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Malaria in Meghalaya: Socio-demographic and Geographical Problems

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In Meghalaya, malaria is still considered as among the major public health problems. The disease is unevenly distributed over the entire area of the State. However, endemicity disappears in area over 5000 feets above mean sea level (MSL), which includes Shillong and the adjoining areas. The occurrence of the disease shows a distinct epidemiological paradigms attributed to environmental conditions, population distribution, the pattern of settlements, the nature of dwellings, administrative and social organisation, and the wide range of economic activities.

Since 1958 almost the entire areas of the State (Meghalaya) was covered under the eradication campaign irrespective of malaria endemicity and socio-economic importance of the areas. The two major vectors involved in the transmission of malaria are *Anopheles minimus* Theobald 1901, and *Anopheles dirus* Baisas 1926. In the past natural infection have also been found in *Anopheles philippinensis* Ludlow 1902, however, it is not considered of much importance (Viswanathan et al. 1941). *An. minimus* usually breeds in clear slow moving water (stream) with grassy margins and swampy vegetation with little shade; *An. dirus* preferred breeding places are forest pools and streams often with decaying leaves; whereas, *An. philippinensis* breeds profusely in rice-fields and other water body exposed to sunshine.

Even though malaria occurs in almost throughout Meghalaya, there are significant differences of occurrence between regions. Malaria stability and equilibrium between host, vector and parasite are conditioned by the competence and longevity of vector (Macdonald, 1957). Stable malaria regions include some areas lying in the foot-hills and flood-plains bordering Assam and Bangladesh, and almost the entire areas in the western parts. In these areas malaria occurs every year at high level and are perennial with a peak transmission during the wet season. The human population acquires strong immunity during the 1st years of life at the price of a high infantile-juvenile mortality. In unstable malaria areas, e.g. peninsular forested hills of the entire central and eastern parts of the state, transmission is lower or irregular from year to year with human population acquiring less immunity and epidemics occurring in almost all age classes (Macdonald 1957).

MAJOR CLIMATIC EVENTS

The State of Meghalaya is directly influenced by the south-west monsoon and north-east winds. The four seasons are Spring - March to April; Summer (Monsoon) - May to September; Autumn - October and November; Winter - December to February. During the summer months the maximum temperature recorded is 34°C at Tura in West Garo Hills district and 28°C at Shillong of East Khasi Hills district. In winter months the temperature comes down to as low as 2°C in the highland of East Khasi Hills district. Rainfall starts by the third week of May and continues right upto the end of September and sometimes well into middle of October. The maximum rainfall occurs over the southern slopes of East Khasi Hills district, that is, over Cherrapunjee and Mawsynram platform, which received the heaviest rainfall in the world. The average annual rainfall in the state is 12,000 mm.

STATEMENT OF THE PROBLEMS

During the past few years, we have tried to sort out the causes of recent malaria fluctuations in Meghalaya. Identification of the causes for the increase of endemicity and occurrence of outbreaks has been found to be complicated. In our studies, we targetted specific cases observed in some endemic pockets, ranging from the increase to the decrease of malaria. Even though these studies are not exhaustive, they cover a large

number of situations concerning the human elements from both socio-demographic and geographical point of view. Particular attention here is paid to mobility of human population as it is most relevant to problems arising in malaria control and possibly eradication.

MOBILITY AND MALARIA

Prothero (1983) pointed out that the problems relating to mobility and malaria are the contribution to continuing transmission of mobile groups within a population and in some instances, the mobility characteristics of the whole population. Mobility factor and malaria may also be illustrated to a considerable extent with regards to Meghalaya. Here, mobility and malaria can be linked to various socio-economic activities, which bring people into close contact with vector species:

Firstly, population movement from highland malaria free areas to lowlying areas of unstable and stable malaria was a common phenomenon during the wet season (monsoon). The inhabitants in search of arable land replaced the marshy fields with crops and fish ponds, suitable breeding habitats for anophelines, mainly *An. minimus* and *An. philippinensis* (Viswanathan et al., 1941; Rajagopal, 1985), thereby leading to the reactivation of malaria transmission and enhancing the spreading of the disease (Packard, 1986, Kondrachine et al., 1997). In the process, problem also arises in communicating with the people to spray their dwellings (which are also mobile) with residual insecticide and to distribute antimalaria drugs (Kalra, 1978). As seen, in areas of Garo Hills, the villagers usually live in Jhum hut in deep jungle for cultivation virtually during the whole transmission time and their houses in the villages are kept locked. This not only hampered the coverage of anti-malaria programmes, but also bringing the people into close contact with the forest vector, *An. dirus* (Baimai, 1988; Kalra, 1991).

Secondly, the quest for other economic developments that set in motion large scale movement of people from non-malarious to malarious areas and vice-versa, and that had also brought in radical changes in the ecosystem often create a situation most condusive for malaria transmission. The coal mining operations at Bapung (Jaintia Hills district), Borsora (West Khasi Hills district) and Nangalbriba (South Garo Hills district); the cement plants at Cherrapunjee (East Khasi Hills district) and Siju (South Garo Hills district); hydel projects; and other forest related activities provide a good case in point. In most of the above activities invariably involves the continuous flow of migrant groups, their aggregation and settlement in the proximity. In such a situation, it facilitate the high malaria transmission (Kondrachine et al., 1989) and also constitute the main cause of epidemic (Veekan, 1986) as seen during the year 1995-1996 (Table 1), especially in those areas of such activities. Moreover, most of the above socio-economic activities that usually consists of migrant labourers coming from other malarious areas outside the state may also be recognised as the original foci of multi-drugs resistance (Verdrager, 1998).

Regular data on malaria morbidity and mortality in most of the project areas are lacking due to absence of a reporting system and poor

Table 1: Epidemiological Information of the State of Meghalaya for the year 1995-October 1999

Year	*Blood Slide Examined (BSE)*	*Total Positive*	*Plasmodium falciparum cases*	*Annual Parasitic Index (API)*	*Annual Blood Examined Rate (ABER)*	*Slide Parasitic Rate (SPR)*	*Slide falciparum Rate (SFR)*	*Death*		*Radical Treatment (RT)*	*Pf %*
								Confirmed	*Suspected*		
1995	299094	24920	12174	12.8	15.8	6.2	3.05	48	918	23034	48.8
1996	295721	26968	14230	13.5	14.8	9.7	4.8	45	140	21932	52.7
1997	252997	22237	10910	10.9	12.4	8.7	4.3	11	nil	10187	49.06
1998	237168	17618	8710	8.3	11.2	7.4	3.5	3	3	17503	49.4
1999	188810	12076	7952	-	-	6.3	4.2	5	59	11546	65.8

Source: Dy. Director of Health Services (Malaria), Meghalaya, Shillong

communication between project management and state health department. Nevertheless, considering the overall malaria situations, recent reports on the epidemiological profile indicated a very high malaria prevalence with Plasmodium falciparum preponderance (Table 1) and a considerable degree of drug resistance (Table 2).

MOBILITY IN EPIDEMIOLOGY

The epidemiological studies on the movement of population were not properly recorded and measured. But considering the observations made on the nature and variety of movements, it is believed that such movement had a differential impact upon the epidemiology of the disease. The socio-economic upheavals since the past 25 years, that is, soon after the emergence of statehood in 1971, followed by large scale population movements along with ecological changes favourable for malaria transmission are the main contributing factors influencing the landscape epidemiology of the disease (Kitron, 1998) and establishment of a new epidemiological equilibrium.

