# Tribal Malaria and its Effects on Air Force Station Amla and Surrounding Areas: An Ecological Study

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## Abstract

Tribal malaria is a major problem in many parts of India. It can have an impact on troops deployed in tribal pockets. The present study was carried out in an Air Force Station situated in an eco-system of tribal malaria in Central India. Methods included both field observations and record studies. It also included elements of targeted anti-malaria interventions and study of their effects. Inside the Air Force Station, Defence Service Corps (DSC) personnel, whose occupation involved night patrolling in densely, forested locales on the perimeter of the Air Force Station, with the tribal villages within flight range of the vector mosquitoes, was the group most affected in terms of both overall malaria incidence and high falciparum rates. Among the neighboring villages, the tribal villages had significantly higher rates of malaria as compared to the non-tribal villages. Vector identification revealed presence of *A culicifacies* and *A fluviatilis.* Heavy breeding was noted in the surrounding villages, both in natural water channels and man-made projects, such as hand pumps without proper drainage. A rising trend of malaria was obvious in these villages. Incidence among service population could be controlled to some extent by specifically targeted measures inside the camp area. Understanding the local eco-system is essential for planning effective anti-malaria strategies. Military medical officers when planning anti- malaria strategies in service stations also need to consider the dynamics of malaria transmission in neighboring civil settlements.

## Introduction

About 44 million populations of tribal areas of Andhra Pradesh, Madhya Pradesh, Gujarat, Maharashtra, Bihar, Rajasthan, Orissa and North Eastern States are contributing 50 percent of P falciparum cases of the country as stated in Government of India Report (1995). Mobile tribal population engaged in forest related activities has been identified as high risk groups. The air force station, in which the present study was carried out, is located in a pocket surrounded by tribal villages, in a highly malarious tribal belt of Central India. Also it has the dubious distinction of recording the highest incidence of malaria when compared with other air force/military stations.

Improvement in local knowledge of malaria epidemiology (especially disease transmission), with refinement of surveillance mechanisms and proper use of collected data, may lead to the implementation of more selective malaria control measures in accordance to report of World Health Organization (2000).

With this in view, a detailed epidemiological study was made in the air force station, to provide long and short term strategies to reduce the incidence of malaria among service personnel and families. The purpose was also to formulate a methodological model for similar application in other similar service situations.

## Material and Methods

The air force station and the surrounding villages comprised the study area. It is situated in a semi-hill, densely forested and highly malarious tribal belt of central India

(Satpura Ranges), at an altitude of 2435 feet above sea level. The air force station comprised of a population of 4,300 including airmen/airmen families/Defence Security Corps (DSC)/ defence civilians and their families. This population is surrounded on all sides by seven villages, four of them are tribal and three non-tribal (tribal population = 2686, non tribal population = 8147).

The methods employed were both inductive and deductive, field observations and record studies, observational and interventional, retrospective and prospective.

1. Field Observations: The area inside the camp and the neighboring villages were extensively surveyed and the relevant ecological conditions that could affect malaria transmission observed. Relevant social and occupational activities both of the Air Force population and the neighboring villagers were noted. Mosquito breeding and potential mosquito breeding sites were identified. Vector studies were carried out by searching for anopheline larvae and adults. Identification of vectors was carried with aid of a standard text on medical entomology (Hati, 1979). Meteorological data was recorded from the meteorological section.

2. Record studies: The quality of record keeping was first assessed. The populations of the villages were confirmed from the Block authorities. The Annual Blood Examination Rate (ABER), of the civil villages was calculated (which was well above the 10% recommendation), before including the following parameters for study:

i Annual Parasite Incidence (API)

ii Annual Falciparum Incidence (AFI)

iii Slide Positivity Rate (SPR)

iv Slide Falciparum Rate (SFR)

The above parameters were worked out category-wise both among the Air force Station population (Airmen, DSC, Families, Defence Civilians) and neighboring villages (tribal and non-tribal). Data for three years (1997 to 1999) were recorded. Chi-square statistical method was used to analyse the data.

