Chapter 15

MIGRATION AND MALARIA

R Mansell Prothero

Introduction

The relationships between migration and malaria are complex. They are two-way relationships - migration affects malaria and malaria affects migration. The former is the concern of this chapter.

An up-to-date comprehensive study of migration/malaria relationships has still to be written, since three decades have passed since the publication of Migrants and malaria (Prothero 1965) (US edition, Prothero 1968). This was concerned exclusively with Africa where pilot malaria eradication projects in the continent were being affected negatively by the movements of people (Prothero 1961). At this time there were continuing but diminishing hopes that global malaria eradication was possible.

During the last three decadese there have been changes in migration and in malaria in Africa and in other malarious parts of the world. Eradication has been replaced by control which requires the ongoing application of anti-malaria measures, and falciparum resistance to chloroquine (and in some places to other drugs) has become widespread. The nature and, more particularly, the scale of migration has changed substantially. Evidence emphasising and exemplifying the importance of malaria/migration relationships has increased, contributed to by bio-medical and social scientists. There has been an increasing recognition of this importance by the former group, a recognition which in the past was limited and which is still not as satisfactory as it should be. In the malaria equation - parasite/vector/people - parasite and vector have received much greater attention than have people. The everyday aspects of people and their lives are of fundamental importance in malaria and its control, among these aspects movements of many kinds are of great significance.

The significance of migration for malaria may be summed up simply as follows.

1. Movements of people in various ways contribute to the transmission of malaria infections.

2. Programmes for malaria control/eradication, and for the improvement of public health in general, are hindered when applied to populations which are in whole or in part mobile. Mobile people are more difficult to access and to contact, and the costs of doing so are much greater than when people are relatively sedentary.

In recent decades (Prothero 1977):

1. there is greater movement of people than there was in the past, for with the rapid growth of population there are now more people to move;

2. the rapid growth of population exerts pressures on resources with major redistributions of people as they seek to improve their economic circumstances;

3. political and environmental disasters may force people to move, with increased movements of refugees and victims of drought, famine earthquakes etc.;

4. the means of movement are greatly increased, so that movements can take place over much greater distances and in much less time than in the past with heightened risks of disease transmission and of imported diseases.

The nature of migration

Migration is not uniform; there are many different types. Movements of people vary in their causes and consequences, and in their spatial and temporal patterns (where and when movements take place and distances covered). All of these may be of importance in their impacts on malaria; particularly spatial and temporal patterns of movement about which remarkably little is appreciated and known.

It is important to distinguish between

1. movements which involve a definitive and permanent change of place of residence between one place and another, which may be termed migration;

2. movements which involve an absence from a place of residence for a period of time followed by return to it, which may be termed circulation.

The spatial and temporal characteristics and patterns of these two major categories vary considerably.

Migration may occur in a regular fashion, movements taking place after due thought and planning for a new place of residence. Or it may occur in irregular fashion, taking place relatively precipitately as a consequence of unforeseen factors (war, environmental catastrophe, famine). Irregular migration is likely to be more significant in its effects on malaria.

Circulation may occur for limited periods of time (daily), for longer periods which may extend for weeks, months or even years, or for periods which are defined by the length of seasons (winter/summer, wet/dry). All of these can have significant effects on malaria.

Both migration and circulation occur within rural areas (rural-rural), between rural and urban areas (rural-urban, urban-rural), and within urban areas (urban-urban).

Also, both migration and circulation take place within countries (internal) and between countries (international), and increasingly between continents. In many parts of the world, where international boundaries may not be recognized and are easily crossed, it may be difficult to distinguish between internal and international movements. This has important implications for malaria transmission and for the design of control programmes which require international cooperation and coordination (see later discussion).

To begin to understand relationships between migration and malaria it is as important to recognize the variations in movements outlined above as it is to recognize the various species of malaria parasites and vectors. It must be realised that movements of people, in whatever forms and under whatever circumstances they occur, are difficult and for the most part impossible to control. Furthermore, they cannot be subject to experiment. It is therefore essential that anti-malaria operations and projects for public health improvements should be designed to work within the constraints imposed by the movements of people and that these constraints are clearly understood.

Population movements and malaria (Figures 1a and 1b)

Through movements people are exposed to malaria risks in a variety of ways (Prothero 1977).

