MALARIA IN SOUTHEAST ASIA

A.V. KONDRASHIN

World Health Organization, Regional Office for Southeast Asia, New Dehli 110002, India.

INTRODUCTION

Almost ten years have passed since last meeting of senior scientists and physicians working on various aspects of malaria in Southeast Asian countries took place in August 1976 in Bangkok. The topics dealt with included different aspects of malaria problem such as epidemiology, pathophysiology, clinical picture and management of cerebral malaria, chemotherapy and other related matters. For the purpose of the meeting, Burma, Kampuchea, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand and Vietnam were regarded as the countries of Southeast Asia (Harinasuta *et al.*, 1976). During the course of meeting, it was observed that during 1972-1976, serious resurgence of malaria affected practically all the above countries. While energetic counter measures were successful in preventing further development of malaria epidemics, even considerably reducing the morbidity in some countries, in general, the number of reported malaria cases has shown slight but steady increase in most countries with endemic malaria.

Malaria was and still is a public health problem of high importance and therefore affected countries will have to continue to devote a significant part of their financial and manpower resources to its control. In this connection, one should bear in mind that irrespective of the considerable changes in the epidemiological situation that has occurred in the last 25 years, the potential for malaria transmission remains almost at the original level, which determines, even today, the priority malaria control is receiving in countries affected by the disease (Lepes, 1984). In fact, malaria control is more complicated today than ever before.

The development of Primary Health Care system is being introduced as a solution including functional integration of malaria services and their activities. There are only few who doubt that this is a logical approach and for most developing countries the only possible one. However, the present malaria situation requires a flexible epidemiological approach for its control. The application of epidemiological approach in malaria control programmes was strongly advocated by WHO Seventeen Expert Committee on Malaria which took place during the period under review (WHO, 1979).

Thirty-first World Health Assembly adopted a conceptual framework for malaria control strategy, which was conceived in such a way as to cover all possible situations in terms of malaria epidemiology and in relation to available resources. Flexibility and epidemiological approach were underlined as basic principles in planning and implementing administrative measures and technical activities in support of any national programme.

Current malaria status in the countries of Southeast Asia

As already stated, malaria has been a major public health problem in all the nine countries under consideration. However, the exact

Presented at the Seminar on Recent advances in Tropical Medicine Research, 24-28 February 1986, in commemoration of the 25th Anniversary of the establishment of the Faculty of Tropical Medicine, Mahidol University, Bangkok, Thailand.

magnitude of the problem is not known and therefore it might be under-estimated. There are reasons to believe that the economic losses due to malaria continue to be quite considerable in terms of losses due to death, cost of treatment, loss of man days, reduction of agricultural, industrial and other productive activities. The epidemiological information of the past few years indicates that the malaria situation in the countries of Southeast Asia varies considerably from country to country.

Burma

Malaria is still considered a major public health problem. The first People's Health Plan (PHP) for 1978-1982 accorded top priority to malaria out of 51 priority diseases or conditions. In the second PHP (1982-1986), malaria was given second priority. However, in the third PHP (1986-1990), now under preparation, malaria will again be the first priority disease in the country.

Malaria case load in the country increased from 14,743 cases in 1977 to 60,488 cases in 1984. Though Annual Blood Examination Rate (ABER) continued to be at low level (about 4% in 1984), nevertheless it showed improvement during last few years over 1977. Annual Parasite Incidence (API) increased from 0.51 in 1977 to 1.78 in 1984, but both Slide Positivity Rate (SPR) and Slide *P. falciparum* Rate (SFR) have shown only marginal increase in 1984 as compared with 1977 (4.27 and 2.94 in 1977 and 5.32 and 4.61 in 1984 respectively). The proportion of *P. falciparum* cases in total malaria incidence constituted 63% in 1977 and more than 86% in 1984.

For operational purposes, the country has been divided into five strategic areas: drug areas; spray areas; surveillance areas; vigilance areas and areas that were originally malaria-free. Out of an estimated population of 35.9 million, 22.1% live in drug areas, 13.6% in spray areas, 41.9% in surveillance areas, 13.9% in vigilance areas and 8.5% in originally non-malarious areas. The key approach to malaria control are anti-vector measures in spray areas, case-detection and treatment in the surveillance and vigilance areas, and the distribution of antimalarial drugs through health institutions in the drug areas.

In addition to already known malaria vectors in the country such as *A. balabacensis*, *A. minimus*, *A. sundaicus*, few more species have been suspected to play some role in malaria transmission like *A. aconitus*, *A. philippinensis* and *A. maculatus*.

Kampuchea

It was estimated that 83% of total area of the country was malarious and that more than 35% of a total population were living in malarious areas (Harinasuta *et al.*, 1976).

