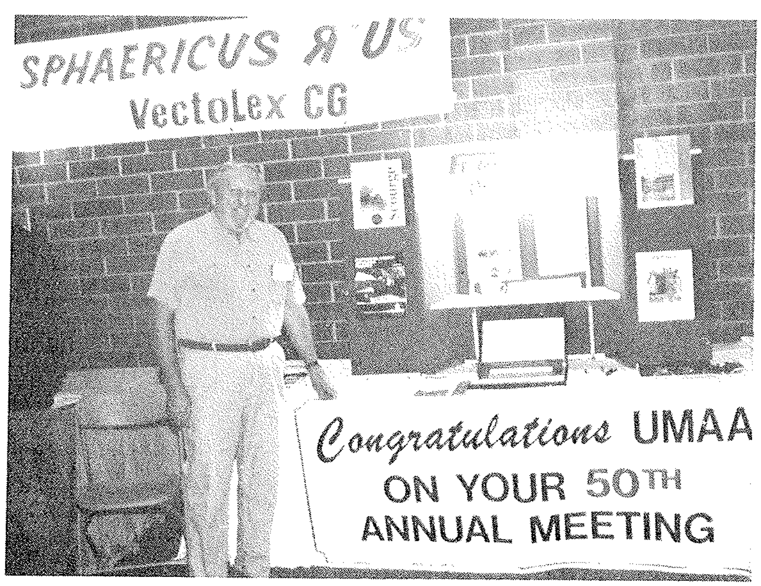

H. B. "Munzy" Munns