Contents lists available at ScienceDirect

Asian Pacific Journal of Tropical Medicine

journal homepage:www.elsevier.com/locate/apjtm

Document heading

Studies on seasonal fluctuation of different indices related to filarial vector, *Culex quinquefasciatus* around foothills of Susunia of West Bengal, India

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ARTICLE INFO

Article history:
Received 21 June 2010
Received in revised form 20 July 2010
Accepted 15 August 2010
Available online 20 September 2010

Keywords:
Seasonal fluctuation
Vector indices
Culex quinquefasciatus
Filarial vector

ABSTRACT

Objective: To collect information on the seasonal activity of filarial vector around foothills of Susunia of West Bengal, India. **Methods:** Indoor-resting mosquitoes were collected from the human habitations of 16 villages. Collected mosquitoes were identified and examined for different parameters following standard methods recommended by World Health Organization and pioneer workers. **Results:** Overall man hour density, infection rate, infectivity rate, human blood index and daily mortality rate of the vector were assessed as 10.54%, 6.31%, 1.38%, 77.33% and 13.00%, respectively, which were 12.17%, 8.63%, 2.26%, 100.00% and 17.00%, respectively in the summer season. Average load of microfilaria, 1st stage, 2nd stage and 3rd stage larvae of *Wuchereria bancrofti* in infected vectors were 10.02, 7.50, 5.56 and 4.68, respectively, which were 11.58, 9.90, 6.27 and 5.44, respectively in summer. Among the searched shelters 63.37%, 8.16% and 2.08% were found to be invaded by any vector, infected vector and infective vector, respectively, which were 68.75%, 12.76% and 3.91%, respectively in summer. **Conclusions:** Different indices related to the vector were much higher in summer, which indicates that, summer is the most favorable season for transmission of lymphatic filariasis in the study area. Available data will help to formulate an effective vector control measure.

1. Introduction

World Health Organization (WHO) identified lymphatic filariasis as one of the major public health problems throughout the world and it is spreading with time. Worldwide 1 254 million people in 83 countries/ territories including 554.2 million in India are at risk of acquiring filarial infection[1]. Information about filarial epidemiology and its vector were available from some parts of West Bengal, India[2-4]. Nevertheless, information about the seasonal variation of many indices related to the vector is scanty. Therefore, the present study has been carried out to collect seasonal information of different aspects related to the vector concerned such as species composition of mosquitoes, man-hour density (MHD) of the vector, percent of shelters with infected and infective vector, vector infection and infectivity rates, number of vectors containing different stages of parasites as well as total count of the parasites, human blood index (HBI), age composition of the vector etc. from 16 villages around Susunia hill of West Bengal in India. All the data were subjected to statistical analysis for an accurate assessment of the situation that may help in formulating appropriate control measures.

2. Materials and methods

Susunia hill is situated at the North-Eastern part of Bankura District of West Bengal, India (latitude 23 ° 24′N and longitude 86 ° 69′E). The study villages were located within 15 kilometer radiuses around the hill. Fields, bushes or forests separated the villages and the communications are often poor.

Mosquitoes were collected from 12 human habitations selected in each of 16 foothill villages. So a total of 192 human habitations were fixed. Between 0600 and 0800

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hours, indoor-resting mosquitoes were captured for 10 minutes from each human habitation by one insect collector using hand collection method[5]. Human habitations of each of 16 villages was searched serially (1st village in 1st week, 2nd village in 2nd week and so on) once in each season from March 2000 to February 2002. One year was divided into 3 seasons, namely summer (March-June), rainy (July-October) and winter (November-February). Thus, a total of 32 man-hours were employed in each season per year, i.e. 192 man-hours during the two year study period[6]. Collected mosquitoes were identified and dissected to search for different developing stages of filarial larvae including microfilariae. After staining with Leishman's stain, number of parasites in each infected mosquito was counted and noted. Mosquitoes were identified following Christophers, Barraud and filarial larvae following Cook and Zumla[7-9].

To assess the extent of man-vector contact, HBI or anthropophilic index of *Culex quinquefasciatus (Cx. quinquefasciatus)*, collected from human habitations were calculated by analysis of blood meals with gel diffusion technique[4]. A total of 300 (100 in each season) mosquitoes were examined to determine HBI.