3. Intervention: After identifying the high risk population inside the Air Force Station (DSC personnel), and exophilism of the vectors, intensive implementation of personal prophylaxis measures such as use of DMP/Odomos for night duty patrols, deltamethrin impregnated mosquito nets and specifically targeted health education of the high risk group was started from June ’99 (at the onset of the malaria season). Similarly selective vector control strategy (on identification of *A fluviatilis)*, such as clean weeding of water channels, introduction of larvivorous fish, besides routine vector activities were instituted from June 1999 inside the Air Force campus. It would be pertinent to point out that earlier to this, antimalaria activities in the station were focused mainly on three rounds of residual spray, and antilarval measures with hardly if any, emphasis on personal prophylaxis measures for night duty patrols.

Results

1. Malaria vector breeding: The air force station and the surrounding villages were found to have thick vegetation, with watercourses running almost perennially through the air force station and neighboring villages. There was very little organic pollution in these water channels. Most of these water streams had vegetation on their banks

under shade, where the anopheline breeding was noted at various sites. Some of the villagers were tapping these water channels by installing pumps to divert water to their fields for irrigation purposes. In the past three years there have been an increasing number of village hand pumps installed without provision for adequate drainage. Pooling of water was observed around these hand pumps with anopheline breeding in some. Rain water collected in hoof and cart marks in the 'Kuttcha' paths used by the villagers. Anopheline larvae were recovered from these collections, which were later identified as *A culicifacies* in accordance to Rao (1981) project on maturation. Adult anopheline vectors were seldom caught in spite of repeated search indoors. Very few samples of adults were therefore available for dissection. Few adults identified had features of *A fluviatilis* in accordance to Rao (1981) project.

2. Activities of natives: Information gathered from direct observation of local tribals and from interviews of the natives revealed that majority of them were engaged in forest related activities such as collection of firewood, leaves for making "pattals" (used for serving food), animal grazing, etc (such activities were indulged in by even tribal women and children). Some tribal men folks were involved in nocturnal forest activities (not always legal, such as brewing of intoxicants, etc). The activities of non-tribal villagers were less adventurous and hardly involved visit to the forested areas. A large number of villagers (both tribal and non-tribal) also slept outdoors because of overcrowding.

3. Meteorological recordings: No extremes of temperature were noted from January to December, summers and winters were mild. The maximum annual temperature was in the month of May touching 37.1$^0$C and minimum in December was 6$^0$C. Relative humidity varied from 55% to 72.5%. Annual rainfall was 1000 mm.

4. Annual Parasite Incidence (API): Comparative rates per thousand are shown in Fig 1. It may be seen that in the year 1997 there was no significant difference between

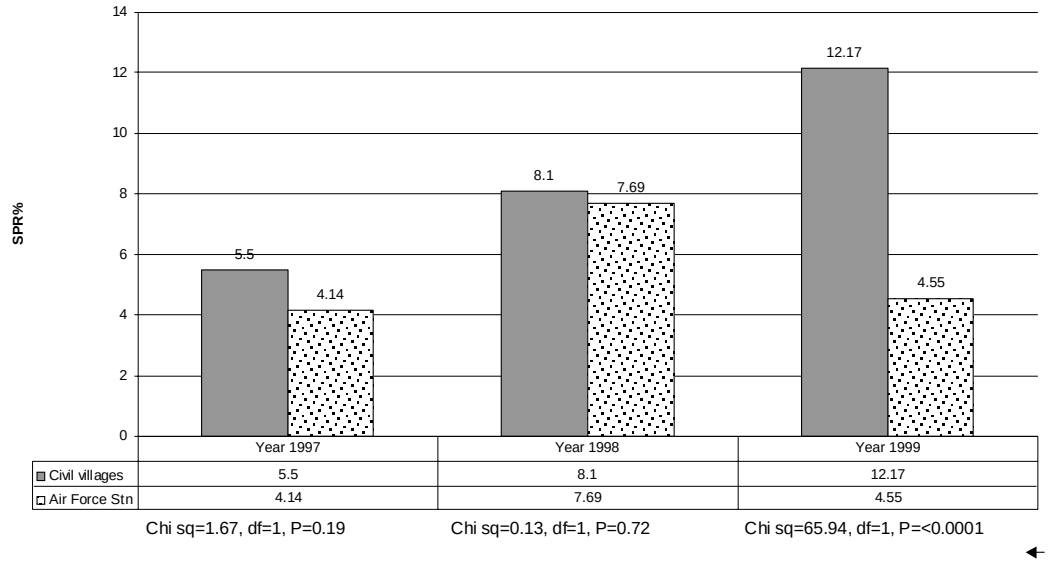
Fig. 1. Rate per 1000 civil villages & AF station