1. As they move between and through different ecological zones; for example, between arid or high altitude areas which are malaria-free and irrigated or low altitude areas which are malarious.

2. Through exposure of people with little or no immunity to infected persons, particularly when strains of malaria are drug-resistant.

3. Through physical and psychological stresses (fatigue, undernutrition/malnutrition, problems of mental adjustment in new environments) which reduce resistance to infection.

Some examples of these risks in relation to the variety of movements outlined previously are as follows.

1. The daily or weekly circulation of hunters, gatherers and farmers may involve movements between areas which differ ecologically in minor respects but still increase contacts with vector-breeding habitats (Singhanetra-Renard 1993). Such movements on forest fringes, particularly in South-East Asia, have given rise to what is now identified as "forest malaria" (Sharma and Kondrashin 1991).

2. Seasonal circulation may involve farmers during times of maximum agricultural activity (in the wet season) in movements from relatively vector-free villages to temporary dwellings on farmland which are foci of vector activity. Or seasonal circulation may take migrant labourers with little or no immunity from higher-altitude, malaria-free areas to lower-lying malarious areas where they suffer severe infection.

3. In the case of regular migration, problems may arise for those who make planned and organized moves from rural to urban areas and settle there for long periods of time. Since these urban areas are relatively malaria-free those who have moved to them will in time have reduced immunity. But it is common to make short visits back to places of rural origin and at these times they may be exposed to the risk of malaria infection.

4. Irregular migration, caused by political pressures or by environmental castastrophe, exposes people to physical and psychological stresses and consequently increases their susceptibility to malaria and to other infections (Prothero 1994).

There are contemporary movements of large numbers of people, significant in various ways for the transmission of malaria and affecting measures for malaria control, to which particular attention should be directed.

1. Movements which are the result of political disruption and environmental catastrophe, especially the large-scale movements of refugees.

2. Movements associated with the resettlement of population for political and for economic reasons.

3. Movements from rural into urban areas.

Refugees in large numbers have exacerbated already complex malaria situations - in north-east Africa as a consequence of Ethiopia/Somalia conflict, in south-west Asia as a consequence of war in Afghanistan, in south-east Asia from conflict in Vietnam and Cambodia, and in Central America. The relatively precipitate and chaotic nature of refugee movements makes forward planning virtually impossible. Higher incidence of malaria is recorded in those parts of countries most seriously disrupted, and it is a major problem in refugee camps. Measures for malaria control are

restricted and sometimes impossible to effect; control of vector breeding has not proved particularly successful in circumstances where populations are transient. When vector control is not possible protection with drugs should be reserved for non-immune and high-risk groups (malnourished children and pregnant women).

Refugee movements have played a significan role in the spread of drug-resistant falciparum malaria in South East Asia in the last three decades, particularly from war in Vietnam and Cambodia and from disturbed conditions on the Thai-Myanmar border (Verdrager 1986). From a South East Asian focus chloroquine-resistant falciparum has spread into north-east India and from there south and west into other parts of the sub-continent (Payne 1987). This spread is further referred to later in this paper.

The movements of people for resettlement in "frontier/pioneer" areas are particularly favourable for increased malaria transmission.

Forced resettlement in Ethiopia in the 1980s brought people from the traditiionally preferred areas of occupation at altitudes above 2000 m, generally malaria-free but where malaria epidemics occur periodically, to lowlands where the disease is endemic. Settlers lacking immunity were at risk to high morbidity and mortality from malaria and also from other infectious diseases (sleeping sickness, river blindness and yellow fever). Malaria risks were increased in agricultural settlements with irrigation, and seasonal movements of migrant labour also contributed to the spread and maintenance of transmission (Kloos 1990).

Transmigration policies in Indonesia have moved people from the densely-populated and relatively malaria-free inner islands of Java and Bali to outer islands (Sumatra, Kalimantan and Sulawesi) which are malarious and where health service to deal with this and other diseases are inadequate. The success of malaria control on the inner islands has meant that migrants from these have low levels of immunity, but in the resettlement islands they are exposed to endemic malaria with a greater variety of vectors in some islands (Sulawesi and Irian Jaya) than in others. Water developments (irrigation, rice cultivation, fish culture) increase the habitats for vector breeding (Abisudjak and Kotanegara 1989).

