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**MALARIA CONFERENCE
FOR THE WESTERN PACIFIC
AND SOUTH-EAST ASIA REGIONS**

(Second Asian Malaria Conference)

Baguio, Philippines, 15-24 November 1954

Report

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MALARIA CONFERENCE FOR THE WESTERN PACIFIC AND SOUTH-EAST ASIA REGIONS

(Second Asian Malaria Conference)

Report*

1. INTRODUCTION

The Malaria Conference for the Western Pacific and South-East Asia Regions convened by the World Health Organization, and formerly planned to take place in Taipei, met in Baguio, Philippines, from 15 to 24 November 1954. A First Asian Malaria Conference had been convened by WHO a year before, in September 1953, in Bangkok, Thailand, and the present one can therefore be termed the "Second Asian Malaria Conference". It was attended by 42 participants, some invited by WHO from 13 different countries or territories, some sent by their governments, others sent by the United Nations Children's Fund or by the US Foreign Operations Administration; finally, some members of the WHO staff were also sent to attend the Conference, together with a special consultant, member of the Division of Medicine and Public Health of the Rockefeller Foundation.¹ It was a technical conference, and participants did not take part in the discussions as representatives of their governments.

For this as for the First Conference, a questionnaire was sent by WHO to the various governments of the regions. Replies were received from 23 countries or territories and circulated to the Conference. The accuracy and promptness of the replies indicated the interest aroused. A list of the documents submitted to the Conference appears in Annex 2 (see page 38).

* The Executive Board, at its seventeenth session, adopted the following resolution:
The Executive Board

1. NOTES the Report of the Malaria Conference for the Western Pacific and South-East Asia Regions (Second Asian Malaria Conference);
 2. THANKS the experts who attended the Conference, and
 3. RECOMMENDS the publication of the full text of the report.
- (Resolution EB17.R20. *Off. Rec. Wld Hlth Org.*, 1956, 68, 7)

¹ The list of participants appears in Annex 1 (see page 36).

The Conference was opened by Dr I. C. Fang, Director, WHO Regional Office for the Western Pacific, and addresses were given by Dr W. M. Bonne, Director, Division of Communicable Disease Services, on behalf of the Director-General of WHO, and by Dr G. Sambasivan on behalf of Dr C. Mani, Director, WHO Regional Office for South-East Asia. The Honourable Carlos P. García, Vice-President of the Republic of the Philippines and concurrently Secretary of Foreign Affairs, addressed the meeting and the Honourable Alfonso Tabora, Mayor, City of Baguio, welcomed the participants. The Honourable Dr Paulino J. García, Secretary of Health of the Philippines, also attended the opening session.

Dr Antonio Ejercito, Director, Malaria Control Project, Department of Health, Philippines, was elected Chairman, Dr K. C. Liang, Director, Taiwan Provincial Malaria Research Institute, Vice-Chairman, and Dr H. T. Soeparmo, Chief, Malaria Division, Ministry of Health, Indonesia, Rapporteur. Dr F. J. Dy, Regional Malaria Adviser, WHO Regional Office for the Western Pacific, was appointed Secretary.

The provisional agenda was approved and the Conference established the following drafting-group to assist the Rapporteur in the preparation of the report: Dr F. J. Dy, Dr J. W. Field, Dr E. J. Pampana, and Dr P. F. Russell. The present report was unanimously approved by the Conference at its last session.

The Conference was closed on 24 November by the Chairman, with an address of the Honourable Dr P. J. García, Secretary of Health of the Philippines; speeches were delivered by Dr S. Rajendram, Dr K. C. Liang, and Dr E. J. Pampana; a message of the Regional Director for the Western Pacific was read by the Secretary, Dr F. J. Dy.

2. VECTOR PROBLEMS OF SPECIAL INTEREST

2.1 Vectors

A review of the vector species in the Western Pacific and South-East Asia Regions brings out some problems of special interest. One of these problems is concerned with the effectiveness of residual insecticides in the control of malaria transmitted by *Anopheles minimus flavirostris* in the Philippines, the *A. leucosphyrus* group in Borneo, and the *A. punctulatus* group in New Guinea, which until recently was thought not amenable to control by residual insecticides. Another is related to observations in some parts of Indonesia, Viet Nam, and Malaya indicating that residual spraying, which has been considered effective in controlling malaria transmitted by *A. sundaicus* and *A. minimus minimus* and in reducing malaria transmitted by *A. maculatus*, might be attended with a certain amount of disappointment.

2.1.1 *The Anopheles minimus group*

2.1.1.1 *A. minimus minimus*

The recent work in Thailand has shown that DDT residual spraying by itself can be relied upon to control malaria transmitted by this vector. In the greater part of the country, it was observed that this species could almost be eliminated during the course of three years' successive spraying with DDT.

In China (Taiwan) and Burma, malaria transmitted by this vector has also been successfully controlled by DDT residual spraying, but the effect on the vector density has not been so dramatic as in Thailand.

However, in the southern highland region of Viet Nam (Pays montagnards du Sud), it was observed that DDT residual spraying of houses alone does not bring about a significant reduction in the malariometric indices until after two or three years' successive spraying. It is possible that this is due to the agricultural practices of the people, which include temporary residence in shelters in the ricefields, 5 to 10 km from the village, during the planting and harvesting seasons. Fortunately, the use of anti-malaria drugs during the first two months of the operations has assisted in reducing the malariometric indices to levels comparable to those obtained in Taiwan and Burma.

In Thailand, selective spraying with DDT limited to a height of six feet (two metres) of the inside walls of houses has been found adequate to control *minimus*-borne malaria, and there is a possibility that the total surface to be sprayed may further be reduced after experimental studies. In the Lashio area in Burma, residual spraying limited to a height of six feet has given satisfactory results, but this requires further observations before it can be adopted on a nation-wide scale.

In Taiwan, selective spraying limited to the walls of the bedrooms and storerooms and to the underside of the beds and furniture has given very satisfactory results. However, it was pointed out that the unpopularity of this method to the local population as well as the practical difficulties in exercising effective supervision in selective spraying have been the main objections to the adoption of this measure in a nation-wide campaign.

2.1.1.2 *A. minimus flavirostris*

Before 1952 it was generally thought that this species, the chief malaria vector in the Philippines, did not often rest indoors during the day. Furthermore, it appeared to be irritated after resting for a short time on a treated surface and even showed some tendency to avoid DDT-treated surfaces. The preliminary trials of Smith and Dy in 1948-49 and of Ejercito and his collaborators in 1949 gave inconclusive results, chiefly due to the choice

of the experimental areas and to other factors limiting the scope of the experiment.

However, the recent work of the WHO-assisted project in Mindoro, Philippines, under the leadership of Sambasivan, has shown that DDT residual spraying of houses will interrupt malaria transmission. The experience from this pilot project, which — as early as March 1953 — showed beyond any reasonable doubt that DDT residual spraying of houses can effectively control *flavivirostris*-borne malaria, formed the basis of the operational aspect of the six-year plan for the control of malaria in the Philippines.

In contrast to the observations in Thailand, it was found that the margin of safety of DDT residual spraying to control *flavivirostris*-borne malaria in the Philippines is much less than that for malaria transmitted by *A. minimus minimus*. For example, a few houses left unsprayed in a sprayed area can serve as harbourage for *A. minimus flavivirostris*, making possible the maintenance of transmission. In areas where *flavivirostris* is the vector, it appears that supplementary measures are more logical and that selective spraying of houses must be carefully evaluated before being adopted in the national programme.

2.1.2 *Anopheles maculatus*

Trap-hut studies on *A. maculatus*, the principal vector in Malaya, indicate that it is more susceptible to DDT and BHC residual insecticides than are some other Malayan vectors, for example, *A. sundaicus*, *A. barbirostris*, and *A. letifer*. Although *A. maculatus* is relatively anthropophilic by comparison with most other Malayan anophelines, greater numbers of this species are attracted to cattle than to man.

A field trial lasting for three years, and using DDT or BHC as residual insecticides applied twice a year, showed no appreciable effect on the overall vector population; this observation is probably explained both by the outdoor resting habits of *A. maculatus* and by its preference for cattle blood. Malaria transmission was reduced but by no means stopped.

In Malaya, the use of residual insecticides is considered a practicable method of reducing endemic malaria in rural areas where *A. maculatus* is the vector, but cannot compare with suppressive drugs when a rapid effect is required.

2.1.3 *The Anopheles leucosphyrus group*

A. leucosphyrus leucosphyrus and *A. leucosphyrus balabacensis* have been proved to be the principal vectors in Sarawak and North Borneo, respectively. As with *flavivirostris*-borne malaria, so malaria transmitted by these

two subspecies was thought not to be amenable to control by residual insecticides.

The recent work of Zulueta and Lachance, of the WHO-assisted malaria pilot project in Sarawak, shows that *A. leucosphyrus leucosphyrus* rest in fair numbers indoors when they come to feed at night, but, while the report of these authors gave encouraging indications that residual spraying might control *leucosphyrus*-borne malaria, the data available to the Conference suggest the need for further studies.

McArthur has recommended selective clearing of jungle by herbicides and cultivation, as a naturalistic means of eliminating *A. leucosphyrus balabacensis*, which was reported to breed chiefly in shaded seepages and springs of ravines. It was also reported that *A. leucosphyrus balabacensis* have been found breeding in fair numbers, not only in heavily shaded seepages, but also in moderately shaded to unshaded streams that abound in the hilly and mountainous interior. However, it was reported that malaria has disappeared from cultivated areas in North Borneo, where in more than 20 years clearing has not led to other problems. The Conference, having considered the matter, felt that selective clearing by herbicides and cultivation deserves a trial in Borneo.

