

AGENCY FOR INTERNATIONAL DEVELOPMENT  
WASHINGTON, D. C. 20523  
BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY  
*Batch 72*

1. SUBJECT CLASSI- FICATION	A. PRIMARY Health	NS00-0000-0000
	B. SECONDARY Tropical diseases	

2. TITLE AND SUBTITLE  
The world-wide malaria eradication program

3. AUTHOR(S)  
Griffith, M.E.

4. DOCUMENT DATE 1965	5. NUMBER OF PAGES 8p.	6. ARC NUMBER ARC
--------------------------	---------------------------	----------------------

7. REFERENCE ORGANIZATION NAME AND ADDRESS  
AID/TA/H

8. SUPPLEMENTARY NOTES (*Sponsoring Organization, Publishers, Availability*)  
(Presented at Plenary Sym. on Int. Programs, Entomological Soc. of Am., New Orleans, 1965)

9. ABSTRACT

10. CONTROL NUMBER PN-RAB-764	11. PRICE OF DOCUMENT
12. DESCRIPTORS Cooperation Insect control Malaria	13. PROJECT NUMBER
	14. CONTRACT NUMBER AID/TA/H
	15. TYPE OF DOCUMENT

# The World-Wide Malaria Eradication Program<sup>1</sup>

By MELVIN E. GRIFFITH

*Deputy Chief, Malaria Eradication Branch, Agency for International Development*

The world-wide malaria eradication program came into being about 10 years ago from 1955 to 1957. Some five years previous to that time the United States had been one of the first countries to eradicate malaria through an organized campaign, using the new residual insecticide, DDT. In the early 1950's, with widespread use of DDT in malaria control campaigns throughout the world, disturbing reports of mosquito resistance to DDT emphasized that the time available to use this powerful weapon against malaria might be limited.

In 1950 and 1954 the Pan American Sanitary Conference urged action toward hemisphere-wide malaria eradication. In 1955 and 1956 the World Health Assembly resolved on the objective of world-wide malaria eradication and called upon the World Health Organization to provide coordinating leadership. The United States delegation to the World Health Assembly joined with others in the commitment to malaria eradication, and this objective was established as U. S. policy in foreign assistance by Congressional action in 1957 under the Mutual Security Act. Each of the three U. S. Presidents since that time has personally made statements continuing this commitment.

Thus, the policy of the World Health Organization, the Pan American Health Organization, the United Nations Children's Fund, and the United States foreign assistance program changed from support of malaria control to support of malaria eradication throughout the world. This change in policy shows both recognition of the importance of malaria to man and confidence in the weapons available to wage a successful war against this disease.

It is well known that for centuries malaria has been one of the most destructive natural enemies of mankind. Until recent years half of the world's population lived in malarious areas. The damages of malaria are not due primarily to its fatality, which is relatively low, but to its debilitation which saps away the mental and physical energies of its victims. The depressive effects of malaria on human resources lend economic, as well as humanitarian, importance to antimalaria campaigns.

A long period of malaria control efforts and some actual achievements in eradication have preceded the present global program. Most malarious countries have made extensive efforts to control the disease, with varying success. For more than 50 years, the United States has supported international antimalaria activities through the U. S. Public Health Service, the U. S. Agency for International Development and predecessor agencies, the Rockefeller Foundation and various voluntary agencies, and the Defense Forces. The World Health Organization and the United Nations Children's Fund have supported antimalaria campaigns beginning shortly after these agencies were established in 1948 and 1946, respectively.

The first government projects aimed at country-wide malaria eradication were initiated during 1945 to 1948

in Venezuela, Italy, Cyprus, the United States and Mauritius. These and other projects followed the discovery of the insecticidal properties of DDT by Müller and Wiesmann in 1936 to 1939 and large-scale production and use of DDT by the United States and the United Kingdom during World War II.

Following the resolution of the World Health Assembly in 1955, about three years were required to convert control programs to eradication programs in the global campaign, so that most country programs got under way about 1958. Then a year or two more of experience was needed to establish and refine some of the operating principles, and numerous programs required further reorganization and intensification as the requirements of malaria eradication became better understood. A report of the U. S. International Cooperation Administration Expert Panel on Malaria in 1961 provides a summary of the historical background and developmental considerations of the global malaria eradication program, with special reference to United States participation.

