# HUMAN ACTIVITIES CONTRIBUTING TO A MALARIA OUTBREAK IN THONG PHA PHUM DISTRICT, KANCHANABURI, THAILAND

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**Abstract.** In Kanchanaburi, the annual peak of the malaria outbreak occurs in May. In Thong Pha Phum District, there are clusters of malaria cases near the border settlements. In order to track the progression of malaria from early exposed people to unexposed people, in-depth interviews were done with 20 sentinel cases during June and July 2007. These people of various cultures and ethnicities provided information about their activities during the past month, including occupations, locations of work, migrations, and travel routes. Evidence of exposure and transmission patterns confirmed the relationship of malaria to: 1) migration of infected individuals into the area, 2) increased human presence due to the deforestation and plantation activities, 3) the lack of self-protection from mosquito-bites when in the forests, and 4) changing activity patterns of villagers, which contributed to the outbreak among children. Except for those who collect mushrooms or bamboo, all the people who brought malaria to the villages had been in army or plantation work crews that stayed together. Three patients had taken quinine in Myanmar before coming to the malaria treatment center. Often, those who knew they were infected did not protect themselves from mosquito-bites, thus facilitating the local spread of malaria. In the villages, malaria seemed to spread from shared evening activities, such as watching TV near houses where the transients stayed. Prior to being located by the researchers, none of the non-Thai patients had intended to do follow-up.

## INTRODUCTION

Malaria shows distinctive seasonal trends in Kanchanaburi Province and other mountainous regions of western Thailand. Kanchanaburi is a multicultural border province that has consistently ranked high among the endemic malaria areas (Bureau of Epidemiology, 2006). Despite many years of attempts to control the disease, recent data show no drop in annual number of cases, and in some years, including 2006 and 2007, an unusually early and large peak in incidence was reported. These changes in case rates present an opportunity to investigate local sources of the malaria parasite and the paths of the vectors. This research focuses on human activities that contribute to the annual surge in malaria cases, and the places where people contract the malaria parasites at the beginning of the rainy season.

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The Ministry of Public Health shows Kanchanaburi reported 2,215 cases in 2006 (268.10 cases/100,000 population/year), including 3 deaths. During April and May of 2007, 333 cases were reported, the highest for any province (Center of Epidemiological Information, 2007). Malaria cases occur in local clusters, and the forest areas of the mountainous border are the places most affected by malaria. Therefore, we expected incidence rates to be much higher in border districts than in the population centers.

In May 2007, the investigators received reports of a malaria outbreak in Thong Pha Phum District of Kanchanaburi Province. Information from the District Office of Vector Control (working in conjunction with the Global Fund and WHO guidelines) showed that the median incidence of malaria in Thong Pha Phum for the years 2000-2005 was 25-30 cases per month for most of the year, but about 50 cases per month for May, June, July, and August. The past two years have seen the monthly incidence reduced by as much as half, except for the month of May, when 71 cases were recorded in 2006 and 60 cases in 2007 (Fig 1).

