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WORKING PAPERS, DISCUSSION AND SUMMARY

WORKSHOP SESSION I

CURRENT STATUS OF MALARIA AND MALARIA CONTROL PROGRAMS IN ASIA AND PACIFIC COUNTRIES

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Current Status of Maleria in China

Maleria is one of the major parasitic diseasesin China. During the period of 1930s to 1940s, it was widely distributed nearly all over the country, and provoked disaster in the community. According to the incomplete statistics in 1950s, the annual malaria cases were estimated to be 35 million, and morbidity 6,46% before 1949. Since the founding of the People's Republic, the Ministry of Public Health has paid great attention to the pursuance of the policy of "prevention first" in health and sanitary work, and antimalaria campaigns were launched since 1950. As a result of active implementation of malaria control measures for more than 30 years, the endimic areas have been diminished, malaria hazard dramatically lessened, and the morbidity rate markedly decreased.

In recent years, however, the number of malaria cases in the whole country (Taiwan Province not included, the same below) is continuously decreasing to a low level (Table 1 Incidence of malaria in China, 1980-1983), but the position is unstable as local outbreaks have often been recorded. So at present malaria is still one of the most important parasitic diseases in China. In view of this, the Ministry of Public Health shows deep concern over the strategies to eradicate the disease, which has been listed in the national program of diseases control.

Table 1 Incidence of Maleria in China
(1980-1983)

Year	No of cases	Incidence %	Cases died	Mortality Per hundred thousand
1980	3,300,349	0.33783	64	0.0065
1981	3,059,635	0.307713	70	0.0070
1982	2,041,359	0.20338	61	0.0060
1983	1,377,647	0.13560	40	0.0039

Data collected in 1983 revealed that there were 1,377,647 malaria cases in China, the morbidity being 0.14% and 40 cases succumbed to malaria (Fig. 1 Annual incidence of malaria in China in 1983). Of the total malaria cases reported, 78% (1,077,520 cases, mainly vivax malaria) occurred in Huanghuai plain and Jianghui plain, which are condsidered to be the major malaria endemic areas in China now. In the southern part, the former high endemic areas, including several provinces, autonomous regions and municipalities, prevalence of malaria has been declining steadily to less than 5 per ten thousand. But there are still some high endemic areas, especially on the southeast border, and those inaccessible mountainous areas of poor socioeconomic conditions. The annual prevalence in the northern and northwestern parts has decreased to less than 1 per ten thousand. Of 1,873 counties in 19 previous endemic provinces, autonomous regions and municipalities of malaria, 367 counties with a population of 200,942 thousand were still noted to have malaria morbidity more than 10 per ten thousand (Table 2 Incidence of malaria in former endemic regions).

Fig. 1 Annual incidence of malaria in China in 1983

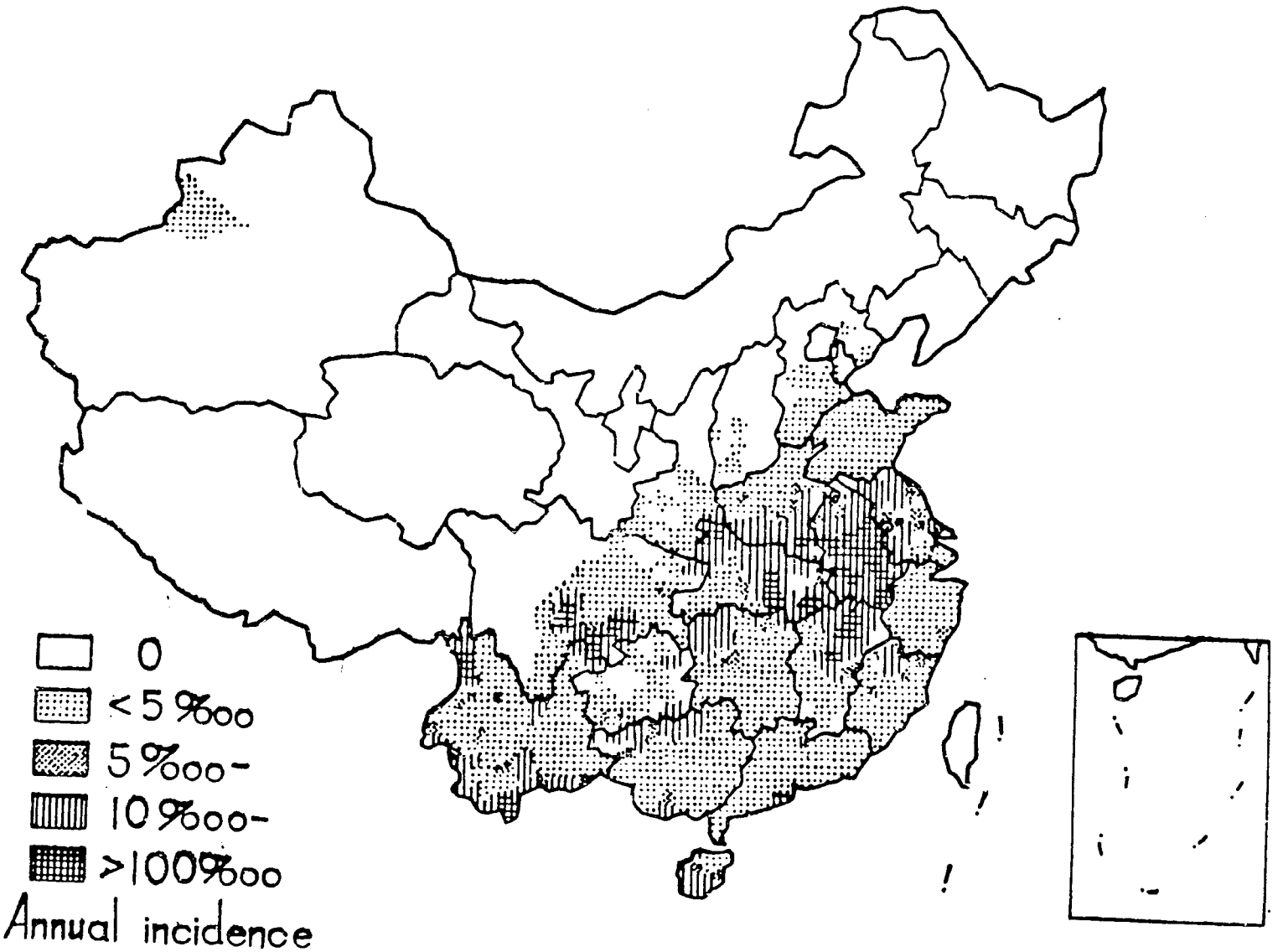


Table 2 Incidence of Malaria in Former Endemic Regions (1983)

Incidence	No. of counties	Population (thousand)
0	389	114,868
<5 o/ooo	1,024	514,536
5 o/ooo-	93	47,226
10 o/ooo -	315	167,756
>100 o/ooo	52	33,186

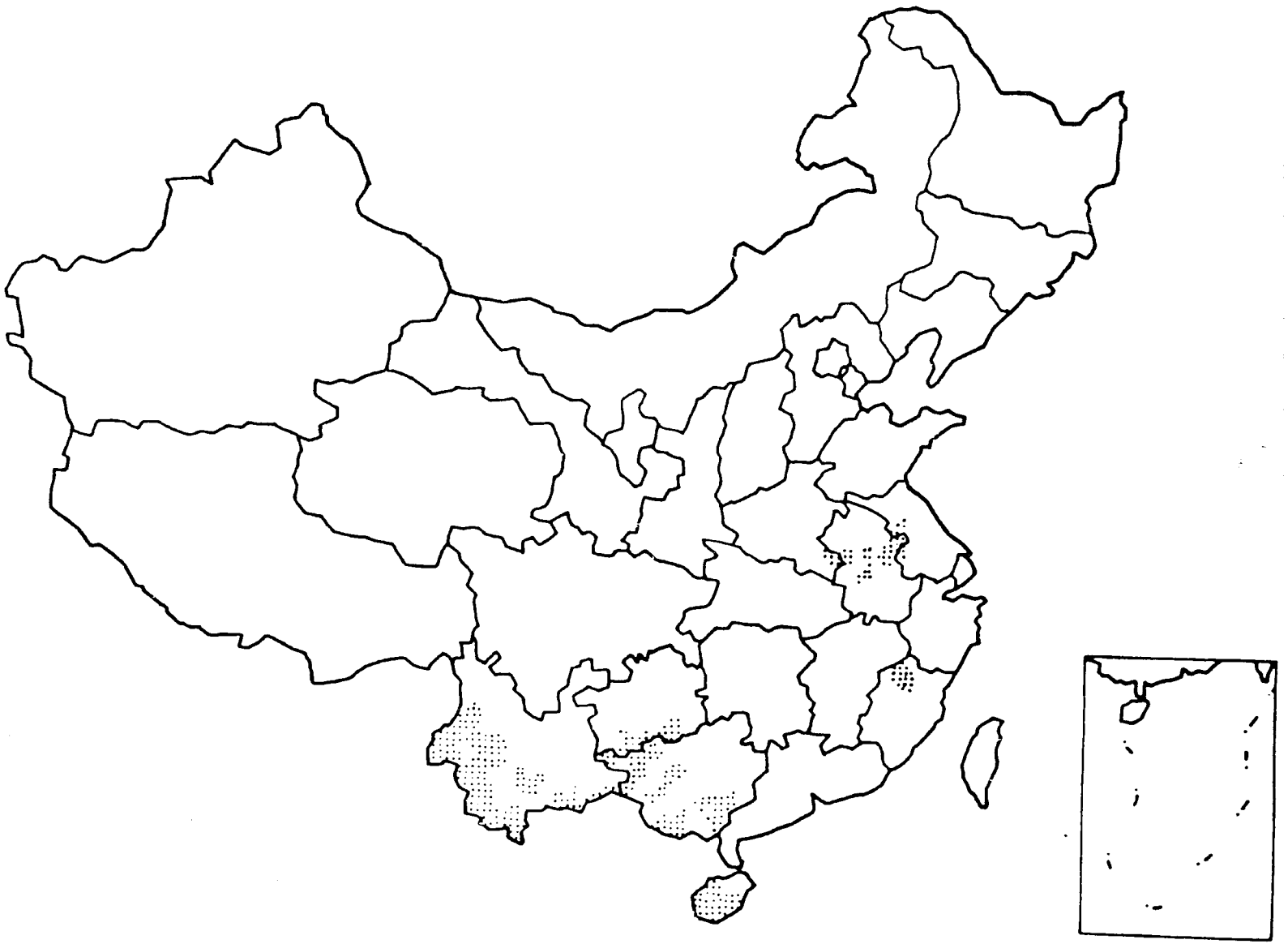
Falciparum malaria was distributed in 8 provinces and autonomous regions in 1983 as shown by active and passive detections (Fig. 2 Distribution of falciparum malaria in China in 1983). In areas south of 25° north latitude including western and southern parts of Yunnan Province, and southwestern part of Hainan Island of Guangdong Province, falciparum malaria accounted for 15% of the total cases, and in certain counties it may reach as high as 30-50%. While in some counties of Jujian and Guizhou Provinces and Guangxi Autonomous Region, falciparum malaria cases amounted to only less than 2.5% of the total cases. As for provinces near 33°ow north latitude, such as Jiangsu, Anhuiand Henan, flaciparum malaria was only endemic in several counties where cases were merely found to 2% of the total. The anopheline vectors of falciparum malaria in China are An. minimus in southern part, An.dirus in Hainnnan Island and An.lestei

thropophagus in middle latitude zone where it is deemed as an important vector of Plasmodium falciparm.

Generally speaking, morbidity may decrease, prevalence can be prevented and achievement consolidated in places where there are perfect health centers at grass-root level with qualified staff and the integrated antimalarial measures have been appropriately implemented. In 1983, by the co-effort of the masses and professional organizations for antimalarial activities, out of 29 provinces, autonomous regions and municipalities in China mainland, 22 with 62.3% of the total population showed morbidity of malaria lower than 5 per ten thousand (Fig. 3 Incidence of malaria in 29 provinces, autonomous regions & municipalities in 1983). Among which 13 with 23.5% of the total population were reported that malaria cases were continuously decreased to less than 1 per ten thousand for 4 consecutive years since 1980.

In the meantime there are three situations which hinder the progress of antimalaria activities and the defence of acquired achievements. The first one is in Huanghuai plain and Jianghan plain (as mentioned above), where vivax malaria is the predominant species and An.sinensis, the only vector. As the vector has exophilic habit, indoor residual spraying measure is uneffective. Besides, the majority of inhabitanta have out-door sleeping habit in summer-autum, so man-mosquito contact is very frequent (Table 3 Incidence of mnalaria in the 5 provinces in Huanghuai & Jianghan plains, 1980-1983). It has been demonstrated that the degree of

Fig. 2 Distribution of falciparum malaria in China in 1983



resistance in the southern part is higher than that in the northern. And it is also found that the resistant P. falciparum has a tendency to spread northward.

Table 3 Incidence of Malaria in the 5 Provinces in Huanghuai and Jianghan Plains (1980-1983)

Year	No. of Cases	As a proportion of the total cases in whole country %
1980	2,798,274	84.79
1981	2,637,436	86.20
1982	1,709,606	83.75
1983	1,077,520	78.21

Under the guidance of malaria control policy: "active control, prevention of prevalence, and finally attain the goal of eradication", now the general task of antimalaria programme is "to prevent outbreak of malaria, to further decrease malaria morbidity, to enlarge the under-controlled area steadily, and to give priority to the implementation of control measures in those areas where malaria prevalence is higher than 1% and where falciparum malaria is still endemic". The target of malaria control programme by the year 2000 is to reduce malaria morbidity to less than 1 per ten thousand in the whole county. In other words, the programme will be synchronized with the achievement of reconstruction to reach a comparatively well-off life level of the whole country. And it will also be in parallel with World Health Organization: "Health for all by the year 2000.

As for malaria vaccine, which serve as a means of prevention for malaria, might acquire worth-while position and play suitable role in malaria control and the protection of people's health as well. For the time being, effective malaria vaccines if available, would prevent the constructors, troops, travellers and children under 6 years from malaria hazard in our country.

On this account, the production of large amount and supply of sufficient quantity of malaria vaccines are expected. Furthermore, easy to preserve, transport and use with no marked side-effect and a reasonable price should be taken into consideration.

It is desired that the idea of developing malaria vaccines could be realized in the near future.

Compiled by Zhou Zu-jie

Fig. 3 Incidence of malaria in 29 provinces, autonomous regions & municipalities in 1983

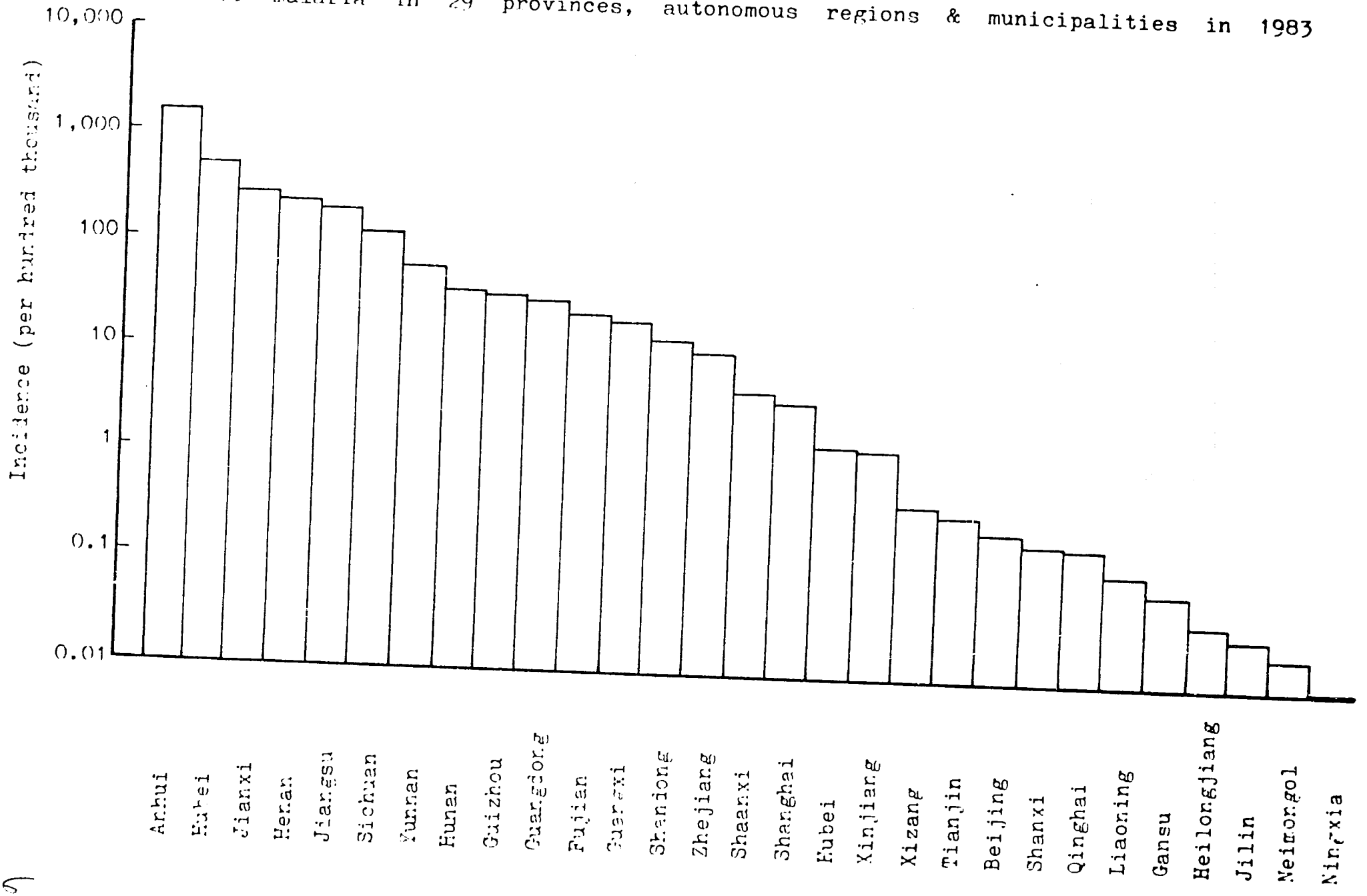
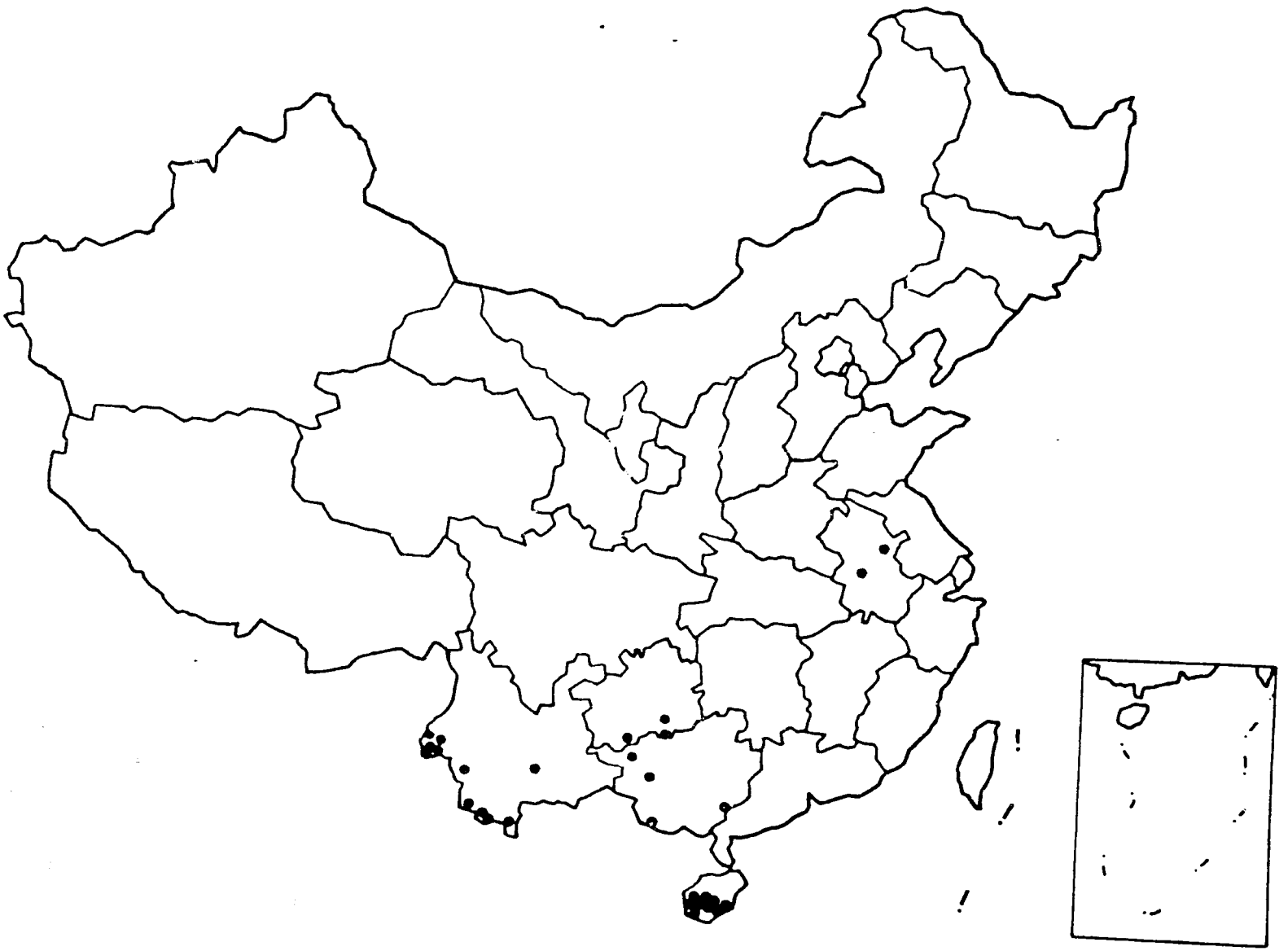


Fig. 4 Distribution of chloroquine resistant *P. falciparum* in China



WORKING PAPER

MALARIA IN THE SOUTHWEST PACIFIC -- A PROTOTYPE DEFINED POPULATION FOR VACCINE TRIALS

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INTRODUCTION

In 1900 Robert Koch studied the effects of quinine on malaria near Madang, Papua New Guinea. The results of his work were interpreted by some as proof that it is possible using quinine alone "to reduce the disease to a minimum or *even make it disappear altogether*" (1). Half a century later, following research carried out prior to and during World War II, it was decided that the malaria problem in Papua New Guinea could be solved by the use of residual insecticides. In 1957 Wallace Peters, malariologist to the Territory of Papua and New Guinea, commenced a pilot project using DDT residual spray at Maprik, East Sepik (2). On the basis of the success of this project an eradication campaign was proposed, and between 1959 and 1963 inter-territorial meetings of representatives from West Irian, Papua and New Guinea, Australia and the Solomon Islands were held with the objective of coordinating anti-malarial activities. A large infra-structure was created and resources commited toward the eradication of malaria. Scaled down in objective to malaria control, the program has continued over the past 25 years -- with more success in some areas than in others. Reductions in resource commitment, lack of adequate field supervision, poor compliance on the part of covered populations and in-attention to many of the broader aspects of malaria epidemiology are some of the problems that have confronted malaria control programs. Consequentially, it is difficult to interpret official figures, evaluate existing or proposed control measures, or make informed policy decisions on alternative courses of action. Rumors of treatment failure and drug resistance cannot always be followed up by carefully conducted trials; and reported increases in incidence or severity of acute malaria cases are often neither well-documented nor can they be evaluated against a defined baseline. In 1985 the prospect of an antimalaria vaccine again raises hopes and expectations for a solution to the malaria problem. Optimism regarding its role and effectiveness should

be tempered by the reflection on the reasons for lack of success in the past. Failures have rarely been exclusively attributable to limitations of the technology itself. The objectives of this paper are to 1) briefly summarize the current status of malaria in selected areas of the Southwest Pacific, 2) describe the experience of defining and monitoring a study population in Papua New Guinea in which a vaccine could be tested, and 3) outline practical considerations in terms of expectations, selection of target populations, and problems of large scale administration of a vaccine in the Southwest Pacific once one becomes available.

STATUS OF MALARIA IN THE SOUTHWEST PACIFIC

Several areas in the Pacific Basin including New Zealand, Micronesia, Polynesia and some of the island groups of Melanesia have never been malarious due to the absence of anopheline vectors. While endemic malaria has been eliminated from Australia, it remains a major public health problem in Papua New Guinea, the Solomon Islands and Vanuatu. In the 1950s and 1960s there was general optimism that malaria eradication could be achieved through residual insecticide spraying given sufficient resources. In Papua New Guinea the spraying program was initiated following a pilot project in 1957 (2), and was gradually expanded to cover nearly half of the country's population by 1971 (3). There was initial reduction in malaria in all provinces where DDT was applied; however, transmission was never interrupted and parasite rates rose again to original levels during the 1970s. In 1972 following the recommendations of a WHO Assessment Team (4), the program was reorganized with the major objectives being changed from eradication to control; but DDT remained the only control measure and no changes in methodology were considered. In 1984, following further deterioration of the program, another WHO Assessment Team (5) recommended that residual spraying be discontinued in all provinces as

a routine malaria control measure. Evidence of lack of effectiveness on a country-wide basis is presented in Table 1.

Malaria endemicity varies throughout Papua New Guinea and the country can be divided into 4 regions: the highlands; the New Guinea mainland; the New Guinea Islands; and the Papua region. Figure 1 shows the pattern of geographic variation in malaria endemicity within the country. The principal vectors throughout the country are members of the Anopheles punctulatus complex: A. farauti; A. punctulatus; and A. koliensis. Transmission is perennial with some variation from the dry to the wet season occurring in most areas. Plasmodium falciparum is the predominant species. The change from a predominance of Plasmodium vivax to P. falciparum has been noted since 1972 (5). However, there is some evidence that P. vivax was dominant in the 1950s, prior to initiation of spraying (2,6). Thus the change in species dominance many not be entirely related to cessation of spraying. Chloroquine resistant strains of P. falciparum, first confirmed in 1976 (7,8), are now widespread. In the area of Madang on the North Coast of Papua New Guinea, 84 of the 103 infections tested in vitro were resistant to chloroquine, but only 48 showed resistance in vivo. Of those resistant in vivo, 43 (89.6%) were at the RI level. Resistance to Fansidar (pyrimethamine 25 mg plus sulfadoxine 500 mg) has also been reported (9).

In the Solomon Islands, optimism regarding eradication persisted longer than in Papua New Guinea. Levels of endemicity prior to initiation of spraying are also shown in Figure 1. The existing Malaria Eradication Program was more aggressive and included mass drug administration and other supplementary measures in addition to residual insecticide spraying (10). In 1973-1976 progress was reported to be hindered mainly by persistent foci in areas of high endemicity in north Guadalcanal (11,12). Since 1977 the resurgence of malaria has become

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one of the biggest health problems in the country (13). Epidemic in proportion, it is characterized by a predominance of P. falciparum as in Papua New Guinea. Chloroquine resistant strains, first reported in 1980 are now widespread. Approximately 50% of P. falciparum infections are currently resistant, but an estimated 95% of these are at the RI level (D. Parkinson, personal communication). Although pyrimethamine resistance has been shown to exist (14), no resistance to Fansidar has been reported.

The malaria situation in Vanuatu, although previously characterized by somewhat lower levels of endemicity (Fig. 2), would appear to be facing problems similar to those encountered in Papua New Guinea and in the Solomon Islands (15). Some of the reasons for these problems are discussed later in this paper.

It is somewhat difficult to interpret data reported from official sources on the status of malaria and its control based on passive case detection, index village monitoring and mass blood surveys. Blood slides are not always prepared from fever cases, quality control in slide preparation and microscopy is sometimes neglected, and in many areas populations have become less willing to participate in routine malariometric surveys. These data would not be adequate for use as a baseline for evaluating vaccine effectiveness at least in Papua New Guinea. Thus even for narrowly defined populations, baseline epidemiological data will need to be collected to establish prevalence, transmission dynamics and variations in parasite populations well in advance of the advent of a vaccine if well-controlled trials are to be conducted. A major objective of this paper is to describe a multidisciplinary approach to the development of a defined population in which vaccine efficacy could be tested.

DEFINED POPULATIONS FOR VACCINE FIELD TRIALS

Three alternative populations in which a vaccine could be tested in Papua New Guinea include: 1) migrant labour or armed forces moving from non-malarious to malarious areas; 2) community schools in endemic areas; and 3) village populations in endemic or epidemic areas. The choice of population would be contingent on preliminary assessment of the efficacy and safety of a candidate vaccine. Non-immunes from the highlands migrate to lowland areas to work on plantations, for logging companies and for resource exploration and mining enterprises. Although there is some turnover in the work force, employment records are normally well kept and employees often live within compounds in housing provided by the company. Informed consent, enrollment and followup would be facilitated in this type of population; but care would have to be exercised that participation was not perceived as a contingency to continuing employment Non-immunes also migrate to towns on the coast seeking employment; since such migrant groups tend to live together in small settlements and form an identifiable community followup of individuals is feasible. Children attenting community schools in endemic areas constitute another possible population in which to evaluate efficacy of a vaccine. Again enrollment and followup would be relatively easy, but monitoring morbidity on non-school days and during vacations would pose problems. Also, the safety of the vaccine would have to be unquestionable and the ethics of informed consent resolved before considering a trial in this age group. Village populations in endemic or epidemic areas would be a third type of population in which to field test a vaccine. The Papua New Guinea Institute of Medical Research (PNG IMR) has over the past 3 years defined a study population near Madang on the North Coast of Papua New Guinea in which a vaccine might be tested. Using a multidisciplinary approach, we feel that our experience may be helpful to others planning to initiate baseline data collection with the eventual goal of evaluating a vaccine.

In a study population of approximately 16,500 we have integrated laboratory based studies and an extensive field program to obtain data on the prevalence of malaria, transmision dynamics, antibody profiles of the population, antigenic variation in parasite populations, drug sensitivity of P. falciparum, and use of antimalarial drugs. The population has been completely characterized demographically, and migrations in and out are routinely monitored. Attempts to assess morbidity and document mortality were carried out over a 2-year period and preliminary studies of genetic variation within the population have been conducted.

The study area (Fig. 3) has been described elsewhere (16). There are 72 villages in the area which vary in size from 50 to 700 inhabitants. The larger of these villages are often divided into geographically discrete hamlets. Demographic data on the population was compiled through a house to house census conducted by the PNG IMR in 1981. Information recorded on census forms and stored on each individual includes: a unique ID number; house number; sex; actual date or estimated year of birth; names of parents; marital status; date of in- or out-migration; and date of visits by census workers. The study area was divided into 8 census units each containing approximately 2000 persons. A resident recorder reports births, deaths and migrations on a monthly basis, and these data are entered on computer files. A full census is conducted annually to validate the results of the reporting system.

Cross-sectional malariometric surveys were conducted at 6-monthly intervals in both the wet and the dry seasons. Systematic random samples of 20-house clusters were designed to include 25% of the population at each survey. An index house was selected at random and the clusters were generated from complete house lists maintained by the demography unit. Sampling was with replacement. Compliance rates were highest in the first 2 surveys (>80%) and dropped to approximately 70% in the following 2 surveys. Data collection included

preparation of thick and thin blood films and spleen palpation on the full sample. Whole blood was collected in microtainers from a subsample for serology and hemoglobin estimation. Parasite isolate typing was carried out in later surveys. Urine samples were collected from approximately 40% of the sample in the fourth survey for determination of presence of 4-aminoquinoline anti-malarial drugs. Both in vitro and in vivo chloroquine sensitivity tests were carried out in the population during the period of the cross-sectional surveys. Laboratory methods used in processing the samples are described elsewhere (16).

Entomological data were gathered concurrently in selected villages maintained as part of a longitudinal study within the area. A morbidity questionnaire was used to ascertain the incidence of fever and other symptoms over a 2-week recall period each 3 months in this same subset of villages. A senior member of each household was the principal respondent and interviews were conducted with those reported as having been ill by medically or paramedically qualified staff members. All reported deaths, whether occurring in hospital or in the villages were followed up by a physician and a cause of death was assigned to each case using a protocol designed and pre-tested for this purpose.