The SPR in 1972 was 28.2%, *P. falciparum* accounting for 45% of the infections. The anti-malaria campaign suffered considerable setback because of insecurity and military activities and eventually completely interrupted. However, during recent years the antimalaria activities gained momentum. Following the recommendations made after the evaluation of the situation in 1981, staff were trained and equipment and material provided (WHO, 1984).

Indonesia

The malaria control programme is integrated with the general health services at all levels. The responsibility for overall planning, technical guidance and operational support, monitoring and evaluation rests with a core group at the national level.

On the islands of Java and Bali, anti-malaria activities include active and passive case-detection and insecticidal spraying in areas of high case incidence and particular vulnerability,

and anti-larval measures in some coastal areas (population: 90 million).

In the priority areas of the outer islands, (population 5 million) malaria control measures were limited to passive case-detection, suppressive treatment, malariometric surveys and insecticide spraying. In the rest of the country, the only measure applied was the distribution of antimalarial drugs through the existing health institutions. In recent years, the malaria control programme has been extended to cover Timor Island and Sulawesi. Some 52 million people remained unprotected in other areas.

The available information does not indicate any significant change in the epidemiological situation. In Java and Bali, the API in 1977 was 1.30, while in 1983 it was 1.34 and in 1984 it was 0.85. Both SPR and SFR did not change also (1.37 and 0.53 in 1977 and 1.4 and 0.7 in 1984 respectively). On the other hand, there was a slight increase in proportion of *P. falciparum* in overall malaria incidence, from 38% in 1977 to 48% in 1983. There is evidence that these areas, besides being highly receptive, are vulnerable to the importation of cases, mainly from the outer islands, especially from the transmigration areas of Sumatra, Sulawesi, Kalimantan and Lumpung.

During 1984, as in previous years, more than 85% of the confirmed malaria cases in Java-Bali were from Central Java, and most of these were from only a few regencies. An epidemic outbreak of malaria occurred during the second half of 1984 at Cilacap in Central Java, resulting in high mortality. Investigations revealed that the vector *A. sundaicus* is resistant to DDT (WHO, 1985a).

In other islands of the country, the available information revealed that malaria situation there did not show significant improvement. The API was low being 1.82 in 1979, 2.40 in 1982 but the ABER was also extremely low 1.0 in 1979, and in 1982 it was 1.8. On the other hand, SPR was considerably higher, 18.1 in 1979 and 13.4 in 1982. The SFR did not show major changes being 5.8 in 1979 and 4.3 in 1982. The proportion of *P. falciparum* was constant 32%.

Laos

Malaria is one of the most important health problems. The antimalaria service remained at an early stage of development, and control activities have been limited to Vientiane plain during recent years, where insecticide spraying combined with drug administration were carried out in 3 provinces. This resulted in the reduction of parasite rate from 18% (1978) to 4.6% (1983) in Champassak province, from 18% to 9.4% in Vientiane province and from 26% to 13% in Savannakhet province, respectively. Preliminary surveys undertaken in Saravane province revealed a parasite rate of 24% (WHO, 1985a). The city of Vientiane and its perimeter of flat country are malaria free. The rest of the country is hilly, covered with jungles and forests, which provide favourable conditions for breeding of *A. minimus* and *A. balabacensis*.

Malaysia

In Malaysia (Peninsular), malaria incidence stabilized around 10,000-12,000 cases annually since 1975 uptill now. Whereas the urban and coastal areas inhabited by 87% of the total population are free of malaria, the hilly jungle regions of the hinterlands of Kedah, Perak, Pahang, Trengganu and Kelantan as well as areas along the northern border are still malarious. Nearly half of all malaria cases were detected among the security forces, the aboriginal Orang Asli and among people working in land development schemes.

In Malaysia (Sarawak), the number of cases in 1982 was 956 compared with 754 in

1981. The rise was explained by the increased population movement to and from jungle areas. The ABER remained very high with 23%. In 1983, there was slight reduction in cases to 860, which was attributed to an improvement in the situation in the areas bordering Sabah and Kalimantan.

In Malaysia (Sabah) the implementation of a new plan of action improved the situation considerably, especially so in the year 1983. In the areas where surveillance is the main control measure only 1300 cases were detected compared to 2,800 in 1982. In the areas where regular spraying operations are carried out (48% of the total population), the incidence dropped also remarkably from 28,000 cases in 1982 to 10,000 cases in 1983. The API decreased from 55.0 in 1981 to 29.0 in 1982 and to 10.0 in 1983. The main vectors are *A. balabacensis*, *A. leucosphyrus*, *A. litoralis*, *A. sundaicus*, *A. letifer* and *A. donaldi* are suspected to play a part in malaria transmission.

Philippines

Although malaria problem has been reduced considerably in the country over the last three decades, in some areas its incidence has remained high.

The highly malarious areas in the country are in the foothills and in the hilly and mountainous areas. Transmission occurs mostly in the fringes of the forest where settlers are moving in to open up new areas for cultivation.