Outstandingly in the last two decades the Amazon basin has witnessed a resurgence of malaria associated with frontier settlement, with a ten-fold increase in the number of reported cases to over 600,000 in 1992, more than a half of all those recorded in the Americas. The physical environment favours vector breeding, but this has been enhanced by settlement construction, road building and mining which extend breeding sites for An darlingi, the major vector (Coimbra 1988; Sawyer 1993). Movements of population have been important in malaria transmission and have reduced the effectiveness of government programmes for malaria control.

Many of the migrants originate in the dry north east and in the southern more temperate parts of Brazil, both for the most part malaria-free, and having no immunity they suffer severely when they arrive in the Amazon region. In reverse of this situation, when infected persons from the Amazon have moved south they have been the source of minor localized outbreaks of malaria in Parana which is generally free of malaria but where there are mosquitoes which can transmit the disease (Cruz Marques 1987).

Temporary dwellings cannot be protected with insecticide spraying, in clearing land settlers are exposed to vector-breeding habitats, and poverty limits their access to measures for protection against malaria. Besides agricultural settlement malaria has increased through mining activities which increase vector-breeding sites, temporary settlements are unprotected and the continual in and out movements of miners maintain the reservoir of infection and make control virtually

impossible (Vosti1990).

Such control as can be achieved in the Amazon basin is principally through the use of residual insecticides (most commonly DDT). Anti-malarial drugs are used frequently without medical supervision and indiscriminate use contributes to the development of falciparum resistance, particularly to chloroquine.

Generally in the malarious parts of the world there is more effective control of the disease in urban than in rural areas, but the continuing large-scale movements of rural people to the towns threatens this control (Service 1989). Rural migrants are infected and the makeshift temporary shanty-towns in which they live provide habitats suitable for mosquito breeding. In India An stephensi, which formerly bred in wells, now breeds in these urban habitats. Urban malaria, which was of marginal importance in India's malaria eradication programme in the 1960s, is now well established in many Indian cities, with about a third of reported cases occurring in urban areas. Circumstances vary, in the early 1990s malaria cases were fewer in Delhi and Calcutta but increased in Madras and Bombay. Manaus, the major city of the Brazilian Amazon, experienced several epidemic outbreaks in the 1980s on its peripheries where the shanty towns are concentrated.

Specific malaria projects

The previous discussion has outlined in general terms the relationships between malaria and different forms of population mobility, and the need for these to be recognized and understood. Evidence in greater detail of these relationships is limited but some indication must be given of their nature and how they may investigated.

Garki, Northern Nigeria

The WHO project at Garki, Northern Nigeria during the first half of the 1970s researched the epidemiology and control of malaria (using residual insecticides and drugs) in the Sudan savanna, where there are large yearly and local variations in the level of transmission (Molineaux and Gramiccia 1980). It concentrated particularly on the measurement of entomological, parasitological and sero-immunological variables and their relationships. Demographic data were collected for the de facto population in the project area, recording birth, deaths, arrivals and departures. All data were recorded longitudinally.

The population was shown to be relatively mobile, with marked variations in patterns of movement seasonally and from one year to another, with some differences between one village and another. However, only two types of movement were measured - movement in and out of villages and short-term absences from villages - and their geographical distribution was not recorded. At least two other types of movement which were recognized as important - short-term visits to villages (which were substantial and variable) and movements of semi-nomadic pastoralists - were not measured and therefore no assessment could be made of their influence. Little account was taken of the fact that the project was undertaken during a period of intense drought which substantially affected many of the movements.

Overall it was concluded that there was no difference in respect of malaria either between those who left and those who stayed in villages, or between those who came and those who were already there and it was concluded

> "It is very unlikely that the mobility of the human population, which was relatively pronounced, was the main cause of the maintenance of transmission".

While this broad statement may be correct the more precise effects of mobility remained unknown and unproven. Data were not complete and certainly not all types of movement occuring in the project area were identified. Despite the range of medical and entomological personnel in the project team there was no social scientist specifically concerned with the study of the mobility and other socio-economic characteristics of the population. A recommendation made at the planning stage of the project that such a person should be included was unfortunately not accepted (Prothero 1977).

