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THE WORLD CAMPAIGN AGAINST MALARIA

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From the outset, the World Health Organization was aware of its immense responsibilities and opportunities in regard to malaria control throughout the world. Every member of the Executive Board and every delegate to the World Health Assembly knew that malaria was responsible for more illness and poverty throughout the world than any other disease. They knew that this disease is by far the most important contributory cause of the backward economic state of so many tropical and semi-tropical countries. If southern Asia, Africa and South America could be rid of this disease, international collaboration in health would be justified forever afterward. Malaria control was therefore given top priority at the first World Health Assembly and eradication of this disease set as an ultimate goal.

Excellent work had been done by the League of Nations Malaria Committee, and the new expert committee of the World Health Organization follows in its steps. Three reports now have been published which give valuable advice regard-

ing the central points in malaria control. The World Health Organization is still young and its malaria work has just come to a state of rapid evolution. Only three years ago the permanent organization was set up in Geneva and it took awhile to get teams into the field. At present the WHO is conducting malaria control demonstrations in India, Pakistan, Thailand, Afghanistan and Iran. It has also protected the Arab-Palestine refugee settlements against malaria which would otherwise have caused havoc among the 800,000 inmates of these camps. In each of these demonstrations, the teams are being trained in residual spraying of houses and other anti-malaria work. It is expected that after two years' demonstration the host country will be able to take over and expand the work farther.

The WHO has also furnished malaria consultants to many countries, granted fellowships and given advice to educational institutions. It has sponsored the important African Malaria Conference held in 1950 at Kampala in Uganda, which may prove to have been one of the landmarks on the road toward the economic development of that continent. A closer collaboration in the field of malaria control has been established between the WHO, FAO and UNICEF. It is realized that irrigation works and other agricultural plans in tropical countries are doomed to failure unless accompanied step by step by malaria control. WHO has

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now a mosquito experimental station near Chiangmai in northern Thailand, in an area where FAO is active.

One should never lose sight of the fact that nearly all malarious countries are poor. Larval control was, therefore, too expensive to be employed other than in small areas of potential wealth or else in marginal lands of malaria's vast domain where a little money was available. With the discovery, toward the end of the recent war, of malaria control by residual spraying of all houses with DDT and other new potent insecticides, this situation was changed over night. Malaria could now be reduced to the vanishing point almost anywhere at a cost of from 20 to 50 U. S. cents per capita a year. This is less than the afflicted countries actually spent on the quinine and other curative remedies.

The amazing and encouraging effect was that the impetus given by WHO to malaria control by residual spraying was so powerful that the programs rapidly outstripped the resources of WHO. In 1949 alone not less than 49 million persons living in endemic areas were protected against malaria by residual spraying programs. Out of this total, only 1,562,600 persons were protected directly by campaigns undertaken by international organizations, which shows that although the World Health Organization has furnished leadership in the great action against malaria, many countries have not waited for outside help before going ahead. Ceylon, Cyprus, Madagascar, Mauritius, the Union of South Africa, British Guiana, Venezuela, Brazil, Argentina and the United States are examples of countries which have already carried out eminently successful programs without other stimulus than the knowledge of the opportunity. This is perhaps the most encouraging aspect of the new all-out offensive against malaria—an aspect of which little has been said or written.

Let us pass briefly in review some of the successful but less well known programs.

South Africa

Malaria is found in the Transvaal over an area of 58,000 sq. miles with 1,350,000 inhabitants between latitudes 22° and 26° South. Endemic areas cover 20,000 sq. miles of which one-half, situated between 500 and 2,500 ft. altitude are heavily endemic. Epidemic malaria is found up to 4,500 ft. The carriers are *Anopheles gambiae* and *A. funestus*.

