

PROCEEDINGS AND PAPERS

OF THE

Thirty-second Annual Conference

of the

California Mosquito Control

Association, Inc.



CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC.

1737 WEST HOUSTON AVENUE

VISALIA, CALIFORNIA

PUBLISHED DECEMBER 30, 1964

Reprint from the Proceedings and Papers of the Thirty-Second Annual Conference of the California Mosquito Control Association, Inc. *Pages 12 - 17.*

WORLD ROLE IN MOSQUITO CONTROL

DONALD R. JOHNSON¹

Mosquito control as carried out in California and many other areas of the United States is considered to be a prerequisite to comfortable modern living, high agricultural productivity, profitable tourism and healthy environs. A few other nations, such as Canada and some of the European countries plus a scattering of cities around the world, also consider it important — but in the world today the vast majority of the 3 billion plus human beings must for the present at least live in the continuous misery of mosquito annoyance and hazard of mosquito-borne disease. For them, mosquito control *per se* is not even contemplated. They cannot seriously think of such luxury when rice and dried fish to feed the family, fuel for the tiny fire, medicine for a sick person, or a piece of cloth to make some new article of clothing all too often are beyond their means. After all, many of the people of our world have a fatalistic philosophy that man was born to live in misery and unless the gods deem it otherwise man must accept the depredations of mosquitoes and other pestiferous creatures.

Nevertheless, mosquito control will become a reality to many of these people some day. A substantial start already has been made, although the world has attacked only a small segment of the overall mosquito problem thus far. Helen Sollers-Riedel (1963) annually has presented a summary of global mosquito control and those who want additional details may refer to her latest paper. Also, Micks (1963) indicates what the future holds for vector control after malaria is eradicated. The present operations to which I am referring are being carried on in the developing regions of the world but usually are not being directed at pest mosquito measures. These programs are aimed at the control of vector-borne diseases. The usual objective, therefore, is disease elimination rather than vector control *per se*. Thus, a campaign aimed at stopping a dengue outbreak in a tropical country frequently is labelled as a “dengue fever control program” even though the operation probably is directed solely against the *Aedes aegypti* mosquito.

¹ Acting Chief, Malaria Eradication Branch, Agency for International Development, Department of State, Washington, D. C. (Present address: Communicable Disease Center, U. S. Public Health Service, Atlanta, Georgia.)

In most campaigns in these developing countries only certain species of mosquitoes are the object of the attack, depending upon the disease problem. The emphasis, of course, usually is on the diseases which are most important to the economy of the country. We here in the United States frequently forget that in vast regions, especially in the tropics, the important diseases still are those carried by mosquitoes and other arthropods. We Americans are apt to think principally in terms of the various arboviruses found in the United States when we speak of vector-borne disease, but elsewhere the emphasis is more often on malaria, yellow fever, dengue, or filariasis.

It is obvious that in any given country the available funds should be utilized to find solutions to the highest priority problems. Yellow fever in Trinidad, dengue in Puerto Rico or just plain pest mosquitoes in Jamaica, have had serious economic consequences because of adverse effects on tourism. Health programs frequently occupy subsidiary positions on the priority lists of many countries, even though in some instances certain health problems may seriously retard economic progress more than is realized. When this happens suddenly in the form of a disease epidemic, high priority may be given quickly to a certain program. The tragic malaria epidemic in Ethiopia during 1958 (Fontaine *et al.* 1961) is an excellent example. An estimated 150,000 persons died in that dramatic epidemic. Malaria eradication thereafter assumed an even greater degree of importance, not only in Ethiopia but in all countries having a potential for a similar epidemic.

Dr. C. M. H. Mofidi (1963), who is Director of the Institute of Parasitology and Malaria in Teheran, Iran, pointed out that certain public health measures have greater potentialities than others for raising the general standard of health and thereby release energy for productive purposes. He indicated that the most important of these health measures is the control of insect-borne diseases, because such control has the most far-reaching consequences. It is encouraging that in the developing countries key individuals such as Dr. Mofidi recognize the great importance of these vector-borne diseases and are taking positive action to bring them under control. The world is thus accepting some of its responsibility in mosquito control.