In 1960 the status of malaria in the world showed about 1.3 billion people living in originally malarious areas, but with malaria eradicated or malaria transmission eliminated for about 25% of the affected population. Active eradication campaigns were under way for an additional 50% of the population, while 25% of the population, largely in Africa, remained without an organized anti-malaria campaign. It is evident that a massive reduction of malaria had already been achieved by control campaigns throughout the world. Some of these campaigns had developed progressively as eradication programs, while others required an extensive effort for conversion.

The principles and guide-lines of malaria eradication are set forth in the reports of the WHO Expert Committee on Malaria, especially in the Sixth to Tenth Reports, published from 1957 to 1964. This series is continuing to improve concepts and application of eradication methodology. Though the literature on malaria control has been voluminous through many years, the first text-book specifically on malaria eradication was published by Emilio Pampana (1963). Professor Pampana was formerly Director, Division of Malaria Eradication at WHO Headquarters.

## POINTS OF ATTACK AGAINST HUMAN MALARIA

The three actors in the drama of malaria transmission are man, mosquito and parasite.<sup>2</sup> There are no known significant reservoirs of human malaria in other animals, though rare instances of transmission between man and monkeys may occur. There is no available method of immunization against malaria, and unfortunately man develops only partial immunity when repeatedly infected. Attack on human malaria is, therefore, conducted by preventing infected mosquitoes from biting humans, thus interrupting malaria transmission, and by treatment of humans to destroy malaria parasites.

<sup>2</sup> Some 65 species of *Anopheles* are recognized as malaria vectors. Of the four known species of human malaria parasites, *Plasmodium falciparum* and *P. vivax* cause more than 95% of the cases. *P. malariae* is unevenly distributed and *P. ovale* occurs mostly in West Africa.

<sup>1</sup> Presented in the Plenary Symposium on International Programs at the meeting of the Entomological Society of America in New Orleans, November 30, 1965.

The methods available to antimalaria campaigns have been familiar for many years, though improvements have been numerous and dramatic. Actual barriers may be used to separate man and mosquito, such as bednets, clothing, good housing and screening, and repellents. Direct attack may be made on the mosquito by treating breeding places with oils, Paris Green dusts and residual sprays; draining, filling and water management to eliminate breeding places; or naturalistic control with larvivorous fishes and other predators.

Following the discovery of the residual insecticidal properties of DDT, the attack on malaria vectors in recent years has been almost exclusively by DDT spraying of human dwellings and associated animal shelters. Under certain conditions, dieldrin, benzene hexachloride and malathion are also used effectively in household application. Space sprays—that is, aerosols, fogs and mists—are rarely used, though a new residual fumigant, DDVP, offers some possibilities.

Just as DDT and other new insecticides greatly improved the ammunition for war on malaria-carrying mosquitoes, so new synthetic drugs have made possible more effective treatment against malaria parasites. Malaria has a low fatality rate and will normally disappear in non-fatal cases within two to three years, unless re-infection occurs. However, some types of malaria may relapse through several years in a low percentage of cases; this is due to persistent generations of the malaria parasite in the tissue cells of the liver.

The attack on the malaria parasite must first eliminate the cycle in the blood which causes clinical malaria and renders a patient infective to mosquitoes. In relapsing types of malaria, it is also necessary to provide radical treatment which attacks the tissue forms and thus destroys the root of the disease. Chloroquine and amodiaquine are commonly used against the blood cycle and primaquine against the tissue cycle. These drugs in combination may thus effect a complete cure in most of the known strains of malaria.

Together with the new insecticides and drugs produced by man's inventiveness, a most fortunate vulnerability has been placed by nature in the malaria transmission cycle. In a newly infected man, or in a newly infected mosquito, a period of about one to three weeks is required for transmissible forms of the malaria parasite to develop. This lack of immediate infectiveness greatly slows the transmission from man to mosquito to man and enhances the opportunity to destroy an infected mosquito before it can transmit malaria.

#### DIFFERENCES BETWEEN CONTROL AND ERADICATION

Control programs aim to reduce malaria to a minor public health problem; therefore, they operate where malaria occurs as a major problem. Their minimum standards must be good, based on local requirements; they will last indefinitely, planned on continuing requirements, and their costs will continue in the same way.