The increasingly intensification of agriculture with temporary concentration of migrant workers created new risk situation in further expansion of the disease distribution (Kondrachine et al., 1989; Morse, 1995). A similar epidemiological patterns also accompanied many development projects in highly malarious areas (Mouchet et al., 1998). For example, the concentration of coal mining operations and limestone quarries, that involve continuous flow of temporary migrant groups from other malarious areas especially outside the State, often result in the reactivation of malaria transmission and making epidemic-prone situation more explosive (Meek, 1988). This, may have also led to the introduction of new strains of malaria parasite and perhaps dissemination of drug resistance (Young et al., 1961). All these activities are believed to be the contributing factors on the worsening malaria situation, particularly in unstable malaria region, where some of the most severe malaria outbreaks in recent years have taken place. For example, the upsurge of malaria incidence and a sudden outbreak of *Plasmodium falciparum* cases with severe intensity during 1994-1995 in Jaintia Hills district known for so long as *Plasmodium vivax* dominant areas, can be linked with the outset of coal mining operation started more than a decade ago. Observation also revealed the role of population movement and the impact of favourable environmental conditions in precipitating the resurgence of the disease. Although most movements are temporary rather than permanent, at least of substantial duration may also be suggested as

Table 2: Results of the Monitoring of Drug-resistance of P. falciparum in Meghalaya

S. No.	*Areas*	*Districts*	*Years*	*Dosage (Chloroquine)*	*Test*	*Total cases*	*Result*	*References*
1.	Dalu	Garo-Hills	1973	1500 mg.	*in-vivo*	21	7RI	Chakrabarty et al., 1979
2.	Byrnihat	Ri-Bhoi	1975	1500 mg.	*in-vivo*	23	18RI 1 RII	Chakrabarty et al., 1979
3.	Bama-Bazar	Garo Hills	1977	1500 mg.	*in-vivo*	22	18RI/S 4RIII	Chakrabarty et al., 1979
4.	Balgiri	Garo Hills	1977	900 mg+50 mgP.	*in-vivo*	30	14*	Chakrabarty et al., 1979
5.	Byrnihat	Ri Bhoi	1977	900 mg+50 mgP.	*in-vivo*	34	10*	Chakrabarty et al., 1979
6.	Amalgiri	Garo Hills	1977	600 mg + 50 mgP.	*in-vivo*	14	6*	Chakrabarty et al., 1979
7.	Byrnihat	Ri Bhoi	1977	600 mg + 50 mgP.	*in-vivo*	25	4*	Chakrabarty et al., 1979
8.	Naya Bangla	Ri Bhoi	1977	600 mg + 50 mgP.	*in-vivo*	41	9*	Chakrabarty et al., 1979
9.	Damalgiri	Garo Hills	1977	600 mg + 45 mgP.	*in-vivo*	40	20*	Chakrabarty et al., 1979
10.	Mendipathar	Garo Hills	1978	1500 mg.	*in-vivo*	4	2RI	Chakrabarty et al., 1979
11.	Bagmara	Garo Hills	1979	1500 mg.	*in-vivo*	14	1RI	Barkakaty et al., 1983
12.	Umsning	Ri Bhoi	1996	1500 mg.	*in-vivo*	63	27RI 2RI 2RI	The team of Regional Director, H & FW, Shillong
13.	Sutnga	Jaintia Hills	1997	1500 mg.	*in-vivo*	12	12RI/S	- do -
14.	Ranikor	Khasi Hills	1998	1500 mg.	*in-vivo*	46	46RI/S	- do -
15.	Dalu	Garo Hills	1998	1500 mg.	*in-vivo*	30	30RI/S	- do -

*Persistence of asexual stage on day 6/7.

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the main cause of the maintenance of malaria transmission (Wessen 1971) and possibly in the diffusion of drug resistance *Plasmodium falciparum* malaria (Beales, 1981).

MOBILITY TYPES AND MALARIA HAZARDS (PROTHERO, 1977)

Gould and Prothero (1975) who defined the various types of mobility by their spatial and temporal characteristics, mentioned it as among the major important factors in the transmission and control of disease. In Meghalaya, the spatial distribution of malaria is not homogeneous and its transmission dynamics and intensity is governed by large number of stable and unstable, biotic and abiotic factors in different paradigms. Sharma et al. (1996) in their review of "Epidemiology and control of malaria in India" defined malaria paradigms as specific situation supporting a level of malaria endemicity which is dependent on local environment and socio-economic activities.