2.1.4 *Anopheles sundaicus*

This species, the principal vector in Indonesia, has disappeared following the first DDT residual-spraying operations in some parts of the country, as in Surabaya and Semarang. This excellent result was attributed to residual insecticides, although in the past a natural but transient disappearance has been observed in certain areas.

The Conference discussed the development of resistance of *A. sundaicus* to DDT in Tandjung Priok, in the vicinity of Djakarta, and in Tjirebon, in northern Java — the first case of anopheline resistance to DDT in the South-East Asia and Western Pacific Regions. In both places, DDT had been used as a larvicide between the years 1947 and 1950, which may have been a factor in the development of resistance.

Issaris and Sundararaman, of the WHO-assisted malaria project in the Tjilatjap area of South Java, have reported a probable behaviouristic change in *A. sundaicus*, which now avoids prolonged contact with DDT-sprayed surfaces. Such behaviour might explain why DDT has not reduced malaria transmission in that area.

The Conference noted that, in some parts of India where this species is a vector, DDT residual spraying has given satisfactory control and neither resistance nor behaviouristic change has been observed.

2.1.5 *The Anopheles punctulatus group*

This group, which consists of *A. punctulatus*, *A. farauti*, and *A. koliensis*, contains the chief malaria vectors in New Guinea. The great variety of their breeding-places makes their control by larvicides impractical in rural areas. In special places like Sorong, an oil-field town in Netherlands New Guinea, larval control is, however, quite practical.

Studies on the bionomics of this group, particularly resting habits, give promise of control by residual insecticides. The preliminary results of the DDT residual-spraying experiment in Netherlands New Guinea by van Thiel & Metselaar are very encouraging. In the New Hebrides, where *A. farauti* is the vector, DDT residual spraying has satisfactorily controlled malaria and this method has been adopted.

2.2 Resistance

The Conference gave especial attention to the report on insect resistance to insecticides which resulted from the WHO Symposium on the Control of Insect Vectors of Disease (Rome, 1953). Three recommendations of the Symposium were discussed at length. The first of these was the suggestion that: "Base lines for the susceptibility of insects of medical importance to the modern insecticides should be determined. An attempt should be made to establish by laboratory methods the median lethal doses of the more important chlorinated hydrocarbons and organophosphates to *Musca*, *Anopheles* sp., *Aedes* sp., *Culex* sp., and other insects of medical importance."¹ Several malaria projects in the two regions have been carrying out field biological tests on vector species. However, base-line studies on median lethal doses were reported from only one country (Malaya). Standard tests (modified Fay technique) were described as routine procedure in the Philippine programme. The necessity for maintenance of vector populations for comparison, either in unsprayed check areas or in laboratory colonies, was recognized.

The Conference heartily endorsed the conclusions of the Rome Symposium in the matter of need for fundamental research on the mechanisms of insect resistance to insecticides. In the Western Pacific and South-East Asia Regions, the rarity of insect physiologists has seriously retarded any basic work on insect physiology or toxicology.

The Conference carefully noted the Symposium's suggestion that: "The use of chemically related insecticides against both the adults and the larvae of the same species should not be carried out simultaneously in the same area, except in cases of emergency."¹ The apparent development of DDT-resistant *A. sundaicus* in Indonesia was noted as occurring

¹ *Chron. Wld Hlth Org.*, 1954, 8, 131

in an area which had received larvicidal treatment several years earlier. At the present time, the spraying under the eaves of Indonesian houses during residual operations is resulting in larvicidal effects in adjoining fish-ponds. Similarly, the ingenious Philippine experiment to control outdoor resting *A. minimus flavirostris* by spraying stream banks is believed to result in some concurrent larviciding, with its possible hazards.

3. RESEARCH

3.1 Entomological

Studies on behaviour characteristics of adult mosquitos were described, but these experiments were admittedly fragmentary, covering only a few of the several malaria-transmitting species. Included were experiments on daytime resting habits, hours of feeding during the night, and use of outdoor harbourage by certain species.

Suspicion was voiced regarding the possible existence of vector subspecies or races differing in feeding and resting habits. Reports on preliminary investigations to distinguish such forms morphologically were discouraging. Not much recent work in the two regions has been undertaken on the redefinition of malaria vectors by special research, either by cross-breeding, by selective mating, or by chromosome analysis. The Conference unanimously agreed that problems of colonization of vector species must be investigated to facilitate these basic biological studies.

Personnel in several malaria-control projects have conducted investigations on outdoor resting habits of mosquitos, but these are still inadequate for guidance in programmes where the vectors show variation in anthropilism and in their house-frequenting habits.

The Conference considered that the experimental use of trap-huts, described by malaria workers from Malaya, Netherlands New Guinea, and elsewhere, is a valuable method of confirming the nocturnal behaviour and feeding preferences of adult mosquitos, and of measuring quantitatively their reaction to residual insecticides.

3.2 Parasitological

Variations in the behaviour of the malaria parasites in the human and mosquito hosts are not uncommon, and the presumption that there are definite races or varieties within at least two of the species infecting man has been widely accepted. These variations involve the duration of the events of the life cycle, the immunological features of infection, the susceptibility to drugs, the ability to infect particular species of mosquito, even the virulence of infection in the human host. With their thousands

of islands and highly endemic malaria, the South-East Asia and Western Pacific Regions offer particularly rich opportunities for the emergence of parasites with inheritable peculiarities of behaviour. Little has been done in this important field, and any observations which research institutions or field workers may be able to report on the behaviour of the parasites of these regions will help to fill a significant gap in our knowledge. Recent work in America, for example, has shown that a vivax strain of New Guinea origin and an indigenous American strain produce infections with marked and constant differences in relapse patterns; and it would be interesting to know whether the behaviour of the New Guinea parasite is a local peculiarity or characteristic of the parasites of the area.

Among the inheritable variations in the parasites is that which leads to resistance to proguanil and pyrimethamine. Resistance to both these drugs is known in a few small foci, but the extent of resistance and the distribution of resisting strains throughout the two regions is little known.

Even less known are the variations which involve the form of the parasites. Geographical varieties with a distinctive morphology have been described from several parts of the world, but the range and distribution of variations in the parasites of the regions are still to be defined, and a fascinating field of inquiry lies open to workers with the time and opportunity.

3.3 Therapeutics

In the South-East Asia and Western Pacific Regions as in other parts of the world, the radical cure of vivax malaria by some simple, safe, and speedy means remains an unsolved problem. It is a problem which will become even more insistent when spraying programmes have arrested mosquito transmission, and residual infections come into greater prominence. The most useful drug seems to be primaquine which, at a dosage of 15 mg of base daily for 14 days, terminates the infections caused by certain vivax strains. But, apart from one strain from New Guinea and other strains from Korea, the sensitivity to primaquine of *P. vivax* in these two regions is not well defined, the dosage and period of treatment necessary for radical cure remain uncertain, and further treatment studies are desirable.

At an early stage of vivax infection, pyrimethamine has been shown to offer encouraging possibilities of suppressive cure. Given at a dosage of 25 mg once a week from the start of infection and continued for at least two months, the drug apparently terminates a proportion of vivax infections due to particular strains. In the South-East Asia and Western Pacific Regions, the possibilities of pyrimethamine in this direction are almost unknown and should be investigated.

Throughout the two regions, the treatment of falciparum infections with single doses of chloroquine or amodiaquine is an accepted and valuable therapeutic measure. The immediate response to this treatment is known to be good. The Conference agreed that the final-cure rate is likely to be high, but more information on the sensitivity to these drugs of the prevailing falciparum strains is necessary before this assumption can be accepted with confidence.

3.4 Control

Although residual spraying with chlorinated hydrocarbon insecticides is being successfully and economically applied for malaria control in many countries on a wide scale, the Conference emphasized the need for continued research in regard to quality of insecticide, formulations, dosages, and methods of application in order to lower costs of control. Should international or bilateral aid be withdrawn or should financial depressions develop, malaria control might suffer unless costs are even lower than at present in certain areas. Such a retreat before malaria has been eradicated might result in serious resurgence of the disease.

The Conference received a report from Taiwan of some experiments in the accurate measurement of surface areas in reference to DDT spraying so that economies in DDT supplies might be obtained. There were also reports of experimental studies of spraying equipment in India. The Conference agreed that savings could be effected in large-scale projects by increasing the efficiency and strength of spraying equipment.

The Conference recognized the need for further studies in methods of determining the amounts of chlorinated hydrocarbons remaining on surfaces of varying composition, and in methods of measuring the degree of absorption and of repellency of the insecticides. Further, the need was recognized for studying the losses of insecticides in the course of residual spraying and the methods of reducing this loss as applied to different formulations, as well as methods of ensuring the application of the desired amount of technical DDT per square metre on surfaces of materials from which the liquid tends to run off before a full dose is reached.

Finally, the Conference noted that there remains a need for limited studies of certain naturalistic methods of malaria control, such as the clearing of vegetation in certain *A. leucosphyrus* areas and the selective use of automatic siphons in certain *A. minimus flavirostris* streams.

3.5 Epidemiological

In some parts of New Guinea, parasite- and spleen-rates in infants and children indicate a very high level of malaria transmission throughout the year. In those areas the spleen-rate in children is constantly over 80%.

Although the parasite-rate tends to decline at an early age, the spleen-rate of adults remains above 70%. This is at variance both with the hyper-endemic and the holoendemic types of endemicity defined by the Malaria Conference in Equatorial Africa (Kampala, 1950).¹ The present Conference suggests that this New Guinea type of endemicity be studied :

(1) by assessing the transmission rate on the basis of the infective density of the vector and the curve of parasite density in infants and children, and

(2) by obtaining further data on the development of immunity to the local strains, with a view to explaining the apparent inconsistencies.