Naya Basin, Colombia

A more recent study of malaria and mobility in the Naya river basin of Colombia presents evidence of more effective interdisciplinary involvement of entomology, malariology and social science (Sevilla-Casas 1993). An initial geographical survey defined ecological zones and the types and locations of settlements from which a cluster sample was drawn to provide households which were surveyed for composition and structure, mobility history, occupation and malaria experience during the previous year. A smaller representative sample provided more detail on the ethnography of village life, circulation movements and malaria prevalence.

At a macro level data on endemicity and mobility (associated with agriculture, logging and trade) identified that the malaria risk was greatest in the delta of the Naya river into which there were movements for economic reasons at times when vector densities were high and biting most intense. This combination of high human and high vector density ensured continuous and intense transmission of predominantly falciparum malaria, with high prevalence among both sexes, prevalence increasing with age from adolescence onwards as the range and number of peoples' activities increased.

Micro study of the daily economic activities in two villages with high endemicity identified particular areas within the delta with greater or lesser risk of malaria transmission. People moving within the beach area of the delta were exposed to the greatest relative risk from the high biting rates of A albimanus in this environment.

Two matters emerged from this study which are of practical importance for the design of more effective measures of selective prevention and of adequate treatment in malaria control programmes, particularly among populations where a high proportion are mobile.

1. The need to identify areas where the risks of infection are greatest, and to concentrate control resources on these rather than spread them more widely.

2. Routine malariological surveys had been inadequately representing the numbers of infected women.

It is known that non-immune pregnant women are particularly susceptible to malaria infection and should receive priority protection (Reuben 1993) Furthermore, women have been neglected in the study of tropical diseases, in general and as migrants who may be exposed to these diseases (Vlassoff and Bonilla 1994).

A further study may be consulted. It reports on the influence of the movements of pilgrims on the persistence of malaria in south India (Rajagopalan et al 1986)

Trans-boundary movements and malaria

Mosquito vectors and infected and non-immune persons are not restricted in their movements by state or international boundaries in any of the malarious parts of the world or in areas adjacent to them. For example, malaria was virtually eradicated from the USA during the first half of the present century, but as recently as 1986 there was an outbreak of malaria in San Diego County, California for the first time since the early 1950s. There were vectors to transmit infection and its source was infected migrant workers from Mexico (Maldonado et al 1990).

Since it is difficult and almost impossible to control the reservoir of infection and transmission when there are movements of people between countries, agreements and arrangements to deal with these circumstances are essential. Without them effective control measures in one country are likely to be negated by the absence of measures in countries adjacent to it (Prothero 1965).
In Latin America the most satisfactory of these agreements is the Southern Cone Pact involving Bolivia, Brazil, Paraguay, Uraguay, Argentina and Chile. Malaria is endemic in the first three and in a small area of northern Argentina, but the greater part of Argentina, Uraguay and Chile are malaria-free. The Pact provides for the exchange of information on malaria and resources for its control. Elsewhere in the highly malarious areas of Latin America there are varying degrees of coordinated malaria control in areas adjacent to and across international boundaries. Coordination and control are limited by political inaction and in some instances by political friction, these being exacerbated by refugee movements and by clandestine and illegal movements of migrant labour. In the coca-growing countries problems are made even worse by drug-trafficking and by the attempts to control this. Overall inter-country cooperation and coordination for malaria control in Latin America are poor, though probably no worse than in most other malarious areas of the world (Prothero 1995).

Probably the present and potentially most difficult region, where population movements promote malaria transmission and drug resistance and complicate measures to counter these, is South East Asia. Here as in many other parts of the world international boundaries have little meaning for the people who live adjacent to them, and in many instances the boundaries artificially divide ethnic groups whose members are continually crossing for economic and social reasons. Many of these ethnic groups are small and are often in conflict with the central governments of the countries of which they are part. Problems of control are compounded by the fact that many of the boundaries run through mountainous and heavily-forested country which is inaccessible and where movement is difficult for the authorities (immigration, customs and health) who wish to exercise control.

Attention has recently been drawn to the "corridor" running through Myanmar, Thailand, Cambodia, Laos, Vietnam and southern China where there is rapidly developing trade and commerce, legal and illegal, involving the movements of large numbers of people which are likely to increase in the future (Kidson 1993). Of a total population of about 300 million, one fifth who live in the more inaccessible parts are at risk of malaria infection, with about a million cases a year, About a half of these cases are falciparum infections resistant to chloroquine and to other anti-malarial drugs. Furthermore, most of the populations of the major vectors - An dirus, An minimus and An maculatus - are exophilic and exophagic and resistant to control measures.