A total of 960 (320 in each season) *Cx. quinquefasciatus* were studied for determination of age. Ovaries were extracted by dissection of mosquitoes and then the ovarioles were isolated from it. The slides with ovarioles were stained by Leishman's stain and then examined under microscope for number of follicular dilatations, if any. The highest number of dilatations was noted for each mosquito. Average duration of gonotropic cycle was estimated *in vitro* by noting the time taken between artificial blood feeding and egg laying of mosquitoes[5]. Indices related to age grading were calculated following the methods of Polovodova, Davidson and Service as described in Chandra[5].

Available data were subjected to statistical analyses using normal deviate '*Z*' and Student's *t*-test[10].

3. Results

During the two year study period, altogether 7 272 mosquitoes of 8 species were collected from the study area. Number of total mosquitoes collected during summer, rainy and winter seasons were 1 652, 3 427 and 2 193 respectively (Table 1). *Cx. quinquefasciatus* was dominant during summer season (47.15%) but shifted to second position by *Anopheles subpictus* during rainy season (22.35%) and by *Anopheles annularis* during winter (21.84%) (Table 1).

During the two-year study period *Cx. quinquefasciatus* was incriminated to be the filarial [*Wuchereria bancrofti (W. bancrofti)*] vector and no other mosquito species was found to carry any developmental stages of the parasite. Seasonal prevalence of *Cx. quinquefasciatus* accounted for were 38.49%, 37.85% and 23.67% during summer, rainy and winter seasons, respectively. Overall MHD of filarial vector was found to be 10.54 (Figure 1), which was 12.17, 11.97 and 7.48 in summer, rainy and winter seasons, respectively (Table 2). MHD in summer and rainy season was not significantly different from each other (P>0.05; t=0.331), but MHD of summer and rainy season was significantly higher than winter season (P <0.05; t=6.852, t=5.390).

The vector mosquitoes were encountered in 63.37% of the searched shelters in study period with higher numbers in summer months (68.75%). Percentages of shelters containing *Cx. quinquefasciatus* in summer was not significantly different from that of rainy season (P >0.05; t=0.721), but those percentages in summer and rainy season were significantly higher than that in winter (P <0.05; t=9.441, t=6.256) (Table 2).

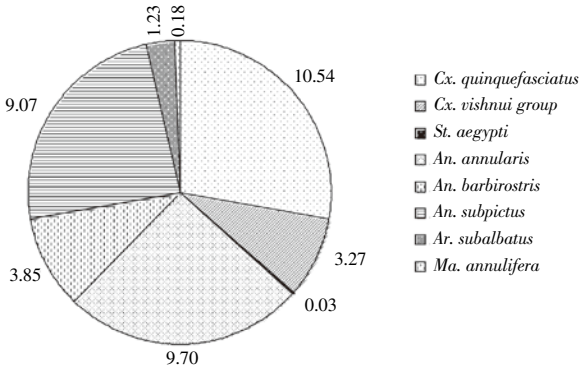

Figure 1. Man-hour density of different species.

In the study period, overall 8.16% and 2.08% of the searched shelters were invaded by infected and infective *Cx. quinquefasciatus*, respectively. The highest numbers of shelters with infected and infective mosquitoes were noticed in summer (12.76% & 3.91%, respectively) followed by rainy season (7.03% & 1.56%, respectively) and winter (4.69% & 0.78%, respectively) (Table 2). Percentages of the shelters containing infected and infective *Cx. quinquefasciatus* in summer were significantly higher from other two seasons (P <0.05; t=6.488, t=12.922 & t=6.518, t=6.138).

Overall, vector infection and infectivity rates among the mosquitoes collected from the human habitations of the study area were 6.31% and 1.38%, respectively. The highest numbers of infected and infective vectors were encountered in summer (8.63% & 2.26%, respectively). Those rates were much lower in other two seasons (Table 2). Vector infection and infectivity rates in summer were significantly higher from other two seasons (P<0.05; t=8.877, t=9.777 & t=8.352, t=5.291).

HBI of the vector species collected from the human habitations indicates high extent of man-vector contact (77.33%). In summer 100% of the indoor-resting vectors fed on human blood, whereas in rainy 73% and in winter 59% of them preferred human blood (Table 2). Higher HBI in summer were significantly different from other seasons (P<0.05; Z=2.053, Z=3.252).

