PROGRESS TOWARD MALARIA ERADICATION IN ASIA [1]

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For centuries, malaria has been the leading cause of death and the principal retardant of economic development and social well-being throughout Asia. The tremendous toll in the form of human suffering on the India subcontinent alone is well-known. In 1936, Sinton estimated there were at least 100 million cases annually in India. He stated that as a result of malaria, millions of land acres were uncultivated or imperfectly cultivated, the natural wealth of India could not be fully exploited, and the progress of most industries was seriously hampered. In Indonesia it was estimated by Soeparmo and Stoker that 30 million persons were exposed annually in that country prior to the initiation of control measures, and many villages and fields were abandoned by the population because of sickness. Numerous additional examples can be cited for these and other countries of Asia.

World War II brought with it modern malaria control measures in areas of military operation. DDT was introduced into Asia, thereby providing a tool to eliminate tremendous suffering. In 1946, Ceylon became the first country of Asia to start a nationwide program of malaria control utilizing DDT residual spraying (Russell, 1952).

In 1947, the World Health Organization (WHO) was organized, and malaria was selected as one of its principal targets. The Marshall Plan and the Point-Four Program of President Truman made possible the financing of malaria control operations in many countries of the world. Encouraged by the elimination of malaria in the United States, Italy, Cyprus, and elsewhere, a vigorous anti-malaria program was continued by the WHO.

The U. S. Government, through its foreign aid program, supported the malaria control program overseas. Malaria control campaigns in Asia initiated with U. S. Government assistance included programs in the early 1950's in the Philippines, Indonesia, China (Taiwan), the then-Indochina area (now Vietnam, Cambodia, Laos), Thailand, Pakistan, Ceylon, India, Nepal, Iran, Iraq, and Jordan (Johnson, 1964). DDT treatment of the houses

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quickly lowered the malaria incidence in these and other countries of Asia.

In 1958, many of these programs of control were changed to programs of eradication. The U. S. Congress had made funds available to the International Cooperation Administration, now named the Agency for International Development (AID), for the technical assistance, training, research, and the purchase of commodities such as insecticides, sprayers, vehicles, drugs, and laboratory supplies. WHO and United Nations Children's Fund (UNICEF) also assisted in many of these countries, as well as in other malaria programs throughout the Asian area.

Anti-malaria activities also may have been carried out in mainland China, North Vietnam, and North Korea, but according to the WHO, no information is available regarding such activities in these areas of the Asiatic mainland. Those portions of the Union of Soviet Socialist Republics that are east of the Ural Mountains, although geographically in Asia, are included in the European Region of WHO. Malaria apparently has been eradicated from *all* of the USSR, but separate figures for the Asian portion are not available for inclusion in this report. The Sinai peninsula of the United Arab Republic (Egypt), also in Asia, is not included here because most of the country is in Africa.

The progress in Asia through 1965 toward attaining malaria eradication is dramatic. Of the 879 million persons living in the malarious areas of Asia, 196 million (22.3 percent) already are in the maintenance phase and another 314 million (35.7 percent) are in the consolidation phase (Table 1). This means that 58 percent of the population is almost free of the threat of malaria. In addition, one-fourth of the people, or 221 million, are being protected by DDT residual house spraying and other attack phase measures, and about 34 million (3.9 percent) are in the preparatory phase. However, 115 million (13.1 percent) still have no eradication program started. Substantial populations in Indonesia, Korea, Malaysia, Pakistan, and Vietnam remain exposed to severe threat from malaria. Countries or territories of Asia that had not started the eradication program by mid-1965, according to WHO, include Aden, Bahrain, Brunei, Cambodia, Korea, Laos, Macau, Malaya, Maldive Islands, Muscat and Oman, Portugese Timor, Qatar, Saudi Arabia, Trucial Oman, Vietnam and Yemen.

On the other hand, great achievements have been attained in certain countries of Asia, including some which previously had serious malaria problems—such as Ceylon, China (Taiwan), India, Israel and Lebanon.