the incidence in civil and AF population (Chi sq = 0.86, P = 0.41). However the incidence increased in 1998 among the air force population as compared to the villages and this difference was significant (Chi sq = 7.68, P = 0.005). With intervention in 1999, the rates fell down appreciably and significantly as compared to the civil villages (Chi sq = 37.06, P = < 0.001). On the other hand the rates among the local villages showed a rising trend and were very high in 1999.

5. Slide Positivity Rates: As compared to civilian villages the SPR did not vary much among the Air Force population in the years 1997 and 1998 (Fig 2). However, it came

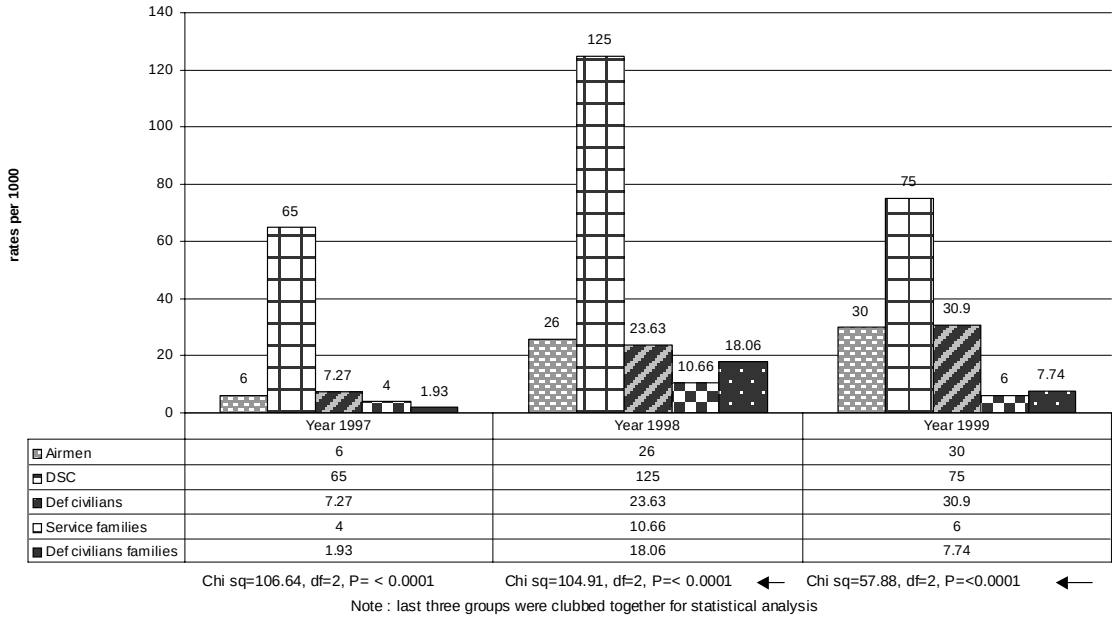
Fig. 2. SPR Civil villages & AF station




down significantly in the year 1999.