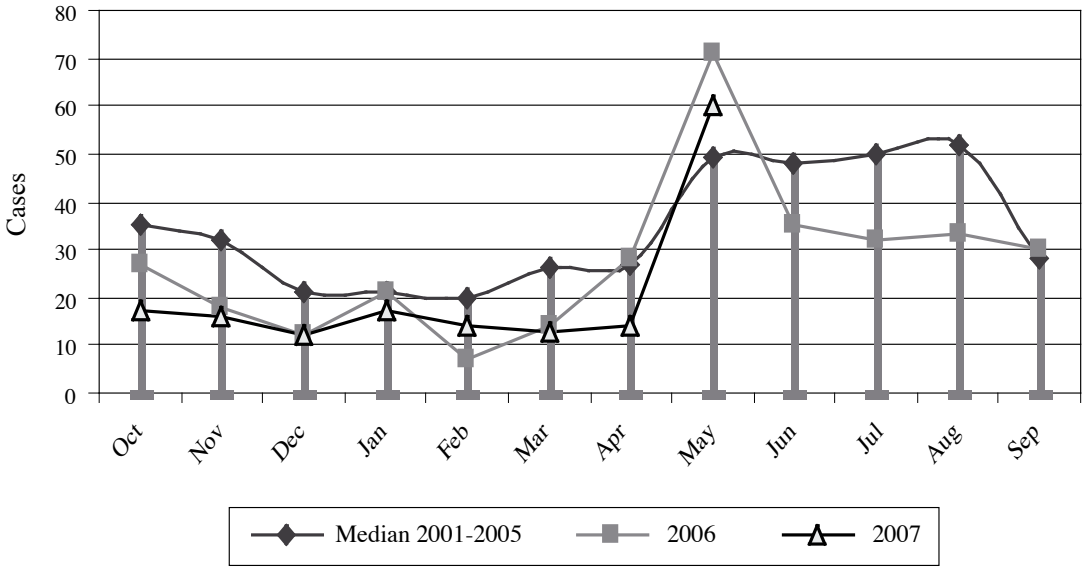


Fig 1- Monthly case reports of malaria in Thong Pha Phum, from October 2000 to May 2007. (Source: Virat Saisang, Vector Control Programs, Tong Pha Phum), Kanchanaburi.

Prothero (1999) noted that, if forest, fringes, and cleared foothills with secondary forest and tree plantations are added together, half of the total area of Thailand is an environment suitable for the transmission of forest-related malaria. For the people that live in the forested and reforestation areas, changes in the climate, ecology, economy, and politics are also affecting their activities, their relationships to the land and to other people, and subsequently, their patterns of exposure to malaria.

Many descriptive surveys have been done along the Thai-Myanmar border. For example, an eight-month qualitative study conducted in 1999 in four villages of Bong Tee Sub-district, Kanchanaburi Province (Panvisavas, 2001) used in-depth interviews of key informants and a malaria survey as research methodologies. It concluded that malaria was a serious problem in 39.6% of the families surveyed. The four villages are located in a valley covered with forests and small streams which were ideal for malaria epidemic. The structure of the villages had changed from stable communities to disrupted ones, divided along ethnic and class lines. There were five ethnic groups, dominated by ethnic Karen. Villagers were poor and thus deprived of anti-malaria resources that caused them to remain exposed to malaria.

Participation in the global economy has increased economic pressures, and the needs of people have led to frequent short-duration movements into and out of environments favorable to the breeding of *Anopheles* spp (*eg*, *An. dirus*, *An. minimus*, and *An. maculatus*), which carry the human malaria. Moreover, the occupations of migrant workers, the agricultural environments they create for their employers, and their living conditions promote the spread of "forest malaria" (*P. falciparum*), which is resistant to treatment with chloroquine and to several other drugs. Research done by Dendoung *et al* (unpublished) explains the economic and ethnic influences that affect the exposures of Karen, Thai Karen, Myanmar, and Thai people in Tak Province. The primary work activities of these groups have been categorized a part of the "circular mobility" that characterizes the occupations of ethnic minority peoples (Singhanetra-Renard, 1993). Additional malaria risk factors include housing styles, latrine and bath facilities, cooking and

eating routines, and common social activities. (Dendoung *et al*, 2005; Krissanakriangkrai and Hengboriboonpong, 2007).

A review of literature suggests that neither medicine-based interventions nor mosquito-abatement efforts can provide sustainable progress in combating malaria and other mosquito borne diseases (WHO/RBM, 2006). Although Malaria Centers and Public Health Centers (PHCs) make diagnosis and treatment available to all people in Thailand, recovery rates are not known because many migrant people do not return to malaria centers or PHCs for follow-up. Those people may be serving as active carriers of plasmodium gametocytes. The activities of humans that make them part of the chain of transmission of malaria need to be studied further, and behavioral interventions need to be designed. Using protective items, such as mosquito nets, chemical sprays, and other protection, such as balms, repellents, or even clothing and dress styles also affects personal susceptibility. Individuals can choose to use these protections, if they are available within their socio-economic environment. As demonstrated by the introduction of bed nets, risk behaviors and preventive behaviors can be identified, and programs can be developed to change knowledge, attitudes, and behaviors (KAB) about mosquito borne diseases. No single program has yet managed to gain cooperation of all the potential victims, or carriers, of malaria, but identifying the occupations and patterns of migration of sentinel cases may be one way to target the malaria interventions and to understand why current abatement efforts have not been successful.