During the five years up to 1944 the malaria situation had become so bad that farmers were beginning to sell out and leave. As much as 70 per cent of the labor force was down with malaria during the most critical harvest period, and crops were lost. Growing out of a meeting of 17 farmers at the village of Nutfield a demand was made by the Organized Farmers' Union that the Government take immediate action. An appropriation of £33,000 was made for this purpose, but the farmers did not await the official assistance. They put up money, got the help of a local health inspector, and divided themselves into groups of six farms with one farmer responsible for engaging the necessary personnel to oil all the waters on their farms. DDT was introduced in 1945-46 with excellent results. House sprayings are made twice, and in places three times a year. Spraying with 5 per cent DDT in kerosene is used in European houses and 50 per cent DDT wettable powder diluted to 5 per cent in native dwellings; 27.1/2 per cent DDT emulsion diluted to 1 in 300 is applied fortnightly in summer to all breeding places of *A. gambiae* and monthly in winter to all the proven winter-breeding places.

About 42,000 sq. miles have now been cleared of malaria. Parasite rates dropped from 62 per cent to 12 per cent in the age group under 2 years. Post office receipts doubled and the commercial bank turnover nearly quadrupled in a typical previously malarious area. School absenteeism almost disappeared.

Says the Chairman of the Tuinplaats

Anti-malaria Control Committee:

"Developments were coming to a standstill and farmers were finding it difficult to work their existing lands to full capacity through labor shortage. The seasons when rain was plentiful and harvests good, malaria was at its peak and consequently heavy losses occurred. After only five years the prices of these same farms rose from £5 or £6 to £22 per morgen. I consider that the rapid rise is due to the fact that no malaria exists. Farmers have extended their fields considerably and production has jumped up by over 400 per cent and is still on the increase.

"One has only to attend one of the many local functions to see the number of young and very healthy looking children to convince oneself that from being an unhealthy malaria area, we can claim to be one of the healthiest communities in the Union."

Incidentally, in Southern Rhodesia the personnel carrying out malaria control by residual house spraying from October to April devote their time to schistosomiasis control during the dry period from May to September. River banks are then sprayed with copper sulphate to kill the snail carrier while the water is low. The first house spraying is with DDT, the second, three months later, with BHC.

Mauritius

For years and years malaria has been the plague of Mauritius. Except for a small area in the center of the island, too high for malaria, the average spleen rates ranged from 56 to 71 and the parasite rates from 32 to 50 per cent. Plans were made in 1948 for a complete house spraying program modeled on the British Guiana campaign.

The campaign began in January 1949 after a thorough survey had been made. By June the same year *Anopheles funestus*, the principal vector, was reported eradicated except in two small strips along the coast. In addition, *Aedes aegypti* had been virtually eliminated. *Anopheles gambiae*

were still present in large numbers, but somehow this dangerous mosquito is of less importance in Mauritius.

The result was that the general death rate, which had ranged from 25 to 30 fell to 16.6 per 1,000 population in 1949. The average spleen rate of children fell to 15.3 per cent and the parasite rate to 2.4 per cent after the first spraying.

Madagascar

A large-scale residual house spraying campaign was started in September 1949. About one million persons have already been reached—one-fourth of them even with two sprayings. An emulsion concentrate containing 5 per cent DDT, 5 per cent BHC and 10 per cent Octachlor was used as well as 50 per cent water wettable DDT. Treatment of swampy areas by helicopter is being considered.

Ceylon

In Asia, Ceylon took the lead in malaria control. A field trial of residual DDT spraying was made in 1945, and the whole malarial part of the island was included in the campaign by the end of 1946.

Malaria was most prevalent in the "dry" part of the island (rainfall 25-75 inches) which should be the most valuable for agriculture, and spleen rates ranged up to 77 per cent. According to Mr. Bandaranaike, the Minister of Health, nearly two-thirds of the land was practically uncultivated owing to malaria. In 1940, 3,413,600 malaria cases were reported, which gives 574 cases per 1,000 inhabitants. One epidemic alone caused 80,000 deaths in 1934-35.