Results of the malariometrical and morbidity surveys and the mortality followups are reported elsewhere (16-18). Data on prevalence of anti-malarial drugs, genetic variation within the study population, and preliminary data on antigenic variation in parasite populations in the area suggest that these are factors that must be investigated, possibly in pilot studies, prior to the selection of populations in which to test a vaccine. Population mobility should also be assessed prior to initiation of trials. We found that 12.7% of urine samples tested using Dill-Glazko reagent showed strong positive reactions for 4-aminoquinolines. If a lighter color precipitate was accepted as positive the percentage was much higher. Problems of sensitivity and specificity are known to be associated with this test (19) but queries regarding use

and sources of supply of antimalarials tended to substantiate the widespread use of chloroquine and amodiaquine. The need for a micro assay for serum levels of chloroquine that could be performed in the field is clear. An extraordinarily high frequency of α globin gene deletion (>90%) was observed in this population (20,21), and variations in frequency of ovalocytosis (20.4 to 31.4%) appeared to exist between the north and south of the study area (22). G-6-PD deficiency and β thalassemia were also shown to be present but at frequencies < 10% (unpublished data PNG IMR). Many of these genetic polymorphisms are also known to occur in Southeast Asia, and populations in this area should be evaluated for presence of these traits prior to their inclusion in vaccine trials. In- and out-migrations of 5.6% and 5.3% respectively were mainly internal to the study population, but short-term mobility (< 3 months absence from the village) was relatively high. This aspect of a population must also be considered in studies in which followup will be critical.

Antigenic diversity in primary isolates of P. falciparum collected in Madang was demonstrated using monoclonal antibodies (23). One antigen previously shown to be absent in $^1/_3$ of isolates from different countries was present in all 108 isolates from this sample. The preliminary studies using monoclonal antibodies suggest significant genetic diversity of parasites that may be geographic-specific in nature. Characterization of populations of P. falciparum with monoclonal antibodies could provide information highly relevant to vaccine evaluation. Attempts to monitor malaria morbidity on a large scale at the village level would appear to be difficult from our experience. Severe episodes of malaria such as cerebral malaria are relatively infrequent in the area; therefore reduction in these episodes could not be used as an outcome measure. Even with a medically qualified observer stationed in each village, episodes of fever in dispersed hamlets would be likely to be missed, and staffing requirements would be unrealistic in areas of scattered rural populations. Mortality that can be directly attributed to malaria in this

area is low (18); therefore, demonstrating reductions in mortality would be difficult in this population.

Our experience has confirmed the importance of having good laboratory facilities available at a field site along with a complement of scientists to integrate studies of the immunology, parasitology and epidemiology (including entomology) of malaria. Micro assays which could measure protective immunity and serum chloroquine levels in the field would also greatly enhance the ability to evaluate a vaccine.

PRACTICAL CONSIDERATIONS OF A MALARIA VACCINE

Setting aside questions of the feasibility and proximity of a safe, effective vaccine to be addressed later in this conference, several issues will have significant impact on the success or failure of vaccination as a control measure for malaria in the Southwest Pacific as well as in other areas of the world. These issues can be somewhat arbitrarily divided into three categories: 1) expectations for a vaccine; 2) factors affecting the feasibility of administration of a vaccine to populations at risk; and 3) issues related to the longer-term implications of dependence on vaccination as a control or eradication strategy. The first of these categories encompasses differing expectations among politicians, health professionals and affected populations. The second includes potential political, economic and sociocultural constraints that can affect the planning and implementation of vaccination campaigns. The third covers epidemiological issues that must be considered in assessing the degree to which vaccination would be an acceptable control measure. The desirability of an integrated approach to control -- combining a variety of methods -- is stressed.

Expectations for a malaria vaccine

The Papua New Guinea Institute of Medical Research has received queries

from members of the press and officials within government asking when the malaria vaccine will be available to the people of Papua New Guinea -- the implication being that a vaccine now exists and that it is a question only of timely distribution. Lack of information and unrealistic expectations on the part of decision making bodies may lead to unwarranted decreases in commitment of resources to other forms of malaria control in anticipation of an imminent solution to the malaria problem. Receiving the impression from the media that a vaccine is close to a reality, they may also begin to question commitments to malaria research in general and to on-going evaluation of other forms of control -- thereby reducing the possibility of an integrated approach to malaria control for the future. In areas where village populations have become routine consumers of health care, some already ask when a "sut" (Melanesian Pidgin for injection or vaccine) will be available to protect them against malaria. The easiest but unfortunately not the most responsible answer would be that a vaccine may soon be available. In the end an answer of this nature is likely to contribute to a reduction in the credibility of the health care system in general and an increasing reluctance among villagers to support and/or participate in other forms of control. We believe that health professionals and researchers have an obligation to provide accurate information and to make an effort to temper excessive enthusiasm and probably misplaced confidence in a vaccine as the definitive solution to malaria. Realistic expectations should centre around its use in selected target populations and as a complement not a replacement for other control measures.

Political and economic factors

One does not need to look far to find examples of disease control programs that have failed owing to insufficient commitment of resources. Some of the problems associated with conventional malaria control or eradication programs have included: lack of funds to attract and hold adequate staff; administrative

complexities hindering recruitment and employment of personnel; budgetary delays affecting purchase of supplies; and bureaucratic procedures affecting the timely delivery of supplies and equipment (24). Other difficulties have included inadequate staff training, problems of morale and maintenance, and competing priorities when modest success is reached -- to mention only a few. Health delivery systems are subject to many of the same problems, and there is reason to expect malaria vaccination campaigns will suffer from these and other difficulties. It is unlikely, given the nature of vaccines currently under development, that a malaria vaccine would be a sufficient control measure in isolation. Vaccination will have to be combined with other existing measures, thereby increasing the already considerable burden on resources required for malaria control. The efficacy, feasibility of administration, and cost of a malaria vaccine may weigh against its acceptability for widespread application in developing countries like Papua New Guinea with chiefly rural populations. Target populations may be apathetic or even offer resistance to receiving the vaccine. The vaccines currently under development are likely to require re-vaccination to ensure continued protection, and even with long term vaccines such as typhoid, tetanus, polio, and yellow fever the administration, cost and acceptance factors have greatly limited success. These are examples of the internal problems facing prospective vaccine administration.

The magnitude of resource commitment, approach (i.e., integrated with existing health delivery or administered independently), complementary control measures, selection of an appropriate target population and effectiveness of long term planning could increase the potential for success of vaccination as a control measure. However, it is probably not reasonable to expect the same degree of success as that achieved in eradication of smallpox. Attempts to control malaria by vaccination might be more appropriately compared with measles. In West Africa, programs in the late 1960s and early 1970s succeeded

in significantly reducing measles incidence and mortality, but these declines were not sustained over time. The reasons suggested for diminishing success included the necessity for mass campaigns every six months, difficulties in storing and transporting the vaccine, and the high costs of delivery in rural areas. Once foreign assistance was withdrawn, the West African governments became unwilling or were unable to assume the costs of the vaccination campaigns, and measles incidence returned to its former levels (25). This does not imply that a malaria vaccine could not play an important role in malaria control strategies. Given the limitations of the prospective vaccines, however, it would be unrealistic to think that they will provide a definitive solution.

Sociocultural issues

Many factors affect the response of people with different cultural identities to immunization programs. These include but are not limited to: beliefs, knowledge, perceptions about preventive medicine, and attitudes toward health workers (26). Whether or not people in high risk areas will accept vaccination must be considered in the context of what motivates individual and group innovation. Foster and Anderson (27) suggest that people will accept innovation if: 1) they perceive social, psychological, health or other advantages as a result; 2) they can afford the economic costs; and 3) the social costs do not outweigh the advantages. One obstacle to acceptance of vaccination against malaria may be the manner in which malaria is perceived in highly endemic areas. Adults develop a level of acquired immunity and symptomatology is usually infrequent. People are infected throughout their lives, making comparison with a malaria-free state of health virtually impossible.

Inhabitants of Papua New Guinea represent many cultures and each small community has a unique political/socioeconomic structure. The nature of the cultures and the characteristics of the communities will have major impact

on the level of participation obtained in vaccination campaigns. Malaria vaccination campaigns will be faced with the same sociocultural problems that the WHO eradication campaign experienced -- including ignorance and/or disregard for important biological and ecological factors. In order to ensure optimum participation rates, these aspects must be carefully considered and addressed in both planning and implementation of programs.

Epidemiological considerations in the role of a vaccine

The place of a vaccine in malaria control or eradication depends on both the local epidemiology of the disease and operational facilities. The epidemiology of malaria in Papua New Guinea as elsewhere varies between different areas of the country, and often within a single area over time.

First we consider vaccination as a control strategy in the case of unstable malaria. Since protection of nonimmunes by a high level of immunity in the population is not operative with malaria vaccination, and the expected duration of vaccines currently being developed may be relatively short, the entire population of epidemic areas would have to be vaccinated and revaccinated at regular intervals to provide adequate protection. Priorities would have to be established to determine where to focus vaccination efforts -- these could be geographical, age-specific, occupation-specific, etc. Effectiveness, as with other control strategies, would depend on the regularity and thoroughness of the efforts to vaccinate and revaccinate the target populations as well as on the effectiveness of the vaccine. In areas where malaria is endemic and stable, the target groups could be more easily selected since morbidity and mortality are clearly more severe in early childhood, among pregnant women and in migrants from non-malarious areas. Again, thoroughness and persistence would be key factors. Risk of infection would have to be evaluated as vaccine protection is allowed to fade.

Decisions regarding the extent to which vaccination might be effectively practiced will depend upon the local epidemiology of malaria, the efficacy of the vaccine and available resources. Good epidemiological baseline data will be necessary to determine the extent of the problem, as well as to evaluate vaccine effectiveness. It must be kept in mind that nutritional status, socioeconomic conditions and general access to health services have major impact on health status, and therefore on incidence, prevalence and intensity of malaria. Acquired immunity offers protection from severe clinical disease, but it also may tax the entire social structure through its effects on the general level of health of the population. It is possible that sterilizing immunity in the short-term could lead to increased susceptibility in the long-term, with increased morbidity and mortality. On the other hand, it is possible that a vaccine developed against a novel immunogen (such as a key receptor site) which established an immunity against which the parasite had no inbuilt counter-strategies could result in a powerful long-term protection, which would be significantly better than the fragile immunity which slowly develops in people growing up in an endemic area. Though we can not presently expect to develop a vaccine of such power -- and we should certainly not create such expectations in the people living in endemic areas -- this possibility should not be lost sight of : and not only to feed the optimism of research workers in the field!

Effectiveness of available methods, resources, sensitivity to attitudes and preferences, and some degree of local responsibility are important issues in the success of a control program. Integration of existing and potential methods -- including chemotherapy, insecticides, biological control of vectors, environmental modification, human behavioral modification, use of bed nets and other means of reducing vector-person contact, health education, and vaccination -- must all be considered in the design of a balanced approach for Papua New Guinea and the rest of the Southwest Pacific.

TABLE 1. Comparison of results of passive case detection January to June in sprayed and unsprayed areas 1980-1983.*

	1980	1981	1982	1983
Sprayed areas				
Slides examined	104 905	119 493	121 279	114 933
Slides positive	41 194	39 225	43 519	46 726
Slide positivity rate	39.3%	32.8%	35.9%	40.7%
P. falciparum %**	74.4%	77.0%	76.7%	81.6%
Unsprayed areas				
Slides examined	55 975	56 132	43 012	36 895
Slides positive	23 108	20 057	17 333	15 898
Slide positivity rate	41.3%	35.7%	40.3%	43.1%
P. falciparum %**	78.5%	80.5%	78.5%	78.0%

* Source: WHO Assignment Report (5)

** Whole year

Hyperendemic

Mezoendemic

Hypoendemic

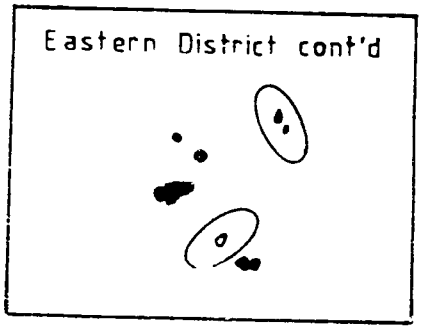

Figure 1. Endemicity of malaria in Papua New Guinea and the Solomon Islands prior to malaria control programs. Adapted from Parkinson (3) and Avery (10).

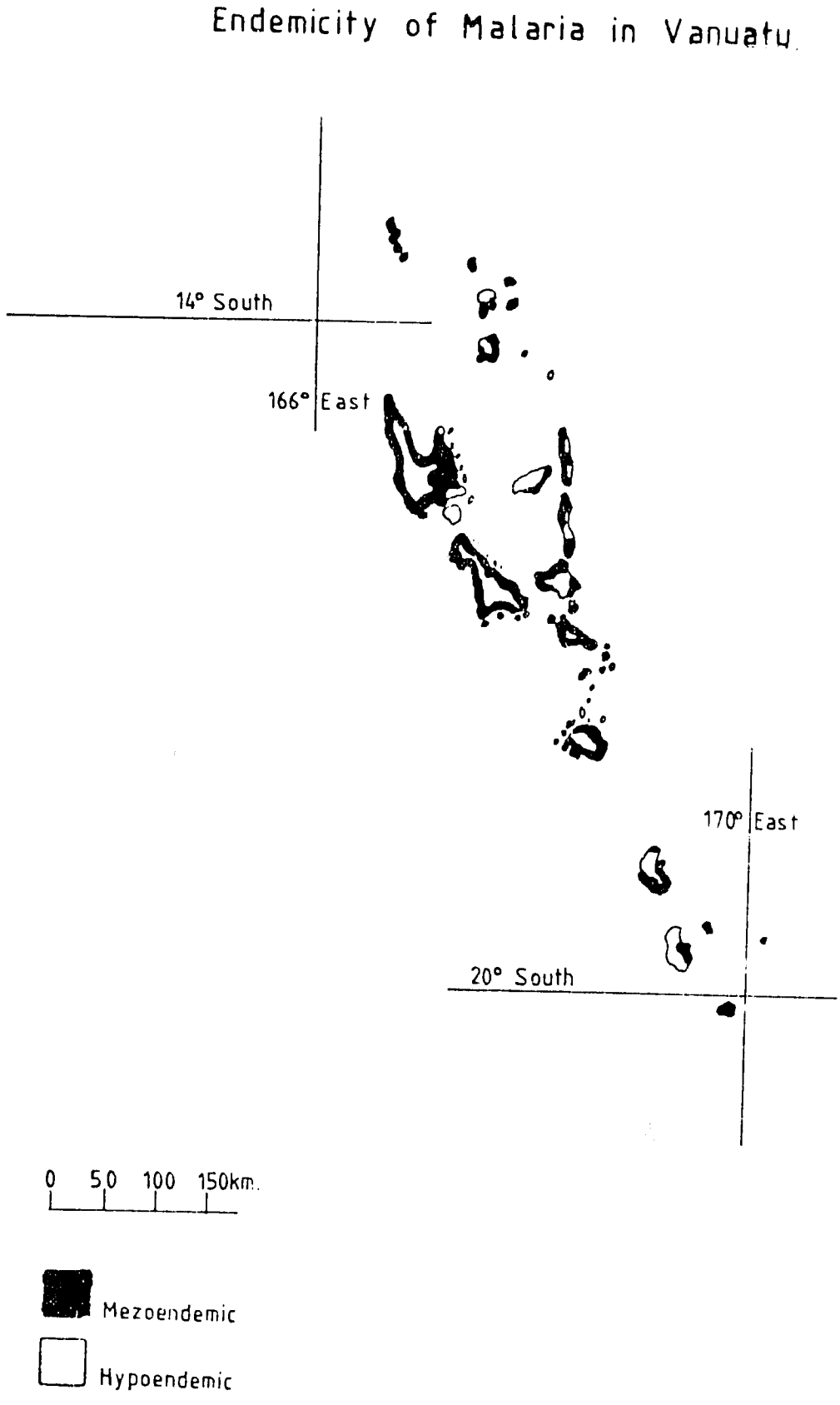

Figure 2. Endemicity of malaria in Vanuatu. Adapted from Ratard (15).

P.N.G. INSTITUTE OF MEDICAL RESEARCH
MALARIA RESEARCH PROGRAM
STUDY AREA

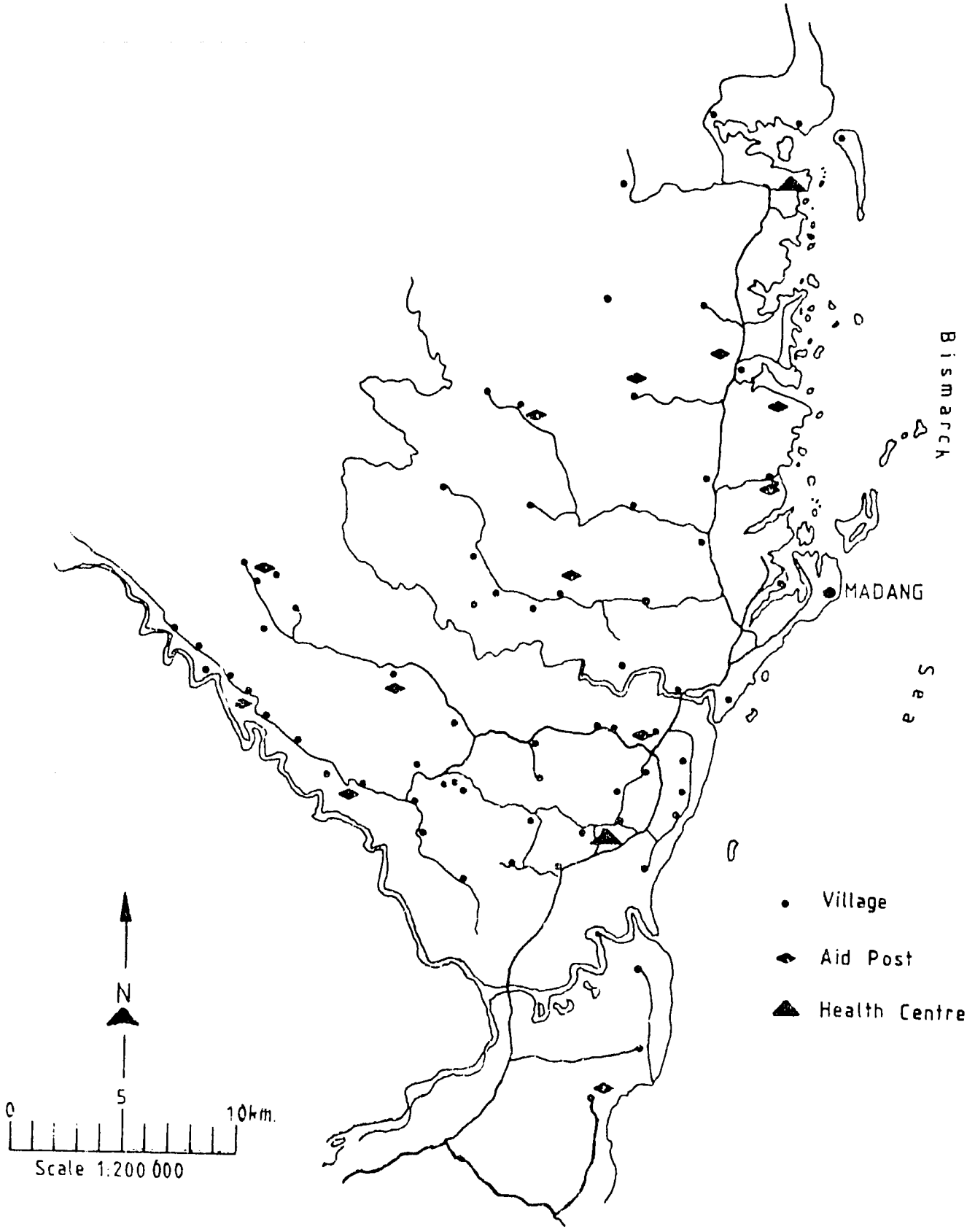

Figure 3. Malaria research program study area, Papua New Guinea Institute of Medical Research.

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Status of Malaria in the Philippines 1984

I. INTRODUCTION

The Philippines lies in the Western Pacific Region bounded on the North by Taiwan, on the East by the Pacific Ocean, on the South by Borneo and the Celebes Seas and on the West by the China Sea. It is composed of 7,100 islands with a total area of 115,707 square miles. The entire country is about 65% mountainous with a tropical climate and divided into twelve (12) health regions. (Attached Map No. 1)

Malaria has long plagued the people and a centralized Malaria Control/Eradication program was established to solve this health problem. In line with the present global strategy, the conventional concept in the campaign to control and eventually eradicate malaria in the country has been modified by utilizing the Primary Hwealth Care approach whose foundations are appropriate technology, sectoral linkages, community participation and self-reliance. To support this strategy, Executive Order No. 851, dated December 2, 1982 has integrated the Malaria Program to the Field Health Services of the Ministry of Health, wherein the control operation has become a partnership with the community.

II. EPIDEMIOLOGICAL FEATURES

The general epidemiological picture of malaria is summarized below:

1. Endemicities varies from hypo to hyperendemicity, unstable and prevalent in almost all provinces.

2. Due to breeding preference of the principal mosquito vector, malaria occurs in the rural areas and is absent in the urban areas.

3. Transmission is perennial with two peaks, during the start and during the end of the rainy season.

4. All the three species of plasmodia are found. The predominant specie at the moment is P. falciparum with the ration: about 65% is P> falciparum, 35% P. vivax P. malariae is rare and no. P. ovale

5. Malaria vectors are zoophilic and prefers to feed on animal blood.

6. There are four (4) anopheline species of malaria vector. The principal malaria vector is An. flavirostris and this prefers to breed in slow flowing, clear and partly shaded streams. Other an. species are An. mangyanus, An. litoralis and An. balabacensis

III. STRATEGY

The strategy is basically control using combinations of insecticide residual spraying of houses, biological control, environmental management, personal protection measures to avoid mosquito bites such as sleeping under mosquito nets, screening houses, use of protective clothing, use of mosquito repellants either chemical or smoke, diverting mosquito bites by tying work animals near houses and surveillance measures utilizing the Primary Health Care approach.

The priority in implementing the appropriate control measures is on selected communities which are categorized according to endemicity and economic importance. Transfer of technology to the community is done until they develop the capability to implement the appropriate control measures, Health education, information dissemination and training is a continuing activity. Residual spraying of houses, environmental management, and biological control is done through community participation under the technical supervision of trained government personnel. Case finding, and drug administration is done by the Barangay Health Workers (Volunteers) in their respective catchment area of twenty (20) families.

Epidemiological investigation of areas and institution of remedial measures is undertaken by a team of government health workers under the supervision of an epidemiologist.

To maintain a regular monitoring and evaluation of the malaria activities in the field, copies of reports is requested from the Health Information Service of the Ministry of Health and quarterly field visits is done from the headquarters level.

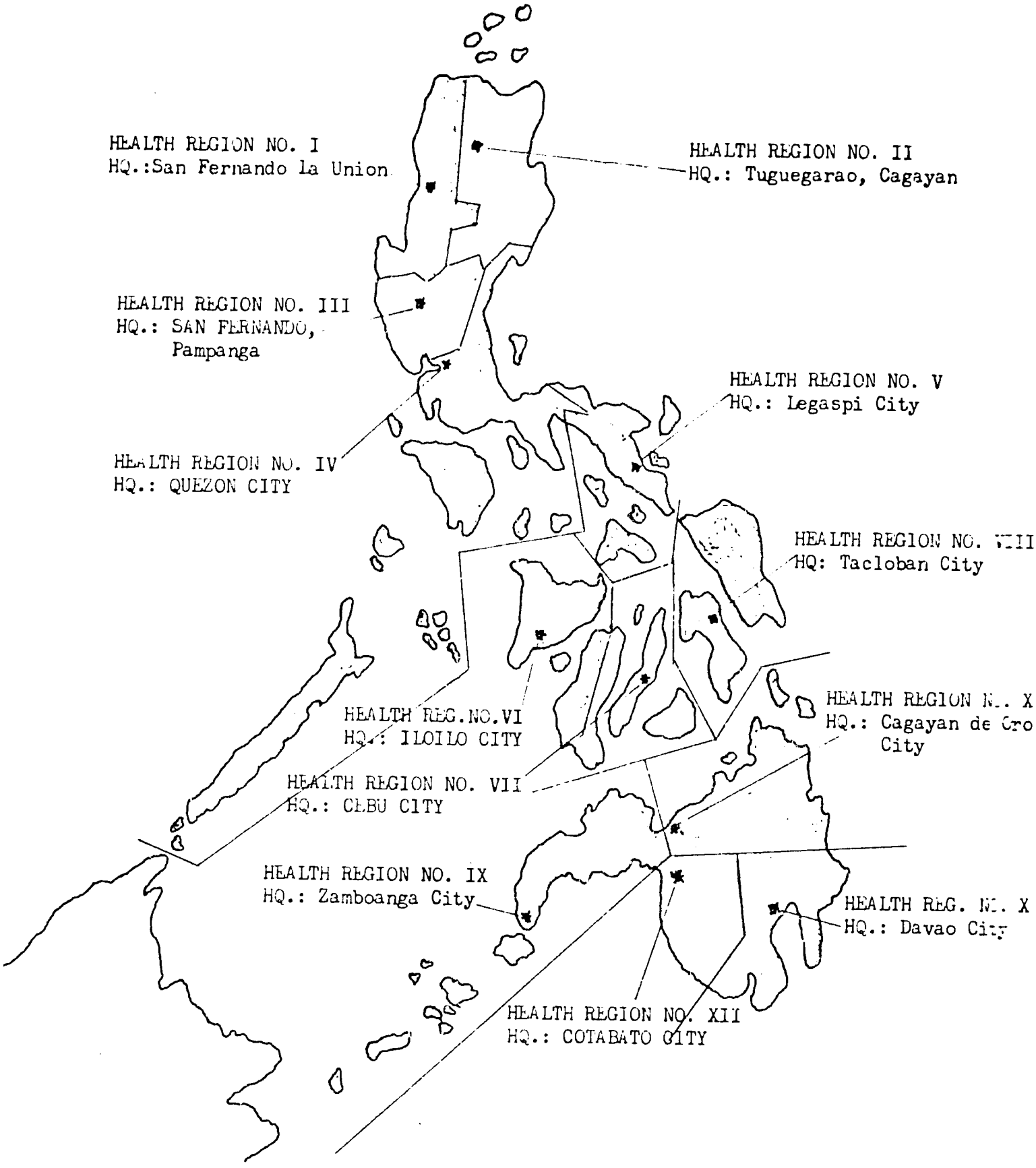
IV. CURRENT STATUS

Malaria which rank as number one (1) among the ten (10) leading causes of morbidity and mortality during the 1940's has decreased to number nine (9) in 1982 in morbidity (Chart No. I) and no longer among the (10) in mortality (Chart 2). About 20% of the areas under malaria risks were already cleared of the disease.

The years 1983 and 1984 have been transition periods from a centralized program to an integrated program during which time the anti-malaria expertise were transferred to the Provincial, Municipal and Barangay Health Workers causing a temporary interruption in the smooth flow of operation. This short period of reorganization has been taken advantage of by the disease which showed an increase in incidence, although not to an epidemic proportion.

Most of the cases were found in Mindanao and Sulu areas followed by North-eastern Luzon and the least in the Visayas. (Attached Table I).

P. falciparum resistance to chloroquine was detected as early as 1968. In 1974, a nationwide monitoring of drug resistant cases was started and continued up to the present (1984), using both *in-vivo* and *in-vitro* techniques resulting in delineating the areas which are sensitive and which are resistant to chloroquine. (Attached Map Nos. 2 and 3) About 70% of the total *P. falciparum* cases were found resistant to chloroquine. This finding is significant since *P. falciparum* is the predominant infection and with the problem of uncontrolled population movements and the temporary nature of inhabitant's dwellings in the hinterland, the use of anti-malaria vaccine as a control method would become an appropriate measure.



MAP OF THE PHILIPPINES SHOWING THE TWELVE HEALTH REGIONS

V. OPERATIONAL RESEARCH

I. Completed studies as of 1984:

1. The effectiveness of DDT emulsion for residual spraying of premises did not differ from wettable powder significantly.

2. "Abate" larvicide is effective in selected low endemic areas.

3. Mass drug administration could only attain a low level of control.

4. DDT pressure on the main vector, *An. flavirostris* did not produce any change in their behavior.

II. On-going studies:

1. Sensitivity of *P. f.* to chloroquine by *in-vitro* (micro) technique.

2. Bionomics of *An. balabacensis*

3. Colonization of *An. flavirostris*

4. Alternative insecticides and antimalarial drugs

VI. PROBLEMS

1. Administrative:
   a. Inadequate financial and manpower support, and

   b. Incomplete coverage of areas.

   Both can be corrected by PHC approach.

2. Operational:

a. Extensive population movements between malarious and cleared areas makes it difficult to maintain the gains already achieved.

b. Ecological changes, like extensive irrigation projects, have contributed to creation of breeding places for local vectors.

3. Technical:

a. Increasing areas with *P. f.* resistance to chloroquine

VII. EXPECTATIONS FOR A MALARIA VACCINE

Some factors which caused the failure of an eradication program such as uncontrolled population migration, temporary dwellings, refusal to insecticide residual spraying of houses, incomplete drug treatment, are expected to be solved by a nationwide vaccination program, which is expected to be cheap, feasible and acceptable to the people. However, a pilot project is necessary before taking this on a nationwide scale.

Chart No. 1

Leading Causes of Morbidity*
(Rate/100,000 Population)
Philippines, 1982

Causes	No.	Rate
1. Upper Respiratory Tract Infections	447,831	882.2
2. Enteritis & other diarrheal diseases	364,78	718.6
3. Bronchitis	353,463	696.3
4. Influenza	300,923	592.8
5. Pneumonia	134,928	265.8
6. Tuberculosis, all forms	127,720	251.6
7. Skin infections	45,890	90.4
8. Intestinal parasitism	45,382	89.4
9. Malaria	41,220	81.2
10. Avitaminosis & other deficiency	40,915	80.6

---

* Data from Planning Service, MOH, Philippines.

Chart No. 2

Leading Causes of Mortality*
(Rate/100,000 Population)
Philippines, 1982

Causes	No	Rate
1. Pneumonias	42,349	85.6
2. Tuberculosis, all forms	20,630	41.7
3. Disease of the Heart	16,573	33.5
4. Enteritis & other diarrheal diseases	11,676	23.6
5. Malignant Neoplasm	8,361	16.9
6. Accidents	8,262	16.7
7. Cerebrovascular Accident	6,530	16.2
8. Bronchitis	4,453	9.0
9. Avitaminosis & other nutritional deficiencies	3,661	7.4
10. Cardiovascular diseases	2,968	6.0

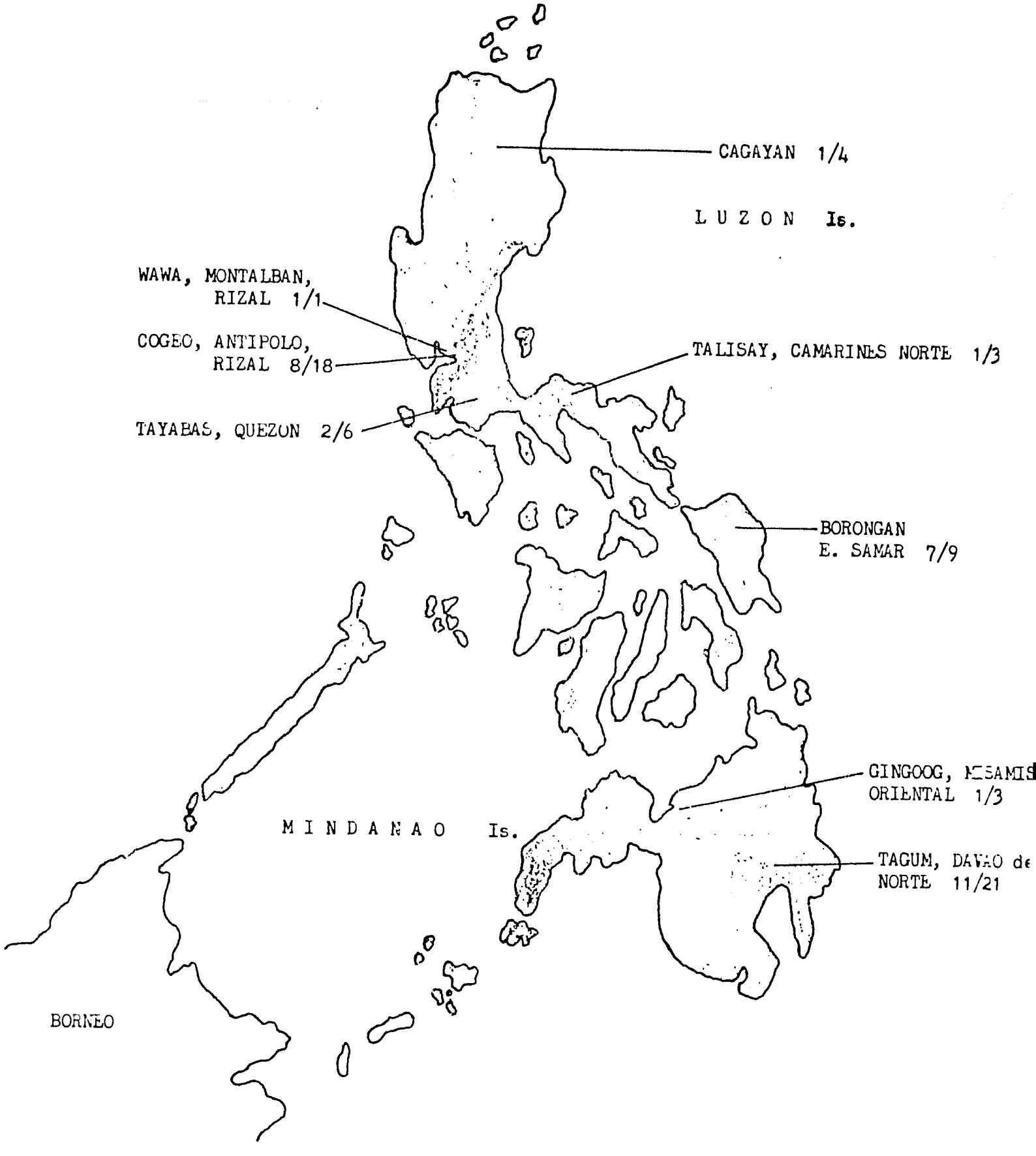
*Data from Planning Service, MOH, Philippines.