Two countries of Asia—India and Jordan—illustrate the methodology, organization, progress, and problems of Asiatic programs today. India's program is the largest, and Jordan's program is one of the smallest of these eradication programs.

India, with a population above 475 million persons, most of whom are at risk from malaria, has been engaged in malaria control work since early in the 20th century. In 1897–98, when Sir Ronald Ross in India discovered that malaria is transmitted by mosquitoes, he set the stage for malaria control through elimination of the anopheline vector. Since that memorable event, India has been a world leader in the field of anti-malaria activities.

In 1953, India undertook a wide-scale malaria CONTROL program with U. S. and WHO assistance (Johnson, 1965). During the years from 1953 through 1957, when the program was in its preparatory phase, nearly 200 million persons were given some protection against malaria through DDT residual house-spraying operations. Starting in 1958, India's program became one of malaria ERADICATION. Toward this goal, the country had been divided into "units," with origi-393.25, with 1.2 million people per unit. The number of these units now totals 393.25, with 1.2 million people per unit.

The program in India at present is organized into three distinct phases, or types of operation, based on criteria established by the WHO Expert Committee on Malaria, Sixth Report (World Health Organization, 1957); namely, the attack phase

TABLE 1.—Status of Malaria Eradication in Asia [a]

Country or Territory	Population in Thousands						
	Total	Original Malarious Area	Maintenance Phase (Claimed)	Consolidation Phase	Attack Phase	Preparatory Phase	Program Not Yet Started
Aden & Protectorate of South Arabia	1,243	1,243	243	...	...	...	1,000
Afghanistan	16,217	6,201	...	1,033	5,168	...	...
Bahrain	170	170	...	...	...	...	170
Brunei	110	43	...	...	...	...	43[b]
Burma	24,746	20,215	...	9,660	10,555	...	...
Cambodia	6,080	2,650	...	...	...	...	2,650[b]
Ceylon	11,282	7,348	1,569	5,679	100	...	...
China (Mainland)	765,570[c]	...	...	...	...	...	...
China (Taiwan)	12,666	12,666	12,666	...	...	...	...
Cyprus	592	592	592	...	...	...	...
Gaza	411	411	411	...	...	...	...
Hong Kong	3,967	3,967	3,190	...	...	...	777
India (includes Bhutan)	481,000	466,000	170,000[d]	203,000	93,000	...	...
Indonesia	104,444	104,444	...	52,000	17,000	1,300	34,144[e]
Iran	23,405	16,544	...	7,901	3,986	4,657	...
Iraq	7,144	4,500	...	...	4,500	...	...
Israel	2,593	2,593	2,485	108	...	...	...
Japan	97,853	...	...	...	...	...	...
Jordan	1,937	1,062	552	210	300	...	...
Korea, Republic of	28,642	23,642	...	...	...	...	23,642[b]
Kuwait	462	...	...	...	...	...	...
Laos	2,635	2,635	...	...	...	...	2,635
Lebanon	2,200	744	480	264	...	...	...
Macau	171	164	...	...	...	...	164
Malaysia:							
Malaya	8,173	8,173	...	...	...	...	8,173[b]
Sabah	549	470	...	44	426	...	...
Sarawak	842	711	257	262	192	...	...
Maldive Islands	97	97	...	...	...	...	97[b]
Mongolia	1,092	...	...	...	...	...	...
Muscat & Oman	574	574	...	...	...	...	574
Nepal	9,839	5,141	...	...	4,236	905	...
North Korea	11,306[c]	...	...	...	...	...	...
North Vietnam	19,176[c]	...	...	...	...	...	...
Pakistan	103,418	92,400	...	2,337	45,863	22,278	21,922
Philippines	32,345	8,748	...	4,005	4,045	...	698
Portuguese Timor	548	438	...	...	...	...	438
Qatar	60	52	...	...	...	...	52
Ryukyu Islands	968	268	268	...	...	...	...
Saudi Arabia	6,600	2,436	...	...	...	...	2,436[b]
Singapore	1,914	1,914	1,914	...	...	...	...
Syria	5,716	2,015	1,546	469	...	...	...
Thailand	30,820	30,820	...	3,900	22,315	4,605	...
Trucial Oman	111	111	...	...	...	...	111
Turkey	31,740	31,740	...	22,761	8,979	...	...
Vietnam	16,104	13,507	...	...	...	...	13,507[b]
Yemen	5,000	2,000	...	...	...	...	2,000[b]
Total	1,882,532	879,449 100%	196,173 22.3%	313,633 35.7%	220,665 25.0%	33,745 3.9%	115,233 13.1%