WHO has implemented an "early detection program" in conjunction with distribution of test kits to the Malaria Centers and Primary Health Care Centers in high risk areas (WHO Country Office for Thailand, 2000; WHO, 2006). The WHO Early Intervention project has already shown that the disease trends and patterns can be affected if attention is paid to the cases. For example, the 2006 data from Thong Pha Phum Office for Vector Control (Fig 1) indicates higher than the median number of cases identified in May, but lower than median incidence for the rest of the rainy season. In order to understand better the underlying reasons for this shift in incidence patterns, the aim of this research was to discover community characteristics and lifestyle, and migration patterns that promote the spread of malaria in the border districts of Myanmar and Thailand during the epidemic peak.

The main objective of this study was to determine the human behaviors and activities that contribute to malaria. The specific objectives were to: 1. Survey malaria types of the current outbreak; 2. Determine exposure settings of people at risk, including place, time, and occupation where exposed, as well as determining if other persons were exposed or were serving as reservoir hosts; 3. Document the movement of the persons infected with malaria; 4. Document people's behavioral responses to malaria illness; and 5. Document malaria prevention measures used in different groups, such as ethnic groups, women's groups, schools, farms, villages, and work camps.

We also attempted to catalog culturally specific knowledge and beliefs about malaria, and how it is spread.

## MATERIALS AND METHODS

### Design

The study design was basic epidemiologic investigation using interviews and secondary data. Research techniques included mapping, time lines, ethnographic classification, and descriptive analysis. The research needed to be done at that time because of the outbreak nature of malaria. Collecting data from sick or recently exposed individuals could eliminate recall problems and insure availability of a complete sample.

The methodology addressed multi-dimensional and multi-scale issues. It was

participatory, and integrated social and gender approaches by considering the families and social networks of the victims as well as the location of exposure. Social research methods were used to note patterns of migration, socialization, work settings, networks, and housing.

Data collection activities for this research were: 1) Review data from Malaria Control Center, District Hospital, and Primary Health Care; 2) Interview health care personnel and community stakeholders, for example, monks and employers; and 3) Conduct in-depth interviews with 20 sentinel cases during June and July 2007.

**Participants**

The target populations were people of the various ethnic and cultural groups who live along the border with Myanmar. Interviews and intervention efforts were directed toward the native Thai and the Karen peoples who are in Thong Pha Phum District, and the immigrants from Myanmar who enter through the border of Myanmar with Kanchanaburi. We attempted to get an interview and other data from at least one participant from each of the major ethnic group in the district.

Inclusion criteria for the interview were: 1) treated for malaria in the past two weeks, 2) available to be interviewed, and 3) able to recall their disease, and details of activity and travel.

**Data collection**

Researchers conducted in-depth interviews with health personnel and community representatives. Local volunteers assisted in locating the patients, and translating/ interpreting the interviews with the victims of malaria in order to trace the source and location of their infections. Environmental and cultural data was obtained as field notes from home visits to the malaria patients. An interview guide were developed to insure consistency of data across subjects and families when we interviewed malaria victims.

**Data analysis**

Both quantitative and qualitative data, such as transcribed data, notes, pictures, and descriptions of exposure settings were recorded and transferred to electronic format (MS Access). The data from malaria patients treated at the hospital and data from patients treated in the community were entered and analyzed in spreadsheets.

**Ethical considerations**

Written informed consent was obtained from participants. The research proposal was reviewed by the Faculty of Public Health and approved by the Burapha University Ethics Committee.

## RESULTS

One hundred and thirteen people were reported as receiving treatment for malaria from the hospital, the community Malaria Center, and the Primary Health Care (PHC) center. Monthly incidence for the District for January to June was 283/100,000/year, which was higher than the annual rate of 268.3/year for the province as a whole in 2006. Eight people had mixed malaria, and the type was not reported for three cases. Thus, the count of malaria cases by type was 64 *P. vivax* (Pv) and 60 *P. falciparum* (Pf). Eight persons (all with Pf) had residences outside of the district. Age had a bimodal distribution, with 78 persons age ≥15. About 42% of malaria cases were female.