Table 1

COMPARATIVE MALARIA DATA, BY REGIONS, PHILIPPINES, 1983 and 1984

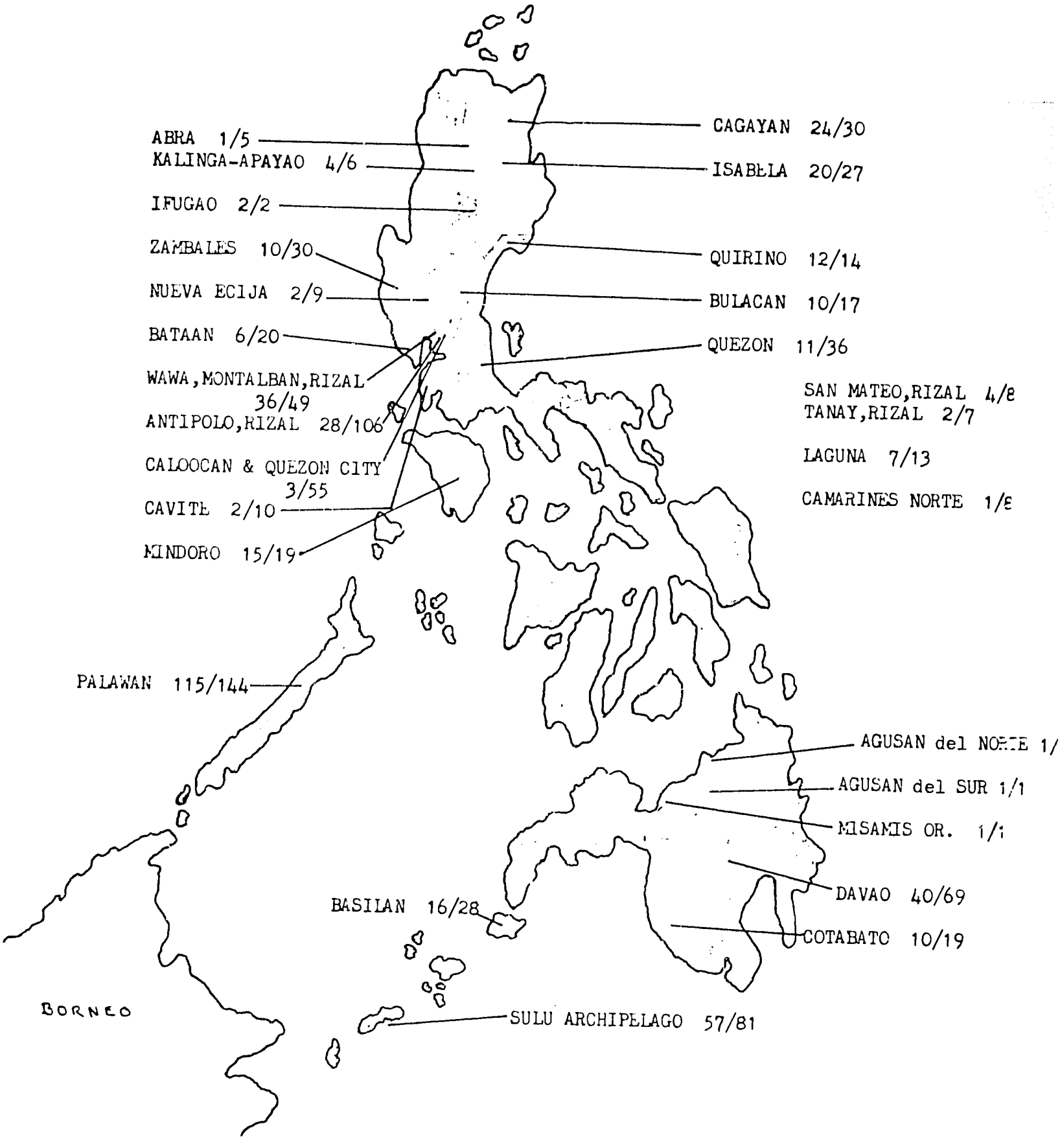
S.	Population 1983	Population 1984	No. Sl. Examd. 1983	No. Sl. Examd. 1984	No. of Positive 1983	No. of Positive 1984	P.f. 1983	P.f. 1984	P.v. 1983	P.v. 1984	P.m. 1983	P.m. 1984	Mx 1983	Mx 1984	SPR 1983	SPR 1984	Case/1000 1983	Case/1000 1984
I	1 241 995	1 260 893	13 045	33 423	721	2 857	404	1 767	315	1 070	0	1	2	19	5.5	8.5	.5	2.2
II	796 027	816 920	88 533	66 179	11 070	15 200	6 509	8 320	4 936	4 821	0	0	75	59	12.5	19.5	13.8	18.1
II	1 728 673	1 763 400	24 966	25 107	2 976	5 385	1 530	3 152	1 431	2 211	0	0	15	22	11.9	21.4	1.7	3.0
IV	2 239 194	2 300 421	216951	177 170	22 099	26 137	12 775	13 575	9 192	12 426	0	0	132	135	10.1	14.7	9.8	11.7
V	1 233 422	1 255 463	23 315	19 795	4 850	3 210	2 278	1 158	2 572	2 052	0	0	0	0	20.8	16.2	2.6	2.5
VI	1 611 305	1 644 201	7 113	2 740	493	350	465	337	6	13	0	0	2	0	6.9	12.7	.21	.21
II	1 346 243	1 374 508	13 412	13 336	294	198	268	164	26	34	0	0	0	0	2.1	1.4	.2	.14
II	991 647	1 010 201	48 623	45 342	1 961	928	1 683	747	274	177	1	0	3	4	4.0	2.0	1.9	.9
IX	904 394	923 394	175693	183 823	27 257	34 916	19 647	25 197	7 442	9 155	4	3	164	201	15.4	18.9	30.1	37.8
X	1 010 023	1 039 129	69 064	76 111	13 507	8 253	9 028	4 841	4 292	3 336	0	0	197	76	19.5	10.8	13.3	7.9
XI	1 233 577	1 271 705	10 321	35 336	508	7 444	373	5 089	130	2 107	1	248	4	4	4.9	20.9	.4	5.8
II	803 015	817 086	29 579	22 072	4 583	8 324	2 212	5 994	2 333	2 260	3	120	32	250	16.0	30.1	5.7	10.7
T.	15 142 521	15 4 3 321	719693	700 769	90 319	111502	56 742	70 342	32 953	40 022	9	372	816	782	12.2	15.2	5.9	7.2

Map No. 2



MAP OF THE PHILIPPINES SHOWING THE DISTRIBUTION OF P. FALCIPARUM TESTED BY THE IN-VITRO MICRO TECHNIQUE (1982-July 1984) NO. RESISTANT/NO. TESTED.

Map No. 3



MAP OF THE PHILIPPINES SHOWING THE DISTRIBUTION OF INFECTIONS OF P.FALCIPARUM TESTED BY THE IN-VITRO MACRO TECHNIQUE (1974-July 1984) NO. RESISTANT/No. TESTED.

MONDAY, April 22, 1985
Abstract No. 4, page 20

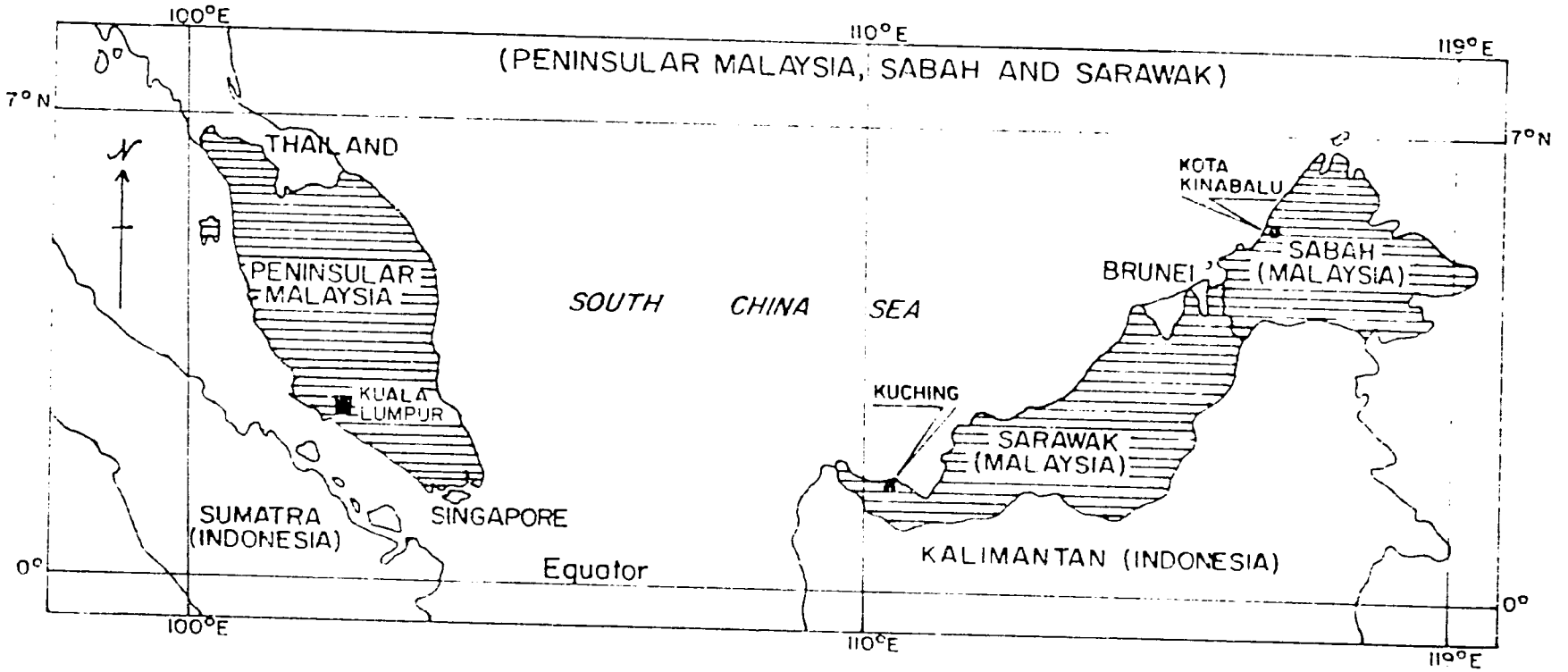
CURRENT STATUS OF MALARIA IN MALAYSIA

COUNTRY REPORT PRESENTED AT THE FIRST ASIA AND PACIFIC CONFERENCE ON MALARIA IN HONOLULU, HAWAII

22 - 27TH APRIL, 1985

BY DR. HO KEONG BIN

MAP OF MALAYSIA



	AREA (sq. Km.)	POPULATION
SABAH	74,389	1,140,000
SARAWAK	124,450	1,461,000
PENINSULAR MALAYSIA	131,587	12,467,000
TOTAL FOR MALAYSIA	330,426	15,068,000

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CURRENT STATUS OF MALARIA IN MALAYSIA

1.0 GENERAL INFORMATION

1.1 Malaysia is an independent federation of 13 states in Southeast Asia (See Map). It consists of two distinct regions separated by 650 kilometres of the South China Sea.

(a) Peninsular Malaysia (or West Malaysia)

It consists of the southern-most part of mainland Asia.

(b) East Malaysia

It is located on the northern coast of Borneo Island and consists of Sabah and Sarawak.

1.2 Malaysia lies close to the equator between latitudes 1° and 7° North and longitudes 100° to 119° East. The climate is equatorial with heavy rainfall, constant temperature and relatively high humidity.

1.3 Malaysia has an area of about 330,426 square kilometres with a population of about 15 million (projected 1984) as shown below:-

	Area (sq.km)	Population
Peninsular Malaysia	131,587	12,467,000
Sarawak	124,450	1,461,000
Sabah	74,389	1,140,000
Total For Malaysia	330,426	15,068,000

1.4 The federal capital, Kuala Lumpur, is situated in Peninsular Malaysia, which consists of 11 states, namely Perlis, Kedah, Penang, Perak, Selangor, Negeri Sembilan, Melaka, Johor, Pahang, Terengganu and Kelantan. (See Annex G).

1.5 Administratively Sarawak is divided into seven Divisions with towns of Kuching, Sri Aman, Sibu, Miri, Limbang, Sarikei and Kapit as the administrative centres of the respective Division (See Annex G).

1.6 Administratively, Sabah is divided into 8 sectors as shown in Annex G.

2.0 HISTORY OF VECTOR BORNE DISEASE CONTROL PROGRAMME

2.1 The Vector Borne Disease Control Programme (VBDCP) in Malaysia started as three separate Malaria Eradication Programmes (MEP), each with its own developmental history as follows:-

2.1.1 (a) Malaria Eradication Programme (MEP) in Sarawak

The first Malaria Control Pilot Project was carried out by WHO in 1953 - 1954. Malaria Eradication Programme (MEP) was started in 1961. Due to the failure of the MEP to interrupt the malaria transmission in many areas of Sarawak, it was re-defined as a Malaria Control Programme in 1972.

2.1.2 (b) Malaria Eradication Programme (MEP) in Sabah

A Malaria Control Pilot Project was started in 1956 with the assistance of WHO and UNICEF. This was followed by the Malaria Eradication Programme (MEP) in 1961. In 1967, a WHO Independent Assessment Team recommended the MEP to revert to a Malaria Control Programme. This was accepted by the government in 1971.

2.1.3 (c) Malaria Eradication Programme (MEP) in Peninsular Malaysia

Ever since the beginning of the present century, Peninsular Malaysia has been famous for its successful Anti Larval Services. These services rendered possible the economic development and the expansion of the country, which by and large was potentially malarious.

Peninsular Malaysia initiated a nation-wide Malaria Eradication Programme (MEP) in 1967 following the success of a Malaria Eradication Pilot Project from 1960 to 1964. Owing to administrative technical and operational problems faced by the MEP, it was reverted back to a Malaria Control Programme in 1981.

2.2 In 1980, two major decisions were made at the national level. The first was the integration of the three separate programmes to form the Anti Malaria Programme. The second was to re-structure the Anti Malaria Programme in 'phases' from 1981 to 1985 to that of a vector Borne Disease Control Programme (VBDCP) as follows:-

Phase I - The Anti Malaria Programme (1981 - 1982)

During this phase, the Anti Malaria Programme took over the existing Anti-Larval Services.

Phase II - The Vector Borne Disease Control Programme (VBDCP) 1983 - 1984

The Anti Malaria Programme took over the control of other important mosquito-borne diseases like Dengue Fever/Dengue Haemorrhagic Fever, and Filariasis resulting in the formation of the Vector Borne Disease Control Programme (VBDCP).

Phase III - Further Expansion of the Vector Borne Disease Control Programme (1985 onwards)

The VBDCP is further expanded to take over the control of other vector-borne diseases such as Scrub Typhus, Murine,Typhus, Plague, Yellow Fever and Japanese B.Encephalitis.

3.0 Objectives

The objectives of the Vector Borne Disease Control Programme are:-

(a) To reduce the morbidity and mortality due to malaria so that it will no longer be a public health problem in Malaysia.

(b) To prevent the re-establishment of malaria in areas where there are no outbreak at present.

4.0 STRATEGIES OF VECTOR BORNE DISEASE PROGRAMME (VBDCP)

4.1 The strategies of VBDCP are directed towards the interruption of malaria transmission and depletion of the reservior of infective cases achieved through:-

(a) Geographical Reconnaissance (GR)
(b) Residual house-spraying with DDT
(c) Surveillance
(d) Drug Chemotherapy
(e) Case Investigation
(f) Case Follow-up
(g) Anti Larval Measures (especially in Peninsular Malaysia).

4.2 Geographical Reconnaissance (GR)

Detailed mapping and census are carried in order to determine the number of people and number of sprayable and non-sprayable structures in the areas.

4.3 Residual House-Spraying with DDT

This is achieved through an effective house-spraying operation with DDT. There is no change in the behaviour of the malaria vectors against DDT. In 95% of the spraying operations, 25% emulsion concentrate is being used in 2 six-monthly cycles each year. The limited usage of 75% water dispersible powder is confined to temporary structures in the inaccessible areas. Spraying activity is being carried out in the following places (See Annex A)

(a) PENINSULAR MALAYSIA

- In late attack phase areas
- In areas along Thailand-Malaysia common border
- In new foci of malaria during focal spraying as a remedial measure.

(b) SABAH

- In Category A areas (equivalent to the late attack phase areas in Peninsular Malaysia)

- In new foci of malaria during focal spraying as a remedial measure.

(c) SARAWAK

All the localities within 16 kilometres along the common border with Kalimantan (Indonesia) and Sabah (East Malaysia).

- Between 1st and 2nd Division (Sarawak) and West Kalimantan Province (Indonesia)

- Between 4th and 5th Division (Sarawak) and East Kalimantan Province (Indonesia)

- Between 5th Division (Sarawak) and Sabah

- In new foci of malaria during focal spraying as a remedial measure.

- In the 7th Division, the border areas are grossly inaccessible and are therefore not covered by the regular spraying.

4.4 Surveillance

Surveillance of malaria is achieved through intensified Active Case Detection (ACD), Passive Case Detection (PCD), Mass Blood Examination (MBE) and Spot Surveys (SS).

In Sabah, PCD is being supplemented by the Malaria Treatment Posts since 1961. There are 34 such posts in the state, each managed by an assistant malaria technician/microscopist, who not only examines blood slides for malaria but also treats malaria patients in the remote areas. This is a good example of primary health care approach in the control of malaria.

4.5 Drug Chemotherapy

Radical treatment is given to all positive malaria cases. Chloroquine and Primaquine are used for radical treatment of all *Plasmodium vivax*, *Plasmodium malariae* and *Plasmodium falciparum* in areas still sensitive to the drugs. In areas where chloroquine-resistant *Plasmodium falciparum* is present, Sulphadoxine-Pyrimethamine combination drug (FANSIDAR) is used together with Primaquine.

Presumptive treatment is given to all fever or suspected malaria cases before their blood-films are taken for blood examination. Chloroquine-Pyrimethamine combination drug is used in chloroquine-sensitive areas whereas Chloroquine-Primaquine combination drug is used in chloroquine-resistant areas.

4.6 Case Investigation/Case Follow-up

All positive cases are investigated thoroughly in order to determine the origin of infection. All *Plasmodium falciparum* cases are followed up monthly for six consecutive months. *Plasmodium vivax* cases are followed up for twelve consecutive months.

4.7 Anti Larval Measures

The larger towns, especially in Peninsular Malaysia, are also protected by anti larval measures. The principle of Species Sanitation was adopted to make conditions unfavourable for the breeding of the malaria vectors. To this end various measures were adopted, such as clearing, canalising of all water collections by various forms of drainage, providing shades in certain water collections, rearing of fish which would eat up the anopheline larvae, and the application of larvicides. All these measures were aimed at getting rid of the larvae of the malaria vectors. In most of the towns, these forms of drainage still exist and form the main anti larval measures.

5.0 MALARIA VECTORS IN MALAYSIA

5.1 Of the 65 anopheline species recorded in Malaysia, only 7 species have been confirmed as malaria vectors, namely: *Anopheles maculatus*, *Anopheles campestris*, *Anopheles letifer*, *Anopheles balabacensis balabacensis*, *Anopheles leucosphyrus*, *Anopheles donaldi* and *Anopheles sundaicus*.

5.2 Out of the 7 malaria vectors in Malaysia, 5 species are responsible for malaria transmission in Peninsular Malaysia; 4 species in Sarawak, and 2 species in Sabah as shown below. Only 2 species, *Anopheles sundaicus* and *Anopheles balabacensis balabacensis*, are common malaria vector throughout the whole country as shown in Table 1 (See Annex C).

TABLE 1 - DISTRIBUTION OF MALARIA VECTORS IN MALAYSIA

Malaria Vectors	Peninsular Malaysia	Sarawak	Sabah
An.maculatus	Confirmed	-	-
An.campestris	Confirmed	-	-
An.sundaicus	Confirmed	Confirmed	Confirmed
An.letifer	Confirmed	-	-
An.b.balabacensis	Confirmed	Confirmed	Confirmed
An.leucosphyrus	-	Confirmed	-
An.donaldi	-	Confirmed	-

5.3 Anopheles balabacensis balabacensis is the main malaria vector in Sabah found everywhere except in the coastal areas. It is known to be a very difficult vector in Sabah and estimated to transmit about 90% of the malaria cases in the state. In Peninsular Malaysia, it is confined to a very narrow strip along the border area with Thailand and in some 'pockets' in other states. In Sarawak, it is confined to the North-east region bordering Sabah and East Kalimantan (Indonesia). Due to its limited distribution, it is not an important vector at present in Peninsular Malaysia and Sarawak.

5.4 Anopheles maculatus

This species is the main malaria vector in Peninsular Malaysia. It is a very efficient malaria vector commonly found the year round. It is estimated to tranmit about 80% of the malaria transmission in Peninsular Malaysia.

5.5 Anopheles leucosphyrus

This species is the main malaria vector in Sarawak. It is extensively distributed throughout the state.

5.6 DDT Susceptibility Test

DDT susceptibility tests are being carried out from time to time to determine the efficacy of the insecticide. At present, all the malaria vectors are still susceptible to DDT. However, Anopheles campestris (in Peninsular Malaysia) and Anopheles donaldi (in Sarawak) have shown better tolerance.

6.0 GENERAL REVIEW OF MALARIA SITUATION IN MALAYSIA

6.1 GENERAL

For the purpose of reviewing the malaria situation in Malaysia, the country has to be divided into three regions namely, Peninsular Malaysia, Sabah and Sarawak. Each of these three regions, due to different political history, malaria vectors and terrains, has different control strategies, experiences and problems.

A general review of the malaria situation in Malaysia is given. This is followed by a review of each region individually later.

6.2 OPERATIONAL CATEGORIES/PHASES

For the purpose of controlling malaria, the country is divided into three operational areas (See ANNEX A and ANNEX B). The population (projected) living in the various phases/operational categories are as shown in TABLE 2:

TABLE 2 - POPULATION (PROJECTED) LIVING VARIOUS PHASES/ OPERATIONAL CATEGORIES IN MALAYSIA (1984)

STATE/ COUNTRY	TOTAL POPULATION	OPERATIONAL CATEGORIES/PHASES		
		AREAS UNDER SPRAYING (LATE ATTACK PHASE/ CATEGORY A)	AREAS UNDER SURVEILLANCE (CONSOLIDATION PHASE/ CATEGORY B)	NON-MALARIOUS AREA (PRE-MAINTENANCE PHASE/ CATEGORY C)
Peninsular Malaysia	12,467,000	536,081 (4.3%)	698,152 (5.6%)	11,232,767 (90.1%)
Sabah	1,140,000	547,200 (48.0%)	467,400 (41.0%)	125,400 (11.0%)
Sarawak	1,461,000	175,320 (12.0%)	1,034,163 (70.8%)	251,517 (17.2%)
MALAYSIA	15,068,000	1,258,601 (8.4%)	2,199,715 (14.6%)	11,609,684 (77.0%)

NOTE: Figure in parenthesis denotes percentage.

(a) Areas Under Spraying (late attack phase/category A)

In these areas, 6 monthly residual spraying with DDT together with case detection (ACD and PCD) are being carried out. They are mainly located in the hilly hinterland of the country. In 1984, about 1,258,601 people (8.4%) live in these areas.

(b) Non-Malarious Areas (pre-maintenance phase/category C)

In these areas, PCD is the only surveillance activity left. They are mainly located along the coastal plains especially in the highly urbanized areas. In 1984, about 11,609,684 people (77.0%) live in these areas.

(c) Areas Under Surveillance (consolidation phase/ category B)

These areas are in-between the areas under spraying (late attack phase/category A) and the non-malarious areas (pre-maintenance phase/category C). In 1984, about 2,199,715 people (14.6%) live in these areas.

6.3 MALARIA INCIDENCE IN MALAYSIA

Malaria is still a major public health problem in Malaysia. In 1984, a total of 32,095 malaria cases were reported in Malaysia as shown in TABLE 3. This was an increase of about 10,000 cases (44%) over the 1983 figures (See ANNEX D).

TABLE 3 - INCIDENCE OF MALARIA AND BLOOD SLIDES COLLECTION IN MALAYSIA (1980 - 1984)

YEAR	ESTIMATED POPULATION	SLIDES EXAMINED	CONFIRMED CASES	API (o/oo)	SPR (%)	ABER %
1980	13,434,520	1,799,977	44,488	3.3	2.5	13.4
1981	13,747,295	1,926,058	59,422	4.3	3.1	14.0
1982	14,061,524	2,035,922	43,915	3.1	2.2	14.5
1983	14,373,355	1,873,433	22,218	1.5	1.2	13.0
1984	15,068,000	1,729,322	32,095	2.1	1.8	11.5

NOTE: API - Annual Parasite Incidence per one thousand population.
SPR - Slide Positivity Rate
ABER - Annual Blood Examination Rate

6.4 GEOGRAPHICAL DISTRIBUTION OF MALARIA IN MALAYSIA

The geographical distribution of the malaria cases in Malaysia is as shown in TABLE 4. In 1984, Peninsular Malaysia contributed 9,722 malaria cases (30.3%); Sarawak 1,015 malaria cases (3.2%); and Sabah 21,358 malaria cases

(66.5%). The malaria cases in Peninsular Malaysia have stabilized around 10,000 - 12,000 cases annually since 1980. Around a thousand cases occurred annually in Sarawak since 1980. The malaria situation in Sabah is volatile. Malaria cases vary from 50,000 cases in 1981 to 11,000 cases in 1983. (See ANNEX D and ANNEX E)

TABLE 4 - GEOGRAPHICAL DISTRIBUTION OF MALARIA IN MALAYSIA (1980 - 1984)

STATE	YEAR				
	1980	1981	1982	1983	1984
Peninsular Malaysia	9,110 (20.6%)	8,631 (14.5%)	12,411 (28.3%)	10,069 (45.3%)	9,722 (30.3%)
Sabah	34,351 (77.7%)	50,037 (84.2%)	30,548 (69.6%)	11,290 (50.8%)	21,358 (66.5%)
Sarawak	765 (1.7%)	754 (1.3%)	956 (2.1%)	858 (3.9%)	1,015 (3.2%)
MALAYSIA	44,226	59,422	43,915	22,217	32,095

NOTE: Figures in parenthesis denotes percentage.

6.5 BREAKDOWN OF MALARIA IN MALAYSIA BY PARASITE SPECIES

P.falciparum (68.5%) is the predominant species followed P.vivax (29.7%). P.malariae constitute only about 0.4% of the total cases in Malaysia. All cases reported as mixed infection were due to P.falciparum and P.vivax. P.ovale is not found in Malaysia.

TABLE 5 - MALARIA IN MALAYSIA BY PARASITE SPECIES (1984)

STATE/ COUNTRY	TOTAL CASES	PARASITE SPECIES			
		P. FALCIPARUM	P. VIVAX	P. MALARIAE	MIXED INFECTION
Peninsular Malaysia	9,722	4,714 (48.5%)	4,696 (48.3%)	9 (0.1%)	303 (3.1%)
Sabah	21,358	17,047 (79.8%)	4,106 (19.2%)	60 (0.3%)	145 (0.7%)
Sarawak	1,015	221 (21.8%)	745 (73.4%)	47 (4.6%)	2 (0.2%)
MALAYSIA	32,095	21,982 (68.5%)	9,547 (29.7%)	116 (0.4%)	450 (1.4%)

NOTE: Figures in parenthesis denote percentage.
Mixed Infection means P.falciparum and P.vivax.

6.6 MALARIA DEATHS IN MALAYSIA

Malaria causes more than 50 deaths annually in Malaysia as shown in ANNEX F. About three-quarters of the deaths occur in Sabah. The rest are from Peninsular Malaysia. Occasionally, one or two deaths occur in Sarawak.

6.7 BREAKDOWN OF MALARIA IN MALAYSIA BY AGE-GROUPS

The adult population (15 years and above) constitutes about 47.1% of the malaria cases in Malaysia (See TABLE 6). There were about 830 infant malaria cases (2.6%). This indicates that active malaria transmission is still going on especially in the areas under spraying.

TABLE 6 - MALARIA IN MALAYSIA BY AGE-GROUPS (1984)

STATE/ COUNTRY	TOTAL CASES	AGE GROUPS				
		Below 1	1 - 4	5 - 9	10 - 14	Over 15
Peninsular Malaysia	99,722	172	1,630	1,723	1,371	4,826
Sabah	21,358	656	4,490	3,492	3,220	9,500
Sarawak	1,015	2	28	78	96	811
MALAYSIA	32,095	830 (2.6%)	6,148 (19.2%)	5,293 (16.5%)	4,687 (14.6%)	15,137 (47.1%)

NOTE: Figures in parenthesis denote percentage

6.8 IMPORTED MALARIA IN MALAYSIA

In 1984, about 488 malaria cases (1.5%) were imported from outside Malaysia as shown in TABLE 7. Most of the cases were from Thailand (162 cases), Indonesia (197 cases), Philippines (46 cases) and Vietnam (22 cases). None were from Singapore. The others include countries like India, Papua New Guinea, Burma and Pakistan.

TABLE 7 - IMPORTED MALARIA IN MALAYSIA (1984)

COUNTRY OF ORIGIN	IMPORTED MALARIA CASES			
	PENINSULAR MALAYSIA	SABAH	SARAWAK	TOTAL
Indonesia	92	31	74	197
Philippines	0	46	0	46
Brunei	0	0	1	1
Thailand	162	0	0	162
Singapore	0	0	0	0
Vietnam	21	0	1	22
Others	57	0	3	60
TOTAL	232	77	79	488

6.9 BREAKDOWN OF MALARIA BY PHASES/OPERATIONAL CATEGORIES IN MALAYSIA

This is a local classification in relation to the place of detection of the malaria cases. The majority of the cases (81.9%) occur in the areas under spraying as shown in TABLE 8. About 3,728 cases (11.6%) were detected in the areas under surveillance. The remaining 2,085 cases (6.5%) were detected in the non-malarious areas.

TABLE 8 - MALARIA IN DIFFERENT PHASES/OPERATIONAL CATEGORIES IN MALAYSIA (1984)

STATE/ COUNTRY	TOTAL CASES	OPERATIONAL CATEGORIES/PHASES		
		AREAS UNDER SPRAYING (LATE ATTACK PHASE/ CATEGORY A)	AREAS UNDER SURVEILLANCE (CONSOLIDATION PHASE/ CATEGORY B)	NON-MALARIOUS AREA (PRE-MAINTENANCE PHASE/ CATEGORY C)
Peninsular Malaysia	9,722	5,729 (58.9%)	2,080 (21.4%)	1,913 (19.7%)
Sabah	21,358	20,180 (94.5%)	1,106 (5.2%)	72 (0.3%)
Sarawak	1,015	373 (36.7%)	542 (53.4%)	100 (9.9%)
MALAYSIA	32,095	26,282 (81.9%)	3,728 (11.6%)	2,085 (6.5%)

NOTE: Figures in parenthesis denote percentage

6.10 DRUG RESISTANT PLASMODIUM FALCIPARUM IN MALAYSIA

Surveillance of drug-resistant *Plasmodium* falciparum is being intensified in Peninsular Malaysia, Sabah and Sarawak. Chloroquine-resistant *Plasmodium falciparum* is quite widespread in the northern part of Peninsular Malaysia and in Sabah. There is no evidence of resistance of *Plasmodium falciparum* to chloroquine in Sarawak. (See ANNEX G).

