TRANSMISSION OF BANCROFTIAN FILARIASIS IN TEA AGRO-ECOSYSTEM OF ASSAM, INDIA

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Abstract. Tea industry is a labor intensive agro-industry and filariasis is mostly localized among the tea garden workers in Assam. The workers live inside the gardens in colonies. Studies conducted in two cosecutive years revealed that among the host seeking *Culex quinquefasciatus* average infection rate was 4.6% and with 2.1 larvae per mosquito. The overall prevalence of infective mosquitos was 0.8% with average L3 load of 2.0 per mosquito. The probability of infected mosquitos surviving to have complete development of filarial larvae (13 days) was 0.17. The expectation of infective life was 1.416 days for man biting *Cx. quinquefasciatus* and the estimated adult survival rate of was 87.6%. It has been estimated that a total of 22,569 mosquito bites were received /man/year in tea garden environment out of which 182 bites/man/year were infective (0.806%). The monthly biting rate varied from 310-4,758.5 bites per man (mean 1,846 ± 1,389.7 SD). Monthly transmission index of *W. bancrofti* filaria showed two periods of transmission. In both the year no infection was detected during February and March and infection rate remained low up to May (average infection in April 0.72% and in May 0.48%).

INTRODUCTION

Filariasis is endemic in Assam, India but it is mostly localized among the tea garden population (Khan *et al,* 1999). About 10.59 million people in Assam are exposed to the risk of filariasis of which 0.40 million are carrying microfilaria in their blood and 0.09 million are suffering from chronic disease.

Filariasis and its vectors have been studied in urban, rural and forest ecosystem in many places (Hati *et al,* 1989; Chang *et al,* 1995), but except a few scattered studies of spot surveys of filariasis and its vectors (Basu, 1957; Dutta *et al,* 1995; Prakash *et al,* 1998), no systematic longitudinal study on transmission of filariasis has ever been conducted in tea agro-ecosystem. In the tea gardens of Assam filariasis is mostly caused by *W. bancrofti* and is transmitted by *Culex quinquefasciatus*. However few pockets of brugian filariasis in declining phase have been reported from Cachar district in southern part of the state (Raina *et al,* 1993). Among the tea garden workers about 6-11% carry microfilaria in their blood and 1.8-3.8% suffer from chronic manifestations of filariasis (Dutta *et al,* 1995; Prakash *et al,* 1998). The tea gardens, due to the climatic conditions of Assam and use of artificial irrigation make these areas conducive for mosquito breeding. At the same time, beside use of insecticides in household as a mosquito control measure, to protect tea plants several pesticides and weedicides are also used. These are expected to exert insecticide pressure and influence vector biology in the ecosystem. Workers engaged in the gardens, live inside the gardens and become the integral part of the ecosystem. Most of the workers of the tea garden are from the stock of migrated population from central and south India, where filariasis is endemic. Since filariasis is mostly limited to the garden population in Assam a comprehensive study will give insight to the problems regarding transmission of filariasis in complex ecosystems of tea gardens.

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MATERIALS AND METHODS

Study population

The labor population in the gardens is mainly from migrated population from central and south India such as Andhra Pradesh, Tamil Nadu, Orissa and Bihar, where filaria is endemic. The workers live inside the garden in colonies called labor line. Each labor line is normally a congregation of several quarters.

Methodology

Sampling for indoor biting *Cx. quinquefasciatus* was done at monthly interval throughout the study period. Stationary bait inside a living room was used for indoor biting collections. Two insect collectors stand by the side of the bait and collect mosquitos landing on the bait. All the suitable mosquitos were dissected for presence of filaria larvae following the standard methods, and larvae if detected were identified on the basis of morphological characters like length, size and shape of caudal papillae and anal ratio.

For age grouping of *Cx. quinquefasciatus*, representative samples were also dissected for parity following standard method (Detinova, 1962). Ovaries were studied in detail and graded as per Christopher stage 1, stage 2, stage 3 and stage 4.

RESULTS

Infected mosquitos coming to bite human beings indoors were detected from April to November except in July (Table 1). Highest infection rate (20.3%) was seen in the month of October and lowest in the month of April. Average infection rate was 4.6% and with a load of 2.1 larvae per mosquito. Mosquitos carrying L3 larvae were detected in the month of April, May, June, October and November. The overall prevalence of infective mosquitos was 0.8%. It was observed that 47.7% of mosquitos coming in search of blood are nulliparous, 36.7% were uniparous, 13.5% were bi-parous and 2.17% were multiparous.

The survival rate of adult *Cx. quinquefasciatus* was estimated by the method of Davidson. For estimation of average survival rates, each gonotropic cycle was taken as an average of 5 days. The rate of daily survival in man biting collections was 87.5%. The probability of infected mosquitos surviving 13

Table 1
Monthwise infection and infectivity status of indoor biting *Cx. quinquefasciatus.*

Month	Total females examined	Infected mosquito (%)	Total larvae recovered	Average larval load	Infective mosquito (%)	Total L3 recovered	Average L3 load
Jan	45	0	0	0	0	0	0
Feb	119	0	0	0	0	0	0
Mar	307	0	0	0	0	0	0
Apr	226	8 (3.5)	12	1.5	1 (0.4)	1	1
May	225	10 (4.4)	20	2	1 (0.4)	2	2
Jun	57	10 (17.5)	28	2.8	2 (3.5)	6	3
Jul	88	0	0	0	0	0	0
Aug	156	6 (5.1)	18	2.3	0	0	0
Sep	65	5 (7.7)	12	2.4	0	0	0
Oct	54	11 (20.3)	25	2.3	3 (5.5)	5	1.7
Nov	122	16 (13.1)	28	1.8	5 (4.1)	10	2
Dec	20	0	0	0	0	0	0
Total	1,484		143	2.1		24	2

Pooled data of monthly collection from September 1995 to August 1997.