**Sample weighting and representativeness**

Table 1 summarizes the data from the hospital and the community and allows comparison of some characteristics of our interviewed participants to the other people with malaria. Secondary health data generally only classes people as Thai citizens or Non-Thai, with all people from Myanmar being grouped regardless of culture or language. The

number of non-Thai people using the hospital is the fact that non-Thai are much more likely to have Pf.

**Occupations and locations of work, migrations, and travel routes**

Fig 2 shows the locations of the sub-districts and the number of malaria cases in May 2000 based on data from the hospital and community treatment centers. Malaria cases from Huai Kayeng and Pi Lok were interviewed. A significant number of cases reported their residence as Tha Khanun Sub-district, which is not a border crossing or native forest area. Fig 3 shows some of the differences in the distribution of malaria in Sub-districts Huai Kayeng and Tha Khanun.

The results of our interviews with community stakeholders provide the following information about human activities in the sub-district. Tha Khanun Sub-district includes the district government offices, the hospital, and the largest market, as well as easily accessible resorts where migrants can get work. It is the site of a dam and hydroelectric plant. There is also a large processor of bamboo shoots, and non-Thai people are anxious to supplement their income by gathering bamboo in the forest, which they sell for 4 baht per kilogram (USD1 THB 34). The suspected sources of Pf malaria in this sub-district were transients who arrive from Sangkhla Buri District to the North. We were told by a Karen migrant soldier with malaria that he had come to Huai Kayeng by this route, staying with friends along the way while looking for work. However, the health officer here had also tested the schoolchildren and found a number of them were asymptomatic carriers of the Pv parasite.

Sub-district Huai Kayeng is almost

Table 1
Cases treated in May 2007 and type of malaria, Thong Pha Phum District, Kanchanaburi.

| | | Total reported | Thai | Myanmar | Other[a] | Median age | *n* <15 yr | %<15 yr | Females (*n*) |
|---|---|---|---|---|---|---|---|---|---|
| Hospital[b] *n*=57 | Pf | 37 | 9 | 27 | 1 | 22 | 14 | 25% | 21 |
| | Pv | 26 | 17 | 7 | 0 | | | | |
| Community *n*=53 | Pf | 16 | 13 | 3 | | 21 | 18 | 35% | 19 |
| | Pv | 37 | 32 | 5 | --- | | | | |
| Total Dx reported | Pf | 53 | 22 | 30 | 1 | | | | |
| | Pv | 61 | 49 | 12 | 0 | | | | |
| Interviewed *n*=20 | Pf | 11 | 0 | 4 | 7 | 18 | 7 | 35% | 8 |
| | Pv | 9 | 3 | 0 | 6 | | | | |

[a]Others interviewed
- Karen (6 Pv + 4 Pf)
- Tawai (0 Pv + 3 Pf)

[b]Some hospital cases were diagnosed with both Pf and Pv


Fig 2- Map of Thong Pha Phum District and malaria cases by sub-districts.

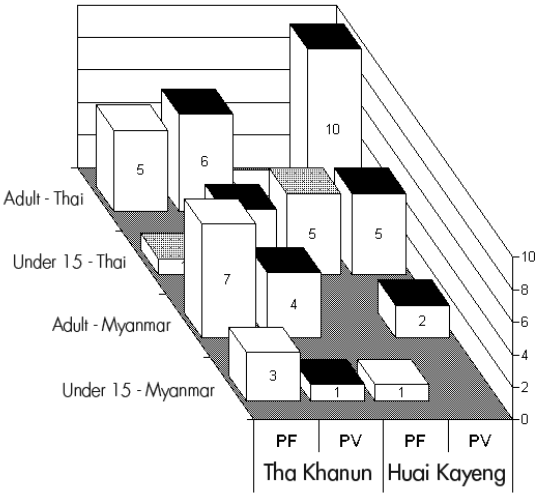


Fig 3- Pf and Pv malaria in adults and children in two sub-districts, Tong Pha Phum, May 2007.

exclusively agricultural. The non-Thai people here live in settlements. Most of the victims of malaria had family or relatives with whom they stayed. The Ban Rai Pa settlement is largely Karen, but there are Myanmar settlements and camps as well. However, the patterns of malaria infection were different; there is little mixing among adults due to language and cultural differences.