As mentioned earlier, control of specific diseases most frequently is the mosquito control objective in the world today. One interesting exception to this

broad generalization is the *Aedes aegypti*² eradication campaign in the Western Hemisphere. This notorious mosquito can be responsible for transmission of dread yellow fever, debilitating dengue fever, disfiguring filariasis and others, such as Philippine hemorrhagic fever. It can also transmit certain diseases of animals such as heartworm (*Dirofilaria*) in dogs and bird malaria (*Plasmodium gallinaceum*) of fowls (Christophers 1960).

In order to understand more fully the present Western Hemisphere emphasis on *A. aegypti* eradication we must go back to the beginning of the twentieth century. Yellow fever, of course, was at that time a subject of major interest. William C. Gorgas, as a result of the findings of Walter Reed and the Yellow Fever Commission in 1900, had been using anti-mosquito measures to control yellow fever in Havana, starting in February 1901, with dramatic success. By September of the same year, after having been a constant threat to Havana for 150 years, yellow fever had been completely eradicated (Strode 1951). The Panama Canal success story with the conquest of yellow fever (and malaria) followed immediately after the Havana campaign. The accomplishments must have seemed to be miracles at that time and undoubtedly gave major impetus to the development of improved and intensified mosquito control measures.

In 1902 another significant event occurred — the predecessor agency of the present Pan American Health Organization (PAHO), then called the International Sanitary Bureau (later changed to Pan American Sanitary Bureau), was founded. Among its various responsibilities, it was charged . . . “to encourage and aid or enforce in all proper ways . . . the destruction of mosquitoes and other vermin.”

Yellow fever continued to be a major threat to many countries for several decades. In 1905 an epidemic of 3,384 cases with 443 deaths occurred in New Orleans. This was the last epidemic of this disease in the United States. Serious outbreaks continued to occur in other

² As a matter of interest, Sir Rickard Christophers (1960) believes that *Aedes aegypti* is responsible for the popularization and common acceptance of the word “mosquito.” Although of apparent Spanish or Portuguese America origin, the scientific name, *Culex mosquito*, was given by Robineau-Desvoidy in 1827 to the mosquito now known as *Aedes aegypti*. The word mosquito thereafter gradually came into popular use, replacing the word “gnats,” the old English designation for mosquitoes.

countries of the Americas. As a result of experience in Brazil, Fred L. Soper and D. B. Wilson made their plea for species eradication, with *A. aegypti* as the target. Their plan, which they applied in Brazil, was a brilliant success against *A. aegypti*, even though jungle yellow fever transmitted by other species of mosquitoes continued to persist outside of urban areas.

Hemisphere-wide eradication of *A. aegypti* was proposed in 1943 at the Pan American Sanitary Conference, but it wasn't until 1947 that a resolution was passed which entrusted the Pan American Sanitary Bureau with developing the solution to the eradication of urban yellow fever based upon the eradication of *A. aegypti*. Up to the present, *A. aegypti* has been eradicated from Bolivia, Brazil, Chile, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, British Honduras, French Guiana and the Canal Zone. The United States, usually a leader in such activities, as recently as last year still had not undertaken *A. aegypti* eradication, probably because of the absence of yellow fever and its immediate threat to the U.S. Finally, however, after years of discussion and development of international agreements, the United States, thanks to the good progress elsewhere and consequent urging of other nations, has embarked upon a campaign to eradicate *A. aegypti* from this country.

Last February, President Kennedy emphasized the importance of this program when he stated as follows to Congress: "A problem of particular significance in the Western Hemisphere is that of yellow fever. Many countries of the Americas have conducted campaigns to eradicate the mosquito which carries yellow fever but the problem of reinfestation has become a serious one, particularly in the Caribbean area. We have pledged our participation to eradicate this disease-carrying mosquito from the United States, and the 1964 budget provides funds to initiate such efforts. This will bring this country into conformity with the long-established policy of the Pan American Health Organization to eliminate the threat of yellow fever in this hemisphere."