Eradication programs aim to stop transmission and eliminate malaria foci, so that the disease permanently disappears; they must work wherever malaria occurs at any level. To achieve their objective, eradication programs require a high degree of perfection, based on internationally accepted guide-lines and criteria. They are essentially limited in time and must be planned at the beginning for the projected duration of operations. Costs of the special campaign terminate when eradication is achieved.

In contrast with control programs, eradication campaigns give major importance to case finding and investigation and must clearly distinguish imported and locally transmitted cases. They are characterized by a system of surveillance activities which will quickly and accurately locate and treat malaria cases and determine the origin of each infection and the remedial action required.

In operational coverage, eradication programs must mount a full-scale attack, both on the malaria vector in an anti-mosquito campaign and on the malaria parasite through the surveillance activities. The coverage must be *total*, reaching every community and home; *adequate*, providing all measures required in the right amounts; *regular*, in scheduled repeated contacts according to technical needs; and *complete*, leaving no treatable person untreated and no sprayable surface unsprayed. Coverage of this nature is probably the single most important characteristic of a malaria eradication program.

Finally, in eradication programs, progress cannot be assessed in terms of what has been accomplished in malaria reduction, as in control programs, but must be considered in the light of what still lies ahead to be done before the goal of eradication is achieved.

#### SPECIAL PROBLEMS

The term "problem area" is applied to a geographical unit within which malaria transmission persists in spite of total, adequate, regular and complete coverage with residual insecticide spraying or, in exceptional circumstances, with mass treatment as the attack method. Areas affected by administrative and operational failures to achieve the necessary coverage are not to be included in this definition. The Tenth Report of the WHO Expert Committee on Malaria (1964) provides a useful treatment of the nature and causes of problem areas and the methodology for their study and remedy.

In problem areas the difficulty may be ascribed to some form of resistance on the part of man, mosquito or parasite to the standard technical approaches of antimalaria activities. The factors of human resistance are often difficult to define as purely technical—that is, deeply rooted social conditions and cultural practices which are not likely to be changed in the period of the planned malaria eradication campaign. Examples are nomadism and seasonal migration, use of shelters which cannot be effectively sprayed, resting and sleeping outdoors where exposed to malaria vectors, and plastering of sprayable surfaces during religious holidays. However, any failure to obtain public cooperation is always suspect as a possible operational problem arising from short-comings in health education and public relations.

Mosquito resistance has had widespread publicity in connection with possible effects on the world-wide malaria eradication program. The most dramatic factor in this problem is actual physiological resistance to residual insecticides, now reported in over 30 species of anophelines for DDT and/or dieldrin. "Behavioristic" resistance has also been shown, involving an ability to avoid lethal contact with sprayed surfaces. A definitive work on "Insecticide Resistance in Arthropods" was published by A. W. A. Brown (1958) in the WHO Monograph Series. The subject has been studied intensively by numerous workers, and a useful compendium entitled "Insecticide Resistance and Vector Control" appeared as the Thirteenth Report (1963) of the WHO Expert Committee on Insecticides.

Malaria parasite resistance to drugs has greatest sig-

nificance in resistance to chloroquine, since this drug has primary importance in malaria treatment in eradication campaigns. Drug resistance has been reported in various localities in South America, Africa and Southeast Asia. The association with the Defense Forces in Vietnam has much increased the publicity accorded this problem. A report of a WHO Scientific Group (1965) on "Resistance of Malaria Parasites to Drugs," considers the nature and distribution of the problem, procedures and criteria for determining drug resistance, and proposals for counter measures and research.

Both insecticide resistance in malaria vectors and drug resistance in malaria parasites are unquestionably important technical problems which fully justify the intensive research they are receiving in connection with malaria eradication programs. However, it may be noted that at present only about one percent of the population in the malarious areas of the world is directly affected. The need is not only to find solutions to the special problems, but to prevent them from spreading to other areas. Among the most contributory moves to be made by any country to protect itself and its neighbors is to develop as rapidly and as effectively as possible those activities which will achieve and maintain malaria eradication.