There is at present no evidence to support the presence of resistance to Sulphadoxine-Pyrimethamine combination drug (FANSIDAR) and Mefloquine in Malaysia. In view of the traffic across Thailand-Malaysia common border, it is essential to monitor the situation carefully. This is important because of the proximity of Thailand where these drugs are now in general distribution. However, it will only be possible to carry out systematic studies when an in-vivo Sensitivity Test for Sulphadoxine-Pyrimethamine combination drug (FANSIDAR) becomes available.

7.0 CURRENT STATUS OF MALARIA IN PENINSULAR MALAYSIA

7.1 OPERATIONAL AREAS AND METHODS OF CONTROL IN PENINSULAR MALAYSIA

For the purpose of anti-malaria activities, Peninsular Malaysia is divided into 3 operational areas; (See ANNEX A and ANNEX B)

(a) LATE ATTACK PHASE AREA

These areas are mainly confined to the hilly hinterland located in the North and eastern part of the country. In these areas 6 monthly residual spraying with DDT together with case detection (ACD and PCD) are being carried out. On 1.1.1984, 4.3% of the population in Peninsular Malaysia live in Late Attack Phase areas.

(b) PRE-MAINTENANCE PHASE AREA

These areas are mainly on the coastal plains especially along the west coast of the Peninsula. Here PCD is the only surveillance activity. Currently, 90.1% of the population in Peninsular Malaysia is in the pre-maintenance area.

(c) CONSOLIDATION PHASE AREA

These areas are mainly in the region between the hilly hinterland and the coastal plain. Here PCD and ACD are carried out in the event of an outbreak. On 1.1.84 the population of these areas was 5.6% of the total population.

7.2 MALARIA INCIDENCE IN PENINSULAR MALAYSIA

The incidence of malaria in Peninsular Malaysia has stabilized around the 10,000 - 12,000 case since 1980 as shown in TABLE 9. In 1984, a total of 9,722 cases were reported (see ANNEX E).

TABLE 9 - INCIDENCE OF MALARIA AND BLOOD SLIDES COLLECTION IN PENINSULAR MALAYSIA (1980 - 1984)

YEAR	ESTIMATED POPULATION	SLIDES EXAMINED	CONFIRMED CASES	API o/oo	SPR %	ABER %
1980	11,138,227	1,099,213	9,110	0.8	0.8	9.8
1981	11,371,094	1,153,491	8,631	0.7	0.7	10.1
1982	11,603,961	1,293,699	12,411	1.1	0.9	11.1
1983	11,836,828	1,204,116	10,069	0.8	0.8	10.1
1984	12,467,000	1,060,693	9,722	0.7	0.9	8.5

NOTE: API - Annual Parasite Incidence per one thousand population
SPR - Slide Positivity Rate
ABER - Annual Blood Examination Rate.

7.3 GEOGRAPHICAL DISTRIBUTION OF MALARIA IN PENINSULAR MALAYSIA

Malaria became a notifiable disease in 1971. The geographical distribution of malaria by State in Peninsular Malaysia is as shown in Table 10. The largest number of malaria cases during the past five years were from Kelantan, Perak, Terengganu and Pahang. The malaria case load from Johore has been on the decline.

TABLE 10 - GEOGRAPHICAL DISTRIBUTION OF MALARIA IN PENINSULAR MALAYSIA (1980 - 1984)

STATE / YEAR	1980	1981	1982	1983	1984
Perlis	4	10	31	11	2
Kedah	411	410	757	325	95
Penang	108	53	101	54	34
Perak	2,129	1,648	3,000	2,413	1,901
Kelantan	3,664	3,198	3,685	3,522	4,099
Terengganu	437	623	2,201	1,451	932
Pahang	1,123	1,386	1,145	1,045	1,407
Selangor	552	490	461	510	556
N.Sembilan	214	278	407	348	371
Melaka	68	75	255	99	52
Johor	400	460	368	291	163
PENINSULAR MALAYSIA	9,110	8,631	12,411	10,069	9,722

7.4 BREAKDOWN OF MALARIA IN PENINSULAR MALAYSIA BY PARASITE SPECIES

In 1984, the number of P.falciparum is almost the same as P.vivax. The falciparum-vivax ratio has changed slowly from 2.6:1 in 1980 to 1:1 in 1984 as shown in TABLE 11. This changing pattern of malaria parasite species is very discouraging to the Vector Borne Disease Control Programme as P.vivax is more difficult to control than P.falciparum Chloroquine-resistant P.falciparum is quite widespread especially in the northern part of Peninsular Malaysia.

TABLE 11 - MALARIA BY PARASITE SPECIES IN PENINSULAR MALAYSIA (1980 - 1984)

YEAR	SPECIES				TOTAL
	P.FALCIPARUM	P.VIVAX	P.MALARIAE	MIXED INFECTION	
1980	6,486	2,496	13	115	9,110
1981	5,695	2,826	8	102	8,631
1982	7,678	4,573	6	154	12,411
1983	5,548	4,363	5	153	10,069
1984	4,714 (48.5%)	4,696 (48.3%)	9 (0.1%)	303 (3.1%)	9,722

NOTE: Figures in parenthesis denotes percentage

7.5 MALARIA DEATHS IN PENINSULAR MALAYSIA

About a quarter of annual malaria deaths in the country occur in Peninsular Malaysia as shown in ANNEX F and ANNEX H. Most of the malaria deaths occur in the remote areas of the late attack phase areas.

7.6 BREAKDOWN OF MALARIA IN PENINSULAR MALAYSIA BY AGE-GROUPS

About 50% of the cases occur in the adult age-group (15 years and over). About 172 cases (1.8%) of infant malaria were detected in 1984 as shown in TABLE 12.

TABLE 12 - MALARIA IN PENINSULAR MALAYSIA BY AGE-GROUPS (1980 - 1984)

YEAR	TOTAL CASES	AGE-GROUPS				
		BELOW 1	1 - 4	5 - 9	10 - 14	Over 15
1980	9,110	153	1,089	1,444	983	5,441
1981	8,631	156	1,116	1,356	914	5,089
1982	12,411	174	1,735	2,259	1,720	6,523
1983	10,069	186	1,508	1,877	1,297	5,201
1984	9,722	172 (1.8%)	1,630 (16.8%)	1,723 (17.7%)	1,371 (14.1%)	4,826 (49.6%)

NOTE: Figures in parenthesis denote percentage

7.7 MALARIA IN PENINSULAR MALAYSIA AMONG THE SPECIAL GROUPS

The special groups consisting of the Armed Forces, the Police Field Force personnel, the Aborigines (Orang Asli) and the workers on Land Schemes, are of special epidemiological significance. The special groups together contribute approximately 44% of the total case load in the country

and constitute a major source of infection. A considerable extent of chloroquine-resistant P.falciparum infection is seen among patients from these special groups. These four groups comprise of highly mobile population. The malaria case load among these groups during the past five years is shown in TABLE 13.

TABLE 13 - MALARIA IN PENINSULAR MALAYSIA AMONG THE SPECIAL GROUPS (1980 - 1984)

YEAR	SPECIAL GROUPS					TOTAL CASES
	ARMED FORCES	POLICE FIELD FORCE	ORANG ASLI	LAND SCHEMES	GENERAL KAMPUNG (RURAL VILLAGES)	
1980	1,193	712	898	1,210	5,097	9,110
1981	588	683	760	1,801	4,799	8,633
1982	876	703	901	2,258	7,673	12,411
1983	739	491	956	2,041	5,842	10,069
1984	398 (4.1%)	518 (5.3%)	1,196 (12.3%)	2,159 (22.2%)	5,451 (56.1%)	9,722

NOTE: Figures in parenthesis denote percentage

7.8 OPERATIONAL PROBLEMS AND CONSTRAINTS IN THE CONTROL OF MALARIA IN PENINSULAR MALAYSIA

(a) Lack of community support due to apathy as well as lack of awareness of their role in malaria control.

(b) Population movements among:-

- Workers in land Developmnt Schemes, Road Construction and Dam Construction
- Immigrant Workers;
- Security Forces;
- Aborigines (Orang Asli);
- People crossing international border.

(c) Increasing incidence of drug-resistant Plasmodium falciparum.

(d) Changing pattern of malaria parasite species. P.vivax is more difficult to control than P.falciparum.

(e) Lack of staff supervision in the deep hinterland due to curfew, remoteness, poor accessibility and security problems.

8.0 CURRENT STATUS OF MALARIA IN SABAH (EAST MALAYSIA)

8.1 OPERATIONAL AREAS AND METHODS OF CONTROL IN SABAH

Operationally, the state is divided into 3 categories as follows (see ANNEX A, ANNEX B and TABLE 2)

CATEGORY A - AREAS UNDER SPRAYING

This category covers the remote hinterland with every difficult accessibility due to dense forest, poor communications system and the presence of semi-normadic groups of people practising shifting cultivation. Spraying was limited to timber camps, estates, land schemes and all accessible villages.

Besides, PCD is present in the form of Government Dispensaries, private dispensaries run by timber camps/ land schemes/estates, village group sub-centres and visits by flying doctor services. In addition, diagnosis and treatment facilities are also provided by the Malaria Treatment Posts.

CATEGORY B - AREAS UNDER SURVEILLANCE

These are areas of low malaria incidence and PCD is the most important anti malaria activities in this category. Epidemiological investigation of confirmed malaria cases followed by remedial measures are carried out. Active case detection is conducted in selected villages only.

CATEGORY C - NON MALARIOUS AREA

These are the non-malarious and highly urbanized areas, PCD is only activity carried out in these areas. This category covers the townships of Kota Kinabalu, Sandakan and Labuan.

8.2 MALARIA INCIDENCE

Malaria is still a major public health problem in Sabah. In spite of various anti malaria measures, its incidence is rising sharply throughout the state reaching an epidemic proportion in 1981, where a total of 50,037 cases were reported (including 41 malaria deaths). However, the upsurge of cases declined in 1982 to 30,548 cases and it declined further in 1983 to 11,290 cases. In 1984, it increased again to 21,358 cases as shown in TABLE 14.

TABLE 14 - INCIDENCE OF MALARIA AND BLOOD SLIDES COLLECTION IN SABAH (1980 - 1984)

YEAR	TOTAL POPULATION	TOTAL SLIDES	TOTAL POSITIVES	API o/oo	SPR %	ABER %
1980	971,974	369,548	34,351	35.3	9.3	38.0
1981	1,010,854	402,731	50,037	49.5	12.4	39.4
1982	1,051,282	414,796	30,548	29.1	7.3	39.5
1983	1,088,078	359,572	11,290	10.4	3.1	33.0
1984	1,140,000	336,423	21,358	18.7	6.3	29.5

NOTE: API - Annual Parasite Incidence per one thousand populatio

SPR - Slide Positivity Rate

ABER - Annual Blood Examination Rate.

8.3 GEOGRAPHICAL DISTRIBUTION OF MALARIA IN SABAH BY OPERATIONAL CATEGORIES

In 1984, more than 94% of the malaria were reported from the Category A areas, which contain about 48% of state population. This incidicates that active malaria transmission is still on in these areas.

The malaria incidence from Category B and Category C areas, which contain 52% of the state population, has shown a marked decline when compared to that of 1983. (See TABLE 15)

TABLE 15 - GEOGRAPHICAL DISTRIBUTION OF MALARIA IN SABAH BY OPERATIONAL CATEGORIES (1981 - 1984)

OPERATIONAL CATEGORY	YEAR			
	1981	1982	1983	1984
A	45,812 (91.6%)	27,716 (90.7%)	10,014 (88.7%)	20,180 (94.5%)
B	4,077 (8.1%)	2,692 (8.8%)	1,178 (10.4%)	1,106 (5.2%)
C	148 (0.3%)	140 (0.5%)	98 (0.9%)	72 (0.3%)
TOTAL	50,037	30,548	11,290	21,358

NOTE: Figures in parenthesis denote percentage

8.4 BREAKDOWN OF MALARIA IN SABAH BY PARASITE SPECIES

Plasmodium falciparum (79.9%) is the predominant species followed by *Plasmodium vivax* (19.2%). *Plasmodium malariae* constitute about 0.3% of the total malaria cases in Sabah as shown in TABLE 16. Chloroquine-resistant *Plasmodium falciparum* is very widespread. (See ANNEX G).

TABLE 16 - BREAKDOWN OF MALARIA IN SABAH BY PARASITE SPECIES (1981 - 1984)

YEAR	TOTAL CASES	PARASITE SPECIES			
		P.VIVAX	P.FALCIPARUM	P.MALARIAE	MIXED INFECTION
1981	50,037	12,194	37,451	171	221
1982	30,548	9,360	20,874	143	171
1983	11,290	3,695	7,463	45	87
1984	21,358	4,106 (19.2%)	17,647 (79.8%)	60 (0.3%)	145 (0.7%)

NOTE: Figures in parenthesis denotes percentage
Mixed Infection means P.falciparum and P.vivax.

8.5 MALARIA DEATHS IN SABAH

Malaria is still an important public health problem in Sabah. Annually, it accounts for nearly three-quarters of all the malaria deaths in Malaysia as shown in ANNEX F.

8.6 BREAKDOWN OF MALARIA BY AGE-GROUPS

The adult population (15 years and above) constitutes about 44.5% of the total malaria cases in Sabah. More than 3% (656 cases) of the cases are Infant Malaria as shown in TABLE 17.

TABLE 17 - BREAKDOWN OF MALARIA IN SABAH BY AGE GROUPS (1980 - 1984)

YEAR	TOTAL CASES	AGE GROUPS			
		LESS THAN 1	1 - 4	5 - 14	OVER 15
1981	50,037	650	4,904	12,509	31,974
1982	30,548	580	3,330	7,942	18,696
1983	11,290	248	1,332	2,733	6,977
1984	21,358	656 (3.1%)	4,490 (21.0%)	6,712 (31.4%)	9,500 (44.5%)

NOTE: Figure in parenthesis denotes percentage

8.7 OPERATIONAL PROBLEMS AND CONSTRAINTS IN THE CONTROL OF MALARIA IN SABAH

(a) The refractory nature of the main vector A.balabacensis balabacensis.

(b) The nature of the terrain.

(c) The difficult accessibility due to poor communications and remoteness of the villages.

(d) Constant movement of the population, due to shifting cultivation and opening of new lands particularly in the rural areas - eg. timber camps, road construction, clearing of jungle for cocoa estates and other agricultural settlements.

(e) Lack of co-operation by the public in accepting anti malaria acitivities.

(f) Poor housing condition (structures with no walls).

(g) Development of chloroquine resistant by Plasmodium falciparum.

(h) The large immigrant labour force from neighbouring countries.

9.0 CURRENT STATUS OF MALARIA IN SARAWAK (EAST MALAYSIA)

9.1 OPERATIONAL AREAS AND METHODS OF CONTROL IN SARAWAK

For the purpose of malaria control, Sarawak is divided into 78 sectors (See ANNEX A and ANNEX B). Currently 20 of the sectors with a population of about 175,320 (about 12%) of the whole state, are placed under residual house spraying with DDT.

The other 58 sectors are placed under surveillance where only the appropriate remedial measures are carried out from time to time based on the epidemiological situation.

The townships of Kuching, Sibu and Miri are highly urbanized areas and are situated in the non-malarious areas.

9.2 MALARIA INCIDENCE IN SARAWAK

The incidence of malaria in Sarawak for the past 5 years has been fairly low.

In 1980, for the first time, it recorded less than 1,000 cases i.e. 765 cases. The number of cases remained below the 1,000 mark for the past few years despite the difficult economic situation. In 1984, a total of 1015 cases were reported as shown in TABLE 18.

TABLE 18 - INCIDENCE OF MALARIA AND BLOOD SLIDES COLLECTION IN SARAWAK (1980 - 1984)

YEAR	ESTIMATED POPULATION	SLIDES EXAMINED	CONFIRMED CASES	API o/oo	SPR %	ABER %
1980	1,324,317	331,216	765	0.6	0.2	25.0
1981	1,365,347	369,836	754	0.5	0.2	27.3
1982	1,406,281	327,427	956	0.7	0.3	23.3
1983	1,448,440	309,745	859	0.6	0.3	21.4
1984	1,461,000	332,206	1,015	0.7	0.3	22.7

NOTE: API - Annual Parasite Incidence per one thousand population

SPR - Slide Positivity Rate

ABER - Annual Blood Examination Rate.

9.3 GEOGRAPHICAL DISTRIBUTION OF MALARIA IN SARAWAK

The 1st and 2nd Divisions which are situated in the South-western region of Sarawak has been noted as the areas where rather active malaria transmission occurs as compared to the other areas of the state as shown in TABLE 19. In fact, more than 60% of the cases were reported from these areas for the past two years.

The rest of the cases were evenly distribution in the other areas where the anti malaria measures were hampered by communication difficulties and rapid movement of people especially in the 7th Division.

TABLE 19 - GEOGRAPHICAL DISTRIBUTION OF MALARIA IN SARAWAK DIVISIONS (1981 - 1984)

DIVISION \ YEAR	1981	1982	1983	1984
I*	195	388	258	253
II*	139	255	280	396
III	53	42	39	58
IV*	70	47	73	60
V*#	63	38	14	14
VI	38	24	20	32
VII	196	162	175	202
TOTAL	754	956	859	1,015

NOTE: * - Has border areas Kalimantan (Indonesia)

- Has border areas with Sabah.

9.4 BREAKDOWN OF MALARIA IN SARAWAK BY PARASITE SPECIES

Plasmodium vivax (73.4%) is the predominant species followed by *P.falciparum* (21.8%). *P.malariae* constitutes only about 4.8% of total cases. All the cases reported under 'mixed infection' were due to *P.vivax* and *P.falciparum* as shown in TABLE 20. Currently there is no report of chloroquine-resistant *P.falciparum* strain in Sarawak.

TABLE 20 - BREAKDOWN OF MALARIA BY PARASITE SPECIES (1981 - 1984)

YEAR	TOTAL CASES	PARASITE SPECIES			
		P.VIVAX	P.FALCIPARUM	P.MALARIAE	MIXED INFECTION
1981	754	566	155	31	2
1982	956	603	291	55	7
1983	859	668	162	27	2
1984	1,015	745 (73.4%)	221 (21.8%)	47 (4.6%)	2 (0.2%)

NOTE: - All mixed infections were *P.vivax* and *P.falciparum*.

- Figures in parenthesis denote percentage.

9.5 MALARIA DEATHS IN SARAWAK

Few malaria deaths occur in Sarawak. No cases were reported in 1981 and 1983. However, 2 malaria deaths per year were recorded both in 1982 and 1984. (See ANNEX F).

9.6 BREAKDOWN OF MALARIA IN SARAWAK BY AGE-GROUPS

The adult population (15 years and above) constitutes more than two-third of the total cases (TABLE 21 below). Less than 3% of the malaria cases were cases reported from children aged 4 years and below.

TABLE 21 - BREAKDOWN OF MALARIA IN SARAWAK BY AGE GROUPS (1981 - 1984)

YEAR	TOTAL CASES	AGE DEATHS			
		LESS THAN 1	1 - 4	5 - 14	OVER 15
1981	754	3	22	180	549
1982	956	2	30	218	706
1983	859	5	28	220	606
1984	1,015	2 (0.2%)	21 (2.1%)	174 (17.1%)	818 (80.6%)

9.7 OPERATIONAL PROBLEMS AND CONSTRAINTS IN THE CONTROL OF MALARIA IN SARAWAK

(a) COMMUNICATION DIFFICULTIES

Control operation has always been hampered by the remoteness of some of the affected areas particularly in the 7th Division and in the interior parts of the 4th Division of Sarawak. The unavoidable delay in sending the slides collected from areas to the nearest laboratory and the difficulties in transporting equipment to these areas would consequently delay the necessary remedial measures.

(b) POPULATION MOVEMENT ACROSS COMMON BORDER

The problem in the 1st and 2nd Division of Sarawak where more than 60% of the total cases in the state occurred so far this year has always been associated with the active movement of population across the common border with Kalimantan (Indonesia). The slide positivity rate among these visitors was always high (more than 10%). Those especially the carriers, who come in undertected or unscreened are thus potential sources of transmission. In this connection unless the situation across the border improves, the adjacent areas in Sarawak will remain vulverable.

(c) SPRAYING COVERAGE

There is a growing concern by the population affected about the regular spraying operation. It is now getting very difficult to achieve the desired spraying coverage due to the increased refusal rate especially in areas where the 2 cycles regular spraying has been carried out for the past 10 - 20 years.

In the 7th Divisions, the border areas are grossly inaccessible and are therefore not covered by the regular spraying.

Many of the temporary living structures like farm huts and garden huts have no proper walls and are thus not amendable to spraying operation.

(d) LOGGING OPERATION

The logging operations in the 3rd, 4th and 7th Divisions account for the persistance of cases in the areas.

10.0 ROLE OF MALARIA VACCINE IN MALAYSIA

10.1 EXPECTATIONS

The malaria vaccine can be regarded as a very useful supplementary tool to minimize mortality and reduce morbidity in malaria control. However, it is not a panacea for the control of malaria in Malaysia. It is useful in the following conditions:-

(a) High risk groups

(b) Chloroquine-resistant *Plasmodium falciparum* areas.

(c) Prophylaxis for people visiting highly malarious areas.

(d) Remote areas with poor transportation.

To be effective, the malaria vaccine must satisfy the following conditions.

(a) Safety of Usage - It must be safe to use

(b) Efficacy - The effectiveness of the malaria vaccine must be sufficiently high in order to protect the recipient. Depending on the epidemiological situation, a polyvalent malaria vaccine may be required to overcome species-specific, strain-specific and stage-specific problems.

(c) Cheap - The malaria vaccine must be cheap and within the price range of the consumer. If it is expensive, its usage would be limited to a small target group only.

(d) Duration of Protection - The malaria vaccine should give 'protection' for a long period.

(e) Storage and Transportation- The malaria vaccine requires a 'cold-chain' for storage and transportation. In the rural areas without electricity supply or with irregular electricity supply, storage can be a problem. A long shelf-life is an asset. In the remote and inaccessible areas, transportation of the malaria vaccine is also a problem.

(f) Ease of Administration - The malaria vaccine must be easy to administer with no side-effect like anaphylaxis. In this case, it can be used on a mass scale by the auxillary health staff. A freeze-dried malaria vaccine is preferable to that of a liquid type.

(g) Readily Available

The malaria vaccine must be readily available at the right place and at the right time. The manufacturer must be able to produce it on a global scale.

The benefits must be weighed against the risks before the malaria vaccine is administered.

10.2 TARGET POPULATION

The high-risk groups in Malaysia are given below in order of priority.

(a) Armed Forces

About 916 malaria cases were reported in 1984. are a potential source of infection to the peo, living in the non-malarious areas when they retu to their home-towns during holidays.

(b) Deep-jungle Aborigines (Orang Asli)

In view of the migratory nature of the deep jungle Orang Asli, absence of a comprehensive health infrastructure, cultural variations and often living in dwellings without walls, it is very difficult to control malaria in this particular group of people. These problems are further compounded by curfews, remoteness, poor accessibility and security problems. In 1984, they accounted for 1196 malaria cases.

(c) Workers in Land Development Schemes

About 2,159 malaria cases were reported among the workers in these massive land development schemes. A large proportion of the workers are illegal immigrant workers from neighbouring countries.

(d) Pregnant Mothers/Infants living in highly malarious areas.

(e) Health staff working in highly malarious areas.

Malaria vaccine has a useful role in the control of malaria in these vulnerable groups.

10.3 FUTURE

This depends on whether the malaria vaccine satisfies those conditions mentioned early on. Finally the price must be CHEAP. The question of whether to use it on a mass scale or on a selected group of people depends on its price.

11.0 CONCLUSION

In spite of all problems faced by the staff in Malaysia, the Vector Borne Disease Control Programme is still a success because it has produced good results. Some of the more prominent ones are discussed below:-

a) Reducing The Incidence of Malaria

The estimated annual incidence of malaria in the early fifties was about 300,000 while in 1984, only 32,095 malaria cases were reported. This is a tremendous achievement. The Individual, the Family and the Nation as a whole will benefit, either directly or indirectly, from 'freedom from malaria'.

b) Production of Detailed Maps

This is one very important contribution of the programme which was not realised at first. The maps produced in the Preparatory Phase and which are regularly updated have so much details that demands are made for them by many Government Departments which have programmes for the rural population.

c) Centre For Training In Malariology

Training is a very important activity of the programme. The training is for staff in the programme itself as well as those from other divisions of the Public Health Services. Lately the training has been expanded to include international participants as well, with the collaboration of the WHO and the Government of Malaysia. The WHO Inter-Regional Malaria Team for the Western Pacific Region is at present situated at Institute for Medical Research, Kuala Lumpur, Malaysia.

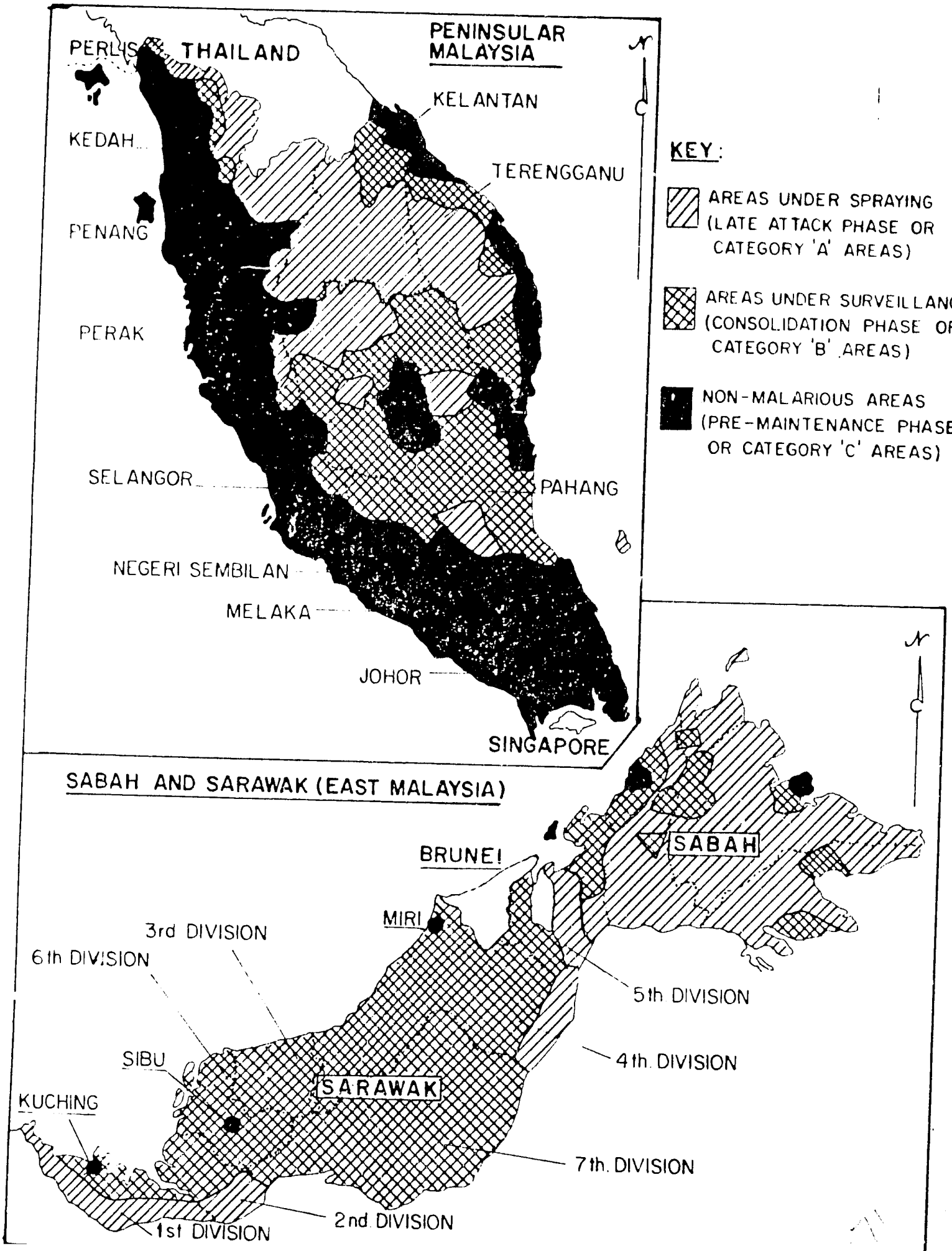
d) Vector-Borne Diseases Control Programme

The Malaria Eradication Programme became the basis for the further expansion and modification of its strategies and activities to develop it into the Vector Borne Disease Control Programme for Malaysia.

ANNEXES

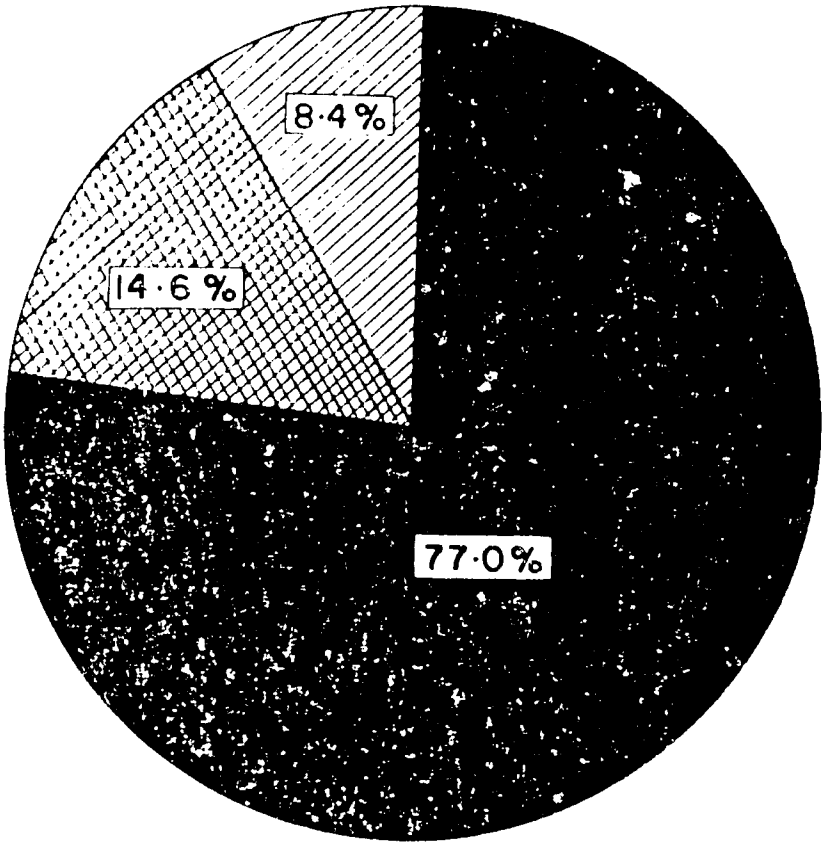
ANNEX

AREAS UNDER VARIOUS PHASES/CATEGORIES OF THE PROGRAMME IN MALAYSIA-1984



ANNEX-

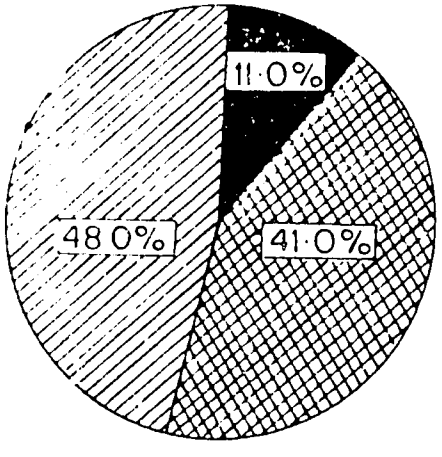
PERCENTAGE OF POPULATION LIVING IN VARIOUS PHASES/ CATEGORIES OF THE PROGRAMME IN MALAYSIA — 1984.