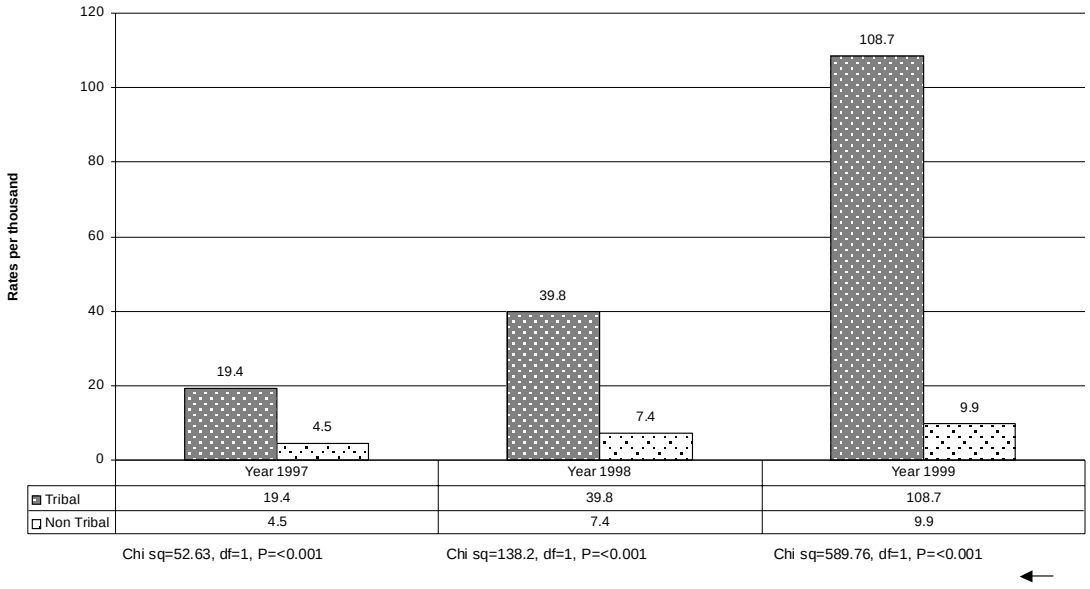
6. Malaria rates in different categories in the AF Station: Fig 3 shows that among the Air Force population it is the DSC personnel who had the highest rates of malaria in the station. The difference in all the three years between the DSC and other subgroups in the AF station was both appreciable and highly significant.

Fig. 3: Malaria rates per 1000 in different categories AF station




7. Malaria rates in tribal as compared to non tribal civil population: As evident from Fig 4 the tribals had significantly higher rates compared to the non-tribals among the civil villagers. Also the rates among the tribals are showing an ascending trend with very high API in 1999 (108.7 per thousand).

Fig. 4: Rates of malaria per 1000 in tribal and non tribal villages



8. Slide positivity & Slide falciparum rates in tribal and non-tribal villages: SPR (%) in tribal and non tribal villages are shown in Fig 5. This also shows a rising trend in the civil villages with significantly higher rates in tribal villages compared to non-tribal villages. Similarly slide falciparum rates were higher in tribal villagers compared to non-tribal villagers (Fig 6.)