#### ENTOMOLOGICAL ACTIVITIES

In a malaria eradication program, entomology is an integral part of the epidemiological services which are concerned with the occurrence and origin of malaria infections and which assess the effectiveness of the measures applied against the disease. The Eleventh Report of the WHO Expert Committee on Malaria (1964) is devoted to entomological methods. The technical report series of the WHO Expert Committee on Insecticides is also highly useful.

The functions of the entomologist are to provide information on the identity and bionomics of malaria vectors and other factors involved in interruption of transmission through anti-mosquito measures; to determine the choice of insecticide, dosage and timing of application, geographical coverage and sprayable surfaces; to evaluate vector control results and assist in appraising the epidemiological situation and potential changes according to entomological evidence.

The most important entomological data for malaria eradication are those indicative of the infectivity rates of man-biting species of anophelines, the density and longevity of the vector species, and the degree of contact between man and the vector species.

Entomological techniques cannot be carried out on a total coverage basis, as are other epidemiological activities in malaria eradication programs. The entomologist will select representative study areas for detailed investigations, supplementing these with random sampling procedures in the operational areas, usually accompanying the malariometric surveys in the early phases of operations.

The entomological methods employed in malaria eradication programs include collection of adult mosquitoes indoors and outdoors while resting and while biting human and animal bait; other collection of adults in baited or outlet traps and of immature stages in breeding places; studies in insectaries and experimental huts; collection of blood-meals for precipitin tests; dissection for malaria parasites and for age-determination of mosquitoes; insecti-

cide susceptibility tests and bioassay of insecticide residues on sprayed surfaces.

#### MALARIOMETRY AND SURVEILLANCE

Any antimalaria campaign using modern methods should achieve an early dramatic reduction of malaria, but in programs applying only control measures an undetermined amount of malaria may remain scattered through the population as a hidden reservoir of the disease. In part this is due to dependence on malariometric surveys for control guidance and evaluation. Such surveys consist of annual or seasonal examination of representative samples of selected age-groups for enlarged spleen or malaria infection.

The malariometric surveys provide an index only to the *prevalence* of the disease—that is, the proportion of positive individuals in the sampled age-groups at the time of the survey. With interruption of malaria transmission after one to three years of spraying, the surveys are not comprehensive enough to reveal the few persistent cases and assure elimination of malaria foci. Control programs can only be expected to reduce malaria to a low level of prevalence as their accepted objective.

In eradication programs, malariometric surveys are sufficient only in early phases of operations. With reduction of malaria to low prevalence rates, a surveillance program of case finding, treatment and investigation must be established. Since surveillance covers all of each operational area continuously, it reveals the true *incidence* of malaria—that is, the proportion of the total population having the disease during the year. The aim of eradication is to assure the reduction of malaria to zero incidence.

Surveillance may be conducted in two principal ways referred to as "active" and "passive" surveillance, both being necessary and complementary in providing total coverage.

Active surveillance is by regular visits to every home once or twice per month to see if fever is present in any household or has occurred since the last visit. Each fever case will be given presumptive treatment with an antimalaria drug and a blood slide will be taken and forwarded to a laboratory. If the case is malaria positive, the malaria eradication services must provide radical (curative) treatment, investigate the origin of the case, and undertake any indicated remedial measures—which may include respraying the area or mass treatment of the community.

Passive surveillance is through malaria detection posts at hospitals and health centers or through volunteer agencies and individuals. The available services at these posts are publicized throughout the operational area, so that people who suffer from fever will seek examination and treatment. Blood examination and follow-up treatment and investigation of malaria positive cases are performed as with active surveillance.

It must always be borne in mind that a malaria eradication program aims at eliminating the malaria parasite from the population in the operational area. Well-equipped laboratories employing well-trained technicians under close supervision are among the primary requirements for an effective antimalaria campaign. Blood examination is the only method by which the presence of malaria can be positively determined. A strict system of cross-checking is necessary to make sure of the accuracy of positive and negative results obtained by each technician.

During the early phases of a malaria eradication program, malarionometric surveys will be made by blood examination mainly of children, using standard population sampling techniques. In later phases such surveys will be replaced by surveillance case finding activities which will greatly increase the number of blood slides to be examined. The surveillance system must include provisions for prompt forwarding and examination of blood slides, so that positive findings will result in the earliest possible application of remedial measures where each case occurs.