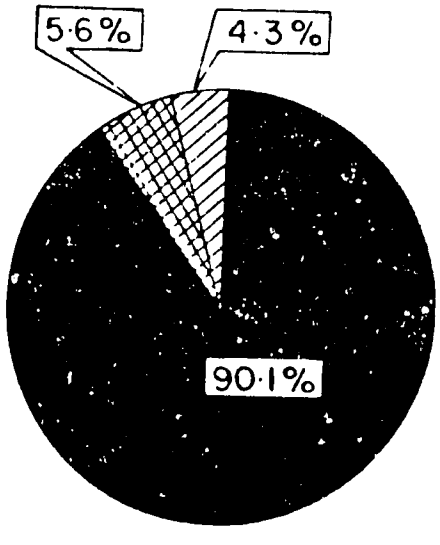
MALAYSIA

KEY :

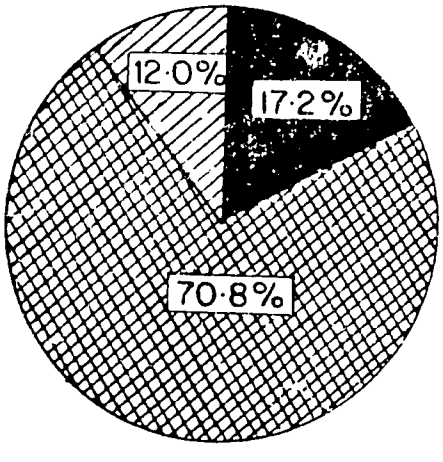
- AREAS UNDER SPRAYING (LATE ATTACK PHASE OR CATEGORY 'A' AREAS)
- AREAS UNDER SURVEILLAN (CONSOLIDATION PHASE OF CATEGORY 'B' AREAS)
- NON-MALARIOUS AREAS (PRE-MAINTENANCE PHASE OR CATEGORY 'C' AREAS)



SABAH
(EAST MALAYSIA)

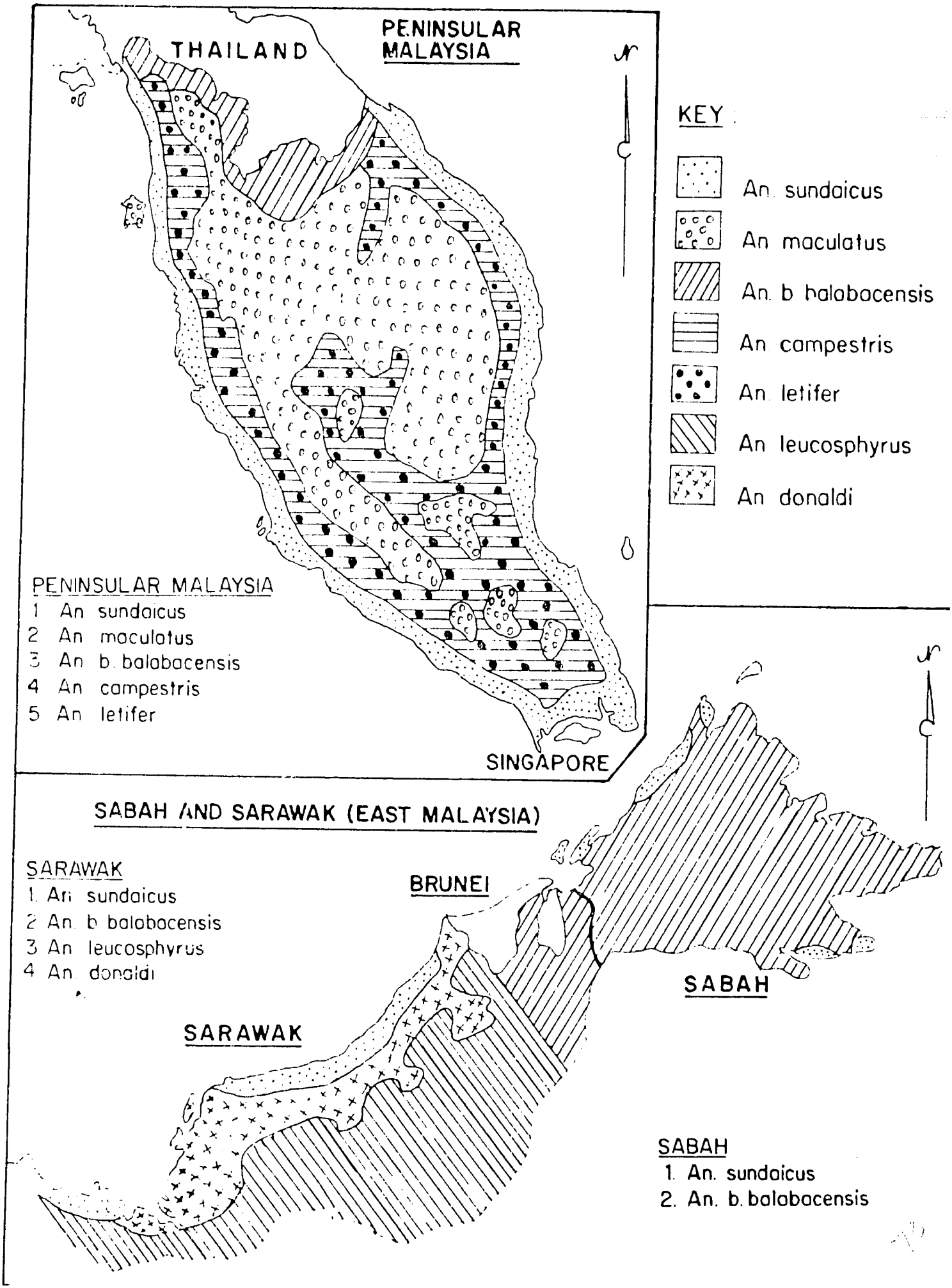


PENINSULAR MALAYSIA



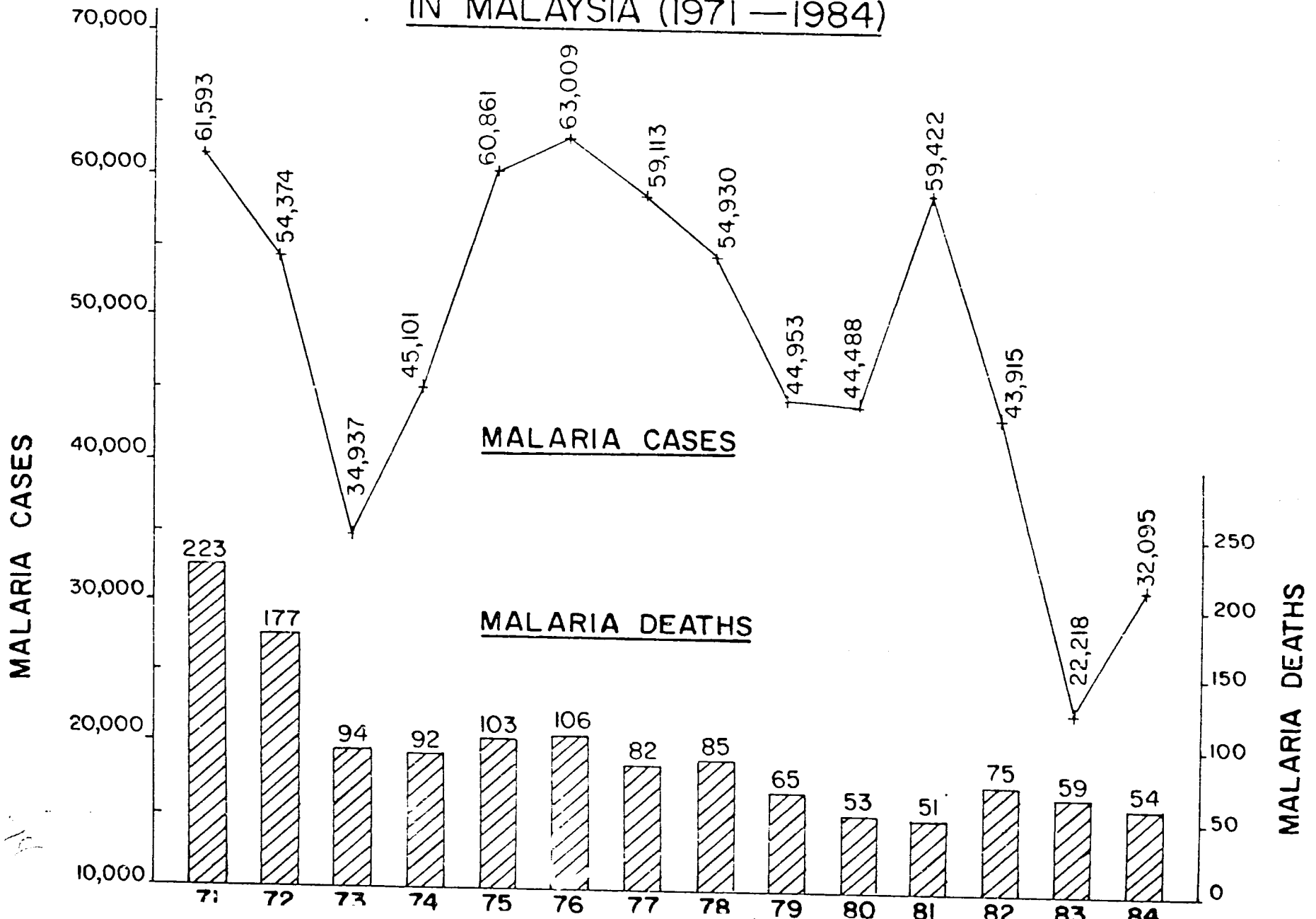
SARAWAK
(EAST MALAYSIA)

APPROXIMATE DISTRIBUTION OF MALARIA VECTORS IN PENINSULAR MALAYSIA, SABAH AND SARAWAK.



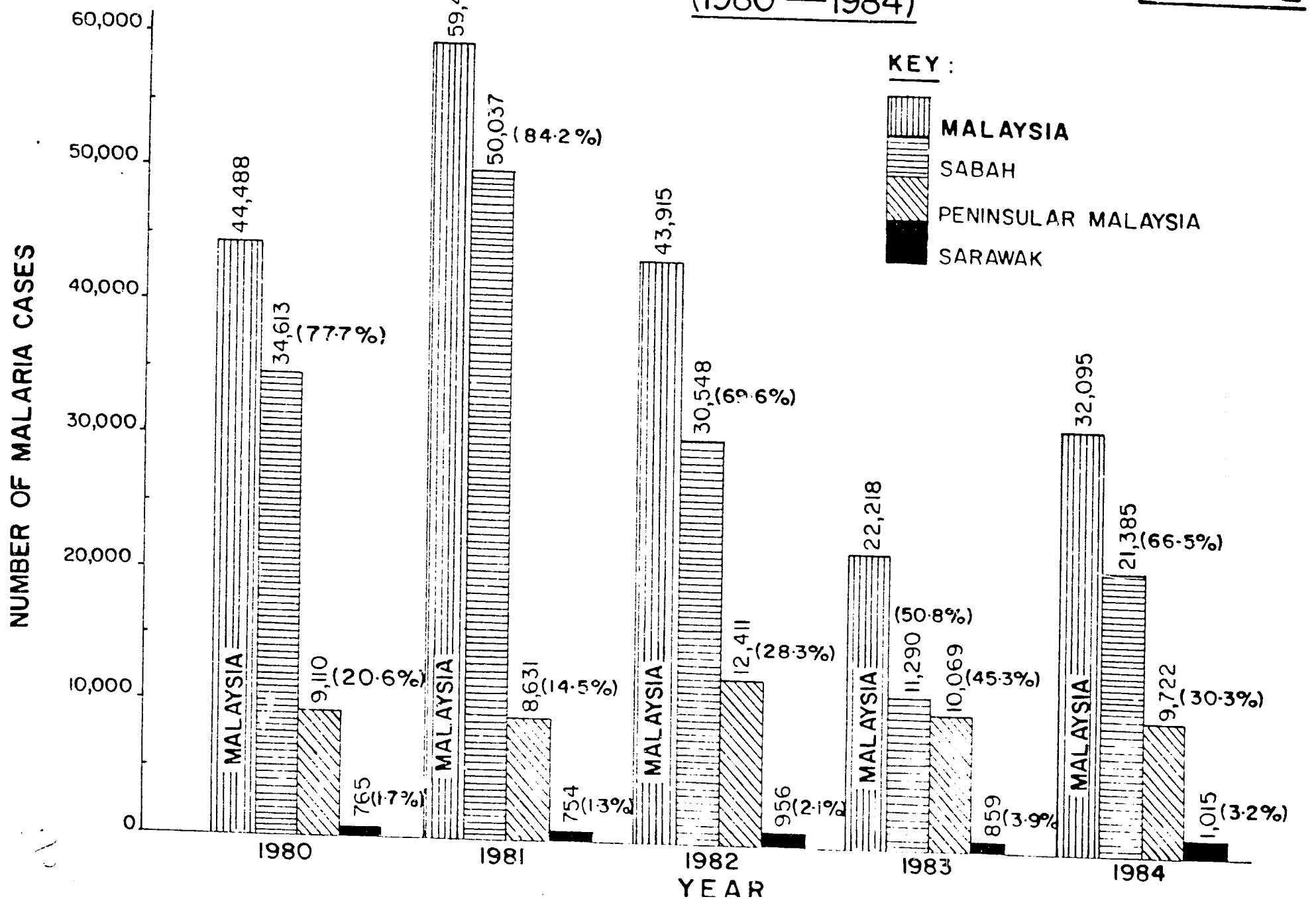
ANNEX-D

MALARIA CASES AND MALARIA DEATHS IN MALAYSIA (1971 — 1984)



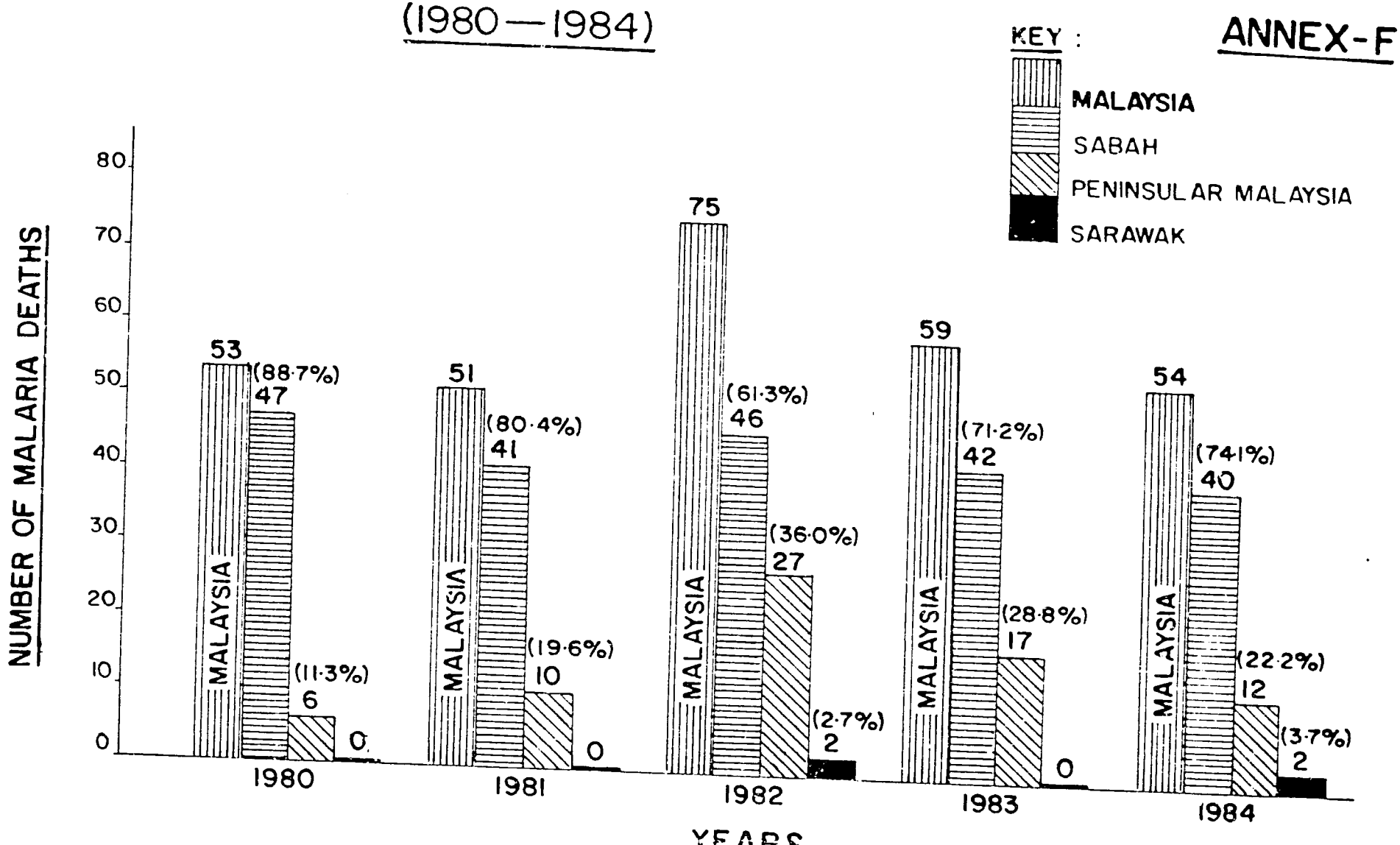
MALARIA CASES IN MALAYSIA (1980 — 1984)

ANNEX-E

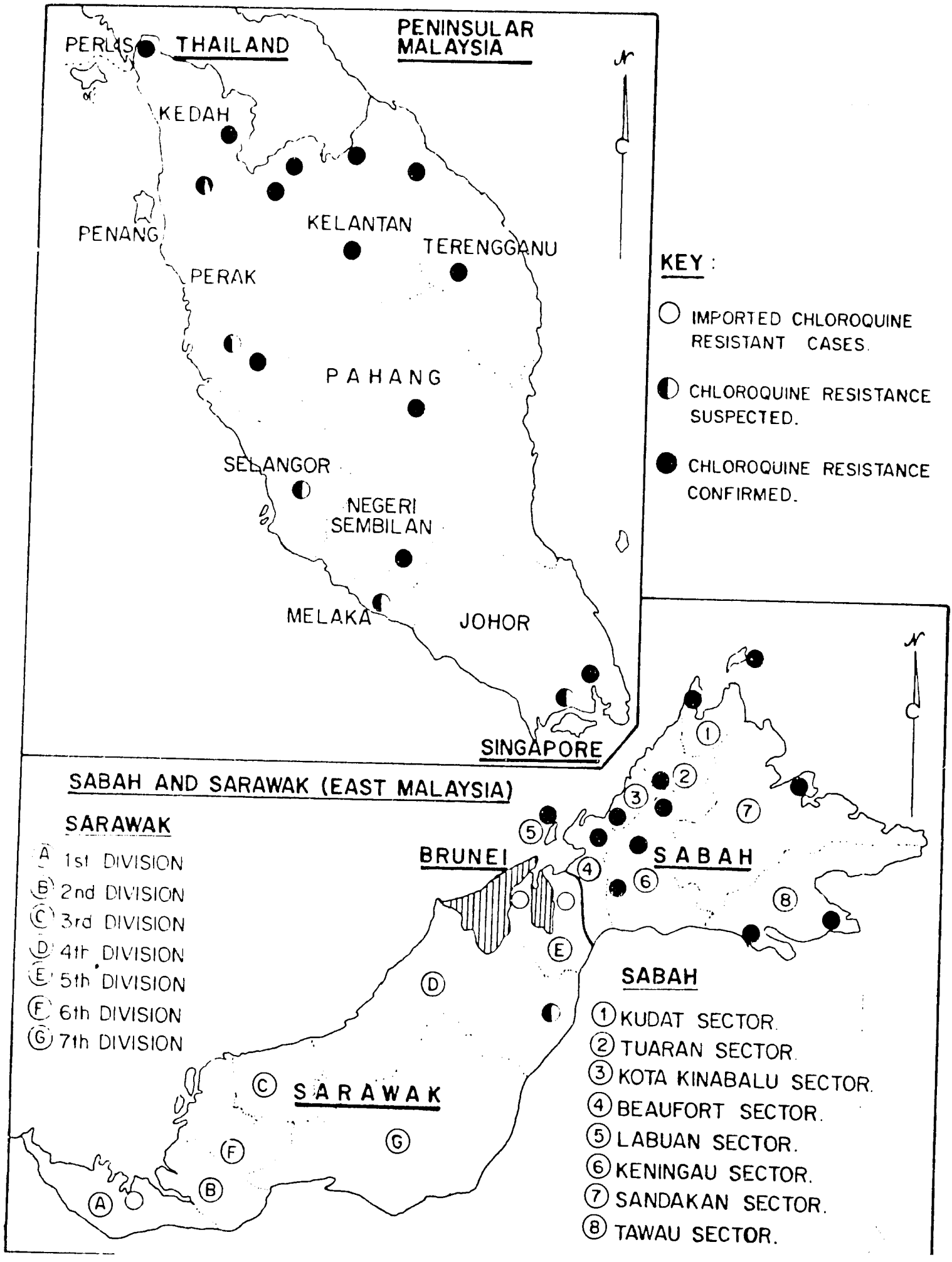


ANNEX-F

MALARIA DEATHS IN MALAYSIA (1980—1984)



DISTRIBUTION OF CHLOROQUINE RESISTANT FALCIPARUM INFECTION IN MALAYSIA – 1984



Yung-han Paik

MALARIA SITUATION IN THE WESTERN PACIFIC REGION

Despite nearly three decades of extensive control activities, malaria still remains a major health problem in some endemic countries of the Western Pacific Region.

After the initial success in malaria control, primarily through DDT residual house spraying at one time, the malaria situation has worsened in two main areas: one is the area where A. balabacensis is the main vector such as countries of the Indochinese Peninsula, some parts of the Philippines and Sabah State in Malaysia; the other is the area where the main vector is A. farauti, such as Solomon Islands and Papua New Guinea.

The disease, however, was eradicated in Australia, Brunei, China (Province of Taiwan), Japan (Ryukyu Islands) and Singapore.

A bright spot in the present gloomy situation is in Malaysia. Further progress was achieved in two programmes, namely, Peninsular Malaysia and the State of Sarawak. In Peninsular Malaysia, the malaria eradication programme has reached a stage where 95% of the total population are either in the maintenance or consolidation phase of the eradication programme, while intensive surveillance operations in the State of Sarawak have been successful in keeping the incidence of malaria throughout the State well below 1000 cases per year.

In my opinion, three factors are mainly responsible for the present sorry state of affairs. First, the effectiveness of residual spraying with DDT, a major weapon in malaria control, has decreased.

A. balabacensis and A. farauti have not developed phyusiological resistance to DDT but have adopted different patterns of behaviour to avoid picking up the lethal effect of DDT deposits on the walls inside the house by not going indoors, by not resting on sprayed surfaces and by biting human beings out of doors. Spraying is sometimes being badly done, particularly in remote areas where good supervision is almost impossible. A second factor is drug resistance. A third is the fact that the integration of the former vertically organized malaria services into the general health services or primary health care system has not gone smoothly and that during the past few years there has been in many places a kind of organizational vacuum.

CHANGING APPROACHES IN MALARIA CONTROL

Efforts to control malaria have moved into a phase of change and reassessment. The time-limited concept of malaria eradication is being replaced with the more realistic but complex goal of long-term control. In recent years, it has also become clear that traditional, semi-military, vertical control programmes could not continue to be supported. The funds for such expensive efforts are not available in most malarious countries. Furthermore, the mandate of "health for all by the year 2000" calls for reliance on multipurpose primary health care workers, especially at the community level, with special emphasis on community involvement in disease control.

Generally, DDT residual indoor spraying, conducted at six-monthly intervals at 2 gms per square metre with wettable powder, is still an effective principal control measure applied in the areas of high transmission potential. However, DDT indoor spraying is only effective when the local vectors are responsibe to DDT spraying and human behavioural factors are favourable.

Thus, an inventory should be made to assess the prevailing epidemiological and entomological conditions, physical environment and even psychosocial factors to decide whether indoor spraying is to be commenced, continued or discontinued.

In some instances, this can be supplemented with mass drug administration using a combination of chloroquine and primaquine. In areas of low or moderate malaria transmission, potential efforts are generally confined to malaria diagnosis and treatment, and here the general health services often function effectively where the health infrastructure at the grass-roots level has reached a certain standard of development. Where the basic health infrastructure is totally lacking or grossly inadequate, a special effort has been directed recently in several countries to develop a network system of malaria aide posts to provide early diagnosis and treatment for acute infections of malaria. It is the general policy in these countries for the malaria aide posts network to play an essential role in and to function as an integral part of primary health care for the population under malaria risk. The diagnostic and treatment services are important also in areas of high malaria transmission potential where the indoor residual spraying method has little or no impact because of vector behaviour, problems of refusals or local housing conditions. In the latter areas, special attention is often given to the care of vulnerable population groups, particularly young children.

Source reduction by environmental management and manipulation is often talked about these days but in reality it is still rather of academic interest as in the case of malaria control.

PROBLEMS AND CONSTRAINTS

The major problems and constraints confronting the malaria control programmes are technical, administrative and managerial.

In all malaria vcontrol programmes, indoor spraying with residual insecticides (chiefly DDT) has been used (in some programmes for more than two decades) as the principal method of attack. Paradoxically, total dependence on this method alone in the past has been the cause of some major failures. Total and complete spraying coverage of all inhabited premises is a prerequisite if this method is to be successful in interrupting malaria transmission but it has not been achieved in a large part of the endemic countries because of operational factors such as unsatisfactory and inadequate supervision of spraying squads, difficult terrain, lack of transport, primitive housing conditions, etc. Mounting public resistance to spraying over a number of years has made the situation even worse.

The increasing evidence of reduction or loss of sensitivity of certain strains of P. falciparum parasites to chloroquine in all endemic countries of the Region, with the probable exception of part of China and Sarawak State in Malaysia, has presented another technical challenge. Quite apart from the magnitude of the problem per se, it has produced a psychological impact, resulting in confusion in the proper use of antimalarial druigs for treatment of patients and for prevention of infection.

From the administrative point of view, some disorganization in the national malaria control service has been observed recently in several countries due to the transition period in the process of integrating the malaria service into the general health services structure or primary health care system.

Other factors affecting the success of the antimalaria campaigns have been the diminishing financial support and the steadily increasing cost of the programme due to inflation, particularly during the last ten years. The cost of DDT residual indoor spraying for two cycles a year now averages US $4 to US $5 per capita per annum multiplied by the population under coverage, a 1000 per cent increase compared with the cost in the 1960s.

The departure of trained and experienced manpower in all categories of the malaria service, particularly in the professional grade, and the frequent turnover of personnel are other common problems encountered by most countries.

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STRATEGIES FOR FUTURE MALARIA VACCINE TRIALS

IN THE WESTERN PACIFIC REGION

The development of strategies for future malaria vaccine trials on humans still depends to a great extent on the types and qualities of vaccines being develope. While the strategic plan for field trials of malaria vaccines has now been formulated, promising vaccines will come out of the R & D programme, including sufficient studies which satisfy the standard requirements for safety, in a foreseeable future.

In developing the strategic plan for the field trials with different types of malaria vaccines, it may be prudent to review briefly the malaria situation in the Region as a whole.

After the initial success in malaria control, primarily through DDT residual house spraying at one time, the malaria situation has worsened in two main areas: one is the area where A. balabacensis is the main vector such as countries of the Indochinese Peninsula and the Sabah State in Malaysia; the other is the area where the main vector is A. farauti, such as Solomon Islands and Papua New Guinea.

The exophilic tendency of these vectors, combined with the habits of the population in staying outdoors at night time, is a major obstacle to the control of malaria by intradomiciliary application of DDT in some parts of these malarious countries. For example, despite a massive control programme culminating in the spending of millions of dollars, and the deploying of hundreds of spraymen since the late 1960's in Papua New Guinea, the malaria situation remains the same or has deteriorated.

Among the above listed countries, Papua New Guinea and Sabah State in Malaysia represent areas with highmalaria transmission potential as well as insurmountable operational and technical constraints on the use of conventional anti-malaria measures. Certain parts of the two countries can be indicative areas for malaria vaccine trials. On the other hand, in a large part of China, Malaysia (except Sabah State),the northern provinces of Viet Nam, there exists an acceptable degree of control of malaria where conventional anti-malaria measures are still effective and economic. In the Philippines, urban centres and major tourist areas are virtually malaria-free.

Three major types of malaria vaccines are being developed and the Western Pacific Region can offer unique opportunities for field trials for different types of vaccine because of the diversity of the epidemiological situation. The following indications for different types of vaccine can be postulated:

(1) The sporozoite vaccine for causal prophylaxis will be tried in the group of international travellers - non-immune travellers from Australia to Melanesian countries - would be most suitable in view of Australia's proximity to highly malarious neighbouring countries.

(2) The merozoite vaccine to prevent severe clinical effects of

malaria will be tried in the southern part of Viet Nam and Sabah State of Malaysia where the management of severe malaria due to P. falciparum is a problem because of drug-resistant strains.

(3) The gamete vaccine to block transmission will be tried on the northern coast of Guadalcanal, Solomon Islands or on the northern coast of New Guinea Island where transmission potentials are most high due to physical and biological environment factors.

In the selection of countries/localities for the field trials, some other factors to be taken into account are:

(a) parameters for evaluation for different types of vaccine;

(b) psycho-behavioural aspects of the population subjected to the trial;

(c) political will of the government of the country to be involved;

(d) field operational facilities;

(e) ethical considerations for the control group;

(f) health systems - horizontal versus vertical, etc.

In the initial stage of the trials, it might be more relevant to evaluate the efficacy of individual vaccine per se with the provision of a control population. The value of vaccines in combination with other anti-malaria measures may be assessed later.

MONDAY, April 22, 1985
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FIRST ASIA AND PACIFIC CONFERENCE ON MALARIA
Honolulu, April 21-27, 1985

MALARIA CONTROL IN INDONESIA

CURRENT STATUS AND TREND

(1979 - 1983)

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1. Introduction

Malaria control programme in Indonesia (population 167 million) is completely integrated with the Directorate General of Communicable Diseases Control at the Central level and with the Sub.Division of Communicable Diseases Control at the Provincial level.

In view of the autonomy of the provincial and peripheral health administration, the role of the Sub-Directorate of Malaria Control Programme/CDC has been primarily that of overall countrywide planning, provision of technical guidance and assistance and operational support, monitoring and evaluation, training and manpower development, initiating operational studies and special measures, institution of emergency operation and inter-sectoral coordination. It has no directional or controlling authority over the provincial malaria control programme in the periphery, the malaria control activities are to be carried out as part of primary health care approaches with the community participation.

Strategically, malaria control activities in Java and Bali provinces are different than those in the islands other than Java and Bali (Outer Islands).

2. Objective

In terms of provision of Health For All By The Year 2000, the Government of Indonesia has formulated the following objectives for the control of malaria.

2.1 Long Term

2.1.1 Java-Bali - To reduce the number of high case incidence Kecamatan/ Sub-District (API more than 7.5‰) to 20 by the end of Sixth Five Year Development Plan (1994/95 - 1998/99) and maintenance of Annual Parasite Incidence/ API to less than one case per thousand population.

2.1.2. Outer-Islands - To reduce malaria prevalence to less than 2% in the priority operational areas and to 5-10% in the remaining areas by the end of Sixth Five Year Development Plan. Priority areas cover transmigration project, socio-economic development areas, areas bordering with neighbouring countries and outbreak areas.

2.2 Short Term

2.2.1 Java-Bali - to reduce the number of high case incidence sub-district from 63 to 37 by the end of fourth Five Year Development Plan (1984/85 - 1988/89) and maintenance of API less than one case per thousand population.

2.2.2 Outer Islands - to reduce malaria prevalence to less than 5% in the priority operational areas and to 15-20% in the remaining areas by the end of fourth Five Year Development Plan.

3. Strategy

Type of Activities	Java Bali	Outer Islands	
		Priority	Non-Priority
Surveillance	ACD, PCD	PCD, MMS	PCD
Treatment	Presumptive, Radical	Suppressive	Suppressive
Vector Control	IRS	IRS	-
Anti Larval Measures	Limited	Limited	-

ACD = Active Case Detection
PCD = Passive Case Detection
MMS = Malariometric Survey
IRS = Indoor Residual Spraying

4. Situation Analysis

4.1 In Java and Bali, evaluation of the epidemiological situation during the past four years of the Third Five Year Development Plan (1979/80 - 1983/84) revealed that there had been a reduction of malaria cases, slide positivity rates and annual parasite incidences during 1982 than the previous years as follows.:

Year	Bl.Sl. Exam.	Positive	SPR%	API‰	ABER%	Pf.%
1979	8,042,198	78,854	0.98	0,84	8.6	46.9
1980	9,085,040	176,733	1.93	1.85	9.5	46.6
1981	9,128,856	124,656	1.37	1.30	9.5	45.2
1982	9,196,556	84,266	0.92	0.86	9.4	54.3
1983	9,226,412	133,708	1.44	1.34	9.2	47.9

Number of the houses sprayed and insecticide used during 1979/80 - 1983/84 is given below:

Year	Houses Sprayed	DDT 75% wdp used (kg)
1979/80	2,840,037	2,082,798
1980/81	1,942,298	1,226,670
1981/82	1,965,469	1,291,741
1982/83	1,471,936	1,068,012
1983/84*	450,435	339,498

* Incomplete

4.2 In the Outer Islands There have not been much changes in the activities as well as in the malaria situation. Malariometric surveys and spraying operations were carried out only in priority areas of transmigration projects, other socio-economical development localities and bordering areas covering 5.6% of the total population in the Outer Islands. Reports received from the Outer Islands regarding malariometric surveys and spraying coverage are given below.:

Malariometric Surveys

Surveys	1979	1980	1981	1982	1983
Blood Slide exam.	155,892	466,355	559,657	600,078	436,243
Positives	6,558	19,283	20,303	31,074	12,458
P.R.	4.2	4.1	3.6	5.2	2.9
P.f.%	34.0	37.1	37.1	35.1	55.7

Spraying Operations

Year	Houses Sprayed	DDT 75% wdp used (Kg)
1979/80	939,892	466,478
1980/81	1,111,976	525,448
1981/82	1,282,828	596,869
1982/83	1,342,310	606,296
1983/84*	751,966	359,927

* Incomplete

4.3 Health institutions (hospitals, health centres, sub-health centres and polyclinics) examine clinical malaria cases and give suppressive treatment. Report received from the Outer Islands regarding passive case detection in the health institutions were as follows .