All malarious areas are divided into 2 category: in the first, the eradication strategy is being pursued with full surveillance and residual insecticide spraying; in the second, a control strategy is being followed with regular spraying operations being limited to high-risk areas, selected on epidemiological grounds. Except for Palawan, where an intensive campaign reduced the number of cases by 27%, the malaria situation remained stagnant in recent years.

In 1983, the antimalaria activities in the country were integrated into the field operation service of the Ministry of Health. Under the Primary Health Care approach, the strategy is to control malaria by a combination of measures: residual insecticide spraying, biological vector control, environmental management and administration of antimalaria drugs. During this year of reorganization, the number of blood slides examined was about 20% lower than last year with a reduction in the number of cases detected from 97,500 in 1982 to 90,300 in 1983, but an increase in the SPR from 10.7% to 12.5%.

Singapore

Due to continuation up to the present time programme of drainage and oiling, malaria practically reached a stage equivalent to the consolidation-maintenance phase of a malaria eradication programme.

During 1982, 282 malaria cases were detected in Singapore, out of total more than 33,000 blood slides examined. Among the cases, 276 were imported ones, mainly from India 49%; Indonesia 29% and Malaysia. Two cases were induced following a blood transfusion, and four cases were introduced (1 *P. falciparum*, 3 *P. vivax*). *A. maculatus* and *A. sundaicus*, the major vectors in Singapore could not be detected in the localities where the cases occurred. Nevertheless vector control measures were carried out immediately, and mass blood examinations revealed no forth cases.

At present time, the occurrence of these isolated local cases does not represent any risk to international travellers (WHO, 1984).

Thailand

In Thailand, where a population of nearly 47 million is considered to be at some risk

from malaria, around 79 % live in areas where malaria eradication is the eventual goal. The rest of its population lives in parts of the country where malaria control is the objective.

The Anti-malaria Programme provides services to all of the population of Thailand with operations divided into two areas-control area consisting of forested hills and mountains, border areas, and insecure areas with a population of approximately 10.5 million, and eradication area, consisting of the major part of the country with a population of about 38.5 million (Pinichpongse, 1985).

The actual control measures applied depend upon the local epidemiological situation and consist of insecticide spraying, radical treatment, provision of anti-malarials and health education. Other measures are supplementary and include larviciding, mass chemotherapy, space spraying, case detection and treatment, use of larvirorous fish. Village voluntary malaria collaborator (VVC) framework has been developed to establish appropriate health care delivery to all individuals in rural areas.

The incidence of malaria throughout the country has been greatly reduced during the past three decades. The API was reduced from 286.0 in 1947 to 2.2-3.6 in 1966-1972. Since that time it has risen annually to 7.1 in 1979, 8.9 in 1980, and 10.6 in 1981. The increasing trend in malaria incidence reached its peak in 1981, thereafter it began to reverse by early 1982 and markedly diminished in 1983. The reasons for this improvement in the malaria situation are not completely clear, however, the most plausible explanation might be due to striking increase in the numbers of malaria clinics in the country combined with enhanced antimalaria activities by VVC's. The SPR and SFR followed the same trend as API during these period. However, in 1984 the malaria incidence increased as compared with 1983. There was marginal decrease of *P. falciparum* from 69 % in 1982 to 66 %, but in 1984 it came back to 71 %.

Residual insecticidal spraying continues by using DDT. Large areas were also brought under fenitrothion spraying. *A. dirus*, *A. minimus* and *A. maculatus* remained physiologically sensitive to DDT, but the first two are largely exophilic and exophagic, thus limiting the effect of the insecticides.

Vietnam

Malaria is one of the main public health problems, particularly so in the southern part of the country. With the exception of about 5 million people residing in urban areas of the plains, the rest of the population is under malaria risk (Harinasuta *et al.*, 1976).

In the northern province of the country, 5,500 malaria cases were reported in 1982 as compared with 3,700 cases in 1981. There were 70 foci totalling more than 1,000 cases. Among the causes for deterioration were flooding, population movements and insufficient coverage of the health services, particularly in mountainous areas.

In the southern provinces most of the areas were protected by DDT indoor spraying. While in some central provinces the situation improved, the malaria incidence did not change in theTaynguyen highland and Songbe province. The total number of cases in the southern part of the country was 45,000 in 1982 compared with 39,000 in 1981.

The number of malaria cases in 1983 continued to increase (43,000 in 1981, 51,000 cases in 1982 and 64,000 cases in 1983). In the northern provinces the rising incidence was mainly due to focal outbreaks especially in the provinces bordering Laos. Although the SPR hardly changed (3.6 - 3.8 %) in the southern provinces, the number of cases increased by 41 % from 39,000 in 1981 to 55,000 in 1983.

In the high plateaus and mountaineous jungle-covered areas, *A. minimus*, *A. balabacensis* and *A. jeyporiensis* are the principal vectors. *A. maculatus* is a suspected vector. In the coastal plains and the delta *A. sundaicus* is the main vector.