[a] Prepared from WHO, EB37/10, 26 Nov. 1965.
[b] Pre-eradication program started.
[c] No other information available.
[d] Satisfies epidemiological criteria for entry into maintenance phase.
[e] Includes a pre-eradication program in province of West Iran.

of 3 to 5 years, the consolidation phase of 2 to 3 years, and the maintenance phase which continues indefinitely.

During the attack phase, all houses in malarious areas are treated two to four times annually. At time of treatment, the inside surfaces of the houses are sprayed with approximately one gram of DDT per square meter of surface. In most of India, this proved highly successful and malaria rates fell rapidly.

During the third year of the attack phase, surveillance activities normally are introduced into the Indian program. During this time, house workers visit each house every two weeks to determine whether any persons have been ill since the last visit of a house worker. Blood slides are taken, drugs are administered to suspect cases, and radical treatment is given to all who prove to be positive upon examination of the slides. At the peak of the surveillance activities, approximately 50 thousand surveillance workers were used in making the fortnightly visits to every house in the malarious areas of the country. Repeated evaluations and observations of the program by many WHO and AID consultants, from 1960 to the present time, confirm the claim that these house visits are being made religiously, even in some of the most remote parts of the country.

When malaria rates reach a low of not more than 100 cases per million per annum for any particular area, and when certain other criteria are met, the program is eligible for passage to the consolidation phase. Transmission must be almost completely interrupted, and the annual blood examination rate shall be at least 5 or 6 percent of the population, depending upon the previous endemicity of the area. Spraying no longer is carried out on a routine basis, but is done only in the case of small focal outbreaks, which may occur.

During the permanent maintenance phase, the program is taken over by the local health services. These health services, of course, must be adequate to prevent reintroduction of malaria into the areas freed of the disease.

It appears at the moment, based on the 1966 Annual Independent Appraisal of the India program (Johnson, 1966), that approximately the following numbers [2] of people are in each of the three program phases in India:

Attack phase	67 million	(55.85 units)
Consolidation phase	161 million	(133.84 units)
Maintenance phase	244 million	(203.56 units)
Total	472 million	(393.25 units)

The India program, as might be expected, has many difficult problems still facing it. To a great extent, the areas most responsive to routine malaria eradication techniques have progressed to the consolidation and the maintenance phases, while the areas still in the attack phase, with a population of 67 million—less than 15 percent of the population once at risk from malaria—are the areas that present the most serious obstacles to eradication. For example, in Maharashtra and Mysore States, where the vector *Anopheles fluviatilis* is present, resistance to DDT has been encountered. In some villages and towns, *A. stephensi* is resistant to both DDT and BHC and larvicidal measures are necessary for control. This problem is further compounded by the fact that the aquatic stages of *A. stephensi* are often found in the wells of drinking water. Lead-free aviation gasoline is used as a larvicide in the wells, where it kills the larvae and pupae, but quickly volatilizes and apparently leaves no appreciable residue. In Madras State, and elsewhere in India, top-feeding minnows, *Gambusia* spp., are being tested for the elimination of *A. stephensi* from wells.

Another problem involves bedbugs that have become resistant to DDT. Local inhabitants claim that DDT increases the number of bedbugs present in their houses. In some cases the people have become quite antagonistic to the spraying activi-

[2] These figures vary slightly from WHO figures given in Table 1, because of the unit system utilized in calculations.

ties. They have been known to lock their houses against the spraymen and sometimes have threatened their lives and actually attacked them. In such places other insecticides or methods must be used. Diazinon has been used when possible to destroy the resistant bedbugs, in order to get the householders to permit spraying for malaria eradication. Of course, this adds to the expense of the program. In certain areas of India the people raise silkworms in their houses. In these instances, no insecticides are used and reliance is placed on intensified surveillance measures and the use of anti-malarial drugs.