Particulars	1979	1980	1981	1982	1983
Clinical Malaria	1,075,658	1,241,403	756,771	1,214,496	831,824
Bloof Slides Exam.	360,428	488,616	353,788	411,758	421,631
Positive	87,105	130,279	90,780	105,121	84,268
S.P.R.	24.3	26.7	25.6	25.5	20.0
P.f. %	31.9	35.5	40.4	31.8	38.0

4.4 During the last two years, the detection of plasmodium falciparum resistance to chloroquine has revealed that the problem is widely spread in the eastern islands of the archipelago. So far, of 27 provinces, 24 have been tested and 22 have been found having resistant foci.

4.5 Of the 80 anophelines species recorded in Indonesia, 16 species have so far been confirmed as vector of malaria. An. aconitus, the main vector of Java-Bali, has been found resistance to DDT in the Inland area of East Java, Central Java and Yogyakarta, while in the Outer Islands so far all vectors/ suspected vectors have been found to be susceptible to DDT.

5. Approaches

For implementation of effective malaria control, the approaches would be based on integrated health services activities, intersectoral collaboration and coordination and community participation.

5.1 Integrated Health Services

At National level, Malaria Control Programme is one of five Sub-Directorates of the Directorate of Vector Borne Diseases Control which in turn is under the Directorate General of Communicable Disease Control. The Sub-Directorate is responsible for overall planning, technical guidance, operational support, programme evaluation, special staff training and some field studies. Sub-Directorate of Entomology works in close cooperation with the malaria control programme along with its other entomological activities.

At the provincial level, vector control section under Sub-Division of CDC is responsible for the implementation of the antimalaria activities in the provinces. Active case detection and treatment, malariometric surveys, laboratory examination, entomological activities, spraying operation and limited larviciding are carried out by the integrated provincial/peripheral staff. Passive case detection and treatment of clinical and confirmed malaria cases

are carried out by the net work of health institutions (hospitals, health centres and sub-centres).

5.2 Intersectoral collaboration and coordination has been identified as an essential component in the overall health development including malaria control activities. Examples of areas for such cooperation include department of transmigration, village development, agriculture, forestry, fishery, public work and education.

5.3 Community participation . PKMD (village community health development) is an operational form of Primary Health Care in Indonesia and is progressing satisfactorily. PROKESA (village health volunteer) under PKMD system are potential workers who could assist in drug distribution, epidemic notification and motivation of community to participate in limited and suitable bio-environmental methods for malaria control at village level.

6. Activities related to Malaria Control Measures

6.1 Spraying operation in Java and Bali

Main insecticide of use will be DDT. Primary criteria for spraying operation will be the presence of three or more indigenous cases in a village during previous year. Number of spray cycle and dossage of DDT will depend upon the local epidemiological situation of the area. High case incidence Kecamatan will be covered by two spray cycles a year during January-March and July-September at a dosage of 1 gr/m^2 or 2 gr/m^2 depending upon the length of transmission and the susceptible status of local vector. Vulnerable and receptive areas will be sprayed once or twice a year depending upon the local epidemiological situation at the dosage of 1 gr/m^2 2 gr/m^2 DDT as stated before. Focal outbreaks of malaria will be sprayed with 2 gr/m^2. Other insecticide for use will be fenitrothion. It will be used only in some selected villages where cases are very high, vector is completely resistant to DDT and P. falciparum are resistant to chloroquine. Dosage will be 2 gr/m^2 twice a year.

6.2 Spraying operation in the Outer Islands

Only the priority areas will be sprayed with DDT twice a year during January-March and July-September at a dosage of 2 gr/m^2.

6.3 Antilarval Operations

Antilarval operation will be applied to An. sundaicus breeding sites of high case incidence areas on weekly basis for 3-5 months during dry season i.e. June-October. Larviciding agents and dosage will be as follows : Diesel oil + kerosine (2:1) 150 liters/Ha, Diesel oil + spreding agent - Triton x 100 (99.5 :0.5) 50 liters/Ha and abate 50% E.C. 0.11 liters/Ha.

6.4 Active and Passive Case Detection in Java and Bali

Active case detection (ACD) will be carried out by village malaria worker on monthly or two monthly basis depending upon the availability of staff. Passive case detection (PCD) will be carried out by hospitals, health centres, sub-health centres and polyclinics. Blood smears will be collected from all current and recent post fever cases.

6.5 Malariometric surveys and Passive Case Detection in the Outer Islands

Malariometric surveys will be carried out in all the priority operational areas to determine the impact of spraying operation. Blood smears will be collected from infants and children upto 9 years of age on sample basis once or twice a year. Passive case detection of clinical malaria cases will be carried out in all the hospital, health centre, sub-centre and polyclinics. Blood smears will be collected from fever cases depending upon the availability of staff and laboratory facilities.

6.6 Treatment

Presumptive and radical treatment of the cases will be carried out all over the country as per guidelines provided. Following is drug regimens used in the MCP :

Presumptive & Suppressive Treatment :

- Sensitive Areas : Chloroquine, single dose, 600 mg base.
- Resistant Areas : Chloroquine, single dose, 600 mg base plus primaquine, single dose, 45 mg base.

Radical Treatment :

- Sensitive Areas : PF - Chloroquine, 1200-1500 mg.base, in 3 days plus primaquine, 15 mg. base, daily, for 3 days.
  PV - Chloroquine, 1200-1500 mg. base in 3 days plus primaquine 15 mg. base daily for 5 days.
- Resistant Area : PF - a) Fansidar, single dose, 3 tablets plus primaquine, 45 mg. base.
  b) Quinine, 400 mg. 3 times daily for 7 days plus primaquine, single dose, 45 mg on day 1.

Prophylaxis

- Sensitive Areas : Chloroquine, single dose, 300 mg. base, weekly.
- Resistant Areas : Fansidar, single dose, 1 tablet, weekly, plus chloroquine, single dose, 300 mg base, weekly.

6.7 Laboratory Services

Blood slides collected by both ACD and PCD in Java and Bali will be examined at health centre level and crosschecked at Regency level. Blood slides collected by malariometric surveys in the Outer Islands will be examined at the Regency laboratories. Limited blood smears collected by health centres in the Outer Islands will be examined either at health centre or at Regency laboratories as per facilities available. Cross checking of these blood smears will be done at Regency laboratories in Java and Bali and provincial laboratories in the Outer Islands. Aim of cross-checking will be to evaluate the reliability of microscopists and provision of refresher training courses if so required. All positive slides and 10% of the negative slides (on random basis) on quarterly basis from each microscopist will be sent for crosschecking. Of these, the crosschecking laboratories will crosscheck only 50-100% of positive and 25-50% of negative slides (selected on random basis) depending upon the availability of staff and their work load.

6.8 Monitoring drug response

Though a limited study on monitoring of *P. falciparum* resistant to chloroquine started in 1973, it was intensified during 1981-1983. By now 24 provinces have been tested and 22 have been found resistant to chloroquine as follows (see Map).

a. Provinces not yet tested (3):

Jambi, Bengkulu, and West Sumatra.

b. Provinces tested but found susceptible (2) :

Yogyakarta and Central Kalimantan.

c. Provinces found resistant with limited foci (19) :

East Java	Maluku	West Nusa Tenggara	South Kalimantan.
Central Java	North Sulawesi	Aceh	
West Java	Central Sulawesi	North Sumatra	
Jakarta	South East Sulawesi	South Sumatra	
Bali	South Sulawesi	Lampung	
Riau	East Nusa Tenggara	West Kalimantan.	

d. Provinces where resistance is well established and wide spread (3):

East Kalimantan, Irian Jaya and East Timor.

Monitoring of P. falciparum resistant to chloroquine is carried out by using in-vitro micro and in-vivo technique.

6.9 Entomological Activities

Entomological activities and their aims in the malaria control programme are summarized as follows.

- Determination of anopheline fauna and their seasonal distribution
- Identification of principle and secondary vectors
- Monitoring the susceptibility status of anopheline mosquitoes to insecticide
- Evaluation of the impact of DDT residual house spraying
- Investigation of bionomics of the vector/suspected vectors.

In Indonesia, entomological work has been carried out since early fifties and even before that the Dutch workers had contributed considerably to the knowledge of the anopheline vectors.

Of the 80 anophelines species recorded in Indonesia, 16 species have so far been confirmed as vectors of malaria as follows .

Java and Bali	. An.aconitus, An.sundaicus, An.subpictus, An.maculatus, An.balabacensis .
Sumatra	: An.sundaicus, An.hyrcanus group, An.maculatus, An.letifer, An.aconitus *
Kalimantan	: An.balabacensis, An.umbrosus, An.hyrcanus group, An.letifer,. An.sundaicus *
Sulawesi	: An.barbirostris, An.sundaicus, An.subpictus, An.letifer, An.hyrcanus group, An.flavirostris
Nusa Tenggara	: An.subpictus, An.sundaicus, An.barbirostris, An.aconitus *
Irian Jaya	: An.farauti, An.koliensis, An.punctulatus, An.bancrofti, An.karwari .

* Suspected vector.

6.10 Field Trials

6.10.1 Use of larvivorous fish , Panchax-Panchax to control rice water-breeder An. aconitus in Central Java and East Java.

6.10.2 Simple drainage scheme to eliminate An. sundaicus in the coastal areas of West Java, East Java and Bali.

6.10.3 Use of bednets in East Nusa Tenggara and Timor Timur.

6.10.4 Use of larvicides such as fenthion, BTI, insect growth regulator (Altosid, Dimilin).

The result of the trials so far are encouraging.

More emphasis will be given to non-chemical measure in controlling malaria.

7. Use of Malaria Vaccine

The introduction of malaria vaccine with its limitation such as species and stage specificity, short period of immunity conferred and cost, will not bring dramatic changes in the control strategies.

In Indonesia, malaria vaccine will be first given to transmigrants from Java-Bali to the Outer Islands. This group of population, poses high risk of contracting malaria in their new settlement as they move from very low endemic areas to a hyper or sometimes a holo-endemic areas. Gradually as condition permits, vaccination can be extended to cover other vulnerable groups such as infant and the under-five in the highly endemic areas throughout the country as an additional effort in reducing infant and underfive mortality rate.

In East Nusa Tenggara, Timor Timur and Irian Jaya provinces, malaria is number one killer in infant and the underfive.

8. Future Trend

It is anticipated that with the speed up of development, coupled with higher population movement, more man-made breeding places will be created.

Therefore drastic reduction of malaria prevalence is not expected in the near future. Thus malaria would probably remain a major public health provlem. Perhaps the more important short term objective is to prevent unnecessary death and alleviate suffering due to malaria.

Primary health care approach in malaria control will be extended. Use of appropriate technology and sufficient attention paid to develop income generating activities in the rural areas are very important factors in sustaining community participation.

9. Constraints

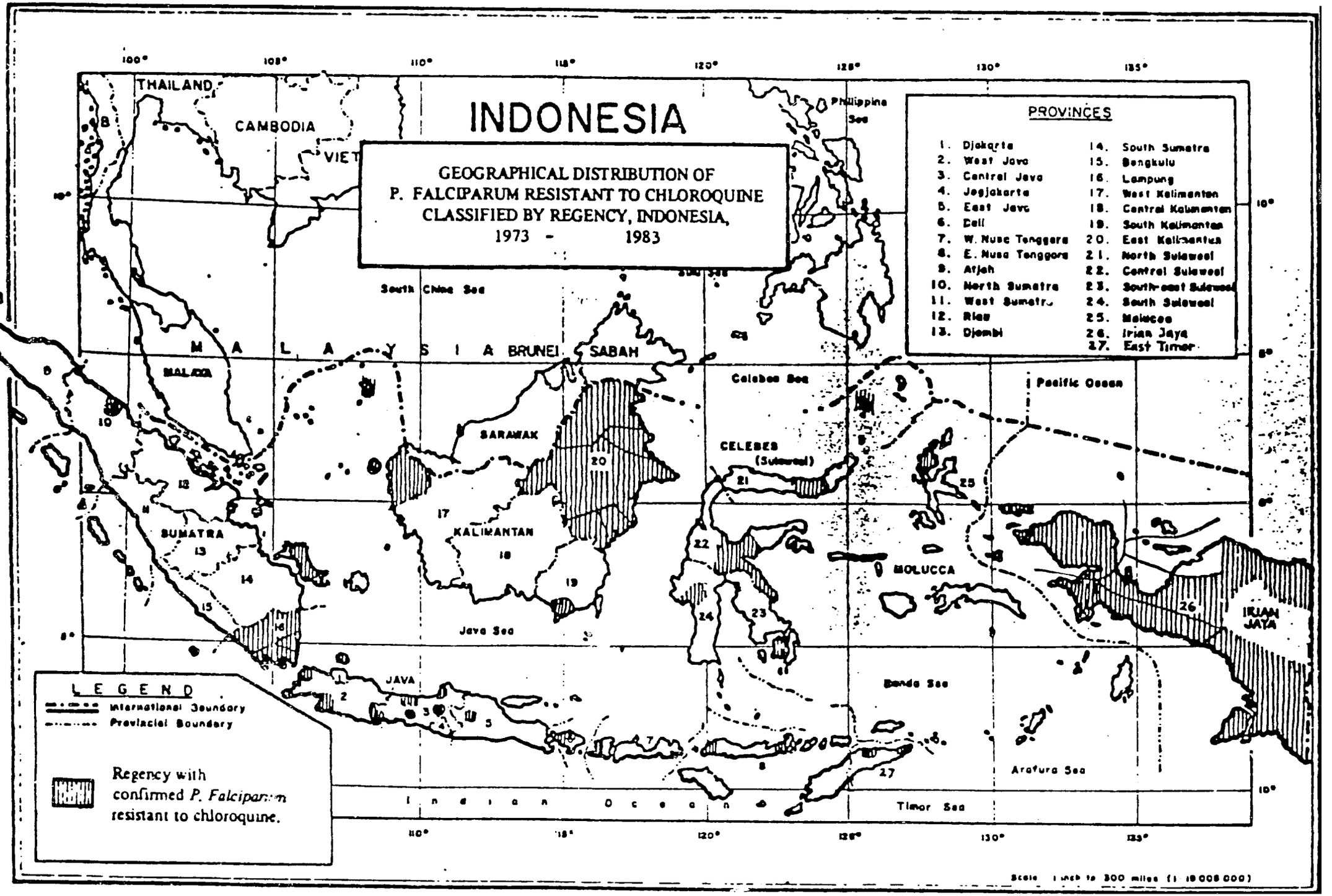
9.1 Territorial vastness

9.2 Shortage of skilled manpower, especially in the Outer Islands

9.3 Increased vector resistance (*An. sundaicus*) to DDT in Central and East Java

9.4 *P. falciparum* resistant to chloroquine becomes more widespread

9.5 Inadequate cross sectoral collaboration.


INDONESIA
GEOGRAPHICAL DISTRIBUTION OF
P. FALCIPARUM RESISTANT TO CHLOROQUINE
CLASSIFIED BY REGENCY, INDONESIA,
1973 - 1983
PROVINCES
1. Djakarta
2. West Java
3. Central Java
4. Jogjakarta
5. East Java
6. Bali
7. W. Nusa Tenggara
8. E. Nusa Tenggara
9. Atjeh
10. North Sumatra
11. West Sumatra
12. Riau
13. Djambi
14. South Sumatra
15. Bengkulu
16. Lampung
17. West Kalimantan
18. Central Kalimantan
19. South Kalimantan
20. East Kalimantan
21. North Sulawesi
22. Central Sulawesi
23. South-east Sulawesi
24. South Sulawesi
25. Maluccas
26. Irian Jaya
27. East Timor
THAILAND
CAMBODIA
VIET
Philippine Sea
South China Sea
M A L A Y S I A
BRUNEI
SABAH
MALAKA
SARAWAK
CELEBES (Sulawesi)
Celebes Sea
Pacific Ocean
SUMATRA
KALIMANTAN
MOLUCCA
IRIAN JAYA
Java Sea
JAVA
Banda Sea
Arafura Sea
Timor Sea
I n d i a n O c e a n
LEGEND
International Boundary
Provincial Boundary
Regency with confirmed P. Falciparum resistant to chloroquine.
Scale 1 inch to 300 miles (1 : 18 000 000)

The Current Status of the Anti-Malaria Programme in Thailand

The first Malaria Control Unit was formed in Chiengmai in 1930, followed the next year by units in Prabuddhabat and Khon Kaen. In 1943 the Malaria Control Division was established, with distribution of medicine as its chief function. At this time Malaria was the leading cause of death in Thailand, with a mortality rate of 351 per 100,000. Following the encouraging results of the WHO/UNICEF assisted Pilot Project for Malaria Control with DDT residual spraying in Chiengmai Province in 1949, the Government, with USAID assistance, developed a country wide malaria control programme in 1951. In 1964, a country-wide eradication programme was established, with an eight year plan of action. Although complete coverage by DDT spraying had not yet been achieved, vast areas were cleared of endemic malaria,and the death rate was reduced to 22.8/100,000 population. By 1970 the rate had been further reduced, to 10.1/100,000. In 1971 a new policy wgs developed, as a result of the WHO revised global strategy of malaria eradication, for maintaining the gains already made and for the prevention of the rise of new problem areas. Thus the plan of operations was revised and implemented for the period 1971-1976. This plan was designed to meet the costs of the project in the face of budget reductions by adjusting programme phasing and developing appropriate criteria for implementation of activities. In 1981, approximately 79% of the population lived in eradication areas with residual insecticide no longer being used in these areas.

Operational Strategy

The Anti-Malaria Programme provides services to all of the population of Thailand with operations divided into two areas as follows:

1) Control Area, consisting of forested hills and mountains, border areas, and insecure areas with a population of approximately 10.5 million.

2) Eradication Area, consisting of the major part of the country with a population of approximately 38.5 million.

The strategy presently implemented is that of long-term malaria control in the forested and hilly areas of the country where malaria is endemic (Control Area), and prevention of the re-establishment of malaria transmission in the remaining areas where a malaria eradication strategy is being applied (Eradication Area).

The actual control measures applied depend upon the local epidemiological situation. The country has been appropriately stratified according to different levels of receptivity in associatin with major variations in the terrain. The main control measures are residual insecticide (DDT/Fenitrothion) house spraying once or twice per year, radical treatment centres (malaria clinics), provision of anti-malaria drugs, and health education. Other measures are supplemented as appropriate and include larviciding, mass chemotherapy, space spraying, case detection and treatment, and the use of larvivorous fish. In order to establish appropriate health care delivery to allindividuals in all

villages, the Anti-Malaria Programme has developed the Village Voluntary Malaria Collaborator (VVC). The VVC is trained and expected to perform the following duties: to spread news about malaria and malaria services, to assist in spraying operations, and to take blood smears from and give presumptive treatment to any person who is suspected of having malaria.

Objectives

The goals of the Anti-Malaria Programme, as set out in the current National Health Development Plan (1982-1986) are as follows:

To reduce mortality caused by malaria to less than 8/100,000.

To reduce morbidity caused by malaria in control areas to less than 12 per 1,000.

To prevent the reintroduction and transmission of malaria in eradication areas by having not more than 1 indigenous case per 10,000 population.

To implement a Primary Health Care approach to malaria control and to involve the local communities in personal protection measures.

Present Situation - Country Wide

1. Morbidity. The incidence of malaria throughout the country has been greatly reduced during the past 35 years. In 1947 the morbidity rate was 286/1,000 population. This rate was reduced until the period of 1966-1972 when the incidence appeared to stabilize, varying from 2.2 to 3.6 per 1,000 population. Since that time it has risen annually, to 7.1 in 1979, 8.9 in 1980, and 10.6 in 1981 (Table 1). The increase in 1979-1981 in malaria incidence was due mainly to population movements, and problems of parasite resistance to drugs. However, the increasing trend in malaria morbidity which reached a peak in 1981, had begun to reverse by early 1982, and the markedly diminishing trend has persisted through 1983. The reasons for this improvement in the malaria situation are not completely clear, but it is most likely not related to climatological or entomological factors. The most plausible explanation may be the striking increase in the numbers of malaria clinics and productive malaria village volunteers (VVC), resulting in earlier diagnosis and treatment with appropriate therapy. In 1979, the Malaria Division had established 174 malaria clinics located at regional malaria centers, unit offices, sector offices and various field sites throughout Thailand. Based upon past results and epidemiological data, the Malaria Division determined that the effectiveness of malaria clinics could be increased by the extension of services outside the sector offices to strategic locations in high transmission areas, marketing centers and on migratory routes. At present there are 454 malaria clinics. The annual parasite incidence for fiscal year 1983 is the lowest in the past 10 years. (Figure 1)

Table 1. Results of Surveillance Activities (1978-1983)

	1978	1979	1980	1981	1982	1983
Population covered by surveillance	41,981,290	42,701,040	44,230,292	44,815,133	46,028,197	46,924,325
Blood Smears examined	4,101,469	4,287,282	4,852,919	5,583,689	6,094,665	5,365,960
Positives	329,512	302,721	395,442	473,210	420,799	243,910
SPR[2]%	8.3	7.0	8.1	8.5	7.0	4.5
ABER[3]%	7.6	7.2	8.1	8.9	9.1	8.2
API[4]	7.7	7.1	8.0	10.6	9.1	5.2

1) Blood smears taken by Active and Passive Case Detection and Mass Blood Surveys

2) SPR = Slide Positivity Rate (%)

3) ABER = Annual Blood Examination Rate (%)

4) API = Annual Parasite Incidence per thousand population

The three species of Plasmodium found in Thailand are falciparum vivax, and malariae. The parasite formula in 1983 showed 65.3% P. falciparum, 34.4% P. vivax and 0.02 P. malariae.

P. falciparum started showing a poor response to chloroquine in 1962, and at the present time it is found that more than 95% of P. falciparum demonstrated some level of resistance, mainly at R I and R II, although R III resistance is presently showing anincreasing trend. Furthermore, during the last four years P. falciparum strains resistant to sulfadoxine-pyrimethamine have also started to appear in many parts of the country, especially in the areas near Kampuchea.

2. Mortality. In 1947 malaria was the leading cause of death in Thailand, claiming some 40,,,-50,,, lives annually with the death rate of approximately 300 per 100,000 population. Now it is the seventh ranking cause of death nationwide, preceeded by accidents, heart disease, malignant neoplasms, respiratory tuberculosis, pneumonia and diarrhoea diseases. The mortality rate from malaria in 1974 was 15.8/100,000 population, decreasing to 5.9/100,000 in 1983, which is the lowest

mortality rate from malaria ever recorded in Thailand (See Figure 2). The steady decrease in the mortality rate since 1974 is due to the expansion of peripheral health care delivery and the establishment of malaria clinics providing prompt diagnosis and treatment in areas of high transmission.

3. Vectors. To date three species of anopheline mosquitoes have been proven responsible for malaria transmission in Thailand, namely Anopheles balabacensis (=An. dirus), An. minimus, and An. maculatus. An. minimus, considered to be the most important vector, is prevalent in forested and cleared forested foothill areas with slow running streams throughout the country. An. balabavcensis (An. dirus) is the other main malaria vector and its area of prevalence can be taken*to coincide with the distribution of forest.An. maculatus has been incriminated as a vector in Sourther Thailand. Two anopheline species, An. sundaicus and An. aconitus are considered as secondary vectors in some particular areas. The result of DDT susceptibility tests carried out so far on the principal and secondary vectors show that they are responding favourable to the insecticide. However, in the presence of DDT residual spray, the vectors show a higher density of outdoor biting than that of indoors.

Problems

At present there are three major problems confronting the Anti-Malaria Programme of Thailand. These include the rapid dissemination of P. falciparum strains highly resistant to both 4 aminoquinolines and sulfadoxine/pyrimethamine drugs, the exophilic behavior ofmalaria vectors and occupational migration of the people.

For many years chloroquine was the mainstay of antimalarial chemotherapy in Thailand and it is still an effective treatment for P. vivax infections. However, in the late nineteen-fifties, P. falciparum clinical treatment failures with chloroquine were noted in Thailand. Studies in six southern provinces using the in vitro macro technique, conducted in 1978-1981, showed chloroquine resistance in 85% to 96% of isolates.

The combination of sulfadoxine/pyrimethamine was an effective replacement until the mid-1970's when true resistance was first noted along the Kumpuchean border. Resistance to sulfadoxine/pyrimethamine is widespread in Thailand but is strongest in the Thai-Kampuchean border provinces and in areas involved in the migration to and from these areas. An in-vivo study on the response to treatment with sulfadoxine/pyrimethamine was conducted in Yala province in mid-1984. Of 15 patients studied only 2 were not positive after treatment and follow-up, indicating a failure rate of 87%. All failures, but one, were at the R1 level.

The regimen which has replaced sulfadoxine/pyrimethamine in areas of high resistance is a combination of quinine and tetracycline. This combined course, while generally effective, is difficult to supervise, and because of the side effects of quinine, compliance in outpatients is poor over the necessary seven days of treatment.

In 1980-1981 studies to determine the sensitivity of P. falciparum to the new anti-malaria drug mefloquine were conducted in Yala and Ranong provinces, using the in-vitro macro technique. Monitoring studies are now under way to determine the sensitivity of P. falciparum to quinine and mefloquine inthese same two areas, using the in-vitro micro technique. Results so far have shown that P. falciparum is very sensitive to mefloquine, and is still sensitive to quinine. At present, an in-vitro micro test for sensitivity to sulfadoxine/pyrimethamine is being developed in Yala province.

Mefloquine promises to be both an effective and an operationally feasible substitute for quinine-tetracycline. The Anti-Malaria Programme in Thailand has beeninvolved in a number of field clinical trials of both mefloquine and the triple combination mefloquine-sulfadoxine-pyrimethamine. It has been recognized that the completion of studies required for speedy release of this drug should be encouraged. Thailand has asked the World Health Organization to help arrange pre-registration availability of mefloquine for use in the context of an expanded field trial. At present a large scale field trial of the triple combination is being carried out in selectedborder areas. This will eventually result inthe treatment of some 100,000 cases of falciparum malaria. The results so far show that this drug has a potent blood schizontocidal activity against strains of P. falciparum resistant toother antimalarial drugs, it gives a cure rate of greater than 95%, and is very well tolerated. Since this drug is given in a single dose, is very effective and safe,it is obviously the best drug currently at hand.

At this point, the Anti-Malaria Programme has begun to plan the deployment of the triple combinatin, when it becomes available probably in Fiscal Year 1985, to be used as the first line drug for the treatment of falciparum malaria throughout the country.

Regarding the exophilic behaviour of the vectors, the principal techniques employed to date to overcome this problem are the use of larvivorous fish, thermal fogging with Fenitrothion in epidemic situations and encouraging the use of personal protection measures such as bed nets and repellent.

The third problem is that of occupational migration of Thai people to the Kampuchean border area for gem mining and farm labour as well as local migration from villages to forests for woodcutting and expanded cultivation in foothill forest fringe areas. This problem has been addressed through increased health education by stressing the importance of personal protection measures such as mosquito nets and repellent.

A malaria vaccine, once made available, would be most useful in reducing the major problem of migratory workers, including military and/or police patrol, in malarious areas. However, vaccines, whatever form, being relatively short-acting should be considered as an additional tool rather than replacement of the exisiting anti-malaria measures.

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INTRODUCTION

Malaria was a major public health problem in the entire Indian sub-continent except in the north Himalayan ranges above 5000 ft. sea level and a narrow coastal belt from Western to eastern ghats. The adverse effects of malaria on human life were stated by the public health commissioner of the Government of India in 1931 as "the combined effects of cholera, plague and small pox were responsible for less than 5 out of every 100 deaths, whereas 60% of the total mortality in the country was ascribed to fevers of which one third to one fourth are probably deaths due to malaria". Noted malariologist Sinton (1935) described the situation as "The problem of existence in very many parts of India is the problem of malaria. There is no aspect of life in this country which is not affected either directly or indirectly by this disease. It constitutes one of the most important causes of economic misfortune, engendering poverty, diministing the quantity and the quality of the food supply, lowering the physical and intellectual standards of the nation and hampering increased prosperity and economic progress in every way". In 1947 it was estimated that 75 million people suffered from the disease and 800,000 died annually, and mortality due to malaria used to increase considerably during the epidemic years. Malaria was a major impediment and scourage in the successful implementation of developmental projects and human welfare. This situation

took a dramatic turn when DDT was made available for use in public health. From 1946 onwards Government of India launched several feasibility projects on malaria control. These projects utilized DDT as the residual insecticide and successfully interrupted malaria transmission in U.P. terai, Rayagada, Malnad and Wynad. This was soon followed by similar demonstrations in Karnataka, Maharashtra,West Bengal and Assam. By 1952 about 30 million population was being protected from malaria. Based on the success in pilot projects, Government of India launched the National Malaria Control Programme (NMCP) in 1953. Progress of malaria control under NMCP was so spectacular that in 1958 Government of India converted NMCP to the National Malaria Eradication Programme (NMEP). As a result of the nationwide spraying of residual insecticides, malaria gradually started disappearing from the country, and at one time it appeared as though the battle against malaria has been won completely. The euphoria of success resulted in the conversion of the one time world famous Malaria Institute of India to the National Institute of Communicable Diseases. Research on malaria was de-emphasized and publicaton of one time famous Indian Journal of Malariology was terminated as there were neither the readers nor the subscribers. Still in 1965 there were atleast 100,000 cases of malaria in the country. Slowly and gradually malaria started raising its head and during these years, there was little preparedness to combat the disease.

As a result in 1976, NMEP recorded at least 6.4 million parasite positive cases of malaria. Deaths due to malaria also started to increase (see table 1).

During early 1970's the Government of India realized that eradication of malaria was not a realistic goal, impossible to achieve. Therefore there was a need of a more realistic approach to malaria control, and a revised strategy known as the modified plan of operations (MPO) was launched by the NMEP in 1977 with the following objectives (i) to eliminate deaths due to malaria (ii) to reduce morbidity due to malaria (iii) maintain the green revolution and industrial development, and (iv) retention of the achievements gained.

In order to meet the above objectives inter alia all areas with 2 or more cases per thousand population per year (2 or more API) were to be sprayed with a residual insecticide, and drug was to be made available to every fever case throughout the country. There were other technical and administrative changes as well (Pattanayak and Roy, 1980).

Implementation of MPO resulted in the improvement of malaria situation. Malaria cases gradually declined from 6.4 million in 1976 to 2.0 million in 1983 (see table 1). The MPO was also augmented with 2 additional schemes i.e. the urban malaria scheme (UMS) and the Plasmodium falciparum Containment Programme (PfCP). UMS was implemented in towns

TABLE 1: MALARIA IN INDIA

YEAR	TOTAL POSITIVES	SPR	P.FALCIPARUM CASES	SFR	P.FALCIPARUM %	DEATHS
1961	49151	0.375	17141	0.131	36.8	-
1962	59575	0.223	16674	0.062	28.4	-
1963	87306	0.225	22750	0.059	26.4	-
1964	112942	0.26	31490	0.073	27.9	-
1965	100185	0.25	26163	0.066	26.3	-
1966	148156	0.37	39618	0.099	26.78	-
1967	278622	0.69	61984	0.154	22.38	-
1968	274881	0.65	92714	0.219	33.74	-
1969	348647	0.83	103217	0.246	29.70	-
1970	694647	1.70	100115	0.245	14.46	-
1971	1312118	2.27	148683	0.255	11.31	-
1972	1430025	3.65	142177	0.363	9.34	-
1973	1934485	4.56	265154	0.626	13.14	-
1974	3172866	7.10	476922	1.069	14.39	3
1975	5166142	9.97	729251	1.395	14.12	99
1976	6467215	11.55	753713	1.346	11.70	59
1977	4740900	8.32	461484	0.807	9.70	55
1978	4144385	6.85	548567	0.907	13.20	74
1979	3064697	4.99	558423	0.909	18.22	198
1980	2896000	4.32	586438	0.375	20.24	207
1981	2666244	3.04	574814	0.871	21.55	170
1982	2182303	3.34	551057	0.84	25.25	187
1983	2018605	3.13	600964	0.93	29.77	239
1984(Prov)	1921264	3.23	508100	0.85	26.45	236

SOURCE : NMEP

with >40,000 population and the API of 2 or more. It was envisaged that 132 towns would be covered under the scheme in a phased manner. As of now, 125 towns covering a population of 43 million are under the urban malaria scheme (Pattanayak et al. 1981).