Most adults earned money by doing agricultural day labor. Major jobs were clearing forest, and planting rubber, teak, or cassava. Occasionally, there was night work harvesting the rubber, but most plantations are new and not ready to harvest. People would travel to distant field or work camps, often to Pilok Sub-district, where there is road crossing to Myanmar. In the camps, people stayed together without protection, and every interviewee admitted that at least one of their coworkers had been sick.

In review of data from community survey and interviews of patients and families, three patterns of transmission came to our attention. One was malaria brought from across the border. Most people with malaria had recently crossed the border or lived with someone near the border. Many of the Karen admitted military activity, and other people worked as guards along the border. Mon and Tawai people usually travel in big groups, but women and children traveling with their relatives are likely to be separated after entering Thailand (Archavanitkul, 1998).

A second pattern was exposure in the forest, or exposure while working in forestry. People who came looking for work told of walking and camping for 3-7 days to get to a settlement on the Thai side of the mountains. Bamboo shoot harvesting was a family occupation for some people, especially the less educated tribal members, such as the Tawai. In work camps, people told us they were bitten while working in the evenings, sleeping without bednets, or cooking outside early in the morning. In the Myanmar settlement, a recently arrived immigrant and her son got malaria while they stayed in a forest with other people for almost

10 days because she feared immigration officers.

The third pattern was the familiar one of a local mosquito vector biting someone in the home, which would account for most of the children who were infected. Electricity is relatively new to the settlements, and people now gather in the evenings to watch TV after bathing, but do not dress to protect from mosquito bites. However, the children who contracted malaria all lived near someone (usually a relative) who had recently arrived from Myanmar and needed treatment for malaria.

## DISCUSSION

The activities of humans often lead to obvious changes in the ecosystems they inhabit. Past activities associated with malaria in this area, such as the building of the Myanmar-to-Bangkok railroad, and the construction of the dam at Khao Laem and subsequent resorts are easily seen on satellite views. The recent activity of "reforestation," which involves converting the mixed species mountain forest to tree plantations, or completely clearing it for cropland, can also be seen on satellite images. The data show that it is the people involved in these activities, or other activities that require long stays in the forest, who make up the bulk of malaria victims during the outbreak.

Evidence of exposure and transmission patterns confirmed the relationship of malaria to the following human activities: 1) increased human presence due to the deforestation and plantation activities; 2) migration of infected individuals into the area; 3) lack of self-protection from mosquito bites when in the forests, and 4) changing evening activities contributing to the outbreak among children.

Human activities are related to culture and lifestyle. The usual way to describe local cultures is the style of housing that they have