4. ROLE OF DRUGS

4.1 In the suppression and cure of malaria infections

The role of drugs in the suppression and cure of malaria infections was well attested by the experience of the Second World War. For the protection of armies in the field, for labour groups, survey parties, and similar groups moving through malarious territory, drugs give a high degree of protection; indeed, no other method of comparable efficiency is known. But the role of drugs in the control of endemic rural malaria is less impressive. They are useful under particular conditions but they must take a second place to residual spraying. The Conference was informed of the imminent publication by WHO of a monograph on the chemotherapy of malaria,² and the discussion was therefore restricted to the supplementary use of drugs in spraying programmes and in certain special situations.

4.2 In relation to spraying programmes

Residual spraying with insecticides cannot, of course, influence the reservoir of infection already present when spraying operations begin. Transmission will usually be arrested, but existing infections must either be left to die out, or else terminated by drugs. Left alone, falciparum infections will sometimes last for a year, vivax infections for about three years, and malariae infections even longer — a sustained source of periodic clinical activity. Broadly stated, the role of drugs in spraying programmes is the eradication of existing infections. The theoretical possibilities are good but practical difficulties impose limitations. Mass suppressive treat-

¹ See *Wld Hlth Org. techn. Rep. Ser.*, 1951, **38**, 45.

² Covell, G., Coatney, G. R., Field, J. W. & Jaswant Singh (1955) *The chemotherapy of malaria*, Geneva (*World Health Organization: Monograph Series*, No. 27)

ment is unpractical and radical cure is difficult except in falciparum infections.

If at the beginning of spraying programmes there is evidence of clinically active malaria, the Conference agreed that three courses are possible and practical :

(1) To use drugs during spraying operations only for persons with fever at the time ; a single dose of chloroquine or amodiaquine would be appropriate. Most falciparum infections would be terminated and all infections so treated would be clinically relieved.

(2) To give single doses of chloroquine or amodiaquine to all persons at the time of spraying, a course for which the occurrence of many cases of fever would be a clear indication.

(3) To give single-dose treatments repeated at short intervals for a few weeks. The most useful drugs are chloroquine, amodiaquine, and pyrimethamine. Giving them in appropriate single doses once a fortnight for two months to children and pregnant women in regions of Viet Nam seriously affected by malaria, Farinaud obtained a more rapid improvement in health conditions than was possible with spraying alone. Difficulties of organization place a limitation on this form of supplementary drug-control, but when malaria is severe, as in the highlands of Viet Nam, and the response to spraying alone is slow, the benefits are beyond doubt.

Towards the end of spraying programmes, when transmission has been interrupted for a significant period, residual vivax and malariae infections are likely to pose a problem for which there is no simple answer, and in many areas with poor dispensary facilities there may be no alternative but to allow the infections to burn themselves out. The most useful drug is primaquine given daily for 14 days at a dosage of 15 mg of base. Whether, with the particular vivax strains of the two regions, a shortened period of treatment may still be effective, is not yet known. After the interruption of the spraying programme, cases of malaria should be promptly dealt with. From available evidence the Conference suggested that a single dose of 600 mg of chloroquine base with 15 mg of primaquine base, given together, would eliminate the immediate dangers to the community.

4.3 In special situations

4.3.1 Epidemics

The Conference emphasized that epidemics occurring in areas as yet unsprayed demand quick action and that drugs can best meet the immediate situation. The most useful drugs are chloroquine, amodiaquine, mepacrine, and pyrimethamine. Various patterns of administration have been recommended ; one of the most effective is perhaps that which depends

on an immediate single dose of 600 mg of chloroquine or amodiaquine base, with a weekly follow-up of chloroquine, amodiaquine, mepacrine, or pyrimethamine at appropriate dosages and continued as appears necessary. The administration of drugs should not, of course, replace or delay an immediate attack on the adult vector mosquito. Spraying with insecticides should begin at once.

4.3.2 *New settlements*

A special situation arises when land is being opened up for settlement. Rational planning will normally provide houses which have been sprayed beforehand with residual insecticides. But if this has not been possible, then drug-suppression during the period of main risk is probably the best answer to the problem.

4.3.3 *Migration*

A malaria problem for which spraying is not a complete solution arises when populations are settled for only a part of the year — farmers, fisherfolk, and the like, who sometimes leave their homes for months at a time for distant farms and fishing grounds. In parts of Viet Nam, for example, disappointing results from residual spraying have been attributed to this seasonal migration. This again is a situation which can be countered by drugs wherever it is possible to organize their distribution. A single dose of 600 mg of chloroquine or amodiaquine base given as a supplement to spraying at the first opportunity after such people return home would go far to speed the clinical response to control.

4.3.4 *Stocks of quinine or mepacrine*

The attention of the Conference was drawn to the special situation of countries which hold large stocks of quinine or mepacrine and are hence reluctant to buy the newer drugs. The use of quinine imposes an extra burden of administrative difficulties on a national malaria-control organization, but efficiently used in times of need the drug will usefully supplement residual-spraying programmes. Though less effective than chloroquine or amodiaquine, mepacrine may replace these drugs at the same dosage when the newer drugs are not readily available.

5. NATIONAL MALARIA-CONTROL PROGRAMMES

5.1 *Review by countries*

The Conference noted that according to the documentation provided by 23 countries and territories, with an aggregate population of more than 650 million (about one-quarter of the population of the world), nearly

280 million live in malarious areas, and that 84 million—i.e., 30%— were protected in 1953.

To give an idea of the scope of the nation-wide malaria programmes now being carried out, the following eight examples may be quoted :

In *Afghanistan*, with a population of 12 million, of whom 1.5 million live in malarious areas, nearly a million people (949 000) were protected in 1953. Of this, 0.68 million were living in houses which had been sprayed at a cost of 2.72 afghanis, equivalent to US\$0.13, per capita per year. Single yearly sprayings at the rate of 1 g of DDT per square metre are sufficient under local conditions. With WHO and UNICEF assistance, it is planned to protect the remaining population, i.e., 550 000, in 1955.

In *Burma*, with a population of 17 million, of whom 7.5 million are estimated to live in malarious regions, 1.35 million were directly protected in 1953 with a single spraying of 2 g of DDT per square metre and at a per capita cost of less than one kyat, i.e., about US\$0.21. It is planned, with WHO and UNICEF assistance, to protect all the 7.5 million in 1957.

In *Ceylon*, there is a population of 8 269 000, of whom 3 million live in malarious areas. A scheme of malaria control by indoor residual spraying was inaugurated in 1946. DDT at a dosage of 0.6 g per square metre or BHC at a dosage of 0.12 g of gamma-isomer per square metre was applied approximately four times a year. The cost of operations works out at Re0.96, which is equivalent to US\$0.20, per capita per year. Malaria has almost been eradicated from the country. As a result, residual spraying has been interrupted over an area occupied by about 600 000 people and a scheme of surveillance has been set up.

In *China*, Taiwan has a population of about 8.5 million, of whom 5.6 million live in malarious areas. In 1953, 1.5 million were directly protected by a single spraying with 2 g of DDT per square metre, at a cost, per capita per year, of NTS2.70, equivalent to US\$0.17. In 1954, with continued WHO and FOA (US Foreign Operations Administration) assistance, all the population at risk has been protected.

In *India*, with its 362 million inhabitants, of whom 200 million live in malarious areas, already 63 million were protected in 1953. As an average, two sprayings a year are carried out with DDT at the rate of 1 g per square metre, at a cost of 11 annas, equivalent to US\$0.14, per capita per year. With continued FOA aid, it is planned to protect 125 million in 1956.

In *Indonesia*, with a population of 70 to 80 million, it is estimated that 30 million live in malarious areas. In 1953, 2.8 million people were protected, mostly with DDT at a rate of 2 g per square metre (one spraying

per year), but a small part with BHC, at a rate of 130 mg of gamma-isomer per square metre (four sprayings a year), the average per capita cost being 1.88 rupiahs, equivalent to US\$0.16. Dieldrin has been used where there has been DDT resistance. With present WHO and FOA assistance, it has been planned to protect all the 30 million by 1964.

In the *Philippines*, with a population of 21.4 million, of whom some 6 million are living in malarious regions, 1.0 million people were protected in 1953 by one spraying with 2 g of DDT per square metre, or, in a few areas for experimental purposes, with BHC or dieldrin (1954). The cost per capita per year, considering purely operational expenses, was 0.43 peso, equivalent to US\$0.22. With continued FOA assistance, it is planned to have all the population at risk under protection or surveillance by 1956.

In *Thailand*, with its population of 20 million, of whom 6 million live in malarious regions, 3 million people were protected in 1953 by DDT sprayed at a dose of 2.2 g per square metre; in 1954, the protection extended to 4.5 million, with 2.4 g per square metre and at a cost of 3.03 baht, equivalent to US\$0.24, per capita per year. DDT sprayings have been discontinued in some areas (64 000 population) after three years. It is planned, with continued FOA assistance, to have all the population protected, either directly with spraying or by surveillance, by 1957, and it is hoped that in 1958 no more systematic spraying of large areas will be required.

Besides these eight major nation-wide programmes, the Conference noted reports from fifteen other countries or territories, as follows: the British Solomon Islands Protectorate, Brunei, Cambodia, Hong Kong, Japan, Laos, Nepal, Netherlands New Guinea, the New Hebrides, North Borneo, Portuguese India, Sarawak, Singapore, the Territory of Papua and New Guinea, and Viet Nam. All the last fifteen programmes are much smaller than the eight previously mentioned. In some the total population or the population at risk is small, in others the programme has hardly begun, or particular problems have hampered its development.