There is only one vector of importance—*Anopheles culicifacies*, which simplifies the problem somewhat. DDT in kerosene solution was used at the outset, but was soon replaced by wettable powder as more suitable for the local dwellings. The campaign is notable for frequency of the applications. The operations are repeated every six, eight or ten weeks. In 1949, the population thus protected numbered 4,500,000, and the cost per head was 22

U. S. cents a year. The whole cost of the three-years' campaign 1947-49 has been \$1,840,000.

Up to and including 1946 the general death rate was from 20 to 22 per 1,000 in good years and over 30 in epidemic years. It fell to 14.3 in 1947, 13.2 in 1948 and 12.6 in 1949, which is a record for a tropical country. It should be mentioned that Ceylon has an unusually competent and complete health administration, but it was evidently mainly the malaria campaign which brought about this result. The spleen rate for the whole island was reduced to 2.7 by March 1949. The disease is not eradicated, but true malaria was confirmed by microscopical examination in only 7 per cent of the clinically diagnosed cases. Large tracts of land are now available for intensive cultivation, and increased agricultural production should not only correct the unfavorable trade balance but also alleviate the population pressure for some time to come.

India

In India, where malaria is probably the greatest single cause of poverty, and certainly of sickness and mortality, modern malaria control by residual spraying has so far been undertaken only in a part of Bombay State and at Delhi.

In the Kanara District of western Bombay *Anopheles fluviatilis* is the sole vector. A vector with a very high sporozoite rate, this mosquito has also a very high anthropophilic index. Dwellings alone are therefore sprayed. In the Dharwar District of eastern Bombay *A. culicifacies* is also a vector. This mosquito being zoophilic, cattle sheds are also sprayed. An emulsion of DDT with Aromex and soap is used. As only the DDT has to be procured abroad the cost of spraying is kept down to 13 U. S. cents a year. The campaign began in July 1946.

The results obtained should certainly encourage India to embark on large-scale projects. From 70 per cent before the application of DDT the spleen rate in the Kanara District fell to 7 per cent in March

1949 while the parasite rate was reduced from 20 per cent to 2 per cent. In the Dharwar District, where pre-DDT rates are not available, the spleen rate fell to 8 per cent and the parasite rate to 1 per cent. The operation resulted also in the elimination of human plague, as DDT is effective against the rat-flea carrier.

It is intended gradually to extend the campaign to the whole malarious area of the State which would result in the prevention of 5 million cases now causing a yearly loss of some 960 million rupees. The cost of the campaign would not exceed 15 million rupees a year.

Pakistan

In East Bengal a World Health Organization demonstration team covered 193 sq. miles of a moderately malarious region by house spraying in 1950. A 15 per cent larger yield of the rice crop was reported in the DDT sprayed areas than in non-sprayed control areas in the same district. This increase of yield must be attributed to the greater efficiency with which malaria-free workers have been able to till their fields. The man hours of labor required to perform the field tasks were lowered 10 per cent by the spraying, and no working hours were lost on account of malaria.

Iran

Following a survey by Justin Andrews of the U.S.P.H.S. spraying operations have begun in selected areas of Iran. About 800,000 persons were protected in 1950.

Greece

Malaria in Greece was tackled by UNRRA in 1946. Operations were subsequently carried on by the Greek government assisted by Economic Cooperation Administration and the Public Health Service. Residual spraying of dwellings and cattle sheds is supplemented by aerial spraying of extensive breeding places and some ground larval control where indicated. The principal carriers are *Anopheles sacharovi* and *A. superpictus*. Five of the

seven million people of Greece lived in highly malarious areas. The disease is now practically eliminated, and the parasite rate for infants is zero. At the same time, the widespread papataci fever, carried by sandflies, disappeared, for DDT is as effective against sandflies as it is against mosquitoes and fleas.

It is worth noting that the cost of operations in Greece equals approximately the savings in importation of anti-malarial drugs. The immense savings to the Greek economy effected by disease prevention is therefore really free of cost.