Fig. 5: SPR(%) in tribal and non tribal villages

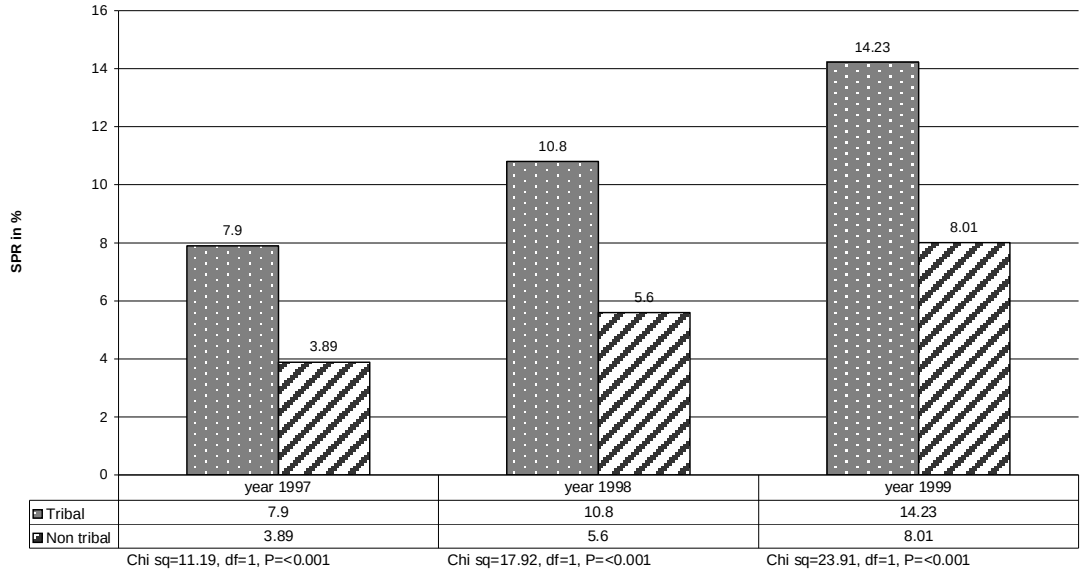
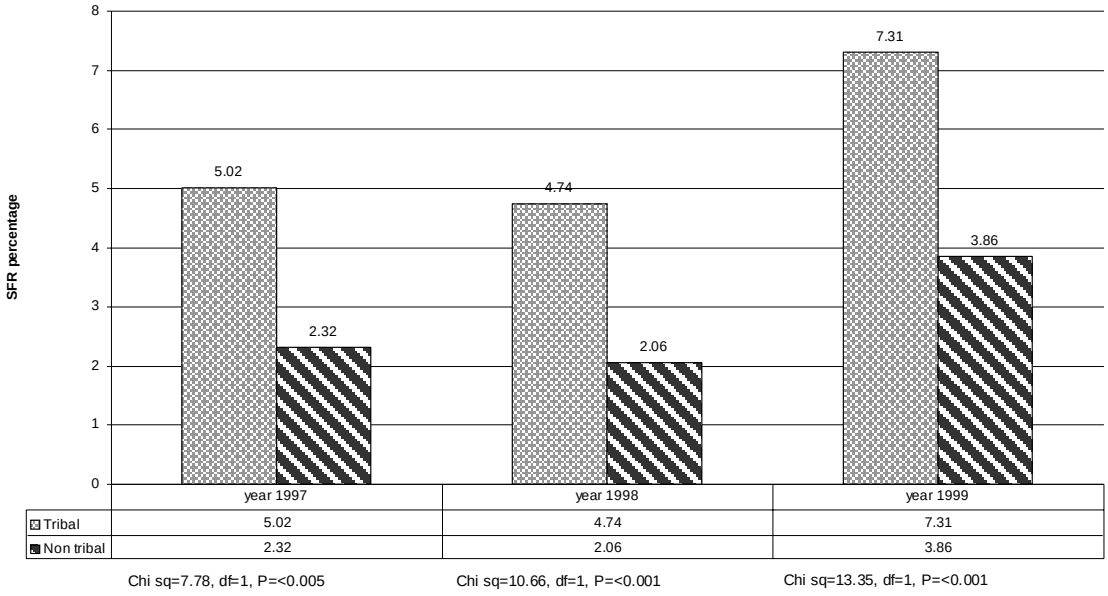



Fig. 6: Slide falciparum rate tribal and non tribal villages



9. Falciparum rates DSC personnel and Airmen: The falciparum rates in DSC and Airmen have been compared in Fig 7. These were much higher and statistically significant in the DSC as compared to the airmen in all the three years. However, in 1999 the rates in DSC as well as in the airmen came down as compared to 1998.