In this context, *spatial* distinction may be made between movement from one ecological set-up to another, for example, movement from malaria free areas to stable or unstable malaria areas and vice-versa. The major *temporal* distinction is between *migration* (mobility involving change of residence) and *circulation* (mobility away from place of residence but with eventual return it). *Circulation* here may also be divided into four sub-category: *daily* (away from place of residence for upto 24 hours); *periodic* (away for more than 24 hours but less than 12 months); *seasonal* (a variant of periodic where time absent is related to the span of one or more seasons); and *long-term* (away for more than 12 months and possibly extending over years). These different types of mobility that have different effects in exposure to malaria infection, also often create some obstacles in the control of disease (Kalra, 1978).

Considering the different mobility within Meghalaya, the major *seasonal* circulation of the population engaged in economic development activities, e.g. mining and agriculture, mostly moved into stable malaria region of low-lying areas (foot-hills and flood-plains). This movement especially during the wet season caused higher risk to malaria infection. In such areas with disturbed ecology, malaria is maintained by *An. minimus* and *An. philippinensis* (Rajagopal, 1976). The transmission in these areas (stable malaria region) is intense and prolonged with moderate to high endemicity and for a population coming from malaria free areas and the areas of low transmission or unstable malaria areas paid a high price to the disease. *Jhum* cultivators are another vulnerable group of people who often sleep in the hilly forested areas of unstable malaria for a variable periods, both during sowing and harvesting of crops and get exposed to infected *An. dirus* (Kalra, 1991) and the hazards of malaria. *Daily* and *periodic* circulations during the wet season in continual search for pasture and other forest related activities further increase the likelihood of contact between human being and vector. The individuals involved especially in timber collection and tree felling stay for variable periods ranging from few hours to few nights in the forest camps and face the risk of contracting malaria. *An. minimus* is more or less absent in these areas (Narasimham 1991) and malaria is transmitted chiefly by *An. dirus*. All these movements combined made it difficult to establish contact with the population at risk for the implementation of anti-malaria measures.

As according to Prothero (1983), these different categories of people which are connected with different categories of *circulation* and *migration* and associated with categories of malaria hazards, may be indicated briefly as follows:

i) Movements from one set of ecological condition to another with consequent exposure to disease (for example, in the case of *Jhum* cultivators during the wet season for cultivation; this circulation takes people from permanent dwellings which have been sprayed with residual insecticide to temporary dwellings with least protection making them vulnerable to the disease).
ii) Movements which bring different groups of people into contact may enhance the possibility of continuing infection and increase the reservoir of transmission (for example, the influx of migrant labourers involved

Each situations requires a specific understanding taking into account climate events, human factors and operational activities. It may be mentioned that, the improving malaria situation in some of the Western Pacific countries (having similar malaria situation) is a reminder of the fact that the constraints of drug and insecticide resistance and population movement are not intractable obstacles to malaria control if the right strategies are applied in the right way, in the right place and at the right time (Kondrachine et al., 1997).

KEY WORDS Meghalaya. Malaria. Mobility. Human factor.

ABSTRACT Recent research assessing the impact of environmental changes on vector-borne diseases has been perceived, studied and investigated to a considerable extend. This is manifested particularly in the case of malaria because of suspected association with various environmental conditions. In Meghalaya, malaria outbreaks became a regular feature in many pockets of the State. It may also be noted that the changing characteristic of land due to increasing human activities along with relatively large scale human population movement into forests, forest-fringes and adjacent man-dominated plantation and agricultural system may be recognised as among many factors responsible for the transmission and problems in controlling the disease. Perusal of relevant literature on these aspects and the observation made in Meghalaya concerning the geographical features, various socio-economic activities and the intervention of what may be called human factor in anti-malaria programme has been highlighted.

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