Other Mediterranean Areas

Species eradication, though costly, is particularly tempting in islands. The classical campaigns in Cyprus and Sardinia, which have cleared these two highly malarious islands from the disease, are so well known that I shall not attempt to go into details.

In Cyprus residual spraying of houses has been combined with thorough larval control. *Anopheles superpictus* was the principal vector. A pilot project was carried out in 1946 on the Karpas Peninsula. During the next two years first one-half and next the other half of the island was treated. In January 1950 the Cyprus Government officially announced that malaria had been wholly banished from the island. The total cost of the eradication campaign was £220,000, toward which the United Kingdom made a grant under the Colonial Development and Welfare Act. The population of the island is about 500,000.

In Sardinia the transmitter was *Anopheles labranchiae*. The eradication campaign, begun experimentally in November 1946, was by 1949 based on alternating house spraying and larviciding. It was found necessary to extend the spraying to mine vaults, churches and natural grottos in order to destroy wintering female *labranchiae*. The staff, led by only a dozen technicians under Rockefeller direction, reached at one time the size of 33,000. The total cost has been about 12 million dollars provided by UNRRA lire and

dollar funds supplemented by ECA and Rockefeller grants. "The impact of these innovations on the population has been dramatic," says the Rockefeller Foundation Annual Report for 1949. "In time they will no doubt alter the balance of the whole island economy, for new possibilities in the development of Sardinia have been opened up. The island, formerly an economic liability, is emerging as Italy's new frontier. Sardinia is now a healthy place to live and work."

Italy is actively pursuing a campaign of residual spraying of dwellings and cattle sheds which has replaced the costly larviciding programs on the continent. In 1949, there was not a single death from malaria in Italy. The general death rate has reached a low never previously encountered in a Mediterranean country.

British Guiana

As Ceylon in the Eastern Hemisphere, so British Guiana furnishes the most striking example in the Western Hemisphere of successful malaria control by residual spraying. After experimental work in 1945 and 1946 the campaign went into full swing in 1947. "DDT has been used exclusively as a residual spray applied to the interior of houses; hydrological conditions have been ignored and remain to this day what they have always been in the past," according to the summary of Dr. George Giglioli's official report "Malaria, Filariasis and Yellow Fever in British Guiana" published in 1948 by the Mosquito Control Service of the Medical Department of British Guiana.

The malaria vector, *Anopheles darlingi*, as well as *Aedes aegypti* have been eradicated from the treated areas. *Culex quinquefasciatus*, transmitter of *Wuchereria bancrofti*, has proved more resistant, but there has been a reduction of some 80 per cent in their numbers. The whole of the populated coastal belt as well as the mining concerns and other settlements in the interior are under DDT residual protection. In two of the suburbs of Georgetown parasite rates have gone down from

55 per cent to nil, and the spleen rates from 44 per cent to 1.5 per cent. Similar reductions are recorded on the estates. Spraying is made at intervals of eight months and is made compulsory by law. Complaints have been negligible and authenticated claims for damages have amounted to only \$15 in three years.

It must be emphasized that should the protective measures ever be suspended, mosquito infiltration will take place from the hinterland and malaria epidemics may follow.

Latin America

Malaria control, largely by residual house spraying, has spread rapidly in Latin America and in many countries developed into important national programs. The WHO in its survey of DDT protected populations in formerly malarious areas gives 1,500,000 in Argentina, 20,000,000 in Brazil, 375,000 in Mexico, 385,000 in Peru, and 863,000 in Venezuela. Malaria was eradicated from Chile by larval control in 1945.

In Argentina, 2,785 cases of malaria, of which only 134 were new infections, were reported during the first half of 1949 as against about 300,000 cases formerly customary during that part of the year.