Table I summarizes pertinent data of the programmes for which reports have been received from the governments of the two regions.

5.2 Cost of malaria

That malaria imposes significant economic and social burdens on individuals, communities, and nations, has not been doubted by any student of the disease since early times. The Second Asian Malaria Conference was in full agreement with the First, that malaria is costly because of its effects on physical, economic, and social health. Naturally, governments or other agencies concerned with the support of malaria-control

TABLE I. EXTENT AND COST OF MALARIA-CONTROL SPRAYING OPERATIONS IN VARIOUS COUNTRIES AND TERRITORIES, 1953*

Countries or territories	Total population	Population in malarious regions	Population directly protected	Population still to be protected	International or bilateral assistance	Cost per person protected (US\$) ^a
Afghanistan	12 000 000	1 500 000	949 000	551 000	—	0.13
Brunei	55 000	36 000	32 000	4 000	—	0.43
Burma	17 000 000	7 500 000	1 345 722	6 154 278	WHO, UNICEF	0.21
Cambodia	4 000 000	400 000	20 000	380 000	WHO, FOA ^b	?
Ceylon	8 269 000	3 000 000	3 000 000	—	—	0.20
China (Taiwan)	8 465 350 ^c	5 555 000	1 526 305	4 028 694 ^d	WHO, FOA	0.17
Hong Kong	2 500 000	2 500 000	2 300 000 ^e	200 000	—	0.04
India	361 822 255 ^f	200 000 000	63 000 000	137 000 000	FOA	0.14
Indonesia	70-80 million	30 000 000	2 798 590	27 201 410	WHO, FOA	0.16
Japan	87 000 000	516 642	2 387 560	129 082	—	0.06
Laos	2 602 380	650 579	279 256	371 313	—	?
Nepal	9 000 000	5 100 000	3 000	5 095 000	WHO, FOA	0.13
Netherlands New Guinea	1-1 1/2 million	290 000	6 000	?	—	?
New Hebrides	48 914	48 000	35 000	42 000	—	?
North Borneo	334 141	290 000	6 000	255 000	—	0.40
Papua and New Guinea	1 616 500	Nearly total population	24 000 ^g	?	—	?
Philippines	21 440 200	6 000 000	1 000 412	4 999 588	WHO, FOA	0.22
Portuguese India	638 000	111 000	51 500	59 500	—	0.21
Sarawak	546 385	546 385	6 350	540 035	—	0.33
Singapore	1 120 777	1 100 000 ^e	1 100 000 ^e	—	—	0.11
Solomon Islands	100 150	95 800	1 000	94 800	—	—
Thailand	20 000 000 ^c	6 000 000	3 016 808	2 983 192	FOA	0.12
Viet Nam	20 000 000	4 500 000	3 000 000	1 500 000	FOA	0.07
Total	650-660 million	278-279 million	84 million	194-195 million	—	—

* Based on replies of governments to WHO questionnaire. It should be noted that the information is not comparable from one country to another since there is lack of uniformity in the data received and in the methods of calculating costs.

^a The cost in US currency has been calculated on the basis of the following exchange rates (equivalent of US\$1.00 in local currency):
 Afghanistan 21 afghanis
 Brunei Straits \$3.03
 Burma 4,762 kyats
 Ceylon 4,762 rupees
 China NT\$15.50
 Hong Kong HK\$5.70
 India 4,762 rupees
 Indonesia 11.40 rupiahs

Japan 360 yen
 North Borneo Straits \$3.03
 Philippines 2 pesos
 Portuguese India 4,762 rupees
 Sarawak
 Singapore
 Thailand
 Viet Nam

^b US Foreign Operations Administration
^c 1954
^d All sprayed in 1954, completed
^e Chiefly or exclusively by antilarval measures or drainage / 1951
^f By drugs
 Straits \$3.03
 Straits \$3.03
 12.65 bahis
 35 piastres

projects will normally weight the cost of malaria itself when considering the cost of malaria control. Thus the measurement of economic and social effects of malaria assumes greater importance as the scope of malaria-control projects increases.

The factors involved in any cause-and-effect relationship are sometimes elusive. Few public problems and their solutions are isolated, all are intertwined more or less tightly. Malaria in particular is apt to be closely related to many other aspects of communal welfare. The Conference recognized that there is further need for units of measurement and for criteria that will bring the benefits of malaria control into sharper focus, that will permit more accurate assessment of the economic and social advantages which have so often seemed to accrue from malaria-control projects.

The Conference noted that among the debit items in reference to malaria and its control are the following :

A. Losses due to malaria illness

- (1) Earnings forfeited :
 - (a) because of physical incapacity
 - (b) because of time spent nursing others
 - (c) because of repayment of unusual debts
- (2) Lessened efficiency while chronically ill or convalescent, resulting in :
 - (a) lower output of labour, smaller or fewer crops
 - (b) lack of energy to plan effectively or to obtain a better job
- (3) Cost of medical care—quacks, physicians, hospitals, medicines
- (4) Cost of spiritual care—priests, candles, sacrifices

B. Losses due to malaria deaths

- (1) Value of a life lost
- (2) Expenses of funerals for those who might have lived long enough to earn this cost

C. Losses due to malaria endemicity

- (1) Lower rentals
- (2) Depreciated real estate
- (3) Forced sales
- (4) Moving from endemic areas

- (5) Difficulty or impossibility of utilizing or reclaiming land for resettlement, cultivation, or other development
- (6) Increased costs of public works such as roads and irrigation projects.

Among the benefits commonly attributed to successful malaria-control projects, aside from preventing the losses listed above, are the following :

- (a) Lower infant and general mortality rates
- (b) Reduced absenteeism among schoolchildren, public servants, and workers in general
- (c) Reduced incidence of certain insect-borne diseases such as plague, leishmaniasis, filariasis, and certain intestinal infections
- (d) Increased and more uniform use of land
- (e) Increased tourism
- (f) Increased public understanding of, and co-operation in, public-health and welfare programmes.

A recent study of economic and social effects of malaria control was made in Taiwan in a township where an epidemic occurred in 1953 in an unsprayed area. This survey of the population involved made clear that there were considerable losses to the individuals affected but no serious disturbance to the country's economic base. For instance, out of the 5256 persons included in the survey, 3005 contracted malaria and spent a total of NT\$96 334 for malaria treatment during the four-month period of the epidemic, and NT\$17 015 for miscellaneous expenses due to the epidemic (NT\$15.50 = US\$1). There was a loss of some 17 680 man-days of work. But by engaging outside labour totalling only 2284 man-days, the community harvested its rice crop without loss. The per capita cost of malaria control in Taiwan averages NT\$2.70.

The Conference agreed that this Taiwan study pointed to the need for more socio-economic surveys related to malaria and its control.

Undoubted benefits have followed malaria-eradication projects. For example, Ceylon has resettled over one million persons on land previously uninhabitable because of malaria. It has also increased its rice crop by about one half, a gain that would have been impossible without malaria control. Numerous specific instances of benefits in other countries were cited by the First Asian Malaria Conference, and many others could be gathered from reports to the Second Conference. However, there was a consensus among the participants that additional specific information over longer periods of time is required regarding the economic and social effects of malaria control. Especially, it is desirable to elucidate the effect of malaria eradication on vital statistics and on morbidity rates from other diseases. Competent statistical analysis is essential.

So far as the Conference was aware, the only serious charge of damage to the economic and social structure of a country by successful malaria control has been on the grounds that a lowering of malaria incidence has resulted in an increased population in certain areas already assumed to be over-populated. The Conference noted that the question of population pressure is exceedingly involved and that its equation, with the three main variables—people, energy, and food—is vastly more complex than any present formulation. The Conference agreed that no one knows or can accurately predict what total population the world can support if potential supplies of energy are utilized properly. Moreover, no one can have the necessary prescience or moral authority to decide from which areas malaria control should be withheld for the sake of a presumed benefit that a higher death-rate might bring to a community. The Conference emphasized that malaria control is not an end in itself but is to be integrated with other public activities designed to foster community welfare. The Conference believed that, where malaria is prevalent, its elimination is a most important first step towards a sound population policy, a more adequate food supply, and a balanced human ecology.

The Conference recognized that, although it is important to obtain precise data relating to the social and economic benefits of malaria control, yet malariologists may not be technically equipped to undertake socio-economic surveys. Therefore, it noted the desirability of enlisting the co-operation of duly qualified agencies or personnel. The Conference suggested that this subject be brought to the attention of international bodies concerned with the public welfare.

5.3 Cost of control

The Conference confidently reaffirmed the conviction that wherever malaria is endemic, malaria control is a sound national investment. This belief has been emphasized repeatedly by the WHO Expert Committee on Malaria and was stressed by the Malaria Conference in Equatorial Africa and by the First Asian Malaria Conference. Once again attention was called to well-documented evidence from countries in which national malaria-control projects have been in progress for several years, which indicates clearly that “no country with a serious malaria problem can afford *not* to control malaria”.

Of course, malaria control must be financially feasible within the framework of a country's budgetary potential. Fortunately, the per capita costs of malaria eradication by residual-spraying methods are so low that no country within the two regions represented at the Conference has been forced to forego a nation-wide malaria-control project because of the monetary requirements. Reports submitted by governments to

the Conference indicate that control costs in major nation-wide projects, calculated on the basis of those whose dwellings have been sprayed with residual insecticide, are usually less than US\$0.25 per capita per year and have been as low as US\$0.07 in one country in the two regions represented. If total populations are considered, the per capita costs to a country in these regions for the elimination of its malaria problem will generally be less than US\$0.15 per year. The Conference noted, as discussed later (see page 28), that interruption of spraying gives promise that this low per capita expenditure for malaria control may be substantially reduced after 4 to 7 years of spraying.