This program now is under way and is to give first attention to Puerto Rico, the Virgin Islands, Florida, and Texas along the Mexican border. During the next fiscal year extensive surveys and other preliminary measures will be undertaken in the remainder of the so-called yellow fever receptive area — Alabama, Ar-

kansas, Georgia, Louisiana, Mississippi, South Carolina and Tennessee. The newly established *Aedes aegypti* Eradication Branch, Communicable Disease Center, Public Health Service, in Atlanta, Georgia, is the nerve center of this newest mosquito control program. A mimeographed document describing the program is available from CDC (Anon. 1963).

Another important program in the world today is the control of filariasis, caused by *Wuchereria bancrofti* and *Brugia malayi*. This program is not as well organized as either malaria or *Aedes aegypti* eradication programs. At present there is much pressure throughout the world to do something about this mosquito-borne disease which causes disfiguring elephantiasis. The social stigma caused by the grotesque malformations of the unfortunate sufferers of elephantiasis is sad indeed. I personally recall the strong plea made to me in 1959 by the then Minister of Health in Ceylon, Her Excellency Vimala Wijewardene. She stated that malaria had been almost conquered in Ceylon but that filariasis still continued unchecked. She felt that filariasis was a more important problem in Ceylon than was malaria at that time. Indeed this is true, not only in Ceylon but in certain parts of India, Burma, Thailand and other countries, which are so unfortunate as to have both diseases present. It is possible that malaria may be eliminated in certain areas of countries even though large multitudes of people in the malaria-free areas still are exposed to filariasis and suffer from elephantiasis.

The control of this disease is far more complex and the efforts less rewarding than malaria control. Filariasis has a long incubation period. After infection occurs, many years may elapse before any physical manifestations of the disease are evident, but once the deformities of elephantiasis appear, they usually remain with the individual for life. The drug (diethylcarbamazine) treatment frequently results in a severe reaction and often leads to hostility on the part of the population. As a result of drug administration even those persons without apparent symptoms may develop an unpleasant foreign protein reaction caused by destruction of the microfilariae.

Because of the multiple vectors of filariasis, mosquito control measures often must be directed against several species, including the most abundant pest mosquito, *Culex quinquefasciatus* — or *C. fatigans* as it is known in many countries. Difficult to control species of *Man-*

sonia may be involved. Usually a general sanitation program is required to stop vector breeding and, although such would be commendable, this will be out of the question for years to come in some parts of the world where sanitation is still a thing of the future due to high cost and lack of understanding of basic sanitation. This, incidentally, reminds me of an actual report which recently came in from a Far East country:

“Sanitary conditions are quite primitive. It is now the law that there must be a toilet in every brick house built. This has resulted in most people building their houses out of other materials.”

In countries where sewerage systems consist of cess-pools and where standing water is everywhere, all of



Figure 1. Advanced elephantiasis — India.

which may breed millions of potential filiarisis vectors, control of this disease is not practical, for the time being at least. George J. Burton (1960) has presented a valuable series of papers on the bionomics of filiarisis vectors in India; included are many remarkable photographs of the disease manifestations (fig. 1) as well as habits of the mosquito larvae especially *Mansonia* species (fig. 2). John F. Kessel of the University of California, Los Angeles, and Emile Massal of the Institute of Medical Research in Tahiti (1962) have prepared an interesting account on the control of filiarisis on Pacific Islands. They felt that at present, bancroftian filiarisis can best be controlled by diethyl-carbamazine administration, folowed by a mosquito control program. Mosquito control alone was not practical in the islands under consideration; in fact, the



(Photographs by Dr. George J. Burton.)

drug administration appeared to them to be the most effective of the two measures.