PfCP was launched with the immediate objective to improve the system of case detection and laboratory services, drug distribution, treatment, management of serious cases and insecticidal spraying. The intermediate objectives were to intensify spraying to intercept transmission and prevent the spread of drug resistant strains. In order to accomplish these objectives, epidemiological teams were established in strategic areas for the monitoring of 2 way population movement from areas known to have foci for drug resistat strains and also to take such measures as are necessary to deal with the problem of malaria under each situation (Ray, 1979).

The scheme (PfCP) was launched in areas with high rate of P. falciparum. During the period of resurgence it was observed that 55 districts had about 70-80% of all P. falciparum infections that occur in India. Of these 18 districts of the northeastern region accounted for 80% of the P. falciparum infections. PfCP was initially launched in these districts with a view to check the spread of falciparum malaria to other areas. Based on the information elicited by the surveillance, PfCP was extended to several

other states. At present PfCP operations are divided into 4 zones covering a total of 79 districts in the country.

FALCIPARUM MALARIA IN INDIA

Before launching of the NMCP/NMEP, the proportion of P. falciparum infections averaged 46% in 1930 and 40% in 1950 (Singh et al. 1952). Spraying of residual insecticides produced dramatic reduction in malaria incidence. During the hey days of malaria control, disease was eradicated from more than 50% of the country, in 25% of the country, the eradication programme was in advanced stage,and in remaining 25% spraying operations were ongoing which included the hard core areas. It appeared as though malaria was about to be eliminated as there were only about 100,000 cases in the entire country in 1965. The success in malaria control was spectacular but short lived, and in subsequent years there were focal outbreaks even in areas that were in the maintenance phase. The main reasons for the resurgence were the shortages of DDT, presence of foci in urban areas, persistent malaria transmission in hard core areas which constituted 9% of the population, and general health services were not mature enough to accept the responsibility of the maintenance phase (Sharma and Mehrotra, 1985). As a result,between 1965 to 1976 malaria cases increased 65 times and the proportion of P. falciparum varied from 10 to 15% (Table 1). The implementation of the modified plan of operations in 1977

produced a steady reduction in the total number of malaria cases, but the incidence of P. falciparum stabilized at about 0.5 million cases annually i.e. there was an increase in P. falciparum proportion in the country from about 10% in 1977 to 30% in 1984. It may be noted that while there was an increase in P. falciparum in areas outside the PfCP zones, there was a considerable reduction in P. falciparum in areas under PfCP (A.P. Ray, perosnal communication). Reasons for this selective drop in vivax malaria could be that (i) P. vivax is sensitive to the commonly used drug chloroquine, and the presumptive dose of 600 mg chloroquine (4 tablets) is enough to clear the parasitaemia. Also the drug is available freely in all parts of the country through a network of DDC's, FTD's and other agencies, (ii) in vivax malaria, the relapse rate is low i.e. 20% of the infections show a first relapse, 8% second relapse, 4% a third relapse and 2% a fourth relapse (WHO, 1983) (iii) chloroquine is gametocitocidal in P. vivax and not in P. falciparum so that presumptive treatment also blocks transmission of vivax malaria (iv) in P. falciparum primaquine is to be administered to kill the gametes, and DDC's give only chloroquine as a presumptive treatment, thus all falciparum malaria cases with gametes continue to produce secondary cases. (v) there are also fears of primaquine induced haemolysis in G-6-PD deficient cases, which prevent the use of primaquine. Thus the transmission continues, even though the patient is relieved of the fever

as a result of the schizontocidal action of the chloroquine. (vi) there is also a clear evidence of the decreasing sensitivity of P. falciparum to chloroquine so that recommended dosages are not enough resulting in recrudescences. (vi) Chloroquine facilitates transmission of resistant Plasmodia through the vectors thus enhancing the spread of falciparum malaria, (Wilkinson et al. 1976), and (vii) P. falciparum has biological advantage of high multiplication rate thus increasing the parasite load and enhancing transmission.

In many states NMEP has recorded a considerable increase in P. falciparum cases during 1984 over 1983. For example the increase was : Andhra Pradesh 44%, Himachal Pradesh 675%, Jammu and Kashmir 209%, Maharashtra 17%, Meghalaya 40%, Orissa 11%, Punjab 57%, Tripura 35%, Uttar Pradesh 19%, West Bengal 49%, Chandigarh 90%, Goa 113% and Mizoram 9%. The situation in Orissa did not improve much and about 40% of all P. falciparum infections occurred in one state alone. There are similar examples of the increase in falciparum malaria from several parts in the country (Sharma et al. 1983, Choudhury et al.1983, Choudhury et al. 1984).

The increase in falciparum malaria is also noticeable in areas which were exclusively vivax malaria areas after the near eradication of malaria. A classical example is that of U.P. terai (distt. Nainital). In this area,

intensive surveillance on daily basis in 1981-82 revealed only 23 cases of falciparum malaria in Kichha PHC (Pf% 1.3) and surveys in other PHCs showed only isolated cases of falciparum malaria. In subsequent 2 years P. falciparum increased enormusly out numbering vivax malaria (Pf% 70-100). Also in certain areas there are epidemics of malaria resulting in deaths like in Shahajahanpur (Sharma and Chandrahas, 1983). In this area even a good coverage with 4 rounds of BHC spraying and adequate availability of durg in the affected villages did not improve the situation. The SPR was 53.8 and Pf% 94 during the epidemic year in 1983 and during 1984 the SPR was 46.2 and Pf% 74.6. Thus the Indo-UK Workshop scientific group which discussed falciparum malaria in India concluded that the independent studies by the Malaria Research Centre (MRC) and by a WHO/PfCP team have indicated that the NMEP figures greatly underestimate the extent of the falciparum problem (Peters, 1984).

Studies on the epidemiology of malaria showed that vivax malaria cases starts increasing from March reaching peak in July-August followed by a sudden decline to low numbers. The incidence of falciparum malaria is very low from March to May and cases gradually starts building up in the following months peaking in October-November followed by a sudden drop to low numbers during the winter months. During the same period in the same community mass blood surveys showed similar peaks of vivax and falciparum malaria

(Fig.1 a & b), and that the proportion of atypical or inapparent malaria cases was extremely high in the villages (Sharma et al. 1983). Subsequent studies showed similar peaks of vivax and falciparum malaria from several parts in the northern states (Sharma, 1984b, Choudhury, 1984 and Choudhury et al. 1983).

The evolution of insecticide resistance in vector species is resulting in an increasing demand of the replacement insecticides. These insecticides are more toxic and many times more expensive, and it is also certain that in course of time resistance would evolve against these insecticides as well. The escalating cost of insecticides would alone make the strategy of intradomiciliary spraying unacceptable. Added to this is the fact that several studies in the field areas have shown that ongoing spraying is only helpful in reducing the incidence of malaria to some extent and preventing the onset of epidemics. It is against this background that it appears that the present strategy of malaria control is at best controlling malaria on a borrowed time. There is therefore an urgent need to intensify research on the integrated control strategy with minimum reliance on insecticides. Towards this objective a study in Nadiad has shown that it is possible to control malaria by environmentally safe and sound methods and without the use of insecticides (Sharma, 1985).

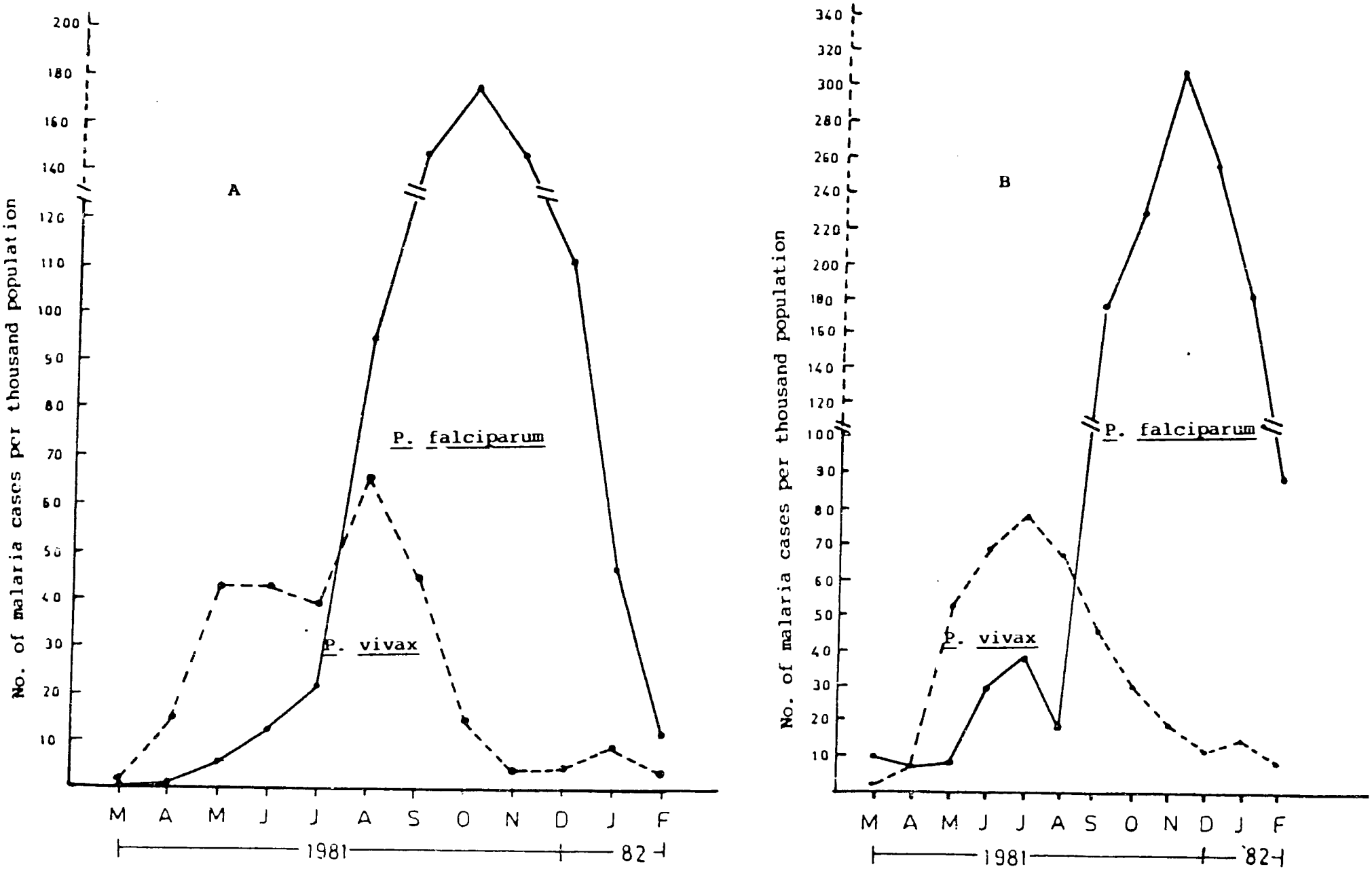

Fig.1. Showing peaks of vivax and falciparum malaria in Kharkhoda PHC (Haryana) as detected simultaneously by (A) active surveillance in fever cases, and (B) mass blood survey in afebrile or inapparent cases of malaria (Sharma et al.1983).

PROBLEMS IN MALARIA CONTROL

Malaria control in India is faced with the formidable problems of administrative, operational and technical nature .accentuated with financial constraints. Some of the important technical problems are discussed below.

Development of multiple resistance in vector species is the foremost problem in the interruption of malaria transmission. There are 7 primary vectors of malaria in India. Of these Anopheles culicifacies is the vector of rural malaria, others being of local importance. This vector has become resistant to DDT and BHC in most parts of the country, and resistance to malathion has also appeared in Gujarat and Maharashtra. As a result insecticidal spraying as a means to control malaria is not producing cost effective impact on transmission. The second vector Anopheles stephensi transmits malaria in urban areas. Although monitoring of resistance has shown that the vector has become resistant to DDT and BHC in many towns of India but under the urban malaria scheme, main reliance is placed on the source reduction and anti-larval methods, and therefore resistance is not an obstacle in the control of A. stephensi. Anopheles minimus and Anopheles fluviatilis are still susceptible to insecticides and a good spray can interrupt transmission.

At one time spraying under NMCP/NMEP almost eradicated Anopheles minimus, but in recent years there has been a considerable increase in its populations and its role in malaria transmission has been re-established (Bhatnagar et al. 1982). Anopheles sundaicus, at one time vector in Orissa and West Bengal and particularly notorious in Chilka lake area, is now almost exclusively found to transmit malaria in Andaman and Nicobar islands. The vector is susceptible to insecticides but perfers to rest and feed outdoors. Anopheles dirus and Anopheles philippinensis are also susceptible to insecticides, and transmit malaria in northeastern states, and particularly later species influences transmission upto West Bengal. Sizeable population of these species are exophilic and exophagic in behaviour and the intradomiciliary spraying of residual insecticides is not very useful in the control of malaria. The technique of control in these vectors would have to be modified to take advantage of the weak links in the biology of these vectors instead of complete reliance on the spraying. It is therefore obvious that the problem of insecticide resistance essentially relates to the control of Anopheles culicifacies.

A serious problem in the control of malaria with the ongoing insecticidal spraying is the poor coverage of houses mainly as a result of refusals. There are many reasons for this, foremost being the poor response of mosquitoes to

spray, lack of colateral benefits, and house holders do not allow their cement houses to be sprayed. It may also be pointed out that spraying of chlorinated hydrocarbon insecticides like DDT is not very effective in the control of Culex mosquitoes, whereas DDT spraying may kill the anopheline mosquitoes. Presence of Culex mosquitoes in large numbers makes the villagers believe that spraying was not at all effective, thus adding to refusals. The spraymen are also half willing to carryout their job. There is also the lack of experienced supervisory staff so that quality of spraying is wanting. It has been observed that there are generally no refusals for spraying the cattlesheds, so that in a village more cattlesheds are sprayed than houses. Because of the excito-repellent action of DDT, vectors prefer to enter houses than cattlesheds. As a consequence, there may be some reduction in vector densities, but without any tangible impact on malaria transmission.

A serious problem that is raising its head is the development of chloroquine resistance in P. falciparum. First report of resistance in P. falciparum to chloroquine came from Diphu and Nowgong in Assam in 1973 (Sehgal et al., 1973). This was followed by several similar reports from Assam, Meghalaya, Arunachal Pradesh, U.P., Mizoram, Orissa, Nagaland, Maharashtra, Andhra Pradesh, Madhya Pradesh, A & N Islands, Karnataka, Haryana and Delhi (Sharma, 1984b). This delimitation of the problem was

possible through a systematic monitoring programme of drug resistance sponsored by the Indian Council of Medical Research under the auspices of the NMEP. It may be noted that under the MPO, chloroquine is being distributed free in the country through the drug distribution centres (DDCs) and the fever treatment depots (FTD's). These have been established at the rate of 3 DDC's and 1 FTD per 10 thousand population, and as of now 2,49,669 DDCs and 1,24,552 FTDs are functioning in the country. DDCs give chloroquine to all fever cases and FTDs while dispensing presumptive treatment also collect blood smears for radical treatment. As a result, chloroquine is most widely distributed antimalarial. It has now been established from several parts in the world that although resistance may be spreading geographically as a result of the movement of population and/or vectors, but pressure of chloroquine over a long period may bring about poor response of chloroquine in the clearance of parasitaemia (Sharma 1984b, WHO 1983). In India, although drug resistance is found in many states, but the most common type is RI whereas RII is also occasionally encountered, and R III resistance has been recorded from 12 PHC's of 9 states in the country. There are a number of other problems which are serious obstacles in the successful control of malaria. Some of these are the rising cost of insecticides, antimalarials and labour etc; poor surveillance, lack of intersectoral cooperation, inadequate man power as the key posts are not filled, complacency of

health staff including the fact that the priority is given to family planning at the cost of malaria work (Sharma 1984a, Clyde and Beljaev 1984).

Among the inputs required to increase agricultural production, irrigation is contributing to the increasing incidence of malaria. Early work in Punjab and Pattukkottai had shown that there was intimate association of A. culicifacies and irrigation water, and that irrigation increases the incidence of malaria (Gill 1938, Russell 1938). Rao (1945) reported that the opening of Visvesvarya canal in Mandaya district (Karnataka) increased the average enlarged spleen rate from 15.3 to 50-90%. There was a 20-fold increase in deaths due to fever and within 3 years of the introduction of irrigation the conditions had settled down to a state of hyperendemicity. In India, area under irrigation has increased from 29m hec. in 1960 to 60m hec. in 1984, and as a consequence of this large epidemic areas such as in Punjab, Haryana, Delhi, and U.P. have become endemic to malaria. A recent study near Delhi showed that canal irrigated areas were more prone to malaria than the tube well irrigated areas. Also there was a considerable increase in falciparum malaria in the canal irrigated areas during the later part of the year (Sharma and Uprety, 1982). Russell (1938) stated that it was not the irrigation per se but defective and untidy irrigation which by misplacing to the advantage of certain anopheline mosquitoes generates malaria. It is commonplace that canals are not lined and

poorly maintained in the country. Sharma and Mehrotra (1982) stated that the unplanned growth in urban and rural housing and lack of adequate water disposal facilities creates mosquitogenic surroundings and increases the receptivity to malaria. Irrigation also increased the average humidity of the atmosphere and made the regions more conducive for the mosquitoes' survival. This had the most profound affect on the basic reproduction rate. As a result there was resurgence of malaria in large parts of the country at one time freed from the disease.

TACKLING THE PROBLEMS

One method to tackle the problem of insecticide resistance is the use of replacement insecticides, but mosquitoes have the ability to evolve multiple resistance. The newer insecticides are more toxic and expensive. As an example the cost of spraying 1 million population in 1985 would be Rs. 2.2 million for DDT, Rs. 3.2 million for BHC and Rs. 20.0 million for malathion, and the cost of some newer insecticides may be many times more. During 1984-85, India's budget for malaria control was Rs. 1650 million, of which Rs.1000 million was for the purchase of insecticides i.e. Rs. 340 million for DDT to cover 210 million population, Rs. 300 million for BHC to cover 110 million population and Rs. 360 million for malathion to

cover 21 million population. Any significant increase in the purchase capacity of insecticides, particularly malathion or change over to newer insecticides like fenitrothion is not possible because of the financial limitations. It is therefore absolutely essential to extend the useful life of the cheaper insecticides like DDT and BHC. Towards this objective, a study was launched in Faridabad villages (Haryana) to demonstrate the usefulness of DDT in DDT resistant A. culicifacies areas. In this area, WHO tests on the susceptibility to insecticides showed that 88% mosquitoes survived one hour exposure on 4% DDT impregnated papers. DDT was sprayed under the supervision of the MRC staff, and a $1gm/m^2$ DDT deposit was ensured in 70-80% structures. Spraying reduced vector densities, and the slide positivity rate was reduced to about half (Sharma et al. 1982).

The study was repeated in 1984 in Loni PHC (Ghaziabad, U.P.). In this area due to DDT resistance in A. culicifacies BHC was being sprayed for several years but this spraying was not producing tangible impact on malaria transmission. Spraying of DDT @ $1gm/m^2$ and BHC @ $200mg/m^2$ in these areas reduced vector densities and malaria to low levels as compared to BHC sprayed @ $200mg/m^2$ by the health department. Study revealed that correct dosage application and increased coverage of houses was important to produce epidemiological impact of spraying, and DDT spraying was better than BHC spraying.

The problem of drug resistance is being tackled by the NMEP/PfCP by implementing alternate drug schedules in areas with resistant foci (Sharma, 1984a). The spread of drug resistance to other regions of the country is being prevented by a systematic action oriented programme such as the (i) area is demarcated for monitoring, treatment and spraying (ii) insecticidal spraying is intensified to curb transmission (iii) monitoring is extended to delimit the problem (iv) treatment schedule is changed to (a) presumptive treatment (ACD, DDC and FTD): Amodiaquine 600mg and PCD sulphalene 1000mg + pyremethamine 50mg as a single dose; (b) radical treatment: sulphalene 1000mg + 50mg pyrimethamine + 45mg primaquine in a single dose.

The migratory labour population leaving the PfCP zones or high P. falciparum areas are given mass drug administration of chloroquine 600mg + primaquine 45mg in a single dose. For radical cure chloroquine 1500mg (600 on day 0, 300 on day 1 & 2 each) + primaquine 45mg on day 0 is given. If there is no response within 72 hours, radical cure with long acting sulphanomide in a single dose is given as the radical treatment. Primaquine is not given to pregnant mother and children. The implementation of above measures was highly successful and major foci of drug resistance in Karbi Anglong (Assam), Chandrapur (Maharashtra) and Mirzapur (U.P.) were curbed.

A long term strategy to control malaria by integrated methodology and without the use of insecticides is being developed in Nadiad Taluka, distt. Kheda, Gujarat. The main components of this strategy are the (i) source reduction (ii) biological control using the larvivorous fishes (iii) chemotherapy (iv) health education (v) community participation and (vi) environmental improvement by introducing social forestry, alternate energy sources etc.

Alternate strategy is being integrated with other developmental projects to make it a holistic approach for the evolution of villages towards the Gandhian way of life. Study aims to generate village economy to help sustain vector control at the village level by social forestry, fish culture and other schemes. It was initially launched in a population of 25,000 and in one year (1984) malaria incidence was reduced by 64% from the previous year or from the comparison area, and if one compares the reduction from 1981 or 1982, when malaria was controlled using BHC and malathion, the incidence was reduced dramatically to low levels. The study has now been extended to 100 villages (0.35 million population) and research is being directed to make it cost effective. Cost projections to control malaria in 100 villages of Nadiad Taluka revealed that 3 year expenditure of malaria control would be Rs. 2.4 million with DDT, Rs. 3.6 million with BHC, Rs. 21.0 million with malathion and Rs. 5.5 million with integrated control methodology. The cost is therefore affordable, and if

benefits from other schemes that are integral to the control strategy like fish culture, social forestry environmental improvement etc. are taken into account, the cost on malaria control may be absorbed almost entirely. The adoption of this method in large parts of the country would therefore on its own eliminate the problems of insecticide resistance, drug resistance and those related to the behaviour of mosquitoes.

ROLE OF MALARIA VACCINES

It is against this background that the importance of malaria vaccines comes out. An ideal vaccine should provide long lasting immunity from the clinical attacks of all Plasmodia, perferably in a single dose and without side effects. Malaria vaccines should first be tried in regions of stable malaria. During the hey days of malaria control, the technique of intradomiciliary spraying of insecticides failed in 9% of the population which remained in attack phase for more than 11 years. In such areas, malaria vaccines could be tried to elicit information on the true value of immunization against malaria. Vaccines would also find easy acceptability for clinical trials in areas prone to epidemics such as Shahjahanpur, and similar other areas where deaths due to malaria occur periodically.

Vaccines would be of immense value in protecting the tourists who come from non-immune areas and become victims of serious episodes of malaria. The estimated tourist flow in India is about 1 million and the industry earns foreign exchange of about Rs. 11,000 million annually. Tourists may have a genuine fear of malaria, and this may adversely effect the tourist flow. Even a short protection period of few weeks would be a great help and save life. Similarly vaccination of migratory labour from endemic to non-endemic areas could prevent the spread of drug resistant and other variant strains. The urban population and defence personnel would make greater use of malaria vaccines. In rural India, even if mass vaccination is not possible, immunization of children would be highly beneficial as this age group is most vulnerble to malaria. Integration of malaria vaccines with the ecologically safe methods of malaria control under development in Nadiad would be very useful in protecting the areas from introduced malaria. Vaccines could be used in immunizing the incoming and outgoing populations and also other vulnerable groups to prevent the onset of secondary cases. A notable feature of the malaria situation in India is the selective decline in vivax and not the falciparum malaria, and therefore vaccine against *P. falciparum* can play a vital role in lowering falciparum malaria by mass immunization of people living in *P. falciparum* dominant areas.

In India, areas above 5,000 ft. sea level and a narrow belt along the western and eastern ghats are naturally free from malaria, and other regions have variable endemicity. These areas could be stratified according to the vector influence or graded according to the endemicity. At present, the National Malaria Eradication Programme of the Government of India is protecting 350 million population living in rural areas. This does not include areas/sections under 2API, and in the same geographical area there may be sections (Section=10,000 population) with <2API which are not sprayed. Therefore these regions with malariogenic potential continue to be the vulnerable groups. A sudden spurt in vector populations due to favourable conditions may bring an epidemic. Macdonald (1957) had shown that with an initial parasite rate of 0.1% (i.e. 1 introduced case in a village of about 1000 population), how epidemics affecting 50% of the population can occur in 7 months even if the reproduction rate is as low as 5, and only 3 to 4 months if the reproduction rate is 20. Therefore even in areas where either the malaria control measures have been successful or in areas with <2API, a constant surveillance is important and malaria vaccines can play an important role in preventing the fulminating epidemics to occur.

Success in immunization against malaria would depend on the protection provided by the vaccine, side effects, and the application procedures. At present immunization against malaria in large parts of rural India is difficult unless

special preparations are made. This may take time in training and integration of the immunization programme with the primary health care system.

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Current Status of Malaria in Asian Countries of the WHO S-E Asia Region

Distribution: Countries of the WHO S-E Asia Region that are affected in varying degree by malaria are Bangladesh, Bhutan, Burma, India, Indonesia, Maldives, Nepal, Sri Lanka, Thailand.

Malaria is widely distributed particularly in the foothill districts of Bhutan, Burma, India, Nepal, Thailand. In Bangladesh it is mainly confined to the eastern hilly districts; in Indonesia is more prevalent in the Outer Islands than in Java and Bali, where vector controlmeasures are maintained; in Maldives it has virtually been eradicated by 1985 (P. falciparum transmission having been eliminated by 1976); in Sri Lanka perennial transmission occurs in belts in the north-center and the south-east, and seasonal transmission elsewhere.

Incidence: The annual incidence profile of malaria in these countries combined (obtained from official data supplied to WHO for the period 1970-1983) is as follows:

Year	Population	ABER	API	SPR	SfR	Pf%
1970	727,606,000	8.3	1.96	2.37	0.47	19.8
1971	739,987,000	7.7	2.28	2.98	0.55	18.6
1972	754,886,000	7.7	2.41	3.14	0.52	16.5
1973	778,711,000	7.7	3.45	4.49	0.64	14.2
1974	792,721,000	7.8	5.04	6.46	1.24	19.2
1975	813,703,000	8.6	7.39	8.60	1.50	17.4
1976	831,908,000	8.9	8.68	9.74	1.37	14.0
1977	850,627,000	8.6	6.45	7.48	0.97	12.9
1978	872,195,000	8.7	5.42	6.21	1.14	18.3
1979	891,362,000	8.7	4.05	4.63	1.03	22.3
1980	913,446,000	9.4	3.98	4.22	1.15	27.4
1981	936,282,000	9.3	3.67	3.94	1.17	29.8
1982	852,454,000	9.1	2.98	3.28	1.09	33.3
1983	972,453,000	8.5	2.59	3.05	0.99	32.5

This tabulation in respect of API, SPR and SfR closely follows the situation in India, where the incidences of malaria dominate those of the other countries. Following the failure to maintain the eradication campaigns during the late 1960's, the incidence climbed to a peak in 1976, when the Regional API was 8.68, and the SPR 9.74. Since then, these figures have been reduced by intensified anti-vector and anti-parasite measures, with increasing decentralisation to community health workers, to 2.59 and 3.05 respectively (year 1983).

This downward trend is attributable mainly to twice yearly house spraying with DDT (or with malathionof HCH 2 to 4 times a year in those

parts of western India, Nepal, Indonesia (Java), and throughout Sri Lanka, where vectors have reduced suspectibility to DDT), and to surveillance with chloroquine distribution to presumptive cases reinforced by treatment with sulfonamide + pyrimethamine, quinine + tetracycline, or mefloquine in cases of falciparum malaria resistant to 4-AQ. In 1983, of the nearly 1000 million inhabitants of formerly malarious areas of the Region, 94% were living in areas benefitting from antimalaria operations. These operations are diversified on the basis of stratification into high and low risk areas, in the latter, where API is below 2, integration with primary health care systems supported by a central expert cadre being the policy.

Types and species: Despite the overall reduction, however, there is a shift in the parasite species proportions that has ominous implications. The proportion of falciparum malaria has been increasing steadily, from 14% in 1976 to 33% in 1983. Analysis must, however, take into consideration the baseline geographical situation. In the eastern countries of the Region including Burma P. falciparum has always predominated, whereas in the westernincluding India P. vivax has always been more common. In Burma since 1979 there has been 5 times more P. falciparum than P. vivax, although previously the ratio was 2 to 1. Considerably more P. falciparum (88% of all species) occurs now in zones under drug or spray operations than in those under surveillance (82%) or vigilance (72%). The Burmese conclude that this swing towards P. falciparum is attributable to the increasing distribution and intensity of resistance of this species to the widely-used chloroquine.

This view is not fully supported by experience in India, where in the north-eastern districts inhabited by chloroquine-resistant P. falciparum this species proportion has decreased from 51% to 45% during the past 3 years, whereas in India as a whole (much of which still has chloroquine-sensitive parasites) there has been an 8% increase in P. falciparum proportions.

The trend towards P. falci parum is seen by comparing the Regional species rates, which indicate that the reduction in SPR from 9.74 in1976 to 3.05 in 1983 has been at the expense of P. vivax, there being no improvement during that period in the SFR. This may be attributed to the wide-spread distribution of chloroquine for presumptive treatment, destroying gametocytes of P. vivax not P. falciparum thus interfering with transmission of the former. That this effect is not related to selective survival of chloroquine-resistant over chloroquine-sensitive P. falciparum is demonstrated by the similar trend in western India, where resistance is only just appearing but where P. falciparum species proportions have risen from 10% to 20% in recent years.

Constraints to national malaria control programs: The trend towards malaria reduction is levelling off due to a number of constraints one of which is national will expressed by financial allocation to the program. On a Regional basis, in 1977-78 13.8% of national public health budgets were allocated thus, whereas in the 1981-82 fiscal year this figure had fallen to 8.5%. Among the exceptions India stands out, still committing nearly 30% of the national public health budget to malaria control. It is

, however, increasingly difficult to discern what funds go to malaria, as the malaria component is being amalgamated more and more in primary health care. Operational and technical constraints are increasing, and include: (1) Decrease in house spray coverage due to consumer resistance and rising costs of insecticides and personnel; (2) Superficial surveillance and understatement of incidence through inefficiency or (particularly in respect of mortality) policy; (3) Increase in vector breeding due to deforestation, flooding and unsupervised irrigation, gemming excavations, shifting cultivation; (4) Migration of gametocyte carriers to receptive areas, and of susceptibles to endemic areas - official resettlement policies, insurgency and military activities, trade and gemming, shifting cultivation; (5) Vector insusceptibility to insecticides, widespread in the Region - to DDT, Anopheles culicifacies throughout Sri .anka and in parts of rural India, particularly the west, and focally in Burma; A.stephensi in Burma; A.stephensi in urban west and south India; A.annularis in Nepal and Burma; A.aconitus in ava. To malathion, A.culicifacies in western India. To HCH, several of these focally. While A.dirus exhibits avoidance in much of its range, it may be truly resistant to DDT in some hilly forested areas of Burma; (6) P.falciparum is resistant to 4-AQ drugs (and widely also to sulfadoxine-pyrimethamine, and in late 1984 beginning to resist mefloquine), the phenomenon has spread through the Region and by 1985 foci are being identified in west and south India, central Sri Lanka, and Nepal. National drug policies vary accordingly, and in some countries notably India ayurvedic products are condoned officially even though scientific tests show their inefficacy.

Future trend: While some degree of improvement may yet be obtained by sharpening national antimalaria operations in the Region,in the absence of greatly increasing financing or new methodologies this will not be dramatic. Indeed even in India the downward trend now seems tohave been checked, an overall increase in incidence of 12% having been stated by the Minister for Health and Family Welfare to have occurred during the past year. Projecting Regional data points of SPR, API and SfR towards the year 2000, and ignoring probably adverse influences of accelerating overpopulation and migration, deforestation, and environmental degredation, the graphs that may be drawn under existing circumstances flatten out almost immediately. To re-establish a hold on malaria in sout-east Asia, a new methodology such as immunization is urgently needed.

Appendices: Reports on malaria in most of these countries are being presented at this meeting by the national managers. Since Bangladesh and Sri Lanka are not represented,summary outlines of the current status in both these latter are appended here.