One other difficult problem in India, which is encountered in many areas still having malaria eradication activities, is that of complacency of the public and of government officials. In the sprayed areas, even though transmission is not always completely eliminated, malaria case rates are brought down to a very low point, which removes the immediate reason for continuing the program. However, unless the program is continued until malaria disappears, there is a real danger that premature withdrawal of the spraying will result in a rapid recrudescence of malaria in the absence of insecticidal protection.

Many other health problems in addition to malaria face the Indian population. There is a great deal of work to be done in the field of family planning, a program already undertaken by the Indian Government. The very limited health budget of the Government of India is being used not only to eradicate malaria but also to provide family planning services, alleviate malnutrition, eliminate plague, smallpox and cholera, control tuberculosis and leprosy, and to provide many of the other services required by the people.

Needless to say, the demands on the available funds are tremendous. There is a constant danger that financial resources required for elimination of the last cases of malaria may be diverted to other programs before malaria eradication is finally attained in all areas in India. Relaxation of the program almost certainly will result in serious epidemics in a population that has been protected from malaria for more than a decade. In Jordan, discussed subsequently, premature withdrawal of the attack and surveillance measures resulted in a rapid buildup of malaria cases.

Jordan is a small country that has had a serious malaria problem in the past. In the fertile Jordan River Valley, which has long been a well-known malarious area, *A. sacharovi, A. sergenti,* and *A. superpictus* are the vectors. When the program was undertaken in the early 1950's, *A. sacharovi* disappeared quickly following DDT treatment of the houses. However, *A. superpictus* and *A. sergenti* frequently did not respond favorably to the DDT residual treatment, even though they were susceptible to DDT. Apparently, these two species did their resting in caves and other outdoor places to such an extent that the normal house-spraying activities had little or no effect on their populations. Also, the people frequently sleep out-of-doors, and the mosquitoes do not have to enter houses for a blood meal. For these reasons, it was considered necessary to undertake an anti-larval program, which is considerably more costly than house-spraying with DDT. The population involved was not large; somewhat over one million people were living in the malarious areas of Jordan.

The so-called West Bank of the Jordan River along the Israel border responded well to the anti-malarial measures, and malaria disappeared from that area. However, the Jordan Valley and the East Bank (consisting of the highland areas from the Syrian border on the north as far south as the Kerak area east of the Dead Sea) had continued to be malarious. In these areas the malaria problem was attacked with house spraying where it proved to be effective, but major reliance was placed on ditching and on weekly larviciding with DDT in fuel oil or kerosene during the breeding season.

From 1959 to 1963, malaria case rates declined somewhat; and in 1963, because the program suffered some of the usual problems, including a lack of funds, it

was decided to withdraw most of the anti-mosquito measures and to rely principally on case finding; that is, utilization of surveillance measures and case treatment similar to the programs employed in India and elsewhere.

In 1963, 225 cases of malaria were detected in some 220 thousand blood smears taken. In 1964, however, in the absence of insecticidal spray application, malaria cases began to show up throughout the Jordan Valley and the East Bank areas, and surveillance workers could not keep up with the rapid rise in malaria cases. During 1964, some 255 thousand blood smears were examined and 644 cases of malaria were detected, which was an increase to approximately three times the rate in 1963.

Officials of the Government of Jordan, WHO, and AID, alarmed by this situation, decided that the program should re-enter the attack phase with a combination of DDT house spraying of *all* dwellings in the Jordan Valley and the East Bank areas, along with larviciding and ditching in areas normally not believed to be entirely responsive to house-spraying activities. As a result, malaria case rates dropped significantly during 1965. Of more than 180 thousand blood smears taken, 239 positive cases were found.