Today, the world is doing something about its worst mosquito problem. Malaria eradication, the greatest health program ever undertaken in the history of mankind, is underway. It is a dramatic effort and for the most part is a gigantic mosquito-control campaign. It undoubtedly is doing more to improve the health and well-being of the human race than could any other program presently within the capabilities of the nations of the world. [As an incidental sidelight, those of us who collect stamps are well aware of the malaria program, for recently 101 nations and territories issued postage stamps commemorating malaria eradication (Johnson and Fritz 1963).]

This dramatic worldwide anti-malaria program was born during World War II and can be considered as one of its beneficial byproducts. When American GI's and troops of other nations went to tropical areas far from home, many quickly fell victim to the mosquito-borne disease, malaria. On Guadalcanal the U. S. Marines suffered more casualties from malaria than from enemy action. Malaria control units suddenly became an absolute necessity to all troops in malarious areas. The discovery of the potent properties of DDT



Figure 2. Searching for *Mansonia* larvae – India filariasis control program. (Photograph by Dr. George J. Burton.)

in 1943 made the task possible and must be credited with the saving of many lives. The work of the malaria control units certainly was a very positive factor in the winning of that war. However, the malaria control efforts also introduced modern malaria control techniques into many parts of the world. The Institute of Inter-American Affairs funded by the U. S. Government was assisting various Latin American countries with malaria control work starting in 1943, thus laying the foundation for the post-war programs.

After the war ended, the World Health Organization (WHO) was founded and selected malaria as one of its targets, just as the Pan American Sanitary Bureau had done in the Americas. The expanded worldwide effort against this disease soon was started. Malaria was the most serious infectious disease of man at that time, accounting for some 200,000,000 cases annually, with 2,000,000 deaths. The United States, through intensive anti-anopheline measures eradicated malaria within a few years. The Marshall Plan and President Truman's Point IV program made U. S. funds available to many countries of the world in order that they might get back on their feet. With U. S. assistance malaria was one of the problems attacked by many lesser developed



Figure 3. Nicaragua malaria control advisor G. A. Bevier (from California) and C. Espinosa, supervisor of larviciding, examining water skates.

nations in the early 1950's with dramatic success. Encouraged by many such successes, the World Health Assembly in Mexico in 1955, following the lead of 1954 action of the Pan American Sanitary Conference, directed WHO to promote the eradication of malaria. The United Nations Children's Fund (UNICEF) made funds available for purchase of insecticides and other commodities needed for this joint world wide effort.

One of the little known stories of that era was the part played by a prominent Californian in this dramatic story. In 1956, there existed what was called the "International Development Advisory Board," (IDAB). Its members had been appointed by President Eisenhower to advise a predecessor agency of A.I.D., (then called the International Cooperation Administration or ICA), on ways to make most effective use of foreign aid. The only expert in public health on IDAB, which, incidentally was headed by the late Eric Johnston, was the late Wilton L. Halverson, M.D., formerly Director of Public Health for the State of California. Dr. Halverson, in consultation with Henry van Zile Hyde, M.D., Chief of the Division of International Health, Public Health Service, made a strong proposal to Mr. Johnston that the U.S. redirect its efforts from malaria *control* to an intensified



Figure 4. Team on water skates carrying motorized duster across Nicaraguan swamp.

malaria *eradication* campaign. Dr. Halverson, as Chairman of a Special Committee, was asked by Mr. Johnston to make an expanded study of this proposition, with the assistance of Paul F. Russell, M.D. and the Public Health Service, Division of International Health. The resulting IDAB document (1956) became the basis for the present A.I.D. malaria eradication program. Dr. Halverson indeed should long be remembered and credited as one of the key individuals in this spectacular health undertaking.

It is not my intent today to attempt to give all the details of this great campaign, for time is too short. You and I as taxpayers are helping to make the global program possible. As a result of Congressional action, starting in 1958, approximately \$30 million annually of U. S. funds have been used to finance direct contributions to some 28³ countries as well as to the Pan Ameri-

³ Since the program started in 1957, the following countries (arranged by A.I.D. regions) have received U. S. assistance:

Far East — Cambodia, China, Indonesia, Laos, Philippines, Thailand, Vietnam.