Fig. 7: Falciparum rates DSC and Airmen

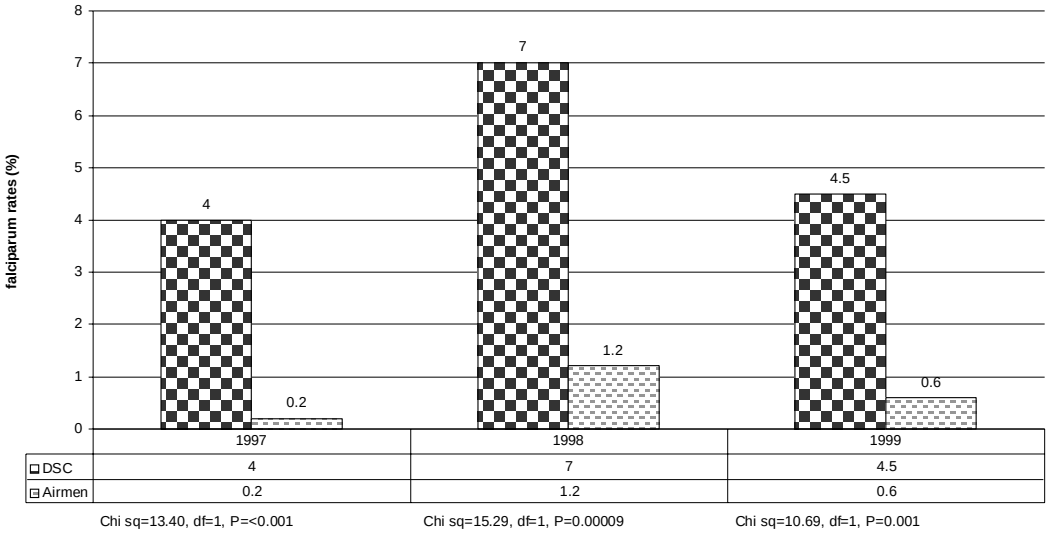
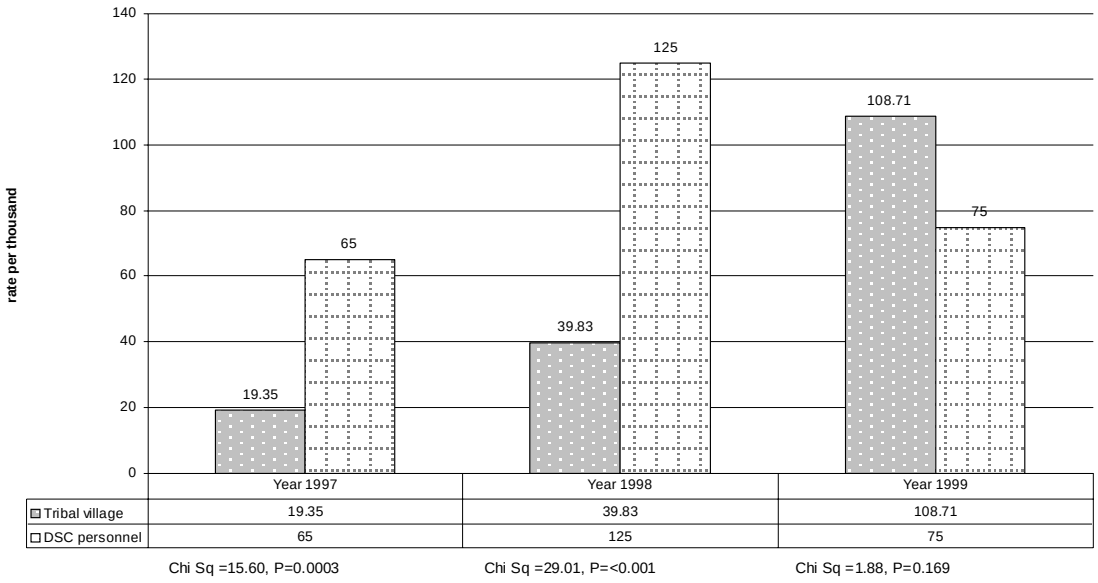



Fig. 8: Rate per 1000 DSC personnel compared to tribal villagers



10. Rates per 1000 DSC personnel compared to the tribal population: As the DSC appeared to be the high risk group among the airmen and the tribal among the civil villagers, it was thought worthwhile to compare the rates among the DSC population and the tribal (Fig 8). Interestingly, the rates among the DSC were significantly higher in 1997 and 1998 as compared to the tribal. It came down appreciably but not significantly among the DSC as compared to the tribal in 1999.