#### PHASES OF A NATIONAL PROGRAM

A malaria eradication program will be provided at the very beginning with a plan of operations which covers all anticipated requirements and activities for the duration of the program. Of course, it is to be expected that modifications may occur as the program goes along, according to technical developments, but the basic plan must be complete and in accordance with well-established international guide-lines.

The active malaria eradication program consists of three phases—*preparatory*, *attack* and *consolidation*—preceded by an indefinite period of *pre-eradication* activities and succeeded by permanent *maintenance* of eradication. The pre-eradication period is concerned with pilot project studies, obtaining the required national and international support, and preparing a plan of operations.

The eradication program begins with the Preparatory Phase in which the National Malaria Eradication Program is established, staffing and training are undertaken, base-line data are obtained in malarious areas by malarionometric and entomological surveys, and geographical reconnaissance—that is, mapping and census of operational areas—is completed. The Preparatory Phase may require one to two years.

There follows the Attack Phase for three to five years, with the main objective of interrupting malaria transmission, usually through spraying human habitation with DDT or other residual insecticides, once or twice per year. Technical assessment is continued in the early attack through malarionometric and entomological surveys. When the malaria reservoir is reduced to a prevalence rate of about one percent, a surveillance program is introduced for total coverage of the operational areas with case finding, treatment and investigation. Adequate surveillance requires blood examination of about one percent of the population per month, at least during the months of malaria transmission.

When an effective surveillance program through at least a full year has shown no malaria transmission, and malaria incidence is less than one case per 10,000 population per year, spraying can be withdrawn, and the program passes into two to three years of a Consolidation Phase. During this phase, the surveillance activities must be conducted with perfection for final elimination of the parasite reservoir. The general health services must also be fully prepared for maintenance of eradication.

After surveillance has demonstrated the absence of endemic malaria for three years, with at least the last two years having no general coverage with spraying or mass treatment, the special campaign may be concluded. The operational areas are then in the Maintenance Phase, with the responsibility passed over to the general health services to continue safeguards against introduction of malaria. This final move is usually planned so that the staff and facilities of the National Malaria Eradication

Program are absorbed, utilizing the experience and organization of the special campaign to build up the general health services.

#### ORGANIZATION OF A NATIONAL PROGRAM

A primary characteristic of malaria eradication is that it must be organized, under normal conditions in most countries, with a high level of autonomy in operations and a position of priority in government support. The special campaign must always be distinctly a program of the country, operated by its government on a clear legal basis, with the understanding and cooperation of its citizens. The National Malaria Eradication Program is usually organized within the Ministry of Health. To assist toward full utilization of country resources in the program, a Malaria Eradication Board is established of high officials of other ministries and with other prominent citizens to advise on policy development and implementation.

To be an effective part of the global effort toward malaria eradication, the country program must be planned in accordance with technical criteria and guide-lines established by the WHO Expert Committees on Malaria. Most countries are unable to carry out a program of the magnitude and perfection required for malaria eradication without assistance. The World Health Organization may assist with advisory services, training and research; the U. S. Agency for International Development with similar technical activities, plus equipment and supplies; and the United Nations Children's Fund with equipment and supplies. These assisting agencies all provide support only to those programs which follow the internationally accepted guide-lines. This is for the good reason that programs which have not observed the principles established by science and experience have invariably come to grief and have required expensive reorganization.

The National Directorate is usually organized with major Divisions for Administration, Operations, Epidemiology (including Entomology and Laboratory Services), and Training and Health Education. Large countries are usually divided into operational Zones, each with about 1,000,000 population, and the Zones are divided into several operational Sectors. The Zone Headquarters are generally organized with Sections corresponding to the major Divisions of the National Headquarters.

The Sector Headquarters are the operational units which actually reach the communities and homes with spraying of premises to stop malaria transmission and with surveillance to find and eliminate the remaining cases. Under the Sector Chief, there will be perhaps two Assistant Sector Chiefs—one responsible for about five Spraying Supervisors and the other for an equal number of Surveillance Supervisors. Each of the Supervisors will have a squad of about four Spraymen or Surveillance Workers.