Epidemiological features of contemporary Malaria in Southeast Asia

From the above given account of present malaria situation in the countries of Southeast Asia, it appears that during the period of the last 10 - 15 years considerable changes have occurred, which determines the necessity to study epidemiological features of contemporary malaria.

The sound knowledge on epidemiology of malaria in each country will enable it to use more beneficially a flexible approach for malaria control. It is a well known fact that interaction of natural and socio-economic factors plays a most significant role in forming epidemiological features of malaria. Natural factors are less prone to drastical changes within the short period of time while socio-economic factors undergo much more rapid changes bringing about with it epidemiological features of the disease. Considering it, brief account of most important socio-economic factors contributing to epidemiology of malaria at present time in the countries of Southeast Asia is given below:

Socio-economic factors

After the Second World War, there was noticed transformation of a largely traditional economy and society in most countries of Southeast Asia to ones apparently undergoing rapid economic development but retaining many traditional and distinctive features.

Growth of population:

Even before the Second World War, the rate of growth in Thailand, Malaysia, Burma and Indonesia was more than 2% per year (MPH, 1979; Choo, 1983). Further the stabilization has occurred at a crude birth rate of 40 per thousand and mortality has also fallen to approximately 10 per thousand. The overall growth rate has shown little change and the population almost doubled since 1950s. This has been instrumental in a population pressure on the available agricultural land and specific pressure on the small farming families, thus increasing numbers of landless farmers and promoting migration either to the urban areas or to an area where new crops or industries create a demand for cash labour, or to previously uncultivated land.

Intensification of agriculture:

Population pressure have been accommodated by an increase in the area and intensity of rice production. In Thailand the area under cultivation rose from 1957 to 1978 by 40% and the output per unit of cultivated land by about 20%. This brought about further mechanizations of operations in agriculture. This mechanization reduced the demand for labour outside the peak harvesting period and also resulted in short term labour migration. Obviously, the mechanization facilitated the reduction in number of draught animals, which might have some epidemiological consequences.

Re-orientation of agriculture:

It was observed in Thailand that the share of rice in agricultural output has been declining as compared with a group of relatively new crops - rubber, maize, tapioca, sugar cane, tobacco. From 1963 to 1977, there was an increase in rice output by about 20%, while in the latter groups the increase was much faster, by about 200%. None of these crops has the same stringent requirements in terms of flat land and easy water control as rice. Rubber and sugar cane are grown on

a plantation basis in a newly opened up lands with a substantial demand for seasonal labour. These crops account for about 33% of the value of exports, and they have maintained this share during the rapid expansion of exports since 1961, while rice exports have declined from 36% to 13% of the total (Choo, 1983).

Industrial Development:

In some cases, non-agricultural production has acted as a centrifugal factor, drawing population to relatively new lands on the periphery of cultivation. Of most remarkable and epidemiologically important such cases is gem-mining, a relatively small construction work on dams and roads also involves labour force on temporarily basis into new peripheral areas of forested, hilly areas.

In Burma, for example, development projects under various ministries are being planned and implemented all over the country. The country's economy greatly depends on these projects. In 1984, there were a total of 226 projects in the country with the total labour force of 203,085 people involved (Ann. Rep. MOH, 1983).

Deforestation:

In Thailand, as well as in other neighbouring countries, the socio-economic pressures of the early 1970s forced the lower income groups into the forested areas in search of land to cultivate and other means of financial support for the family. As a consequence, vast areas of forest have been destroyed and in the process numerous malaria cases and deaths have occurred (Beales, 1980).

Unemployment:

This problem is quite an acute one at least in some countries of the Region.

In Indonesia, the labour-force participation rate for Java-Bali-Madura and the Outer Islands is 49.9%. While the general population has been growing at about 2% a year, the labour force has been growing at 2.6% per annum. Thus, the actual annual unemployment rate is 9%, which is slightly more than two times greater than the reported official unemployment rate. In addition to that, there is substantial under-employment, which is believed to be about 30% of total labour force (Berouti, 1974).

In Thailand, the problems of the north-east are of particular importance for malaria because the shortage of steady all-the-year -round employment has csaused considerable seasonal migration to malaria endemic areas in the south, southeast and west (Beales, 1980).

Transport:

There is greater mobility than there was in the past, and more sophisticated forms of transport permit the movement of people from one end of the world to the other in a matter of hours with hightened risk of imported diseases, like malaria (Prothero, 1974, 1977).

The great improvement in transport and communication has come about largely through the improvement of the road system and the increasing range of vehicles operating on it. This clearly facilitates the population movement, goods and information, and all the associated economic, social and health effects, both positive and negative.

Population movement:

Growth of population, intensification of agriculture, reorientation of agriculture, industrial development, deforestation, unemployment and under-employment, improvement in transportation facilities and few other factors altogether resulted in population movement in the countries of Southeast

Asia on a scale, unknown in the history of these countries.