## Discussion

Meteorological conditions of the station as noted favour longevity of both the vectors identified as well as development of strains of *P. vivax* and *P. falciparum* (Rao, 1981). The vectors identified *A culicifacies* and *A fluviatilis* both appear to rest outdoors in the station, as attempts to collect indoors by knock down sprays were futile. While numerous observations all over India have confirmed indoor resting of *A culicifacies*, some outdoor resting has also been observed. Exclusive exophily of *A culicifacies* have been noted in Dhadgaon area of West Khandesh district in Maharashtra where it was found biting on forest workers engaged in charcoal manufacture as reported by Rao (1981). Similarly, the other local vector, *A fluviatilis*, has been noted to exhibit exophily. Rao (1981) observed sizeable proportion of adult population resting outdoors in the Satpura ranges (near the station site). In sylvan surroundings, where the tribal visit and the DSC jawans carry out night patrols, the possible resting-places are numerous and far outnumber a few houses that occur in such localities. In spite of best efforts, adequate number of adults could not be caught for dissection purposes. Rao (1981) has reported that collection of adult mosquitoes in outdoor places is very difficult unless special techniques are used, which were lacking in the present study.

Exophily of the vectors is also collaborated by the different incidences of malaria in the subgroups both inside the camp area, as well as in the neighboring villages depending on their occupational/social activities; night patrolling in the case of the DSC and visits to the forests in case of the tribal. Both these subgroups had the highest incidences of malaria overall and falciparum malaria in particular.

In such settings, both occupational (for e.g. night operations of soldiers in forested malarious areas), as well as vectorial (exophily), personal prophylaxis measures take precedence over other malaria control methods. Targeted intervention among the DSC in the AF station in the year 1999 brought down the incidence appreciably in-spite of rising incidence in the neighboring villages. In service settings where involvement of soldiers in night operations is frequent, personal prophylaxis measures such as use of mosquito repellants should be emphasized. Trials on use of repellant impregnated uniforms should be carried out on a large scale including long term adverse effects if any.

Meteorological and topographical features of the place ensuring longevity of the vectors coupled with outdoor resting in dense forests preclude satisfactory vector control measures, particularly in the forested areas. Consequent heavy transmission of falciparum malaria among the tribals perennially contributes to the local tribal developing some immunity leading to a state of stable malaria in them as reported in Manson-Bahr (1982). This makes the nomadic service populations who come in contact with such tribal areas within flight range of vector mosquitoes, highly vulnerable because of their non-immune status. These can raise additional problems in that the very presence of such non-immunes may convert endemic stable malaria into an epidemic unstable one. Control procedures in such situations must emphasize control of the vector at the

outset inside the service camps. We have at our disposal facilities and resources, which could support practical anopheline control not economically feasible in the adjoining civilian areas. We could even extend these vector control measures to the civilian tribal villages including residual anti-adult spray. This may not prevent the tribal contracting malaria in the forests but may prevent the second batch of anopheline mosquitoes getting infected from the tribal villages and affecting the inmates of the camp area which is within the flight range of these vector mosquitoes. Provision for extra insecticides can be considered in such stations.

A disturbing trend seen was the steady increase in malaria rates during the study period in both tribal and non-tribal civil villages. This is likely due to the installations of village hand pumps in recent years without ensuring proper drainage – a case of man-made malaria superimposed on tribal malaria. Efforts are on to tackle the rising trend in the civil areas with assistance of civilian health authorities and other sectors. Besides these antilarval activities in these areas by our team, active and passive surveillance along with modified radical treatment with help of multipurpose workers of the Primary Health Centre has been going on for some time.

Malaria control can be compared to guerilla warfare. Any relaxation of control measures will lead to the activation of the guerillas. At least in this venture we can go across the “line of control” and extend our antimalarial activities beyond our camp limits to root out “cross border *malarism*.” We have the expertise because historically malaria is a disease of military importance.

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