The Conference noted the need to be continuously alert to possibilities of reducing the cost of malaria control still further. The advantages of decentralized control operations, supported in matters of training, standardization, research, and surveillance by a strong central organization, were recognized. In some areas, the introduction of selective, as opposed to general, spraying arouses objection from people who welcomed the collateral benefit of relief to their animals from insect annoyance. Eventual integration of a spraying project with local health programmes may also result in lower costs of malaria control. But the Conference noted the need to maintain a specialized staff concentrating on malaria control and surveillance during such time as the need exists. Participation of local governments in the costs of malaria control may relieve a central government of some of the financial burden.

The Conference also noted the need to standardize procedures, supplies, and equipment so far as possible in the interest of economy. Finally, the Conference emphasized that the local manufacture of DDT and of spraying equipment in some countries would result in a saving of foreign exchange and possibly a lowering of costs.

5.4 Personnel and training

The Conference fully agreed that successful nation-wide malaria-control programmes can be executed only with significant numbers of well-trained personnel. In the first phase of organization, malaria must be emphasized as the primary problem, and the use of personnel for the control of other diseases must not slow down the progress of the malaria-control programme. When a programme is rapidly expanding, the problem of obtaining and training personnel is of first importance. Jaswant Singh outlined the status of training facilities and needs in the two regions, with special emphasis on categories and facilities of training in the Malaria Institute of India. These facilities meet the needs of India and can be used by other countries to supplement their own training programmes. However, certain categories of workers should be trained locally, and more-advanced training should be a part of any programme of substantial size.

Differences in government organization prevent standardization of personnel and training. Without considering qualifications of the different kinds of personnel, Table II shows the approximate number of personnel being used per million population in the current programmes of various countries. Higher officers such as malariologists and entomologists should be equally well trained regardless of the country in which they will work. They should be able to adapt to various working conditions. The lower officers and workers, on the other hand, should be trained in the country concerned because of the need to apply immediately the skills they have learned. Filling the needs of a country depends upon the following factors :

- (a) availability of candidates ;
- (b) position in government service after training ;
- (c) assurance of employment as far as practicable in government service ;
- (d) the government's willingness to budget long-term projects.

People thinking in terms of a career are particularly interested in the above points. In planning a training programme it is necessary to take into consideration the possible use of personnel when the malaria programme may be curtailed. To increase the staff of an organization may not present difficulties, but when the need for a large staff ceases there must be a place for continued employment. If the health ministries can assure further training in the control of other diseases, it will create greater peace of mind and tend to give more productive work on the part of the employees.

The Conference noted that little thought has been given in the past to the need for and training of competent administrators. A well-organized malaria-control programme needs administrators at several levels, and if they are given some elementary training in malaria, as well as in the technical forms they must handle, efficiency and enthusiasm might be stimulated. In this category there should probably be at least one person per million population protected.

In general, the report of Jaswant Singh gives an outline of probable needs of personnel and training for the various country programmes. This document, which may be used as reference for countries seeking aid in setting up new training centres, points out the urgent need for increasing the existing facilities and initiating new training centres where personnel and facilities are available.

5.5 Co-ordination

The Conference emphasized that large-scale malaria-control operations by residual spraying require accurate planning and painstaking co-ordination

**TABLE II. NUMBER OF PERSONNEL, VEHICLES, AND EQUIPMENT
PER MILLION OF POPULATION DIRECTLY PROTECTED
BY MALARIA-CONTROL PROGRAMMES IN VARIOUS COUNTRIES**

	Burma	Ceylon	China (Taiwan)	India	Indo- nesia	Philip- pines	Thailand
Population protected (millions)	1.3	3	5.5	63	2.8	6.3	3
Number in each category, per million of protected population							
Personnel							
Malariaologists ^a . . .	1	3	1	1	0.1	6	2
Entomologists . . .	1	0.3	0.4	—	—	—	—
Sanitary engineers . . .	—	—	0.4	—	—	2	—
Sanitarians	3	0.3	3 ^b	—	—	—	—
Senior supervisors . . .	10	2	3 ^c	4	1	3	10
Supervisors	—	17	29 ^c	4	6	4	20
Technicians	—	4	4 ^b	—	8	17	20
Attendants	—	10	—	—	—	19	—
Foremen or squad leaders	50	40	159	4 + 20 ^d	30	—	150 ^e
Skilled labour and/ or spraymen	400 ^f	100	636	10 + 110 ^d	180	140 ^g	450 ^e
Unskilled labour	—	—	308	5	—	280 ^{d,g}	150 ^e
Mechanics and drivers	11	6	1	6	12 ^h	—	5
Storekeepers	1	0.3	—	1	—	—	1
Vehicles							
Trucks	1	—	—	4	—	—	3
Station-wagons	—	—	0.4	0.1	—	5	1
Power-wagons	—	—	—	—	4 ⁱ	5	1
Jeeeps	10	—	0.5	1	—	24	10
Pick-ups	—	—	0.7	—	—	5	10
Equipment							
Sprayers	400	—	572 or 477 ^j	90	150	500	600 ^k

^a Includes Director, Executive Director, and malariaologists.

^b Malaria Institute personnel

^c 60-75 days only

^d 5 months only

^e 60-90 days only

^f Skilled labourers, 5 months a year

^g 100 days only

^h Mechanics and drivers are taken from the group immediately above.

ⁱ Motorized land vehicles, not including bicycles.

^j The first figure applies when hand sprayers only are used; when lift and pressure sprayers are used as well, the total figure is 477 (286 hand sprayers, 191 lift and pressure sprayers).

^k Including 150 spares.

in all directions. If the target of the campaign is that of eradicating malaria so that the spraying can be discontinued before insecticide resistance may develop, the programme becomes more exacting than most of the ordinary control programmes now being carried out. A deadline cannot perhaps be defined, but the anxiety that resistance may develop will be such that all efforts will bear on conducting the campaign as efficiently and as rapidly as possible. In order to achieve this result, co-ordination in planning and implementing the programme is a *sine qua non*.

It is of course highly desirable "to obtain malaria control simultaneously in as large areas as possible, both for increasing the efficiency of

the campaign and for saving expenses and eventually discontinuing the campaign".¹ This implies the merging of areas of control, in order to avoid the persistence of uncontrolled sectors among those that have been controlled. Merging various areas, however, or integrating separate local, provincial, or state programmes into one national programme, will not reach the purpose if the tempo of achieving the end-point of transmission is not the same throughout the area. Obviously, if some sectors are put under control one or two years later than the others that surround them, it will not be safe to discontinue the campaign until all sectors of the area have reached eradication of the disease. This drawback can be prevented in the planning stage; but it is a frequent experience that even when the plan provides for this simultaneous protection, the implementation of the plan often fails, so that when a large part of the area has reached a satisfactory degree of control, some sectors are well behind, remaining as pockets where malaria transmission persists and preventing the interruption of spraying in the rest of the area. It is superfluous to point out how such delays not only prolong the duration and expense of the campaign but increase the danger of resistance.

The failure to reach simultaneously throughout the area the degree of control that had been aimed at is generally the result of either a lack of co-ordination in the logistics of the campaign, or of efficiency of the personnel: both these causes should of course be prevented or at least corrected as soon as possible. But sometimes the failure may have been caused by an unforeseen and unpreventable circumstance due either to the vector—such as a local change in its behaviour or in its physiological susceptibility to the insecticide—or to local human ecological characteristics interfering with the efficiency of the residual-spraying campaign—such as immigration, building of new unsprayed houses, sleeping outside protected structures, etc.

Several examples of pockets where transmission continued while it had been reduced or interrupted in the surrounding areas have been brought to the attention of the Conference. It appears that these particular instances deserve study, wherever this is possible; but in most instances it would seem advisable not to "wait and see" but to intervene with methods of control other than the residual spraying thus far applied, so that the dangerous sector could rapidly be brought to the same level of control as the rest of the area. It is in these instances that the use of drugs, space spraying by pyrethrum insecticide, or larviciding with oil or paris green appear to be indicated as emergency measures. The increased cost of the methods to be applied to these particular sectors is negligible when

¹ *Chron. Wld Hlth Org.*, 1954, 8, 127 (Recommendation on co-ordination of planning)

compared to the costs that even one year's prolongation of the general campaign would entail.

This co-ordination of the efficiency of the campaign throughout its component sectors is most difficult to achieve. It requires painstaking logistic preparation and careful technical and administrative supervision. Just as a surgeon does not ordinarily intervene unless his assistants, his equipment, and all the material that might be needed during the operation—and during the emergencies that might arise in its course—are available, likewise a large-scale malaria programme requires that the assignment of adequate personnel, the allocation of equipment, transport, and supplies to the various operational centres, the smooth working of channels of communications and responsibilities, and of the supervisory machinery, be all timely prepared.