There are different types of mobility and movement of population in those countries. However, from operational and epidemiological points of view, two types of population movement are more important: movement of labour force and development and resettlement schemes.

Movement of Labour Force

This type of population movement is very common in Thailand. By estimation, based upon few studies on the subject, the volume of labour migration is quite high, accounting for nearly 9% of the total local population of the areas (Kanjanapan, 1983). There is short-distance and long-distance labour force movement. In some of the development projects in the country, only 33% of all labourers and family members belong to the same areas, whereas the rest are coming from distant places from all over the country. Duration of stay of migrant workers does not exceed few months only (Kanjanapan, 1983).

When population movement in and out of each region in Thailand was mapped, it appeared that the majority of migration was of seasonal and temporary character.

In north-western Thailand district town of Mae Sariang and surrounding suburban communities, it was found that out of total population, about half of it was lifetime labour migrants (Kunstadter, 1983). The proportion of male migrants was higher than that of female migrants. The age composition of migrants was strongly skewed, with many more migrants than non-migrants in the 20 – 79 year age groups and a low proportion of migrants under age 20.

The reasons for the movement to and from Thai-Kampuchean border provinces is economic. That part of the country is rich in natural and agricultural resources. Large fruit orchards, rubber, cassava, and black pepper plantation abound in the area. Most important, however, are the gem-mines, located on both sides of the international border.

It is for these gem mines that labourers come from economically depressed areas elsewhere in the country. The mines are in deeply forested areas, where the major vectors of malaria in Thailand *A. dirus* and *A. minimus* are plentiful (Pinichpongse and Doberstyn, 1983).

Land Development and Resettlement Schemes

In Malaysia, major nation building efforts of the Government were focussed on correcting the ethnic imbalances in development through accelerated rural development programmes. By 1978 Federal Land Development Authority (FELDA) had successfully developed 800,000 acres of land, largely under rubber and oil palm and resettled 200,000 settlers. It had also directly contributed towards the relocation of about 220,000 people. Most of these settlers were migrants from all over the country (Sidhu and Jones, 1981).

Another rural land development settlement scheme, the Federal Land Consolidation and Rehabilitation Authority (FECRA) was instrumental in bringing 129,849 acres of land under cultivation and settling 8,816 settler families, 4,788 rehabilitation and in-site families and 2,593 fringe settler families at the end of 1978. Thus, these schemes and similar projects like them, which have expanded during the last decade of development have directly or indirectly redistributed substantial proportions of the rural population in Peninsular Malaysia (Choo, 1983).

In Indonesia, the Outer Islands is one of the priority programmes in the country and is designed to help the economic development

of the areas by supplying needed manpower. Transmigration of population from Java and Bali to the sparcely populated provinces of Sumatra, Kalimantan, Sulawesi, Maluku and Irian Jaya began to be intensfied in 1969. Judging from malaria epidemics in the new transmigration sites in 1974 (Lampung, Sumatra, Bengkulu and Sulawesi Selatan), it can be assumed that high malaria morbidity and mortality have occurred during the early years of transmigration.

Numerous major construction projects were planned or are in progress in malaria areas, which is leading to more population exposed to the disease. The endemicity showed very wide variations from holo-endemicity in part of Irian Jaya to hypo-endemicity in some of the low-lying coastal areas of South Kalimantan, with meso- and hyperendemic areas in whole areas of the Outer Islands.

By the end of the second Five Year Development Plan period, a total of 118,620 families, with an average of 5 persons each, were already transmigrated to the Outer Islands. During the Third Five Year Plan period, a total of 50,000 families will be transmigrated every year from Java and Bali to the Outer Islands. As the programme expands to the Outer Islands, particularly to the Kalimantan area where logging industry and clearing of forests associated with temporary human settlements is proceeding and expanding, the role of vectors such as *A. balabacensis* is increasing.

Some epidemiological features of malaria

Spatial distribution of malaria:

At present, most malarious areas are situated at the periphery of the territories of the countries. There is not any geographical confinement of *P. vivax* to certain areas, whereas there is a very definite confinement of *P. falciparum* to forested hills and mountains, border areas, insecure areas, jungles. In many countries, the prevalence of *P. falciparum* is very high in areas bordering neighbouring countries.

Malaria species:

In Thailand, Burma, Vietnam, Kampuchea, Laos and Philippines, *P. falciparum* infections contribute more than 50% into an overall malaria incidence. In Indonesia (Java and Bali) *P. falciparum* incidence is almost equal to that of *P. vivax*.