Near East, South Asia — Ceylon, India, Iran, Jordan, Nepal, Pakistan.

Africa — Ethiopia, Liberia, Libya.

Latin America — Bolivia, Brazil, Colombia, Ecuador, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Nicaragua, Paraguay, Peru.



Figure 5. Unloading DDT and spray equipment at a long house in the high plateau area of Darlac province in Vietnam.

can Health Organization and the World Health Organization. Basic and applied research pertinent to this program is being carried out by our government both here and abroad (Quarterman 1963). A few examples of A.I.D. malaria eradication activities are shown in figures 3-6. About 70 American technical staff members are overseas with A.I.D. in the eradication program itself, and as all of you are so well aware, many now with the program, or previously with it, are California mosquito control workers. Actually, California has made a greater contribution to this program than any other state in the country. On behalf of A.I.D., I wish to thank the State of California for this. As a result of the high standards insisted upon by your State, California is a world leader in the field of mosquito control. The liberal policies and progressive



Figure 6. Manual application of Paris green dust formulation on rim of swamp in Nicaragua.

leadership in California, which have made it possible for many of your well-trained experts to be utilized by the U. S. Government in malaria eradication work, have been a tremendous help to the program.

Also, we are grateful that California has welcomed the many foreign malaria program trainees whom we have sent here as observers. You have been gracious hosts, and as a result of your kindness, many malaria workers around the world are good friends of California and its mosquito control workers. The observations of your activities have proven to be invaluable demonstrations of American "know-how" in action.

Let me illustrate the magnitude of the malaria eradication program by just a few statistics. Table 1 gives the latest information as to the world-wide status of this program. Of the 3.2 billion persons in the world today, 1.5 billion (plus an unknown number in mainland China, North Korea and North Vietnam for which no information is available) live in areas that either are or recently were malarious. Of these, about 340 million are living in areas where eradication is complete. Nearly 360 million more have almost achieved eradication as they are in the consolidation phase, during which time spraying operations for the most part are terminated. This means that at least 700 million people previously exposed are now malaria-free. About 730 million more receive protection by active attack measures which for the most part consist of residual spraying of their houses with DDT water-dispersible powder in water. Dieldrin, benzene hexachloride and malathion are used in areas of DDT resistance. (Quarterman *et al.* (1963) and Schoor *et al.* (1963) discuss dichlorvos as a residual fumigant; dichlorvos appears to be a promising insecticide for use in double resistance areas.)

I am sorry to add however, that there still are 388 million people who do not yet have any protection whatsoever from malaria. The largest portion of these live in Africa where the campaign is not yet underway. We all hope that someday the program will be extended to all people everywhere so that the cruel chills, fevers and debilitation of malaria no longer will be a millstone around the neck of these people. It has been shown frequently that when this weight is removed, excellent economic and social progress has been made in many countries.

We have many problems in the program, such as insecticide resistance of certain anopheline species,

poor administration in some countries, lack of well-trained personnel in others, and insufficient funds in most. It is unfortunate that in certain quarters the principles of good mosquito control are not always observed, for some think of this only as a medical program and tend to lose sight of the fact that the goal must be reached principally through the avenue of vector control. In some countries there is still a lack of adequate knowledge and understanding of malaria eradication principles, as well as a scarcity of well-trained, experienced national personnel. The world has had these and other problems of setbacks, but despite the deficiencies the program is progressing fairly rapidly. As experience is gained and as people everywhere realize what this effort does for all countries and its inhabitants, the world will demand complete elimination of malaria from all nations. Through such measures the world is learning that freedom from disease — and from mosquitoes — is possible.

All of us benefit either directly or indirectly from the role that world mosquito control is playing. These benefits may be those derived from technological advances in the field of mosquito control developed in other countries — or merely because other people are able to live more productive, healthy lives. The improved economic productivity of these people brings about a higher standard of living which eventually benefits world trade and social progress.