Brazil began a vast program of malaria control by DDT in March 1947. An emulsion is the medium most often employed in spraying. In 1947, 200,000 houses were treated. The number grew rapidly to 1 million in 1948, to 2,206,000 in 1949, and to over 3 million in 1950. 3,000 tons of DDT are needed annually at the present scale of operations. The most formidable carrier is *Anopheles darlingi*, but *A. tarsimaculatus* and *A. albitarsis* are also vectors. In the southern part of the country two species of *Kerteszia* not having the decided domestic habits of the *darlingi* are of some importance. It seems, however, that house spraying somewhat interrupts also their transmission. In most DDT controlled areas parasite rates now approach nil.

In Peru, the National Social Security

Fund, the National Agrarian Society and industrial employers collaborate in and contribute to the malaria control program. A kerosene solution of DDT is employed, and the program is so far limited chiefly to the coastal valleys. The principal vector is *Anopheles pseudopunctipennis*, and the season of transmission is short. Parasite rates now range from 0.6 per cent to nil where formerly they were running from 5 to 25 per cent. *Falciparum* infections had completely disappeared after three years' control.

Venezuela has a very important anti-malaria residual spraying program particularly in the hyperendemic Llanos regions which roughly cover the great plains between the Orinoco and the coastal cordillera. The program is now in its fifth year and aims at bringing an area of 233,000 sq. miles under control. In many localities spleen rates were from 80 to 100 per cent before the program was started. In a number of these localities rates of only 3 per cent are now encountered. In three states with about 500,000 inhabitants the malaria mortality was reduced from 173 per 100,000 population in 1941-45 to 5 in 1948. The principal vector, *A. darlingi*, has been radically reduced, but *A. albimanus*, which is second in importance has not shown a measurable reduction.

Conclusions

Malaria control by residual spraying, which is done almost entirely with DDT, has brought health to millions of homes in the tropics and subtropics where the meaning of good health was formerly unknown. The world has never before felt the impact of a health program, so quickly, so dramatically achieved.

First of all, the method is cheap. Malaria is being pushed back in areas where the population was too poor and miserable to dream of malaria conquest by larval control. Perhaps when wealth has been accumulated permanent bonification may get under way. Meanwhile, vast tracts of rich tropical lands will re-enter world economy and that at a negligible cost.

Secondly, these programs can be set in motion and maintained by a very small qualified technical staff, foremen and labor being easily trained. That makes rapid expansion possible, which can hardly be said for any other kind of disease eradication project.

Thirdly, the method is adaptable to nearly all climatic and social conditions. As has been seen in the preceding, nearly all of the anthropophilic mosquitoes are susceptible to this method of control, and other effective vectors are so reduced that transmission becomes rare or ceases. There have been some failures, such as in the Philippines where *Anopheles minimus flavirostris* appears not to roost on sprayed walls, and in Malaya, but means may still be found to deal with such cases.

Today, well over 50 million people depend for their life and working capacity on an adequate supply of DDT. Requests for help present the urgent need of extending this protection to something like 800 million people as fast as possible. An action of this kind extended over ten or twenty years would go a long way toward establishing a huge prosperity sphere of democratic countries.

It is essential, however, to keep in mind that so long as the malaria vectors remain in the hinterland and human carriers travel freely these programs must be kept up. Failure of the DDT supply would not only interrupt the most promising tropical and sub-tropical health improvement ever seen but would also immediately expose millions, who will have lost their immunity, to devastating malaria epidemics. DDT production must not only be kept up but also be kept expand-

ing to meet the growing needs. The free flow of this precious product to all friendly countries and their dependencies must be maintained at all costs. Of this need the WHO is well aware. It has canvassed the world supply and has informed us of the vital role played by producers in this country. Now that DDT is in short supply we must therefore assure an adequate export allotment even though it curtails manufacture of household sprays. Less than 5 per cent of the DDT needed for residual house spraying is on a give-away basis, directly or indirectly. Profit, political necessity and humanitarian intent blend amazingly well in the magic white powder.

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