Thus, in a Sector, there may be about 5 squads of 4 men each for spraying and surveillance, or 20 Spraymen and 20 Surveillance Workers. Spraying may proceed at about 10 houses per man-day or 200 houses per day in the Sector, or 25,000 houses in a spraying cycle of 5 months, with 25 working days per month. Surveillance house visits in the Sector can be accomplished at a minimum rate of 50 houses per man-day, allowing every house to be visited 12 times per year. The actual organizational requirements vary greatly according to local conditions.

Spraying and surveillance must accomplish in each

operational area a coverage which is total, adequate, regular and complete. This requires thorough geographic reconnaissance to locate every human dwelling and shelter, isolated or in communities, where people may be exposed to vectors of malaria or constitute a reservoir of the disease. Geographic reconnaissance is, therefore, like spraying and surveillance, a total coverage program. An extensive system of maps must be developed, delineating the malarious areas and showing details of habitations, communications and operational units. Each dwelling must be numbered and complete census information is required on number, sex and age of members of every household. An accurate picture of the nature and amount of sprayable surfaces must also be obtained. All such information must be available before the Attack Phase can begin and must be regularly updated as long as operations continue.

The logistics of malaria eradication are technically uncompromising in requiring that supplies arrive where and when needed in the field. An enormous quantity of insecticides is used in malaria eradication programs each year. The U. S. Agency for International Development buys between 40 and 60 million pounds of 75% water-dispersible DDT powder annually and the United Nations Children's Fund about half that amount. Provisions must be made for proper storage, as well as timely distribution.

Many thousands of vehicles are used in malaria eradication programs. The U. S. Agency for International Development has supplied over 6,000 vehicles, mostly of the jeep type, to the programs receiving commodity assistance by this Agency. The United Nations Children's Fund, the World Health Organization and the Pan American Health Organization have also supplied this type of equipment. Since malaria is largely a disease of under-developed areas, numerous places are difficult or impossible to reach by vehicle, even with four-wheel drive. It may be necessary to use any of a great variety of transport, from bicycle to bullock-cart, power-boat to dugout canoe, to ride horse or elephant, or to go on foot. But malaria eradication does not admit any malarious area to be inaccessible: where people live, the malaria worker can also go.

Obviously, though effective methods may be available for malaria eradication, none can work unless it can be applied in the field. An over-all requirement of critical importance in a program which operates essentially in every home in the malarious community is to develop public interest, understanding and cooperation. The best way to achieve this is to go to the people with a clear explanation of what the program aims to do, how it operates, what is required to make it successful, and the benefits which may be expected.

Malaria eradication programs utilize a great variety of health educational and public relations approaches, including posters, leaflets, mobile motion picture units, group meetings and individual contacts. Professional leadership in working with people is as important as in working against the malaria parasite and its vectors; however, it is axiomatic that every malaria worker must be thoroughly versed in making effective contacts with the public.

#### TECHNICAL TRAINING

To achieve the necessary high degree of perfection in operations, a malaria eradication program requires an extensive training program, including both basic and refresher courses at all staff levels. Most countries provide

standard courses centralized at the national and zone levels for the higher supervisory staff, who will then participate in organizing and conducting decentralized training for the local staff in the Sectors of the operational areas.

The development of informed and effective leadership for country programs is a requirement of major significance to the world-wide program. Both the World Health Organization and the Agency for International Development provide fellowships for training abroad in universities and other institutions and for observational tours of other country programs. These two agencies jointly sponsor an international Malaria Eradication Training Center at Manila, Philippines, and the World Health Organization also supports two similar institutions in Africa at Lagos, Nigeria, and Lomé, Togo.

In a number of countries, national institutions concentrating on malaria have opened their facilities to international participants. A notable example is the National Institute of Communicable Diseases, Delhi, India, which in recent years developed logically from the famed Malaria Institute of India of past years. In the United States, the Communicable Disease Center of the U. S. Public Health Service, with facilities at Atlanta and Savannah, Georgia, is especially active in orientation of health personnel in malaria eradication and conducting special courses in this field.