In all the seasons, number of mosquitoes containing different developmental stages of *W. bancrofti* and total count of each stage larvae showed gradual decrease from microfilaria (mf) to 1st stage to 2nd stage and then a slight increase in 3rd stage. In summer season percentage of *Cx. quinquefasciatus* containing mf, 1st stage, 2nd stage and 3rd stage larvae were much higher than the other seasons (Table 3). Average load of mf, 1st stage, 2nd stage and 3rd stage *W. bancrofti* larvae in infected vectors was significantly higher in summer than in winter (P<0.05; t=3.484, t=4.933, t=3.000 and t=4.573, respectively) and in rainy season (P<0.05; t=13.006, t=6.747, t=9.390 and t=3.924, respectively) (Figure 2).

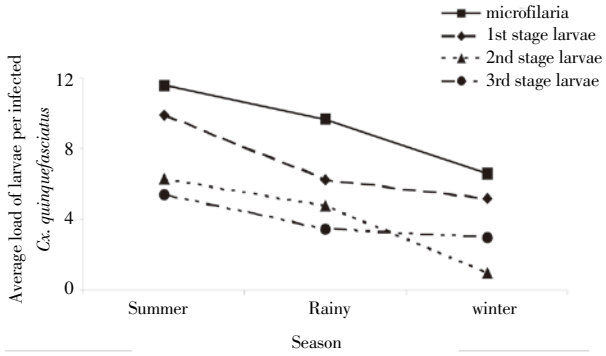

Figure 2. Seasinal change in load of parasites.

Average duration of gonotrophic cycle of *Cx. quinquefasciatus* was estimated to be 4.69 days (approximately 112.67 hours). Duration of the cycle in the summer, rainy and winter was 4.00, 4.04 and 6.04 days, respectively. Overall proportion parous (PP), daily survival rate (DSR) and daily mortality rate (DMR) of the natural population of vectors in the area during the two year study was calculated as 0.53, 0.87 and 13, respectively. Seasonal analysis given in Table 4 showed that, PP and DSR were lower (0.48 and 0.83, respectively) and thus DMR was higher (17) in summer than other seasons, but the differences were not significant (P>0.05).

Table 1

Species composition of mosquitoes in different seasons in the study area [*n*(%)].

Mosquito species	Summer	Rainy	Winter	Overall
Cx. quinquefasciatus	779(47.15)	766(22.35)	479(21.84)	2024(27.83)
Culex vishnui (group)	173(10.47)	400(11.67)	55(2.51)	628(8.64)
Anopheles annularis	112(6.78)	587(17.13)	1164(53.08)	1863(25.62)
Anopheles barbirostris	118(7.14)	480(14.01)	141(6.43)	739(10.16)
Anopheles subpictus	366(22.15)	1113(32.84)	263(11.99)	1742(23.95)
Armigeres subalbatus	98(5.93)	55(1.60)	83(3.78)	236(3.25)
Mansonia annulifera	3(0.18)	26(0.76)	6(0.27)	35(0.48)
Stegomyia (=*Aedes*) *aegypti*	3(0.18)	0(0.00)	2(0.09)	5(0.07)
Overall	1 652(22.72)	3 427(47.13)	2 193(30.15)	7 272 (100.00)

Table 2

Seasonal variation of different indices of filarial vector (*Cx. quinquefasciatus*) population collected from human habitations.

Season	Percent collected(%)	MHD	Percent of shelter with vector species(%)	Percent of shelter with infected vectors(%)	Percent of shelter with infective vectors(%)	Vector infection rate (%)	Vector infectivity rate (%)	HBI (%)
Summer	38.49	12.17	68.75	12.76	3.91	8.63	2.26	100.00
Rainy	37.85	11.97	67.45	7.03	1.56	4.98	0.88	73.00
Winter	23.67	7.48	53.91	4.69	0.78	4.56	0.72	59.00
Total */Overall	100.00*	10.54	63.37	8.16	2.08	6.31	1.38	77.33

Table 3

Number of indoor resting *Cx. quinquefasciatus* containing different stages of *W. bancrofti* and total count of each stage in different seasons[*n*(%)].

Seasons	No. of mosquitoes containing different stages of larvae									
	mf/TC		1st/TC		2nd/TC		3rd/TC		Any/TC	
Summer	24(48.98)	278(56.62)	10(41.67)	99(55.00)	11(68.75)	69(77.53)	16(64.00)	87(74.36)	61(53.51)	533(60.78)
Rainy	16(32.65)	154(31.36)	8(33.33)	50(27.78)	4(25.00)	19(21.35)	6(24.00)	21(17.95)	34(29.82)	244(27.82)
Winter	9(18.37)	59(12.02)	6(25.00)	31(17.22)	1(6.25)	1(1.12)	3(12.00)	9(7.69)	19(16.67)	100(11.40)
Total	49(100.00)	491(100.00)	24 (100.00)	180(100.00)	16(100.00)	89(100.00)	25(100.00)	117(100.00)	114(100.00)	877(100.00)

mf = microfilaria, TC = total count.