Contrary to the previous notions that *P. falciparum* is the first to disappear after implementation of intervention measures-(Pampana, 1969)., it is actually on increase in most countries of Southeast Asia. This phenomenon may be because of different reasons, one of which could be due to high prevalence of *P. falciparum* resistant populations. The conclusion reached by the Burmese workers was that the swing towards *P. falciparum* (82%) was probably attributed to the increasing presence both in geographical distribution and intensity towards RIII of chloroquine resistant parasites. *P. vivax* is prevalent malaria species in Indonesia, especially in Outer Islands, *P. malariae* is reported in a very small number only in a few countries like Thailand, where its ratio was reduced from 0.12% in 1970 to 0.02% in 1979 (Beales, 1980). There are reasons to believe, especially that *P. malariae* incidence might be under- reported especially in areas with high prevalence of *P. falciparum*. Philippines had been for long period, the only country in the Region where *P. ovale* species were found. However, over recent years there have been reports on the detection of *P. ovale* among indigenous population of Thailand, in the USA army infected in Vietnam (Schultz, 1974)., in Indonesia Timor (Gundelfinger, 1975), and in imported cases in Burma (Clyde, 1984). These data suggest that *P. ovale* is more prevalent in the countries of Southeast Asia than it has been considered so far.

Sex- age- and occupation-related malaria incidence

These three parameters are primarily related to the problem of population movement. As discussed earlier, the proportion of male migrants is higher than that of female migrants, for example, in Thailand. Studies undertaken among labour migrants revealed that migrant workers show a higher rate of people suffering from malaria. API among migrants - 45.0 as against 25.0 among stationary population (Kanjanapan, 1983). Male migrants affected much more than migrant female and male and female of settled groups. (API 61.0 as against 27.0, 35.0 and 13.0 respectively).

Malaria incidence among different age-groups of migrant workers shows that most affected by malaria is age-group between 21-30 and 31-50 years age group (API 79.0 and 64 % respectively) and the lowest malaria incidence was reported among age group of under 10 years (API 6.0).

Malaria clinics screening Thai gem miners who had been prospecting across the border in Kampuchea usually found that 40 % of all screens are positive for *P. falciparum*. It had been assumed also that a high proportion of the remainder had pre-patent infections (Pinichpongse and Doberstyn, 1983). It is estimated that perhaps 100,000 gem miners are operating in this way, indicating that nowadays malaria can be considered as 'occupational disease' of this trade in Thailand.

The above described sex- and age-related malaria pattern is very much the same among stationary population as well, though the malaria incidence in general is lower compared with that among migrants.

In Burma, incidence of malaria among different age-groups does not show any significant difference between infants and children, young and older, being slightly higher in age-group of adults (Ann. Rep. MOH, 1983).

It appears that contemporary malaria is more 'grown-up' than it used to be few decades ago.

Seasonal pattern of malaria

This characteristic is also very closely related to population movement in the countries of Southeast Asia, as migration patterns affect both the transmission of malaria, and its control (Velez, 1983). In this broad framework, migration patterns can easily be seen as an antecedent factor leading to changes in various types of human conditions and behaviours, which in turn affect the level of exposure to disease organisms and therefore, the incidence of infectious diseases. Within this framework, population movements have been linked to the incidence of specific tropical diseases, such as malaria.

Population movement can also lead to change in the biological pattern affecting the transmission of malaria by increasing the exposure of the population to vectors by increasing the population density of those exposed by importing new effective vectors, etc. Migrants can also influence the pattern of malaria transmission due to seasonal and/or very often anarchie character of population movement. The graph showing monthly distribution of malaria cases in Thailand in 1980-1985 supports these views.

Malaria mortality

This is at present most unreliable parameter as it is difficult to know accurately how many people die from malaria in the countries of Southeast Asia. Nevertheless, Thailand, e.g. has recorded malaria deaths since 1930s. In 1947, malaria was the leading cause of death in the country, claiming some 50,000 lives annually with the death rate of 3,000 per 100,000 population (Pinichpongse, 1985). Since then the malaria mortality rates have

steadily decreased to 15.8 per 100,000 in 1974, 7.8 per 100,000 in 1982, which was the lowest mortality rate from malaria ever recorded in Thailand.

In Burma, malaria case fatality rate (CFR) did not show any significant change for the last decade. In 1976, it was 1.7%, in 1980, 2.1% and in 1983, 2.2%. The highest CFR was found to be in Yakhine State (3.39%), followed by Tenasserim Division (2.8%). The lowest CFR was observed in Chin State (0.5%), followed by Kayah State (0.84%) and Rangoon Division (0.99%).

Low mortality due to malaria is believed to be the result of the programme's strategy to provide earlier and more effective treatment of *P. falciparum* through malaria clinics and due to expansion of peripheral health care delivery (Pinichpongse, 1985).

The other possible explanation could be that malaria severity is often mitigated by the administration of antimalaria drugs, often on an irregular basis. Self-medication with less than adequate drug or dosage regimens is a widespread phenomenon in many areas of Southeast Asia and has probably contributed to the drug resistance problem. However, suboptimal treatment or suppression of malaria does have an advantage, as it allows to develop partial immunity to falciparum malaria in response to persisting patent or subpatent parasitemia and thereby impedes the development of severe, possibly fatal infections (PAHO, 1984).