#### INTERNATIONAL COORDINATION

The world-wide malaria eradication program is made up of country programs, planned and conducted in accordance with internationally developed principles and criteria. The coordinating leadership in the international program was assigned in 1955 by the World Health Assembly to the World Health Organization. Other supporting agencies are also involved in implementation and coordination, especially the U. S. Public Health Service, the U. S. Agency for International Development, the United Nations Children's Fund and the Pan American Health Office (which serves as the WHO Regional Office for the Americas). Effective inter-country and inter-agency coordination are basically essential to achieve the objective of global malaria eradication.

Inter-agency coordination includes a meeting, at least once yearly, of headquarters representatives of the assisting agencies to discuss the status of eradication throughout the world, research needs and progress, and supporting resources and activities. Occasional inter-regional meetings are held, bringing together representatives from agencies and countries in the Americas and in associated areas of Africa, Europe and Asia. Such meetings are sponsored by the World Health Organization primarily for the benefit of national participants.

All agencies provide their support basically to the country plans of operations, and close communication between agencies and countries is *sine qua non* to attainment of their mutual objective. Inter-country coordination meetings, with national and international representation, are frequently held by countries along their common borders or to cover their mutual problems within subdivisions of one of the larger continental regions.

#### STATUS OF WORLD-WIDE MALARIA ERADICATION

The world-wide malaria eradication program has made great progress during the past five years. As of September 1965, the World Health Organization reported for 148 countries affected by malaria (Table 1) that 29

Table 1.—Status of Countries in World Malaria Eradication Program.<sup>a</sup> (As of September 30, 1965).

Region	No.	Countries		Malaria Eradication		
		With-out Ma-laria	With Ma-laria	All in Maint.	Ac-tive Pro-gram	Not yet Protected
American	47	12	35	11	24	0 ( 0) <sup>b</sup>
African	48	4	44	0	6	38 (15)
E. Medit.	24	1	23	3	8	12 ( 5)
European	40	21	19	11	6	2 ( 2)
S. E. Asia	9	1	8	0	7	1 ( 1)
W. Pacific	42	23	19	4	3	12 ( 6)
Total	210	62	148	29	54	65 (29)

<sup>a</sup> From World Health Organization data.

<sup>b</sup> (In parentheses) Countries with pre-eradication programs.

could claim eradication, 54 were engaged in active eradication campaigns, and 65 were not yet protected. However, 29 of the last group of countries were undertaking pre-eradication work, leaving 36, largely in Africa, still without an organized malaria eradication or pre-eradication program.

If the progress is considered in terms of population affected (Table 2), there were nearly 1.6 billion people in originally malarious areas (excluding mainland China, North Korea and North Vietnam which do not report to the World Health Organization). Advances of malaria eradication programs into consolidation and maintenance placed over 800 million of the population in areas where malaria transmission had been stopped or malaria eradicated. This is more than double the figure in 1960, so that the rate of progress seems highly encouraging. However, nearly one-quarter of the population, largely in Africa, still remains without an organized program, though the majority of that population lives in countries with pre-eradication work under way.

It is true that there have been severe reversals in some countries, due to administrative or technical difficulties or where unstable internal conditions have interrupted the planned antimalaria campaign. However, the overall view of the world program shows steady and massive advances in phasing from Attack to Consolidation to Maintenance of eradication, so that well over half of the world's population formerly in malarious areas is now living free of the dangers of malaria infection.

These results have been achieved only with large costs in funds and human effort. But the campaign is so enormous in scope and significance that the expenditures must seem relatively small when compared with the

Table 2.—Status of Population in World Malaria Eradication Program.<sup>a</sup> (As of September 30, 1965).

Region	Malar. Areas	Maint. Phase	Consol. Phase	Attack Phase	Prep. Phase	Not yet Protected
American	164.2	61.4	33.1	33.7	35.6	0.4 ( 0.4) <sup>b</sup>
African	195.0	3.2	2.7	0.5	0.0	188.6 (111.4)
E. Medit.	176.7	6.4	11.6	54.4	26.9	77.4 (31.3)
European	327.8	268.2	29.4	9.0	0.0	21.2 (21.2)
S. E. Asia	640.3	171.6	275.3	152.4	6.8	34.2 ( 0.1)
W. Pacific	82.4	18.3	4.3	4.7	0.0	55.1 (48.1)
Total	1,586.4	529.1	356.4	254.7	69.3	376.9 (212.1)

<sup>a</sup> From World Health Organization data. Population in millions.