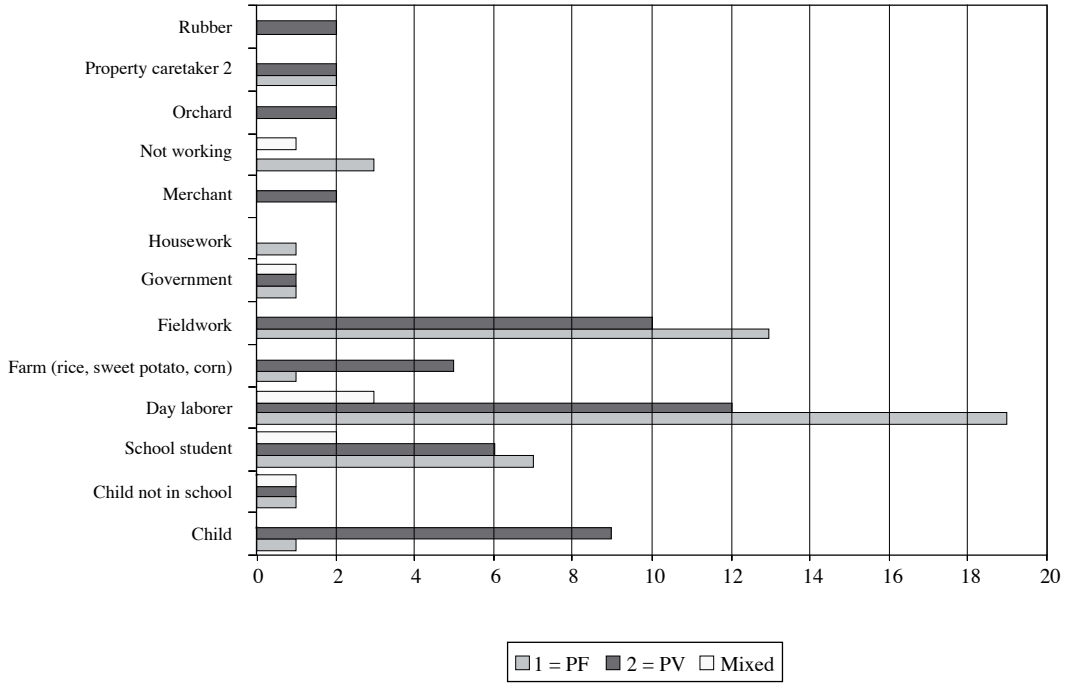


Fig 4- Malaria type by occupation, Thong Pha Phum, May 2007.

or the way they dress. The information from interviews indicated that most exposures were related to occupational or recreational activities, not to culture. However, there were cultural differences in the meaning of being sick with malaria, in reactions of the people to malaria, and their motivation to prevent mosquito bites.

Major misunderstandings about malaria of all cultural groups are the incubation period and times during which a person with malaria is contagious. This is important because most people are mistaken regarding the location at which they may have contracted malaria. They are also ignorant of the need to protect their caregivers from local transmission while they are sick. Moreover, there is currently little incentive to worry about malaria. For example, days lost from a job that pays less than subsistence needs are days that can be used in doing subsistence activities such as house building, hunting, or gathering.

Policy designed to promote malaria prevention should include some economic incentives for health promoting behaviors. As long as malaria treatment is free, it will be easier for people without cash to seek treatment than to pay for prevention (*eg*, buying clothing, bednet treatment, or repellents). This should be done before the end of WHO contributions to the anti-malaria campaign.

There should be a protocol for teaching about malaria to those who come for treatment at health centers and malaria centers. We could target interventions to the place in which the carriers of active malaria are living, and provide education to families of malaria victims. Information about the outbreak and about the transmission of malaria could be given to people at temples and by employers of labor crews.

Follow-up procedures for the WHO recommended regimes for drug resistant malaria need to be emphasized, especially because the people do not consider malaria a serious problem. Our participants knew the side effects of the intense medication regime can seriously restrict individual activities, so some people would rather wait for the active symptoms to subside than to take medication. People who have severe side effects from malaria medications do warn others about the side effects of the medication. Newly arrived immigrants are especially suspicious of the effects of the medications, and after taking the first dose, may decide to avoid the next dose.

People should be reminded to protect themselves from mosquitoes during extended evening activities, such as cooking, bathing, and watching TV. Villagers must beware of new arrivals or visitors who have come from across the border. Local people will need to design the appropriate measures for elimination of mosquitoes and preventing their bites, such as improving housing, control of mosquito larvae, encouraging repellent use, and so forth, by mobilizing people who represent the groups we identify as at risk.

Problems in conducting this research included the uncertain legal status of participants, and the difficulty in collecting and reporting longitudinal case data. Future work should target intervention efforts toward the native Thai, the Karen, and Mon peoples who are in Kanchanaburi, and the immigrants from Myanmar who enter through the border with Kanchanaburi. This research could be extended into an action research program to evaluate education efforts toward protection from mosquitoes, and promote prevention by encouraging community-based protection efforts such as monitoring of vectors and carriers, source reduction and environmental hygiene.

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