P. falciparum resistance to antimalarials

This phenomenon is a most pronounced epidemiological feature of contemporary malaria in the countries of Southeast Asia and it is also very closely associated with the problem of population movement. The problem of the spread of drug-resistant strains of *P. falciparum* through the internal and international population movement is a serious one in Thailand. It is believed that the evolution of chloroquine resistant parasites, the result of spontaneous mutation began near the Thai-Kampuchean border. When population movement in and out of each region of Thailand is mapped, it is quite evident, that the majority of migration, occurs between the Kampuchean border provinces of Chanthaburi and Trat and certain areas of the north, northeast and parts of the Burmese border (Pinichpongse and Doberstyn, 1983).

The most intensive foci of *P. falciparum* resistant malaria in the world are confined to the countries of Southeast Asia (WHO, 1985b).

In Burma, resistance is widespread and reported from all States and divisions at RI to RIII levels. Resistance to chloroquine is much higher in the non-immune than among more stable semi-immune population. There is a growing evidence of development of resistance to Fansidar, especially in areas close to the Thai border. There has been a considerable reduction in cure rates in civilians returning from the Burma-Thai border areas, although the combination drug is still considered effective in cases occurring in other areas (WHO, 1985c). Several studies were conducted with the combination drug Fansimef since 1981. A few cases have been shown to give a recrudescence late in the follow-up period but the parasites disappeared from the peripheral blood without further treatment.

In Kampuchea, resistance was recorded at RI - RII level. It is spread throughout the major parts of malarious areas, especially bordering Thailand.

In Indonesia, studies were conducted in 23 out of 28 provinces and in 22 provinces chloroquine-resistant foci were found at various degrees and with a variable distribution.

In Laos, the studies were conducted in Vientiane Province and it was found that

resistance to chloroquine is a widespread phenomenon at RI-RIII level.

In Peninsular Malaysia, chloroquine-resistant malaria is found at RI-RII level in many parts of the country. In Sabah, *P. falciparum* resistant to chloroquine is found in 13 districts at RI-RII levels, and in Sarawak, resistance was established at RI-RIII level in 3 Divisions.

In the Philippines, chloroquine-resistance was detected in Central and Southern Luzon.

In Thailand, chloroquine-resistant malaria was documented in Thailand in 1962 (Harinasuta *et al.*, 1962). In the two subsequent decades, chloroquine resistance had spread rapidly throughout the whole country and Southeast Asia. Current *in vitro* studies indicate that over 90% of the isolates are resistant to chloroquine. The clinical response is at RII-RIII level. Thus, the use of chloroquine for the radical treatment of *P. falciparum* in malaria control programme has been discontinued since 1972. Recent studies in 1980-1984 showed that amodiaquine also provided a very low radical cure rate with a significantly high number of RII and RIII failures.

Standard dose regimen of Fansidar was evaluated in the various regions of the country in 1980. It was apparent that the efficacy of it was low in three regions of the country, namely the Kampuchean border, the northeast and at a point on the Burmese border. In the south and north, Fansidar was still found to be effective. Studies in 1984, however, indicated that response of *P. falciparum* to this drug in many parts of the country was very poor, with many RII and RIII.

In Vietnam, resistance of *P. falciparum* to chloroquine is widespread in practically all areas, where infections occur.

Urban malaria

There is no malaria transmission in urban areas of Southeast Asia countries though the importation of malaria cases into urban areas is going on a large scale.

Susceptibility status of main malaria vectors to insecticides

The vectors of malaria are different in different countries of the Region and their relative importance also varies from place to place. *A. minimus minimus* and *A. balabacensis balabacensis* are the main vectors of malaria in Burma, Kampuchea, Laos, Thailand and Vietnam. These species are still susceptible to DDT, however, due to the exophilic and exophagic habits in association with the human ecology in the forest areas which include various activities, such as gem mining and wood cutting, and also the temporary nature of houses or shelters, some with walls and others without, insecticide residual spraying sometimes does not produce the desired effect. Nevertheless, it maintains a certain degree of control, particularly in *P. falciparum* resistant areas, when it has been applied. In many forested hilly areas *A. minimus* has become more prevalent than *A. balabacensis (A. dirus)*, which has decreased with the change in ecological conditions resulting from deforestation.

A. sundaicus, once considered as an important vector in the coastal areas of Indonesia, is highly susceptible to DDT.

DDT resistance either in *A. culicifacies* in the plains of central Burma or in *A. annularis* except in Yakhine State, is so far of little, or no operational significance in the country.

Of the rest important malaria vectors in the Region is *A. aconitus*. It is responsible for transmitting malaria in areas with population more than 90 million, of which about one-quarter of the population at risk is in areas affected by DDT-resistant *A. aconitus*, mostly in East and Central Java.