Obviously this need of thorough planning and over-all co-ordination in its implementation requires a national malaria service endowed with full authority and technical responsibility in the field of malaria. It should be responsible for surveys, epidemiological intelligence, control operations, the evaluation of results, the training of personnel, the standardization of methods, procedures, and equipment, general supervision, laboratory work, and co-ordination with existing services for the distribution of drugs and for registration of malaria cases and deaths. Further, when the time of interruption of transmission approaches, it should also be responsible for epidemiological inquiries into malaria cases and for the surveillance of machinery. Many of these functions, and particularly the operational ones, could and often should be decentralized, but the malaria service should decide how far this decentralization is to be carried without interfering with co-ordination. The First Asian Malaria Conference gave attention to the type of central malaria organization required, and the present Conference concurs with its conclusion.¹

If the national malaria service must have full authority and technical responsibility in the field of malaria, this does not imply that it should be independent of the health service. The Conference learned with interest of the system followed in Ceylon, where the personnel of the malaria service is taken from the public-health staff (and appropriately trained in malaria work) so that when a reduction of the strength of the malaria service will be needed, its excess personnel could be shifted to other health activities, and particularly to the control of arthropod-borne diseases.

¹ "While there are advantages in decentralizing the operations of malaria control, a central organization is necessary to deal with research, training of personnel, assessment of results, and standardization of methods, equipment, and supplies. In large countries where State or provincial autonomous antimalaria services may exist, the central national organization should give technical guidance and higher training, and should assist in co-ordinating the activities of the State or provincial malaria services on a nationwide plane." (*Chron. Wld Hlth Org.*, 1954, 8, 126)

It may be difficult for the national malaria service in some countries to obtain responsibility for control in military camps, airfields, or in areas belonging to industrial concerns where antimalaria operations are generally carried out by the relevant services. It is imperative in such cases to establish a co-ordinating committee, which can procure all information relevant to malaria in the country and can urge that operations be integrated into a national plan and carried out according to the technical standards of the national malaria service.

The more malaria-control programmes are developing in the various countries, the more the trend towards malaria eradication acquires impetus; as a consequence, the importance of malaria as an international health problem is progressively increasing. If a country has eradicated malaria, danger might be serious if the surrounding countries are still highly malarious; hence the necessity of inter-country agreements, so that eradication may be obtained in as large a zone as possible and that the danger of introducing carriers of malaria parasites from the countries beyond the border may be minimized.

Another circumstance that emphasizes the international character of malaria control is the development of resistance in anopheline populations. It might indeed be assumed, although no examples have been brought to the attention of the Conference, that if DDT-resistant anophelines from a given locality are brought into a similar ecological area in the same or in a foreign country they might give rise to a resistant population. Such an occurrence might have serious consequences and should therefore be foreseen and prevented in time.

The Conference confirms the recommendation of the First Asian Malaria Conference: "(1) that in planning malaria-control programmes the principle of merging the areas of control both within and outside the borders of the countries concerned, on an inter-country, intra-regional, and inter-regional plane be followed; and (2) that WHO offer appropriate assistance for the co-ordination of national plans through its regional offices, and if need be, through other suitable methods, such as inter-regional conferences and committees".¹

5.6 Legislation

The Conference discussed the subject of malaria legislation and was of the opinion that appropriate legislative measures are particularly necessary to support nation-wide programmes aiming at malaria eradication. Some countries of the two regions already have antimalaria enactments, adapted to the older forms of control. These may need revision in the

¹ *Chron. Wld Hlth Org.*, 1954, 8, 127

light of modern objectives and methods. The various points that should be covered by appropriate legislation are summarized in Annex 3 (see page 40).

5.7 Standardization of techniques, procedures, and reports

Co-ordination between various units active in any field can hardly be achieved if the units do not adhere to a same course of action, do not follow similar methods, and do not produce comparable data. The attention of the Conference was drawn to the efforts of WHO towards standardization in the field of malariology. The monograph *Malaria Terminology*¹ defines malariometric and entomological terms, suggesting procedures for determining their values ; a pattern of " uniform reporting of field research in malaria control " was proposed by the Malaria Conference in Equatorial Africa (Kampala, 1950) ;² finally, patterns for tabulating results of spraying campaigns and calculating the cost of operations have been followed during the last five years by WHO malaria personnel in the various WHO-assisted projects in different parts of the world, and the Conference noted that several malaria services have followed them. The Conference was of the opinion that these patterns could be adopted by all national malaria services, as they would ensure international comparability of results (see Annex 4, page 41).

The Conference had added to the provisional agenda the item : " Methods of collecting data for assessment of the effects of malaria control on other insect-borne diseases, such as plague, leishmaniasis, and filariasis ". The Conference is aware that in some countries of the regions the central malaria organizations have sections devoted to the control of other insect-borne diseases, such as filariasis, and that in the Americas they are often responsible for the prevention of yellow fever, Chagas disease, and sometimes for all insect-borne diseases. But the Conference believes that, unless the national malaria service has been structurally conceived to deal with other insect-borne diseases, it should not be loaded with the additional responsibilities of controlling them or assessing the variations of their incidence following malaria control. Such responsibilities would interfere with the efficiency of malaria-control operations and evaluation.

5.8 Ultimate goal

The Conference agreed that the ultimate goal of a nation-wide malaria-control programme is the eradication of the disease. This may or may

¹ Covell, G., Russell, P. F. & Swellengrebel, N. H. (1953) *Malaria terminology*, Geneva (*World Health Organization : Monograph Series*, No. 13)

² *Wld Hlth Org. techn. Rep. Ser.*, 1951, **38**, 63

not concurrently result in disappearance of the vector mosquitos. The Conference noted that eradication of vector species can today only rarely be a practical goal in national malaria-control projects. However, in some areas with an especially susceptible malaria vector, as with *A. minimus minimus* in parts of Thailand, routine residual spraying of houses has resulted in a disappearance of the vector to an extent that suggests eradication.

The Conference attempted to define the point at which malaria eradication has been attained, in other words, the time at which malaria has ceased to be endemic. There was a consensus that the absence of any fresh case of indigenous malaria for a minimum period of three years would be an acceptable indication of malaria eradication. Naturally, an adequate organization for the discovery and diagnosis of cases of malaria is essential in applying this criterion in determining when malaria is no longer endemic. This routine search for malaria cases will naturally include not only infants but also older children and adults as well. In some areas, it may be useful to have supporting entomological evidence that the vector mosquitos are not unduly prevalent and are in no case infected.

The Conference agreed that the periodical examination of infants and young children might give useful confirmation of continued absence of malaria transmission, but it was realized that a negative index among infants on a given day would not necessarily guarantee the absence of indigenous malaria in the total population.

5.9 Interruption of spraying

The Conference was in full agreement that it is desirable to interrupt residual spraying of insecticides for malaria control as soon as feasible. Such interruption will not only reduce costs of control but may also prevent or at least retard the development of resistance to insecticides in the vector mosquitos.

The determination of an end-point to malaria endemicity in an area has already been discussed. But the point when spraying may be safely interrupted is not necessarily the final end-point of malaria endemicity in a given locality. The Conference suggested that in each country criteria for interruption of residual spraying should be set up by competent authorities who understand thoroughly the local epidemiology of malaria. It seems clear that in some cases selective interruption of spraying can be instituted in a country before the entire area is free from malaria, the remaining pockets of malaria being known and being kept under strict control measures.

In addition to the basic criteria for interruption of spraying, certain safeguards are essential. The Conference agreed that adequate surveillance

of malaria incidence and of the prevalence of malaria vectors should be initiated well before the time of interruption of spraying. Moreover, it should be carried on for a considerable number of years afterwards. Well-qualified and highly mobile surveillance or vigilance units should be independent of local control-units and should report directly to the chief of the national control projects. Annex 5 (see page 42) shows the structure and functions of the vigilance units and sub-units in Ceylon.

The Conference agreed that there should be adequate staff, transport, equipment, supplies, and drugs, with ample budgetary provisions, for immediate emergency resumption of spraying operations wherever and whenever the need arises.

Another important point stressed by the Conference was that places chosen for interruption of residual spraying should be surrounded either by natural barriers or by areas from which malaria is absent or has already been eradicated. Otherwise, there is constant danger of infiltration of malaria-parasite carriers or vectors.

The Conference recognized that the eradication of malaria by residual spraying alone may not be possible in some areas, particularly in those parts of the equatorial, wet, seasonless zones where the habits of the vector tend to reduce its contact with the insecticide. For such areas, the Conference suggested the advisability of considering the abandonment of residual spraying in order to avoid the development of insect resistance to the insecticide. Other methods of control should be substituted for the residual spraying. For example, in certain small *A. minimus minimus* areas, brought to the attention of the Conference, that have not responded to DDT residual spraying for several years, it should be possible to eradicate malaria by a combination of pyrethrum house-spraying, paris-green larviciding, and the appropriate administration of drugs. In other places, the provision of recognized sanitation facilities, to prevent the breeding of the vector mosquito, might be a good investment.

The Conference emphasized that when DDT resistance has developed the simple alternative of replacing DDT by dieldrin, chlordane, BHC, or lindane may not remain effective for long. Experience with the chlorinated hydrocarbons suggests that when insect resistance develops towards one member of the group it may quickly extend to the others. The important point stressed by the Conference is that it is inadvisable to continue *indefinitely* to attempt malaria control by residual spraying with chlorinated hydrocarbon insecticides.

6. RECOMMENDATIONS AND CONCLUSIONS

6.1 Vector species

The Conference,

I. Having noted that malaria transmitted by *A. minimus minimus* and *A. minimus flavirostris* can be controlled by residual insecticides ;

Having been informed of experiments in the control of malaria transmitted by the *A. leucosphyrus* and *A. punctulatus* groups ;

Having been informed of the resistance to DDT and the behavioural change of *A. sudaicus*, and of the effect of residual spraying in malaria transmitted by *A. maculatus*,

RECOMMENDS :

(1) that experimental work on the control of malaria transmitted by the *A. leucosphyrus* and the *A. punctulatus* groups by residual insecticides be continued and extended to other areas, and that field studies on the use of selective herbicides and cultivation for the control of *A. leucosphyrus*-borne malaria be undertaken ; and

(2) that efforts be made to colonize malaria vectors for undertaking fundamental research on biological variations ; and further,

II. Having noted the valuable information on mosquito behaviour and reaction to insecticides that may be provided by the use of experimental trap-huts,

RECOMMENDS that consideration be given to the wider use of trap-huts, especially before undertaking a control project in a new area.