Presently, the program is continuing in the attack phase even more intensively than during 1965, and it is anticipated that significant decreases in malaria will be attained during the current operational season. Case-finding activities will be intensified, more entomological studies will be made, and administrative methods improved. Continued cooperation between the Government of Jordan, WHO, and AID should be able to reduce malaria to a point where maintenance can be considered within several years.

One of the problems facing the Jordan program, and not unusual to other Asiatic countries, is the threat of malaria from neighboring countries. Saudi Arabia still has active transmission, and individuals returning to Jordan from Saudi Arabia, where they are frequently employed as schoolteachers, account for most of the imported cases in Jordan. To the north of Jordan is Syria, which passed to the maintenance phase in 1962, but apparently did not continue adequate surveillance activities. During the 1965 season, several malaria outbreaks were experienced in Syria, and more than 900 cases were detected, according to the World Health Organization. Syria, no longer receiving assistance from UNICEF, is faced with the problem of obtaining DDT quickly for the current spraying season. Unless the Syrian problem is brought under control, malaria may spread across the border to Jordan to areas already cleared of the malaria parasite, but where anopheline vectors are still present.

Until malaria is eliminated simultaneously from all countries of Asia and other continents as well, there are bound to be similar episodes. The presence of malaria in any one country gives neighboring countries an excuse for not doing an adequate job with their own program. Psychologically, it is important, therefore, that all malaria problems be attacked simultaneously and eliminated as rapidly as possible.

Pakistan, which delayed its entry into the malaria eradication campaign, had a major malaria problem, with some 92 million persons living both in East and West Pakistan requiring a complete program. About four years ago, Pakistan, with help both from AID and WHO, embarked upon a carefully planned malaria eradication program. At the present time, two million are in the consolidation phase and the attack phase covers more than 45 million persons. In addition, in 1965, 22 million were living in areas in the preparatory phase and nearly 22 million more still were not included in the program, although initiation of the attack phase is planned for these areas.

One of the most successful programs in Asia is found in China (Taiwan). At one time the entire 12.6 million population of Taiwan was exposed to malaria. Now the disease has been eradicated from that country in a program so thorough that it may be looked upon as a model. China,

of course, had certain advantages, such as the insular nature of the country, a well-disciplined population, a good administrative structure, and an excellent staff of personnel well-versed in malaria eradication techniques. Adequate funds were available to do the job, and the government gave full support to the program through its completion. Finally, a good permanent health service is available to prevent reintroduction of malaria into the country.

The program in Ceylon, another insular country, made excellent progress but has had a recent setback. The entire country was in the consolidation phase when, in 1964, an outbreak of 300 cases occurred, and an area of some 100 thousand persons had to reenter the attack phase and be resprayed. Approximately 10 years earlier, the relaxation of malaria control measures in Ceylon had resulted in a serious epidemic. The government, alarmed at the malaria outbreaks at that time, had entered into a vigorous anti-malaria program, eventually resulting in the current eradication campaign.

Eradication of malaria, although attainable with presently used methods in most of Asia, requires an even greater effort on the part of all governments and international agencies. A well-planned, carefully administered campaign including the necessary entomological, parasitological and medical aspects must be maintained. Anti-malaria measures, supplemented by good epidemiological investigations of residual cases, must be intensified and continued until the disease is eradicated.

Achievements in China (Taiwan), India, portions of Ceylon, and elsewhere on the continent have demonstrated the feasibility of eradication as a goal. However, as long as malaria remains anywhere on the continent, any country that has eliminated the disease will have to support a continuous and costly program as a defense against its reintroduction.

The alternative to eradication of malaria would be reversion to epidemics, chronic malaria, economic setbacks, and generally depressed conditions in areas where the people now know that malaria *can* be eradicated. Experience has shown that the affected populations in such areas will exert strong political pressures in favor of eradication. Thus, with domestic interest and a concerted effort on the part of the still-malarious countries, and the cooperation and assistance of international agencies and friendly governments, eradication of malaria from all of Asia is sure to be the ultimate result.

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