Table 2
Annual transmission potential of *Cx. quinquefasciatus* and related *W. bancrofti* transmission indices in tea gardens of Assam.

Number of bites/man on 24 days collection	1,484
Estimate number of bites/man/year	22,569
Percentage of infective mosquitos	0.81%
Mean number of L3 larvae/mosquito	2
Estimated annual infective biting rate	680
Annual transmission potential	364
Annual transmission index	365.6
Risk of infection index	0.021

Table 3
Monthly transmission indices of *W. bancrofti* in tea gardens of Assam along with the monthly biting rates of *Cx. quinquefasciatus.*

Months*	Monthly biting rate	Monthly transmission index
January	697.5	0
February	1,695.8	0
March	4,758.5	0
April	3,390.0	13.56
May	3,487.5	27.9
June	855.0	92.9
July	899.0	0
August	2,418.0	0
September	975.0	0
October	837.0	79.7
November	1,830.0	150.1
December	310.0	0

Based on pooled data of two years (September 1995 to August 1997).

days (average duration of extrinsic cycle of *W. bancrofti* in *Cx. quinquefasciatus* (Luo *et al,* 1997) was 0.17. The life expectancy was 7.71 days for man biting females. The expectation of infective life was 1.416 days for man biting mosquitos. It was found that a total of 22,569 mosquito bites were received/man/year [Annual Biting Rate (ABR)], out of which 182 bites/man/year were infective (0.806%). The annual transmission potential of *Cx. quinquefasciatus* to transmit bancroftian filariasis was 364 with risk of infection index (RII) 0.021 (Table 2). The monthly variations in biting rate and transmission indices are given in Table 3**.** The monthly biting rate varied from 310-4,758.5 bites per man (mean 1,846 ± 1,389.7 SD). Monthly transmission index (MTI) of *W. bancrofti* filaria showed two periods of transmission. The first period extended from April to June and monthly transmission index varied from 13.56 to 92.9 (mean 44 ± 42.28 SD). The second period was in the months of October and November with a MTI of 79.7 to 150.1 (mean 114.9 ± 49.78 SD).

DISCUSSION

In both the years no infection was detected in pre-monsoon and early monsoon period in this region. The rate of infection in resting mosquitos was sustained at higher level (3.18% to 7.69%) from June onward to December with an overall infection rate of 1.6%. Earlier study (Basu, 1957) reported 2.6% infection rate in *Cx. fatigans* (=*Cx. quinquefascatus*) in Chabua area (Area near the present study gardens). This shows that filariasis is being maintained almost at a static level in the area. In the present study infected mosquitos were coming to bite human being indoors from April to November except in July. However, among the infected no infective (mosquitos with L3) *Cx. quinquefasciatus* was found during July to September. The low survival of mosquitos in these summer months (De and Chandra, 1994) may be responsible for this. Highest infection rate (20.3%) was seen in the month of October and lowest in the month of April (5.5%). However in south India the infection in biting mosquitos were recorded throughout the year (Rajagopalan *et al,* 1977). Hence it may be presumed that the compensating factor for transmission of bancroftian filariasis in tea garden is perhaps high density of the vector. Transmission of filariasis in an area also depends on the vector density, number of microfilaria carrier, microfilaria density in the carrier and the man-mosquito contact. The transmission potential in tea gardens seems limited as only 0.81% of biting mosquitos were

infected with a mean of 2.1 third stage larvae per infective mosquitos. The annual transmission index of 365.6 in tea gardens is far below the ATPI of Pondichery (Rajagopalan *et al*, 1977).

It has been estimated that only 41.4% of the infective larvae leave the mosquitos and out of them only 32% actually succeed in penetrating the host. If similar assumptions were made about 48 infective larvae are actually introduced in one man per year in tea gardens of Assam.

Annual transmission potential (ATP) below 96-106 limits the new infection in an area (Ramaiah *et al*, 1994). In the present study it was found that transmission of *W. bancrofti* does not take place throughout the year. This also helps in increased force of infection in certain months of a year. Seasonal transmission dynamics of *W. bancrofti* may be related to minimum temperature, which is acting as a limiting factor in the tea gardens of Assam. Because there is no transmission during peak winter months, when minimum temperature goes below 15ºC. In the present study spanning two years no infective larvae were detected in the months of June and July of 1996 and 1997, although minimum temperature was optimum. More study is needed in these months, as there is chance of missing infective biting mosquitos in once in a month sampling.

ACKNOWLEDGEMENTS

Authors are grateful to Mr CK Sarmah and Mr PK Doloi for their technical help.

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