6.2 Resistance to insecticides

The Conference,

Having discussed the first appearance of anopheline vector resistance to DDT in the two regions ;

Having reviewed the recommendations of the WHO Symposium on the Control of Insect Vectors of Disease (Rome, 1953),

RECOMMENDS :

(1) that collection of base-line data in respect of vector susceptibility to insecticides be undertaken ;

(2) that a standard test of vector susceptibility to DDT and similar insecticides be made routinely in the course of nation-wide malaria-control projects ;

(3) that, in the absence of an emergency, chlorinated hydrocarbon insecticides be not used either concurrently or consecutively as both adulticides and larvicides in a given area ;

(4) that, in the interest both of economy and of preventing the development of insect resistance, residual spraying be interrupted as soon as feasible.

6.3 Variations in the malaria parasites

The Conference,

Having considered the probable occurrence of biological and morphological variations in the parasites of human malaria in the two regions, and the scanty evidence of variation now available,

CONCLUDES that more information is required in this important field.

6.4 Radical cure of vivax infection

The Conference,

Having recognized the importance of relapsing vivax infection, particularly in territories where transmission has been arrested by residual insecticides,

CONCLUDES that more information is needed on the sensitivity of *P. vivax* to primaquine and pyrimethamine in the two regions.

6.5 Drugs in spraying campaigns

The Conference,

Having considered the evidence of a slow response of malaria to residual insecticides in some hyperendemic areas,

RECOMMENDS that under these conditions drugs be used as a supplementary control measure to speed the response.

6.6 Cost of malaria

The Conference,

Having reviewed the cost of malaria in terms of physical, economic, and social health ;

Having discussed the benefits that accrue to individuals and communities from malaria control but which frequently have not been clearly defined,

RECOMMENDS that further attempts be made to formulate criteria and units of measurement that will facilitate more accurate assessment and thus bring the benefits of malaria control into sharper focus.

6.7 Cost of control

The Conference,

Having studied the current reports of national malaria-control programmes in countries of the two regions ;

Having noted that nation-wide malaria control by residual spraying continues to be financially feasible ;

Considering nevertheless the possibility that financial retrenchment or curtailment of international aid funds might occur,

RECOMMENDS that malaria-control services investigate increased standardization and possible changes in organization that would lower the per capita cost of malaria control.

6.8 Training and personnel

The Conference,

Recognizing the importance of the recommendations of the First Asian Malaria Conference on training and personnel, and

Having considered this problem in the light of new developments,

RECOMMENDS :

(1) that governments establish strong central and peripheral facilities for training all categories of malaria workers ;

(2) that health ministries recognize the advantages of developing a cadre of malaria workers trained in fundamentals of malaria control and protective surveillance ;

(3) that governments organize and maintain competent protective surveillance units which will initiate their work before the interruption of spraying operations, and which will continue their efforts even when the obvious dangers of malaria have passed ;

(4) that health ministries attempt to furnish additional training and opportunities for re-integration in other phases of public-health work for malaria workers who may become available at the termination of malaria control and surveillance efforts ;

(5) that the malaria organization ensure that trained malaria workers are assigned specifically to antimalaria work without delay.

6.9 Co-ordination

The Conference,

I. Having discussed the conditions required for the successful undertaking of nation-wide programmes of malaria control ;

Noting with satisfaction that present programmes tend progressively to identify their objectives with eradication of malaria ;

Considering that co-ordination in space and time between the anti-malaria activities of various sectors is indispensable in any national programme of malaria eradication,

RECOMMENDS :

(1) that national malaria services be set up with appropriate authority and full technical responsibility in the field of malaria control ;

(2) that national malaria advisory committees be established wherever necessary to co-ordinate all plans and activities of malaria control within the country ;

(3) that antimalaria legislation be enacted, or existing legislation revised, according to modern objectives and methods, with a view to supporting malaria-eradication programmes ; and further,

II. Being convinced of the soundness of the " Recommendation on co-ordination of planning " adopted by the First Asian Malaria Conference, and believing that WHO can effectively stimulate the inter-country co-ordination therein envisaged,

RECOMMENDS :

(1) that the malaria services of the various countries and territories of the two regions inform WHO systematically of the progress of their programmes, and of any new fact or problem in their development, with a view to having this information circulated to the other malaria services in the two regions ; and

(2) that the relevant WHO regional offices explore the possibilities of bringing to the attention of the malaria services any scientific or technical information that might have important implications for the development of the national programmes.

6.10 Standardization

The Conference,

Being aware of the difficulty of comparing reports on antimalaria operations in different countries ;

Recognizing that some patterns of reporting and of calculating costs of operations have so far been satisfactorily followed in WHO-assisted projects in the two regions ;

Recollecting that WHO has published a monograph on malaria terminology, where procedures and techniques for obtaining comparable malariometric data are described, and that its Expert Committee on Insecticides

has proposed a standard nomenclature for insecticides and their formulations and for spraying apparatus and its component parts,

RECOMMENDS that in reporting surveys, operations, and results of antimalaria campaigns and in calculating their costs the national malaria services adhere so far as practicable to the patterns and the terminology proposed by WHO.

6.11 Procurement of equipment

The Conference,

Recognizing the importance of proper equipment capable of continued service under severe field conditions ;

Recollecting that the WHO Expert Committee on Insecticides has set up specifications for spraying equipment to be used in malaria-control operations,

RECOMMENDS that procurement and supply agencies of individual countries or international organizations give particular attention to honouring the specifications of equipment as requested by national malaria services or as recommended by the WHO Expert Committee on Insecticides.

6.12 Ultimate goal

The Conference,

Having reviewed the evidence that it is possible by DDT residual spraying to terminate malaria transmission over wide areas,

RECOMMENDS that the ultimate goal of a nation-wide malaria-control programme be the eradication of the disease.

6.13 Vote of thanks

The Malaria Conference for the Western Pacific and South-East Asia Regions

EXPRESSES its deep appreciation and thanks to all those who have made possible the success of its meeting, namely :

(1) the Government of the Republic of the Philippines, in its capacity of host country, for the hospitality and the facilities provided for in the meeting ;

(2) the Government of the Republic of China, for its kind invitation to hold a post-conference visit to the Malaria Control Project in Taiwan ;

(3) the Secretary of Health and the Department of Health of the Republic of the Philippines, for their co-operation and hospitality ;

(4) the Malaria Control Division of the Health Department of the Republic of the Philippines, for the facilities given to the meeting and for its hospitality ;

(5) the Mayor and City of Baguio, the Baguio Medical Society, and the Rotary Club of Baguio, for the hospitality they have extended to the participants in the Conference ;

(6) the Commanding Officer of Camp John Hay, for the courtesies extended to the participants in the Conference ;

(7) the Superintendent and the Philippine Military Academy, for their hospitality and for honouring the Conference with a military review ;

(8) the Balatoc Mining Company, for making it possible for participants in the Conference to visit its mines ; and

(9) the Management of the Pines Hotel of Baguio, for their co-operation and services.

Annex 1

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- Dr G. Sambasivan, Malariologist, WHO Central Antimalaria Organization, Rangoon, Burma
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Annex 2

LIST OF DOCUMENTS SUBMITTED TO THE CONFERENCE

Published works

- Dy, F. J. (1954) Present status of malaria control in Asia. *Bull. Wld Hlth Org.*, **11**, 725-763
- Farinaud, M.-E. & Choumara, R. (1954) La prophylaxie du paludisme dans les Pays montagnards du Sud Viet-Nam. *Bull. Org. mond. Santé*, **11**, 793-838
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- Vincke, I. H. (1954) Prophylaxie médicamenteuse du paludisme en zone rurale. *Bull. Org. mond. Santé*, **11**, 785-792
- World Health Organization (1954) Control of insect vectors of disease: WHO Symposium, Rome — October 1953. *Chron. Wld Hlth Org.*, **8**, 129-135
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- World Health Organization & Commission for Technical Co-operation in Africa South of the Sahara (1951) Report of the Malaria Conference in Equatorial Africa. *Wld Hlth Org. techn. Rep. Ser.*, **38**

Unpublished working documents

- WHO/Mal/102 Provisional agenda
- WHO/Mal/103.1 Request for information on malaria-control programmes
- WHO/Mal/103.2
to 103.24 Information on the malaria-control programme in the following countries or territories:
- WHO/Mal/103.2 North Borneo
- WHO/Mal/103.3 Hong Kong
- WHO/Mal/103.4 Singapore
- WHO/Mal/103.5 Nepal
- WHO/Mal/103.6 Afghanistan
- WHO/Mal/103.7 China (Taiwan)
- *WHO/Mal/103.8 Cambodia
- WHO/Mal/103.9 Netherlands New Guinea