Appendix A

Current Status of Malaria in Bangladesh
(Outline)

Distribution

Malaria occurs mainly in the north-east (Mymensingh area), east (Sylhet), and south-east (Chittagong Hills Tracts), in the hilly districts both forested - *A.balabacensis* transmission - and cleared - *A.minimus*. In the central, western and souther plain/estuarine districts - *A.philippinensis*, *A.sundaicus* - there is a greatly reduced amount of malaria.

Incidence

The incidence in the country as a whole, annually from 1970 to 1983, is summarized in the following official data:

Year	Population	ABER	API	SPR	SfR	Pf%
1970	62,810,000	9.4	0.13	0.14	0.07	49.6
1971	63,570,000	5.6	0.05	0.08	0.04	53.6
1972	65,220,000	8.3	0.28	0.34	0.12	34.6
1973	69,288,000	4.7	0.20	0.43	0.25	57.2
1974	71,585,000	2.7	0.24	0.91	0.63	69.7
1975	72,730,000	4.0	0.43	1.07	0.67	62..
1976	73,930,000	4.8	0.66	1.38	0.80	58.2
1977	76,395,000	1.8	0.38	2.11	0.91	43.1
1978	78,916,000	1.8	0.42	2.40	0.48	20.2
1979	81,520,000	1.7	0.61	3.62	0.76	20.9
1980	84,210,000	3.1	0.80	2.57	0.84	32.8
1981	87,670,000	2.7	0.52	1.96	0.65	33.2
1982	89,130,000	2.7	0.43	1.61	0.66	40.8
1983	92,120,000	2.5	0.44	1.74	0.71	40.8

While the peak of incidence occurring around 1979 has been brought down by intensified controlmeasures, the very low ABER casts doubts on the validity of the API. The long-term increase in the SfR is apparent, reflecting continuing control of transmission in the plains areas where P.vivax predominates and is increasingly resistant to chloroquine, and where less-immune immigrants are being settled having come from the low-transmission plains.

Control measures

These measures are adapted to the 3 defined epidemiological strata in Bangladesh, namely:

Stratum -1 - All forested areas with principal vector being A.b.balabacensis.
- Cleared foot hill areas with presumably A.minimus as a major vector.
- P.falciparum predominant areas.

In this stratum, the main objectives are to prevent mortality and reduce morbidity in high risk groups. To achieve the objectives, case detection, treatment and residual spraying with DDT twice a year are employed. In the less accessible parts of the Chittagong Hill Tracts, volunteers have been trained for drug administration, more than 80 such centers having become operational.

Stratum -2 - mainly plains areas with A.philippinensis and A.sundaicus as main vectors. The general objectives in this stratum are to prevent mortality and to reduce substantially the incidence of P.falciparum infections, along with the prevention of establishment of local transmission from imported P.falciparum cases. To achieve the target, one round of premonsoon spraying using DDT along with surveillance operations are considered to be effective. The reintroduction of epidemiological investigation of every P.falciparum case is considered to be an important measure.

Stratum -3 - plains areas where the vector is A.philippinensis, and P.vivax the only indigenous malaria species. The objectives are to maintain the gains achieved through a well developed surveillance machinery and to contain focal outbreaks of P.vivax. In this stratum in addition to surveillance operations, (radical) treatment,epidemiological investigations and focal spraying using DDT will be carried out around the clusters of confirmed indigenous malaria cases in pre-monsoon and post-monsoon periods.

Appendix B

Current Status of Malaria in Sri Lanka
(Outline)

Distribution

Malaria occurs at lower altitudes throughout the country, but is absent in the greater Colombo are. It takes two epidemiological forms - endemic in years of normal rainfall, and epidemic in drought years when pooling and intense A.culicifacies breeding develops in rock pools in the river beds.

Incidence

Intensified control measures followed the great epidemic of the 1930's, and culminated in a successful eradication campaign using DDT, in 1963 only 17 cases being reported. Spraying ceased in 1964, but the disease reappeared and in 1968 an explosive epidemic of P.vivax malaria occurred, forcing the reintroduction of attack measures using DDT and chemotherapy. The gains were short-lived, and by 1973 P.falciparum incidence rose sharply. The only vector, A.culicifacies, had become resistant to DDT.

From 1970 onwards, the annual incidence has been officially reported to be as follows:

Year	Population	ABER	API	SPR	SfR	Pf%
1970	9,188,000	14.4	50.96	31.21	0.09	0.3
1971	9,428,000	13.0	15.42	10.60	0.29	2.7
1972	9,655,000	15.2	13.73	8.58	0.23	2.6
1973	9,885,000	13.6	23.04	15.64	0.66	4.2
1974	10,004,000	13.0	31.53	22.17	1.84	8.3
1975	10,244,000	14.5	39.12	26.86	4.28	15.9
1976	10,400,000	13.4	29.11	21.62	1.34	6.2
1977	9,980,000*	9.6	26.30	27.49	1.13	4.1
1978	10,197,000	9.3	6.83	7.20	0.19	2.7
1979	10,334,000	9.7	4.65	4.79	0.14	2.9
1980	10,456,000	7.7	4.59	5.97	0.18	3.1
1981	10,474,000	8.5	4.52	5.31	0.14	2.6
1982	10,868,000	10.4	3.55	3.42	0.14	4.2
1983	11,065,000	9.5	11.50	12.06	0.43	3.5

* Population in malarious areas reassessed.

In 1977, 1 5-year intensive program was introduced, based on residual spraying of houses using malathion,chemotherapy,source reduction particularly in river beds by flushing of dams and larviciding, and surveillance. Space spraying was used on festival occasions at pilgrimage centers. In 1981, malarious areas were stratified to reduce spraying, those having perennial transmission receiving 4 rounds of malathion each year and those with seasonal transmission, selective spraying.

Present control measures

In 1984 an upsurge of transmission, which had commenced at the end of 1982, made it necessry to re-establish quarterly spraying of houses with malathion throughout the malarious areas. The measures also include space spraying with pyrethrum/kerosene in pilgrimage areas on festival occasions, anti-larval measures (larviciding, source reduction including filling of abandoned gem mining pits, river-pooling management by intermittent flushing of dams) and chemotherapy using chloroquine. The upsurge of P.vivax has commenced to increase also, late in 1984 the first cases resistant to chloroquine being identified at Dambulla in the center of the country. Another ominous finding is a somewhat reduced susceptibility of the only vector, A.culicifacies, to malathion.

CURRENT STATUS OF MALARIA AND MALARIA CONTROL PROGRAMS IN ASIA AND PACIFIC COUNTRIES

David Clyde, Rapporteur

Knowledge of the current status of malaria and malaria control programs in the littoral countries of Asia and the Pacific is essential for the planning of further interventions, including incorporation of vaccination procedures. In this section, the general situations in the two regions are presented, together with summaries of the status in the individual countries.

Western Pacific Region

Despite nearly three decades of extensive control activities, malaria still remains a major health problem in some endemic countries of the Western Pacific Region.

After the initial success in malaria control, primarily through DDT residual house spraying, the malaria situation has worsened in two main areas: one is the area where *A. balabacensis* is the main vector such as countries of the Indochinese Peninsula, some parts of the Philippines and Sabah State in Malaysia; the other is the area where the main vector is *A. farauti*, such as Solomon Islands and Papua New Guinea.

The disease, however, was eradicated in Australia, Brunei, China (Province of Taiwan), Japan (Ryukyu Islands) and Singapore.

A bright spot in the present gloomy situation is in Malaysia. Further progress was achieved in two programs, namely, Peninsular Malaysia and the State of Sarawak. In Peninsular Malaysia, the malaria eradication program has reached a stage where 95% of the total population are either in the maintenance or consolidation phase of the program, while intensive surveillance operations in the State of Sarawak have been successful in keeping the incidence of malaria throughout the State well below 1000 cases per year.

Three factors are mainly responsible for the present sorry state of affairs. First, the effectiveness of residual spraying with DDT, a major weapon in malaria control, has decreased.

A. balabacensis and *A. farauti* have not developed physiological resistance to DDT but have adopted different patterns of behaviour to avoid picking up the lethal effect of DDT deposits on the walls inside the house by not going indoors, by not resting on sprayed surfaces and by biting human beings out of doors. Spraying is sometimes being badly done, particularly in remote areas where good supervision is almost

impossible. A second factor is drug resistance. A third is the fact that the integration of the former vertically organized malaria services into the general health services or primary health care system has not gone smoothly and that during the past few years there has been in many places a kind of organizational vacuum.

The major problems and constraints confronting the malaria control programs are technical, administrative and managerial.

In all malaria control programs, indoor spraying with residual insecticides (chiefly DDT) has been used (in some programs for more than two decades) as the principal method of attack. Paradoxically, total dependence on this method alone in the past has been the cause of some major failures. Total and complete spraying coverage of all inhabited premises is a prerequisite if this method is to be successful in interrupting malaria transmission but it has not been achieved in a large part of the endemic countries because of operational factors such as unsatisfactory and inadequate supervision of spraying squads, difficult terrain, lack of transport, primitive housing conditions, etc. Mounting public resistance to spraying over a number of years has made the situation even worse.

The increasing evidence of reduction or loss of sensitivity of certain strains of P. falciparum parasites to chloroquine in all endemic countries of the Region, with the probable exception of part of China and Sarawak State in Malaysia, has presented another technical challenge. Quite apart from the magnitude of the problem per se, it has produced a psychological impact, resulting in confusion in the proper use of antimalarial drugs for treatment of patients and for prevention of infection.

From the administrative point of view, some disorganization in the national malaria control service has been observed recently in several countries due to the transition period in the process of integrating the malaria service into the general health service structure or primary health care system.

Other factors affecting the success of the antimalaria campaigns have been the diminishing financial support and the steadily increasing cost of the program due to inflation, particularly during the last ten years. The cost of DDT residual indoor spraying for two cycles a year now averages US$5 per capita per annum multiplied by the population under coverage, a 1000 per cent increase compared with cost in the 1960's.

The departure of trained and experienced manpower in all categories of the malaria service, particularly in the professional grade, and the frequent turnover of personnel are other common problems encountered by most countries.

Individual countries of the Region that may particularly be considered here are China, the Philippines, Malaysia, Papua New Guinea, the Solomon Islands, and Vanuatu.

In China, the number of malaria cases has been decreasing to a low level but the position is unstable as local outbreaks occur. Data collected in 1983 revealed that there were 1,377,647 cases, the morbidity being 0.14%. In 1984 the number was below 1 million.

Of the total cases reported, 78% (mainly attributable to *Plasmodium vivax*) occurred in Huanahuai plain and Jianghui plain, which are considered to be the major malaria endemic areas in China now. In the southern part, the former high endemic areas, including several provinces, autonomous regions and municipalities, prevalence of malaria has been declining steadily to less than 5 per ten thousand. But there are still some high endemic areas, especially on the southeast border, and inaccessible mountainous areas of poor socioeconomic conditions. The annual prevalence in the northern and northeastern parts has decreased to less than 1 per ten thousand. Of 1,873 counties in 19 previous endemic provinces, autonomous regions and municipalities of malaria, 367 counties with a population of 200,942 thousand were still noted to have malaria morbidity more than 10 per ten thousand.

Falciparum malaria was distributed in 8 provinces and autonomous regions in 1983 as shown by active and passive detections. Including western and southern parts of Yunnan Province, and southwestern part of Hainan Island of Guangdong Province, falciparum malaria accounted for 15% of the total cases, and in certain counties it reached as high as 30-50%. While in some counties of Jujian and Guizhou Provinces and Guangxi Autonomous Region, falciparum malaria cases amounted to less than 2.5% of the total cases. As for provinces near 33° north latitude, such as Jiangsu, Anhui and Henan, falciparum malaria was only endemic in several counties where cases were found to be 2% of the total. The anopheline vectors of falciparum malaria in China are *A. minimus* in southern part, *A. dirus* in Hainan Island and *A. lesteri anthropophagus* in middle latitudes zone where it is deemed as an important vector of *Plasmodium falciparum*.

In 1983, by the co-effort of the masses and professional organizations for antimalarial activities, out of 29 provinces, autonomous regions and municipalities in China mainland, 22 with 62.3% of the total population showed morbidity of malaria lower than 5 per ten thousand.

There are three situations which hinder the progress of antimalaria activities and the defence of acquired achievements. The first one is in Huanghuai plain and Jianghan plain (as mentioned above), where vivax malaria is predominant species and *A. sinensis*, the only vector. As the vector has

exophilic habit, indoor residual spraying measure is ineffective. Besides, the majority of inhabitants have out-door sleeping habit in summer-autumn so man-mosquito contact is very frequent. It has been demonstrated that the degree of resistance in the southern part is higher than that in the northern. And it is also found that the resistant P. falciparum has a tendency to spread northward.

In the Philippines, about one third of the population of 54 million are living in endemic areas. Despite intervention measures, malaria incidence remains high, which in the average is 7.2 per thousand population. The predominant species are P. falciparum in the ratio of 65% P. falciparum and 35% P. vivax. Of the P. falciparum about 79% of infections are resistant to chloroquine and scattered throughout the country with RI level in the majority, incidence is highest in the southern islands.

The general epidemiological picture of malaria is summarized below:

1. Endemicities vary from hypo to hyperendemicity, unstable and prevalent in almost all provinces.

2. Due to breeding preference of the principal mosquito vector, malaria occurs in the rural areas and is absent in the urban areas.

3. Transmission is perennial with two peaks, during the start and during the end of the rainy season.

4. All the three species of plasmodia are found. The predominant species at the moment is P. falciparum with the ratio: 65% P. falciparum, 35% P. vivax, P. malariae is rare and no P. ovale.

5. Malaria vectors are zoophilic.

6. There are four anopheline species of malaria vector. The principal vector is A. flavirostris and this prefers to breed in slow flowing, clear and partly shaded streams. Other Anopheles species are A. mangyanus, A. litoralis, and A. balabacensis.

Control strategy is basically the use of combinations of insecticide residual spraying of houses, biological control, environmental management, personal protection measures to avoid mosquito bites such as sleeping under mosquito nets, screening houses, use of protective clothing, use of mosquito repellants either chemical or smoke, diverting mosquito bites by tying work animals near houses and surveillance measures utilizing the Primary Health Care approach.

The years 1983 and 1984 have been transition periods from a centralized program to an integrated program during which time the anti-malaria expertise was transferred to the Provincial, Municipal and Barangay Health Workers causing a temporary interruption in the smooth flow of operation. This short period of reorganization has been taken advantage of by the disease which showed an increase in incidence, although not to an epidemic proportion.

Most of the cases were found in Mindanao and Sulu areas followed by North-eastern Luzon and the least in the Visayas.

P. falciparum resistance to chloroquine was detected as early as 1968. In 1974, a nationwide monitoring of drug resistant cases was started and continued up to the present (1984), using both in-vivo and in-vitro techniques resulting in delineating the areas which are sensitive and which are resistant to chloroquine. About 70% of the total P. falciparum cases were found resistant to chloroquine. This finding is significant since P. falciparum is the predominant infection and with the problem of uncontrolled population movements and the temporary nature of inhabitant dwellings in the hinterland, the use of anti-malaria vaccine as a control method would become an appropriate measure.

In Malaysia, each of the three constituent regions, namely Peninsular Malaysia, Sabah (East Malaysia) and Sarawak (East Malaysia) has individualised programs related to local epidemiological situations. In 1984 32,095 malaria cases were reported in the country as a whole, the API being 2.1 and SPR 1.8. The situation in each region may be summarized as follows:

a. Peninsular Malaysia

Peninsular contributes 9,722 malaria cases (30.3%). The vivax-falciparum ratio is almost 1:1. Resistance of P. falciparum to chloroquine is quite widespread especially in the northern part of Peninsular Malaysia. Around one-quarter of the annual malaria deaths in the country are from Peninsular Malaysia. About 49.6% of the malaria cases occur in the adult. 1.8% of the malaria cases are infant malaria. 90.1% of the population live in malaria-free areas. All the 5 malaria vectors, A. maculatus (main vector), A. campestris, A. sundaicus, A. letifer and A.b. balabacensis are still susceptible to DDT.

b. Sabah (East Malaysia)

Sabah contributes 21,358 malaria cases (66.5%). P. falciparum accounts for nearly 80% of the malaria cases in the state. Resistance of P. falciparum to chloroquine is quite widespread. Around three-quarters of the malaria deaths in Malaysia are from Sabah. About 44.5% of the malaria cases occur in the adult. 3.1% of the malaria cases are infant malaria.

11% of the population live in malaria-free areas. Both the 2 malaria vectors A.b. balabacensis (main vector) and A. sundaicus. are susceptible to DDT.

c. Sarawak (East Malaysia)

Sarawak contributes 1,015 malaria cases (3.0%). More than 60% of the malaria cases occur in the 1st and 2nd Divisions of Sarawak due to active population movement across Sarawak-Kalimantan (Indonesia) common border. P. vivax (73%) is the predominant parasite species in Sarawak. There is no resistance of P. falciparum to chloroquine in Sarawak. Few malaria deaths (usually one or two) are reported annually. More than 80% of the malaria cases are adults. In 1984, 17% of the population live in malaria-free areas. All the 4 malaria vectors, A. leucosphyrus, A. donaldi, A. sundaicus, and A.b. balabacensis are still susceptible to DDT.

The common problems faced by the Vector Borne Disease Control program in Malaysia are as follows:-

(1) Lack of community support due to apathy and lack of awareness.
(2) Active population movement: construction workers, security forces, migrants.
(3) Increasing incidence of drug-resistant P. falciparum
(4) Changing pattern of malaria parasite species.
(5) Lack of supervision in the remote areas.
(6) Refractory nature of the malaria vector A.b. balabacensis in Sabah.
(7) Poor housing condition.walls incomplete.

In Papua New Guinea, the Solomon Islands, and Vanuatu the current status of malaria may be outlined as follows:

Malaria endemicity varies throughout Papua New Guinea and the country can be divided into 4 regions: the highlands; the New Guinea mainland; the new Guinea Islands; and the Papua region. The principal vectors throughout the country are members of the Anopheles punctulatus complex: A. farauti; A. punctulatus; and A. koliensis. Transmission is perennial with some variation from the dry to the wet season occurring in most areas. Plasmodium falciparum is the predominant species. The change from a predominance of Plasmodium vivax to P. falciparum has been noted since 1972, the species proportions now being P. falciparum 75-78%, P. vivax 20%, P. malariae 5%. Chloroquine resistant strains of P. falciparum, first confirmed in 1976, are now widespread. In the area of Madang on the North Coast of Papua New Guinea, 84 of the 103 infections tested in vitro were resistant to chloroquine, but only 48 showed resistance in vivo. Of those resistant in vivo, 43 (89.6%) were at the RI level. Resistance to sulfadoxine-pyrimethamine has also been reported.

In the Solomon Islands, since 1977 the resurgence of malaria has become one of the biggest health problems in the country. Epidemic in proportion, it is characterized by a predominance of P. falciparum as in Papua New Guinea. Chloroquine resistant strains, first reported in 1980 are now widespread. Approximately 50% of P. falciparum infections are currently resistant, but an estimated 95% of these are at the RI level. Although pyrimethamine resistance has been shown to exist, no resistance to the sulfadoxine-pyrimethamine combination has been reported.

The malaria situation in Vanuatu, although previously characterized by somewhat lower levels of endemicity, would appear to be facing problems similar to those encountered in Papua New Guinea and in the Solomon Islands.

South-East Asia Region

Countries of the WHO S-E Asia Region that are affected in varying degree by malaria are Bangladesh, Bhutan, Burma, India, Indonesia, Maldives, Nepal, Sri Lanka, Thailand.

Malaria is widely distributed particularly in the foothill districts of Bhutan, Burma, India, Nepal, Thailand. In Bangladesh it is mainly confined to the eastern hilly districts; in Indonesia is more prevalent in the Outer Islands than in Java and Bali, where vector control measures are maintained; in Maldives it has virtually been eradicated by 1985 (P. falciparum transmission having been eliminated by 1976); in Sri Lanka perennial transmission occurs in belts in the north-center and the south-east, and seasonal transmission elsewhere.

The incidence profile in these countries combined may be highlighted during the 13 years thus:

Year	API	SPR	SfR	Pf%
1970	1.96	2.37	0.47	19.8
1976	8.86	9.74	1.37	14.0
1983	2.59	3.05	0.99	32.5

These data parallel those of India, where the incidence dominates that of the other countries. Following failure to maintain the eradication campaigns during the late 1960s, incidence reached a peak in 1976; since then, it has been reduced by twice yearly house spraying using DDT (or malathion or HCH 2 to 4 times a year in parts of western India, Nepal, Java and throughout Sri Lanka where vectors have reduced susceptibility to DDT), and by surveillance with treatment adapted to local patterns of drug resistant Plasmodium falciparum. The proportion of P. falciparum has, however, been increasing steadily.

The trend towards malaria reduction is leveling off due to a number of constraints additional to reduced financial allocations by several countries: (1) decreased spray coverage due to householder resistance and rising costs of insecticides and personnel; (2) deficiencies in surveillance and under-reporting of incidence; (3) increased vector breeding due to deforestation, flooding, unsupervised irrigation, gemming excavations, shifting cultivation; (4) migration of gametocyte carriers to receptive areas, and susceptibles to endemic areas; (5) vector insusceptibility to insecticides in Burma, India, Indonesia, Nepal and Sri Lanka, and avoidance in Thailand and Burma; (6) P. falciparum resistance to chloroquine widely in Bangladesh, Burma, India, Indonesia, Thailand, and focally in Bhutan, Nepal, Sri Lanka (and resistance also developing to alternative drugs).

Unless new methods such as immunization are introduced and increased funding is provided, projection of existing data graphs suggest that little further reduction of malaria will occur by the year 2000.

Individual countries of this Region that may be considered here are Bangladesh, Burma, India, Indonesia, Sri Lanka, and Thailand.

In Bangladesh, malaria occurs in the north-east (Mymensingh areas) east (Sylhet), and south-east (Chittagong Hill Tracts) - in the hilly districts both forested (where Anopheles balabacensis is the principal vector) and cleared (A. minimus). In the central, western and southern plain/estuarine districts (A. philippinensis, A. sundaicus) there is much less malaria.

The incidence in the country from 1970 to 1983 may be highlighted as follows:

Year	API	SPR	SfR	Pf%
1970	0.13	0.14	0.07	49.6
1979	0.61	3.62	0.76	20.9
1983	0.44	1.74	0.71	40.8

The peak of post-eradication incidence occurring around 1979 has been brought down by intensified control measures. Increase in the SfR since that peak reflects continuing control of transmission in the plains where Plasmodium vivax predominates, in contrast with the difficult situation in the hilly areas where P. falciparum predominates and is increasingly resistant to chloroquine, and to which transmigration is in progress involving relatively non-immune settlers from the plains

Control measures are adapted to three defined epidemiological strata: 1 - all forested areas where the principal vector is A. balabacensis, cleared foothill areas

having A. minimus, and areas dominated by P. falciparum: in this stratum the objectives are to prevent mortality and reduce morbidity in high risk groups by means of treatment and residual spraying with DDT twice a year; 2 - mainly plains areas having A. philippinensis and A. sundaicus as the principal vectors: in this stratum the objectives are to prevent mortality and reduce greatly the incidence of P. falciparum infections indigenous and imported, by means of one round of pre-monsoon DDT spraying and surveillance; 3 - plains areas where the vector is A. philippinensis and the parasite P. vivax: in this stratum the objectives are to maintain gains through surveillance, and contain focal outbreaks of vivax malaria using (radical) treatment of cases and DDT spraying pre and post-monsoon where there are clusters of cases. In this major part of Bangladesh the primary health care system (thana health complex) is largely responsible for the program.

In Burma, two-thirds of the population in the malarious areas are covered by malaria control activities, and the remainder have access to treatment facilities. The following selected data indicate the progression of the situation:

Year	API	SPR	SfR	Pf%
1975	0.50	4.24	2.73	64.5
1980	0.99	7.71	6.35	82.3
1983	1.10	4.21	3.60	85.4

While the significance of the API is vitiated by an extremely inadequate ABER, it is apparent that dramatic changes in incidence have not been the rule in recent years.

The main areas of distribution are the forested foothills where Anopheles balabacensis/dirus predominates. In the plains areas A. annularis and A. culicifacies occur, while along the coast A. sundaicus may be found. Control measures are diversified, and are increasingly undertaken at community level under supervision of the Vector Borne Disease division. The measures include DDT spraying, anti-larval measures, and chloroquine distribution, with vigilance and surveillance in areas freed of malaria. Measures have not so far been seriously impeded by reduced vector susceptibility to DDT, although this does occur focally in some A. culicifacies and A. annularis populations. A. balabacensis/dirus exhibits avoidance, and may be truly resistant to DDT in some foci.

A major problem is the widespread resistance by P. falciparum to chloroquine, and now in the south east on the Thailand border to sulfadoxine-pyrimethamine. To this, Burmese attribute the increase in P. falciparum incidence: prior to 1979 the Pf:Pv ratio was 2:1, but since 1979 it has been 5:1. The proportion of P. falciparum in zones under drug or spray operations is 88%, but is 82% in surveillance and 72% in vigilance zones.

In India, the control program is faced with the formidable problems of insecticide resistance in Anopheles culicifacies, chloroquine resistance in Plasmodium falciparum, exophilic and exophagic behaviour of mosquitoes, escalating cost of insecticides resulting in shortages due to financial constraints, and managerial failures. The problem is also aggravated by a 100% increase in irrigation in the last 2 decades, thus making vast areas endemic to malaria. The incidence of malaria was reduced to c 2 million by 1984 as against 6.4 million in 1976. It may be noted that this decline in malaria was the result of the selective elimination of P. vivax. Incidence of falciparum malaria has remained at about 0.5 million cases annually for several years now.

Malariometric data during the period since 1976 may be highlighted by these selections:

Year	API	SPR	SfR	Pf%
1976	10.97	11.55	1.35	11.7
1980	4.47	4.32	0.88	20.3
1983	2.78	3.11	0.88	28.1

In 1984, however, the downward incidence trend halted, and a 12% increase was officially reported.

Focal studies have shown under-reporting of malaria cases and considerable increase in falciparum malaria. It appears as though the present strategy of intradomiciliary spraying to interrupt transmission is at best controlling malaria on borrowed time. There is therefore a felt-need to discover alternative strategies which are economically viable and ecologically sound.

In Indonesia, intensive malaria control operations are undertaken in Java and Bali, and less intensive operations in the outer islands. Malariometric data in Java-Bali have been as follows:

Year	API	SPR	SfR	Pf%
1975	1.53	1.51	0.54	35.4
1980	1.85	1.93	0.91	46.6
1983	1.34	1.44	0.69	47.9

These data indicate continuing success of the programme in Java-Bali, where the main insecticide used for spraying operations is DDT; in areas where the main vector, A. aconitus, is completely resistant to DDT, fenitrothion is used. Antilarval operations will be applied to A. sundaicus breeding sites during the dry season.

The outer islands for malaria control purposes are divided into non-priority and priority areas. The latter covers trans-migration project, socio-economic development areas, areas bordering with neighboring countries and outbreak areas.

Generally speaking malaria control activites consist of case finding and treatment, indoor residual spraying with DDT and anti-larval measures. In the non-priority areas, indoor residual spraying is not implemented.

In priority areas, the Parasite Rate, obtained from malariometric surveys, ranged between 2 to 5 per 100 population. Malaria situation in the non-priority areas is not exactly known. Slide Positivity Rate (SPR) as revealed by the passive case detection at health centres and hospitals ranged between 20 to 27%.

P. falciparum accounted for 30 to 56% of the total infections. Resistance to chloroquine is widespread. Out of 27 provinces, foci were detected in 25.

Recently, larval control with larvivorous fish, larvicides and source reduction as well as personal protection with bednet have been given more emphasis, using primary health care approach where appropriate. With the speed up of development and higher population mobility, malaria will remain a major public health problem in the future. The use of malaria vaccine, however, will not replace the present control measures. It will merely supplement the existing activities.

Constraints include territorial vastness, shortage of skilled manpower especially in the outer islands, vector insusceptibility to DDT in Java, widespread resistance to chloroquine by P. falciparum, and inadequate inter-sectoral collaboration.

In Sri Lanka, malaria occurs at lower altitudes throughout the country, but is absent in the greater Colombo area. It is endemic in years of normal rainfall, but epidemic in dry years when pooling occurs in the river beds promoting breeding of the only vector A. culicifacies, which is resistant to DDT.

Following an epidemic in 1968, the incidence may be highlighted by these data:

Year	API	SPR	SfR	Pf%
1970	50.96	31.21	0.09	0.3
1975	39.12	26.86	4.28	15.9
1981	4.52	5.31	0.14	2.6
1983	11.50	12.06	0.43	3.5

In 1977, an intensive control program was introduced using quarterly residual house spraying with malathion, chemotherapy, source reduction particularly in river beds by flushing from

dams and larviciding, surveillance, and space spraying with pyrethrum/kerosene in pilgrimage areas on festival occasions. In 1981 stratification differentiated seasonal from perennial transmission areas, the former to receive only selective not quarterly residual spraying.

An upsurge of P. vivax transmission commencing at the end of 1982 and peaking in 1984 resulted in re-establishment of quarterly malathion spraying in all malarious areas, together with larviciding, river-pool management by flushing from dams, source reduction including filling of abandoned gem mining pits, and space spraying in pilgrimage areas. Chemotherapy using chloroquine was intensified, but late in 1984 the first cases of falciparum malaria resistant to this drug appeared, while indications are being found of reduced susceptibility of A. culicifacies to malathion.

Because of the epidemic potential, integration of anti-malaria program and primary health care is being developed cautiously.

In Thailand, in the forty years since establishment of the Anti-Malaria Programme malaria incidence has been reduced from 300/1,000 population to 5.2/1,000 in 1983. Emphasis in recent years on expansion of case detection and treatment facilities, most notably establishment of malaria clinics throughout the country and of a network of village malaria voluntary collaborators, has brought about a 42% reduction in malaria cases in 1983 to a current, 10-year low level. In 1981, 79% of the population lived in eradication areas where residual insecticide was no longer used.

The Anti-Malaria Programme provides services to all of the population of Thailand with operations divided into two areas as follows:

1) Control Area, consisting of forested hills and mountains, border areas, and insecure areas with a population of approximately 10.5 million.

2) Eradication Area, consisting of the major part of the country with a population of approximately 38.5 million.

The strategy presently implemented is that of long-term malaria control in the forested and hilly areas of the country where malaria is endemic (Control Area), and prevention of the re-establishment of malaria transmission in the remaining areas where a malaria eradication strategy is being applied (Eradication Area).

The actual control measures applied depend upon the local epidemiological situation. The country has been appropriately stratified according to different levels of receptivity in

association with major variations in the terrain. The main control measures are residual insecticide (DDT/Fenitrothion) house spraying once or twice per year, 454 radical treatment centres (malaria clinics), provision of anti-malaria drugs, and health education. Other measures are supplemented as appropriate and include larviciding, mass chemotherapy, space spraying, case detection and treatment, and the use of larvivorous fish. In order to establish appropriate health care delivery to all individuals in all villages, the Anti-Malaria Programme has developed the Village Voluntary Malaria Collaborator (VVC). The VVC is trained and expected to perform the following duties: to spread news about malaria and malaria services, to assist in spraying operations, and to take blood smears from and give presumptive treatment to any person who is suspected of having malaria.

Malariometric data may be highlighted as follows, revealing the considerable recent improvement:

Year	API	SPR	SfR	Pf%
1978	7.7	8.3	4.59	57.2
1981	10.6	8.5	5.87	69.3
1983	5.2	4.5	2.67	65.3

The three species of Plasmodium found in Thailand are *P. falciparum*, *P. vivax*, and *P. malariae*. The parasite formula in 1983 showed 65.3% *P. falciparum*, 34.4% *P. vivax* and 0.02% *P. malariae*.

P. falciparum started showing a poor response to chloroquine in 1962, and at the present time it is found that more than 95% of *P. falciparum* demonstrated some level of resistance, mainly at RI and RII, although RIII resistance is presently showing an increasing trend. Furthermore, during the last four years *P. falciparum* strains resistant to sulfadoxine-pyrimethamine have also started to appear in many parts of the country, especially in the areas near Kampuchea.

Anti-malaria operations are hampered by a number of factors: chloroquine resistance in more than 95% of *P. falciparum* and resistance to sulfadoxine-pyrimethamine now in many areas, widespread population mobility involving malarious border and other areas, and changing patterns of vector bionomics particularly exophily of *A. dirus*. Research aimed at overcoming these problems is being carried out, including a large-scale field trial of combined mefloquine-sulfadoxine-pyrimethamine in areas of drug resistance, development of primary health care components within the anti-malaria program, and investigations into vector bionomics and speciation.