REFERENCES

ANNUAL REPORT, MOH, (1983). Vector-Borne Diseases Control Project, Department of Health, Ministry of Health, Rangoon, Burma.

BEALES, P.F., (1980). Antimalaria Programme, Thailand. *SEA/Mal/126* : 1.

BEROUTI, L., (1974). Population and manpower patterns and trends in Indonesia, ILO, Jakarta. p. 28.

CHOO KENG KUN, (1983). Population movements and redistribution in Peninsular Malaysia: Past and present trends. Proceedings of the Workshop on Human Population movement and their Impact on Tropical Disease Transmission and Control. University of Peradeniya/ UNDP/World Bank/WHO. p. 42.

CLYDE, D.F., (1984). Tour report to Burma from 6-12 May. Unpublished WHO/ SEARO document.

GUNDELFINGER, C.H. *et al.*, (1975). Observations on malaria in Indonesia Timor. *Am. J. Trop. Med. Hyg., 24* : 393.

HARINASUTA, T., GILLES, H.M. and SANDOSHAM, A.A., (1976). Malaria in Southeast Asia. *Southeast Asian J. Trop. Med. Pub. Hlth., 7* : 645.

HARINASUTA, T., MIGASENA, S. and BUNNAG, D., (1962). Chloroquine resistance in *Plasmodium falciparum* in Thailand. UNESCO First Regional Symposium on Scientific Knowledge of Tropical Parasites, Singapore, p. 148.

KANJANAPAN, W., (1983). Health effects of labour mobility: A study of malaria in Kanchanaburi province, Thailand. Proceedings of the Workshop on Human Population Movements and their Impact on Tropical Disease Transmission and Control. University of Peradeniya/ UNDP/Word Bank/WHO. p. 12.

KUNSTADTER, P., (1983). Lifetime migration and mortality in a north western Thailand town. Proceedings of the Workshop on Human Population Movements and their Impact on Tropical Disease Transmission and Control. University of Peradeniya/UNDP/World Bank/WHO. p. 69.

LEPES, T., (1984). Present status and future prospects for malaria control in the World. *Ann. Acad. Med., 13* : 163.

MPH, (1979). Briefing document for malaria assessment team. Malaria Division, Department of Communicable Disease Control, Ministry of Public Health, Bangkok.

PAHO, (1984). Epidemiology and control of falciparum malaria in the America. PAHO Scientific Publication No. 471 : p.7.

PAMPANA, E.G., (1969). *Textbook of Malaria Eradication.* (2nd ed.) Oxford University Press, London.

PINICHPONGSE, S., (1985). The current status of the anti-malaria programme in Thailand. Malaria Division, Department of Communicable Diseases Control, Ministry of Public Health, Bangkok.

PINICHPONGSE, S., (1985). The malaria situation and anti-malaria operations in Thailand. *In:* Problems of malaria in the SEAMIC countries. Harinasuta, C. and Reynolds, D.C. (eds). SEAMIC, Tokyo. p. 54.

PINICHPONGSE, S., and DOBERSTYN, E.B., (1983). The role of population in the spread of drug—resistant falciparum strains in Thailand. Proceedings of the Workshop on Human Population Movements and their Impact on Tropical Disease Transmission and Control. University of Peradeniya/UNDP/World Bank/WHO. p. 102.

PROTHERO, R.M., (1977). Disease and mobility. A neglected factor in epidemiology. *Int. J. Epidemiol., 6* : 259.

PROTHERO, R.M., (1983). Some issues in population movements and health studies. Proceedings of the Workshop on Human Population Movements and their Impact on Tropical Disease Transmission and Control. University of Peradeniya/UNDP/World Bank/WHO. p. 111.

SCHULTZ, M.G., (1974). Imported malaria. *Bull. WHO.*, *50* : 329.

SIDHU, M.S. and JONES, G.W., (1981). Population dynamics in plural society, Peninsular Malaysia. UMCB Publications, Kuala Lumpur.

VELEZ, C.N., (1983). Migration and Health: A literature review with emphasis on tropical diseases. Proceedings of the Workshop on Human Population Movements and their Impact on Tropical Disease Transmission and Control. University of Peradeniya /UNDP/World Bank/WHO. p. 153.

WHO, (1979). Seventeenth report of the WHO Expert Committee on malaria. *WHO. Techn. Rep. Ser.*, No. 640.

WHO, (1984). World Health Statistics Quarterly, *37* : 130.

WHO, (1985a). The work of WHO in the South-East Asia Region, 37th Annual Report of the Regional Director, *SEA/RC38/2* : 160.

WHO, (1985b). World Health Statistics Quarterly, *38* : 193.

WHO, (1985c). Report on an Intercountry Meeting on Drug Resistant Malaria. WHO Project: ICP MAL 001, *SEA/Mal/157.*