* In French only

WHO/Mal/103.10	Brunei
WHO/Mal/103.11	Sarawak
WHO/Mal/103.12	British Solomon Islands Protectorate
WHO/Mal/103.13	Philippines
WHO/Mal/103.14	Ceylon
WHO/Mal/103.15	Thailand
*WHO/Mal/103.16	Laos
*WHO/Mal/103.17	New Hebrides
WHO/Mal/103.18	Territory of Papua and New Guinea
*WHO/Mal/103.19	Viet Nam
WHO/Mal/103.20	Burma
WHO/Mal/103.21	India
WHO/Mal/103.22	Portuguese India
WHO/Mal/103.23	Japan
WHO/Mal/103.24	Indonesia
WHO/Mal/104	Malaria research in the South-West Pacific, by R. H. Black
WHO/Mal/105	The role of drugs in the prevention of malaria, by J. W. Field
WHO/Mal/106	The use of antimalarial drugs as adjuvants to DDT in malaria control in Viet Nam, by M.-E. Farinaud
WHO/Mal/107	Selective spraying of premises in the control of <i>minimus</i> -transmitted malaria in Taiwan, by D. J. Pletsch & E. A. Demos
WHO/Mal/108	Economic and social effects of malaria control, with some specific instances from Taiwan, by D. J. Pletsch & C. T. Ch'en
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WHO/Mal/111	A retrospect of thirty-five years of malaria control by anti-parasite measures, by K. Morishita
WHO/Mal/112	Experiences in the control of malaria carried by <i>A. minimus</i> in Burma, by E. B. Weeks
WHO/Mal/113	An experiment in rural malaria control in Malaya, by T. Wilson
WHO/Mal/114	The control of <i>Anopheles leucosphyrus</i> , by J. McArthur
WHO/Mal/115	Behaviouristic change in <i>A. sundaicus</i> and its effect on malaria control in the WHO Project Area, Tjilatjap, Indonesia, during the period 1951-1954, by P. C. Issaris & S. Sundararaman
WHO/Mal/116	Experience with residual spraying of insecticides in the control of <i>A. leucosphyrus</i> -carried malaria in Sarawak, by J. de Zulueta & F. Lachance
WHO/Mal/117	Experiences with DDT residual-spray control of <i>A. minimus</i> -carried malaria in Northern Thailand and <i>A. minimus flavirostris</i> -carried malaria in Mindoro, Philippines, by G. Sambasivan
WHO/Mal/118	<i>Anopheles sundaicus</i> and its control by DDT residual house-spraying in Indonesia, by H. T. Soeparmono & R. L. Laird

* In French only

- WHO/Mal/119 Observations on the behaviour of *Anopheles farauti*, a malaria vector in the Territory of Papua and New Guinea, by R. H. Black
- WHO/Mal/120 The pilot project of residual spraying in Netherlands New Guinea, by D. Metselaar
- WHO/Mal/121 Criteria for discontinuance of residual house-spraying for malaria control in Thailand, by L. Ayurakit Kosol, Udaya Sandhinandh & M. E. Griffith
- Deaths among gravid anopheles which seemed due to a parasite of the eggs, by F. E. Baisas & A. U. Pagayon
- One year's observation on anopheles resting in houses during the day, by F. E. Baisas, A. del Rosario & D. Santiago
- Measurement of superficial areas sprayed with DDT: observations made in Taiwan, China, by P. Echavez
- A new type of microscope for malariology, by J. McArthur
- A note on *A. sondaicus* in Burma, by M. Postiglione & V. Venkat Rao
- The appearance of *A. subpictus* in Biak (Schouten Islands), by H. de Rook
- Control of malaria in Sorong, by H. de Rook

Annex 3

ANTIMALARIA LEGISLATION

The various points that might be covered by appropriate legislation in facilitating activities of a national malaria service are outlined below, as an example taken from the malaria-control programme in Ceylon:

1. The proper authority shall be the Head of the Malaria Service of the country. He, his assistants, and his servants shall have authority to enter premises for the purpose of:
 - (a) investigating malaria cases;
 - (b) determining the prevalence of dangerous anopheles in houses;
 - (c) verifying whether residual insecticide is applied regularly and to the satisfaction of the proper authority;
 - (d) administering radical treatment in those cases where the proper authority considers it necessary.
2. The proper authority shall serve a notice on the owner and/or occupier of premises, calling upon such person or persons to carry out one or both of the control measures listed below before a specified date and time:
 - (a) to prevent or to destroy the breeding of dangerous anopheles;
 - (b) to destroy the adult mosquitos resting indoors.

On the failure of such owner and/or occupier to carry out the measures imposed on him, the proper authority, his assistants, or servants shall enter the premises and carry out the antimalaria measures. The cost of such measures may be recovered from the owner and/or occupier.

3. Any person failing to carry out the written orders of the proper authority or obstructing him, his assistants, or servants from carrying out the order shall be guilty of an offence punishable in a magistrate's court with a fine of . . . or imprisonment for a period not exceeding six months, or both.
4. Malaria shall be made a compulsory notifiable disease in a country or in parts of a country as the objective of malaria eradication is reached.

Annex 4

DATA TO BE INCLUDED IN REPORTING THE RESULTS AND COSTS OF RESIDUAL-SPRAYING OPERATIONS

A. Data on residual spraying

1. Area of operations (square kilometres or square miles)
2. Number of houses and other structures sprayed during the year :
 - (a) first cycle
 - (b) second cycle
3. Population directly protected (i.e., living in sprayed structures)
4. Population protected by other methods of control
5. Surface area covered per spraying (square metres or square feet)
6. Insecticides and formulations used ; total annual consumption in terms of the technical grade (or gamma-isomer) of the insecticide.
7. Average dosage of insecticide applied per square metre or square foot for each spraying :
 - (a) DDT (in terms of the technical product)
 - (b) BHC (in terms of gamma-isomer)
 - (c) Dieldrin (in terms of the technical product)
 - (d) Others (specify)
8. Number of sprayings per year
9. Average amount of insecticide sprayed per capita protected per year
10. Total man-hours or man-days per spraying
11. Average number of hours per man per day

12. Total man-hours or man-days of disinfestors (men who actually spray)
13. Surface area treated per inhabitant directly protected
14. Surface area treated per man-hour or man-day (item 5 divided by item 10)
15. Surface area treated per man-hour or man-day of disinfestor (item 5 divided by item 12)
16. Average number of inhabitants per structure.

B. Costs of the programme per year

1. Total expenditure on insecticides
2. Total expenditure on labour
3. Expenditure on supervisory staff¹
4. Expenditure on transportation : maintenance and operation of vehicles²
5. Expenditure on equipment³
6. Expenditure on contingencies
7. Expenditure per spraying cycle (if spraying is conducted more than once a year)
8. Total expenditure per year
9. Expenditure per capita protected per year.⁴

Annex 5

VIGILANCE IN CEYLON

The system of vigilance carried out in Ceylon in areas where interruption of residual spraying has taken place is as follows :

A. Notification of cases of malaria

1. Officers in charge of medical institutions where treatment of malaria cases is carried out regularly are instructed by the Director of Health

¹ Salaries of the staff belonging to the malaria service at all levels. In some instances, it may be proper to include the relevant portion of the salary of the officials of the health services who are devoting a significant part of their time to malaria control.

² Suggested rate of depreciation : 2% per month.

³ Suggested rate of depreciation for sprayers : 25% per two months' operation.

⁴ When the malaria-control work is a nation-wide project, it might also be useful to indicate the expenditure per capita of the total population per year.

Services to report promptly to the nearest health officer every malaria patient seeking treatment at their institutions, giving the address of the patient to facilitate his being seen in the home by the health officer or by his nominee.

2. A blood film from each case is taken by the officer administering treatment. This is sent to the Central Malaria Laboratory in cases where there are no facilities for such examinations in the institution itself. The results of such examinations are forwarded to the health officer and to the Superintendent of Antimalaria Campaigns. Treatment is administered immediately after the blood film has been taken.

3. The health officer or his nominee, who may be his public-health inspector or the officer in charge of the malaria vigilance unit or sub-unit, will investigate the case and note down the particulars on a special investigation card. The main purpose of the investigation is to find out the source of infection.

4. Further treatment is administered at the home with a view to sterilizing the patient of all malaria parasites.

5. As a safeguard against any officer in charge of the medical institution failing to report genuine malaria cases or diagnosing such cases as due to some other cause, test checks are carried out by officers from headquarters by taking blood films from all cases of fever attending an institution for treatment on one or more days.

B. Vigilance units and sub-units

1. Vigilance sub-units, which have an officer of the foreman class assisted by a field labourer, operate in areas within a radius of ten miles (16 km) from fixed headquarters stations. Their duties are :

(a) On four days a week, they examine fixed catching-stations (12-15) for adult mosquitos. They do hand-catching first and follow it up with spray-catching. Adults caught by hand are sent to the Central Laboratory for identification and dissection, the others are sent in pillboxes for identification and recording. On the same four afternoons, they examine a stretch of a mile (1.6 km) of a selected stream or river in the village area. They also examine all other likely breeding-places of the vector. Specimens so collected are sent to the Central Laboratory for identification with a special report on a specified form. These examinations are normally done fortnightly in selected villages.

(b) Two days in a week are spent collecting blood films, following up reported cases, and looking for others.

2. Vigilance units are manned by specially trained public-health inspectors who are selected on account of their reliability. They have a minimum of two sub-units under them and have their own special stations to visit and examine. The nature of their work is similar to that done by the vigilance sub-units. Their responsibility is greater and their areas of operation are bigger. They are paid a motorcycle allowance and are assisted by a field lieutenant.
 3. Supervising public-health inspectors of the Antimalaria Campaigns have over-all supervision of both the units and the sub-units.
 4. Four regional medical officers of the Antimalaria Campaigns are the administrative and technical judges of the above.
 5. The Superintendent of Antimalaria Campaigns and his senior assistant pay frequent visits to the field and check up on the work. They are assisted by a flying squad stationed at headquarters and directed by the Superintendent, who pays surprise visits to the field units.
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