<sup>b</sup> (In parentheses) Population in malarious areas of countries with pre-eradication programs.

benefits being obtained. In the eight fiscal years completed since the world-wide program began, the costs may be estimated as close to \$800 million, with the U. S. foreign assistance program contributing about \$200 million in foreign exchange and over \$160 million in local currency support jointly controlled with the assisted governments. The U. N. agencies also contributed over \$100 million in foreign exchange costs and the remainder—the largest single proportion—came from the assisted governments.

This is an enormous sum, but during this period originally malarious areas of over 800 million population were freed, or maintained free, of malaria transmission at a total average cost of less than 15¢ per capita per year.

There still remains nearly one-quarter of the people originally affected by malaria, mostly in Africa, who do not have an organized malaria eradication campaign for their protection. The present position in this regard might be stated generally as one which necessarily strives to avoid dilution of the available resources for malaria eradication, until this goal can be assured in the areas now in operation, and also to assist governments to develop their capacities to launch an eradication campaign. Pre-eradication studies have been stepped up, especially in Africa, and future plans must certainly meet the challenge of extending the global program to all malaria-stricken areas of this Earth.

#### LOOKING FORWARD

Looking back on the experience thus far, we may conclude that the available methods have proven effective and should continue to be so in most malarious areas. Looking ahead in the true spirit of the eradicationist, we must recognize that though the special problem areas are relatively limited in the over-all view, we must eventually deal with them effectively, if global eradication is to be achieved.

A great deal of research remains to be done toward development and improvement of insecticides, drugs, equipment and operational approaches. The World Health Organization has a large program of this nature, and numerous country and institutional programs overseas are making their contributions. In the United States, the Agency for International Development is budgeting nearly \$1,000,000 in fiscal year 1966 for malaria research. The U. S. Public Health Service is making extensive studies of insecticidal equipment and methods, through the Communicable Disease Center, and of chemotherapy, including problems of parasite resistance to drugs, through the National Institutes of Health.<sup>3</sup> The Defense Forces are conducting similar investigations, and the U. S. Department of Agriculture is providing much useful information on insecticides and mosquito control. Universities and other institutions have related research programs.

Thus, while the way to malaria eradication on a global basis is long and difficult, we may feel some confidence that progress is being made and the way ahead is becoming increasingly clear. To be sure, there will be obstacles ahead, but there should also be breakthroughs in improved methods. With continued support and intensive effort, man is showing the capacity and is gaining

<sup>3</sup> Since the presentation of this paper, the U. S. Public Health Service in an agreement with the Agency for International Development has assumed responsibility for administration of the A.I.D.-supported malaria eradication program.

the know-how to rid himself permanently of one of his oldest and worst diseases through the world-wide malaria eradication program.

#### REFERENCES CITED

- Brown, A. W. A.** 1958. Insecticide resistance in arthropods. World Health Organization Monograph Series, No. 38: 240 p.
- International Cooperation Administration Expert Panel on Malaria.** 1961. Report and recommendations on malaria: a summary. Amer. J. Trop. Med. Hyg. 10: 451-502.
- Pampana, Emilio.** 1963. A textbook of malaria eradication. Oxford University Press, London: 508 p.
- WHO Expert Committee on Insecticides.** 1963. Insecticide resistance and vector control. WHO Tech. Rept. Series, No. 265: 227 p.
- WHO Expert Committee on Malaria.** 1957. Sixth Report. WHO Tech. Rept. Series, No. 123: 84 p.
1959. Seventh report. Ibid., No. 162: 51 p.
1961. Eighth report. Ibid., No. 205: 50 p.
1962. Ninth report. Ibid., No. 243: 43 p.
1964. Tenth report. Ibid., No. 272: 52 p.
1964. Eleventh report. Ibid., No. 291: 46 p.
- WHO Scientific Group.** 1965. Resistance of malaria parasites to drugs. WHO Tech. Rept. Series, No. 296: 65 p.

---

*Reprinted from the*  
BULLETIN OF THE ENTOMOLOGICAL SOCIETY OF AMERICA  
Volume 12, Number 2, pp. 130-136, June 1966