Official border posts estimate that movements between Yunnan and Myanmar, Laos and Viet Nam involve more than 10 million people in the course of a year, and at one crossing point on the Thai-Cambodian border more than 40,000 passed during one month. To these must be added unknown but probably larger numbers involved in illicit activities (gems, drugs and arms traffic) who avoid, as they can easily do, any border controls. The contribution of these movements to the transmission of malaria (and more recently of AIDS) and to the build-up and spread of multi-drug resistance cannot be estimated but is of enormous significance. Government attitudes, at least to legal

economic activities, are that these should be encouraged and officials are often less concerned with their negative effects on disease spread and control.

In these difficult circumstances there is an urgent need for international cooperation and coordination within the region. Moves towards these were made at a meeting held at Kunming in November 1993 organized by the WHO and the Ministry of Health in China (Karbwang and Harinasuta 1993). National malaria programmes need to exchange information on the most effective drugs to be used and their correct dosage, on developments in drug resistance, on vectors, and on changes in socio-economic factors (including movements) which affect all of these. Such measures are required in all other malarious parts of the world.

Besides movements affecting malaria within continents there are the increasing number of inter-continental movements which are resulting in malaria occurring in areas from which it has been eradicated. The US example was quoted earlier, and more recently in 1993 there was a localized outbreak in Singapore when infection was introduced from outside the country.

Cases of "imported malaria" occur in Europe as a consequence of the greatly increased movement of non-immune travellers from that continent, particularly tourists seeking holidays in exotic places which are malarious without adequate chemoprophylaxis. There were some 8000 reported cases in Europe in 1992 but the actual number is reckoned to be greater. In the UK in 1994 1800 people returning from malarious areas developed the disease and 11 died, the risk of fatality being much greater for those with falciparum infections. Deaths often occur because of the failure of travellers to declare that they have been in malarious areas, and whose illnesses have consequently been incorrectly diagnosed. Instances have also been recorded of malaria infection occurring in malaria-free areas from infected vectors being transported on aircraft.

Conclusion

Movements of people in their many different forms present major issues in the latter decades of the twentieth century at a variety of scales - global, inter- and intra-continental, national, regional and local. They are causally related to a great range of factors and similarly have wide implications - political, social, economic and, as in this chapter, medical, for malaria and for many other public health problems. Though the medical implications are being increasingly recognized, this recognition has been slow in developing and, as stated earlier, the basic facts of peoples' lives, including their movements, have not received the attention they require in planning malaria control and eradication.

The reports of the WHO Expert Committee on Malaria from the 1950s onwards have made reference to the significance of population movements for malaria transmission and for programmes for its reduction. This significance is recognized in the standard work, Malaria: principles and practice of malariology (MacGregor and Wernsdorfer 1988), but there is virtually no reference to it in Malaria: waiting for the vaccine (Targett 1991). In the past and at the present much lip-service has been paid to this significance but too little practical action has been taken. The fact that in anti-malaria work people and their actions require the expert attention of social scientists, as do parasites and vectors the expert attentions of malariologists and entomologists respectively, has not been fully appreciated.

Advances have been made, particularly with the setting up in the late 1970s of the Socio-Economic Working Group in the World Bank/UNDP/WHO Special Programme for Research and Training in Tropical Diseases (Vlassoff 1991). Reference is made earlier in the paper to some of the outcomes of this development (see also Ministerio da Saude 1982, Fernando 1984; Singer and Oya Sawyer

1992). There is now wider multi-disciplinary involvement in the study of malaria control and eradication, but still less inter-disciplinary involvement than there should be. Malariologists, entomologists and social scientists still have to learn to work together more closely, and particularly for the last of these to be more accepted by their colleagues who study parasites and vectors. These will continue to be necessary even if and when more effective anti-malarial measures (drugs, vaccines and insecticides) become available.

It is hoped that what has been set out in this chapter will point up the significance of migration in its many forms in malaria transmission and in programmes for control/eradication. If social science expertise should not be available then it is even more important that malariogists and entomologists should know something of people and their movements, so that they are aware of the problems that these may create. They may then be able to adjust their activities more appropriately to matters of importance which have been neglected in the past.