Table 4

Seasonal variation in proportion parous, daily survival rate and daily mortality rate of the natural population of vectors.

Seasons	No. of mosquitoes studied	Duration of gonotrophic cycle (days)	Proportion parous	Daily survival rate	Daily mortality rate (%)
Summer	320	4.00	0.48	0.83	17
Rainy	320	4.04	0.54	0.86	14
Winter	320	6.04	0.57	0.91	9
Total*/ Overall	960*	4.69	0.53	0.87	13

4. Discussion

The present study area is highly endemic for bancroftian filariasis[6,11]. The present study depicts that *Cx. quinquefasciatus* is a domestic pest mosquito and dominant over the other species of house frequenting mosquitoes. The maximum density of indoor-resting *Cx. quinquefasciatus* from Susunia foothills area was found during summer months

probably due to favorable climatic conditions. Although the MHD of the vector were in lower side in comparison to many other endemic areas[3,4, 12, 13], it is sufficient to establish itself as a strong vector, probably due to some other favorable conditions like availability of suitable breeding places including poorly maintained drainage & sanitation, tropical climate, man-vector contact, underdeveloped awareness of common people etc. MHD reduces during winter, may be, due to low breeding rate supported by long gonotrophic cycle.

Expert committee on Filariasis stressed on the aspect of numbers of shelters with high density of mosquitoes, as shelters with more vectors are of more epidemiological importance[14]. More number of shelters with vector species may increase the probability of the parasite transmission; hence, human habitats with any vector were noted during the study. Although, the density of indoor-resting *Cx. quinquefasciatus* in foothills area of Susunia was not very high, a good percentage of shelters were found to contain those filarial vectors throughout the year with a peak in summer.

Expert Committee on Filariasis also suggested the importance of shelters with infected and infective vectors[14]. But only very few workers attempted this parameter, moreover prior to the present study no record was found on its seasonal variation. In summer months, greater number of shelters was invaded by infected and infective *Cx. quinquefasciatus* than those in other months in the present study area. As the peoples are more exposed to infective bites of mosquitoes in summer, they are more susceptible to filarial infection at that time than in other times of the year.

Vector infection and infectivity rates in the area were quite high in comparison to some other areas of West Bengal, India[3,4]. In other parts of West Bengal infection and infectivity rate is generally in peak in the monsoon or both in summer and monsoon, but in the present study area higher infection and infectivity rates are encountered in summer season only. It suggests that risk of acquiring infection by the people of the area is grater in warmer months, facilitated by the local trend of using fewer clothes and staying or sleeping in open room or outside the room at night during that time.

HBI of human house frequenting vector population in the study area indicates very high rate of man-vector contact and the contact rate was higher in summer than in other seasons. As all the vectors imbibed on human blood in the summer, it becomes the peak time for filarial parasite transmission in the area.

A strong fall from number of vectors carrying mf to number of vectors carrying infective stage larvae of *W. bancrofti* and also in the average load of microfilaria to average load of infective stages in those vectors shows a natural bearing in control of filarial transmission, which was also reported in some other studies[15]. Considerably higher number of vectors carrying the infective larvae and higher average load of infective larvae in those vectors was found in the study area than some other areas[3,4]. Moreover, in the summer, average load of parasites of all the stages becomes higher in comparison to other seasons, increases potentiality of transmission at that time. High average parasitic load can also be an explanation of *Cx. quinquefasciatus* becoming a strong vector of *W. bancrofti* in low MHD.

Study related to the age of indoor-resting *Cx. quinquefasciatus* in the area shows that, proportion of parous mosquitoes was highest in winter and the proportion declined with rise of temperature as evidenced by higher DMR during the warm season. The vector population does not survive longer in warmer months, but other factors (as discussed above) enhance the probability of filarial transmission in summer.

Situation of the area can be considered as alarming and summer provides most suitable conditions for its spread. To rectify the situation, vector control, drug treatment of microfilaremics and developing awareness among the peoples about the disease and concerned vector may be some effective steps. Vector control during summer and annual drug treatment of microfilaremics just before summer may be more helpful.

Conflict of interest statement

We declare that we have no conflict of interest

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