All of us involved in mosquito control work should be proud of the part each of us has played either directly or indirectly in this humanitarian global program which is doing much to help draw nations more closely together. We fervently hope that these and other worthwhile improvements in the way of living of all peoples will make this a better world in which to live.

TABLE 1.—Status of global malaria eradication (population in thousands).^a

A.I.D. Regions	Total Population	Original Malarious Area	Eradicated Claimed (Maintenance phase)	Eradication programs in process				Eradication program not yet started
				Consolidation phase	Attack phase	Preparatory phase	Total	
Far East	371,581	230,175	17,399	9,528	95,857	10,355	115,740	97,018
Near East & South Asia	696,556	630,904	7,109	301,394	230,169	19,162	550,725	73,070
Africa	257,129	223,535	3,421	1,505	1,184	2,689	217,425
Europe	643,418	256,340	250,717	5,623	5,623
Latin America	436,213	157,599	60,593	40,384	42,548	13,084	96,016	999
Total	2,407,897 (3,161,121) ^b	1,498,553 100.00%	339,239 22.63%	358,434 23.92%	369,758 24.67%	42,601 2.84%	707,793 (51.43)	388,521 25.94%

^a Includes the estimated population (of 753,224 thousands) of mainland China, North Korea, and North Vietnam from which no additional information is available.

^b From World Health Organization, Document EB 33/4, Sept. 30, 1963 (Processed).

REFERENCES CITED

- Anon. 1963. Program for the eradication of the *Aedes aegypti* mosquito from continental United States, Puerto Rico and the Virgin Islands. U. S. Department of Health, Education, and Welfare, Public Health Service, Communicable Disease Center, Atlanta, Georgia. Processed.
- Anon. 1963. Report on development of malaria eradication programme. World Health Organ. Document EB 33/4. Processed.
- Burton, George J. 1960. Studies on the bionomics of mosquito vectors which transmit filariasis in India. Terminal report. (Includes five papers which originally appeared in Vol. 13 and 14, Indian J. Malariol.). U. S. Technical Cooperation Mission to India, New Delhi, 145 p.
- Christophers, S. Rickard. 1960. *Aedes aegypti* (L.). The yellow fever mosquito. Cambridge University Press. 739 p.
- Fontaine, Russell E., A. E. Najjar, and J. S. Prince. 1961. The 1958 malaria epidemic in Ethiopia. Am. J. Trop. Med. Hyg. 10:795-803.
- International Development Advisory Board. 1956. Malaria eradication report and recommendations. Processed.
- Johnson, Donald R., and Roy F. Fritz. 1963. Postage stamps portray a world united against malaria. Proc. N. J. Mosquito Exterm. Assoc. 50:381-403.
- Kessel, John F., and Emile Massal. 1962. Control of bancroftian filariasis in the Pacific. Bull. World Health Organ. 27:543-54.
- Micks, D. W. 1963. Vector control after malaria eradication. Bull. World Health Organ. 29(Suppl.):171-6.
- Mofidi, C. M. H. 1963. Vector control in developing countries. Bull. World Health Organ. 29(Suppl.):167-9.
- Quarterman, Kenneth D. 1963. Research in vector control. Bull. World Health Organ. 29(Suppl.):63-8.
-, M. Lotte, and Herbert F. Schoof. 1963. Initial field studies in upper Volta with dichlorvos residual fumigant as a malaria eradication technique. 1. General considerations. Bull. World Health Organ. 29:231-5.
- Schoof, Herbert F., George W. Pearce, and Willis Mathis. 1963. Dichlorvos as a residual fumigant in mud, plywood and bamboo huts. Bull. World Health Organ. 29:227-30.
- Sollers-Riedel, Helen. 1963. An international review of activities concerning mosquitoes in 1962. Proc. N. J. Mosquito Exterm. Assoc. 160-91.
- Soper, Fred L., and D. B. Wilson. 1942. Species eradication; practical goal of species reduction in control of mosquito-borne disease. J. Natl. Malaria Soc. 1:5-24.
- Strode, George K. 1951. Yellow fever. McGraw-Hill Book Co., New York. 710 p.