References

Abisudjak B and Kotonegara R (1989) "Transmigration and vector-borne diseases in Indonesia" in Service M W (ed) Demography and Vector-Borne Diseases CRC Press Baton Roca 207-223

Coimbra C E A (1988) "Human factors in the epidemiology of malaria in the Brazilian Amazon" Human Organization 47: 254-260

Cruz-Marques A (1987) "Human migration and the spread of malaria in Brazil" Parasitology Today 3: 188-190

Fernando M A (ed) (1984) Human Population Movements and their Impact on Tropical Disease Transmission and Control Faculty of Medicine Unversity of Peradenyia Sri Lanka

Karbwang J and Harinasuta T (1993) "Editorial: International border malaria control" Southeast Asean Journal of Tropical Medicine and Public Health 24: 615-616

Kidson C (1993) "Editorial: Trade, population flow and transnation malaria control" Southeast Asean Journal of Tropical Medicine and Public Health 24: 213-215

Kloos H (1990) "Health aspects of resettlement in Ethiopia" Social Science and Medicine 30: 643-656

Maldonado Y A et al (1990) "Transmission of Plasmodium vivax malaria in San Diego County, California 1986" American Journal of Hygiene and Tropical Medicine 42: 3-9

McGregor I and Wernsdorfer W H (eds) (1988) Malaria: principles and practice of malariology Churchill Livingstone Edinburgh

Ministerio da Saude (1982) Doencas e Migracao Humana Ministerio da Saude Brasilia

Molineaux L and Gramiccia G (1980) The Garki Project: research on the epidemiology and control of malaria in the Sudan savanna of West Africa World Health Organization Geneva

Payne D (1987) "Spread of chloroquine resistance in Plasmodium falciparum" Parasitology Today 3: 241-246

Prothero R M (1961) "Population movements and problems of malaria eradication in Africa" Bulletin of the World Health Organization 24: 405-425

Prothero R M (1965) Migrants and Malaria Longmans Green London (US edition Migrants and Malaria in Africa University of Pittsburg Press Community Health Series Pittsburg)

Prothero R M (1977) "Disease and mobility: a neglected factor in epidemiology" International Journal of Epidemiology 6:259-267

Prothero R M (1994) "Forced movements of population and health hazards in tropical Africa" International Journal of Epidemiology 23: 657-664

Prothero R M (1995) "Malaria in Latin America: environmental and human factors" Bulletin of Latin American Research 14: 357-365

Rajagopalan P K et al (1986) "Population movements and malaria persistence in Ramaswaram island" Social Science and Medicine 22: 879-886

Reuben R (1993) "Women and malaria: special risks and appropriate control strategy" Social Science and Medicine 37: 473-480

Sawyer D (1993) "Economic and social consequences of malaria in new colonization projects in Brazil" Social Science and Medicine 37: 1131-1136

Service M W (1989) "Urbanization: a hotbed of vector-borne diseases" in Service M W (ed) Demography and Vector-Borne Diseases CRC Press Baton Roca 59-83

Sevilla-Casas E (1993) "Human mobility and malaria risk in the Naya river basin of Colombia" Social Science and Medicine 37: 1144-1167

Sharma V P and Kondrashin A V (eds) (1991) Forest Malaria in Southeast Asia New Delhi

Singer B and Oya Sawyer D (1992) "Perceived malaria illness reports in mobile populations" Health Policy and Planning 7: 40-45

Singhanetra-Renard A (1993) "Malaria and mobility in Thailand" Social Science and Medicine 37: 1147-1154

Targett G A T (ed) (1991) Malaria: waiting for the vaccine Wiley Chichester

Verdrager J (1986) "Epidemiology of the emergence and spread of drug-resistant falciparum malaria in South East Asia and Australasia" Journal of Tropical Medicine and Hygiene 89: 277

Vlassoff C (1991) "Social and economic research in TDR: future directions" Parasitology Today 7: 37-39

Vlassoff C and Bonilla E (1994) "Gender-related differences and the impact of tropical diseases on women: what do we know?" Journal of Biosocial Science 26: 37-53

Vosti S A (1990) "Malaria among miners in southern Para, Brazil: estimates of determinants and individual costs" Social Science and Medicine 30: 1097-1105