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NIGHT HUMAN BITING MOSQUITOES DURING THE NORTHEAST MONSOON IN BATTICALOA (dry zone) OF SRI LANKA

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Abstract

We report for the first time species of mosquitoes from the east coast (dry zone) of Sri Lanka. The study was done in an urban and a rural site during the monsoonal period of October 1993 to January 1994. There was a difference in the species diversity between the two locations. Culex quinquefasciatus Say was the most prevalent species in the rural site and Culex fuscocephala Theobald and Cx. quinquefasciatus were the most prevalent in the urban site. Culex sitiens Weidmann and Mansonia species were found in the two locations. Even though the incidence of Malaria was high in the district we did not find a high number of Anophelenes. Anopheles nigerrimus Giles, Anopheles subpictus Grassi and Anopheles jamesii Theobald were found in the urban site but anophelines were not collected in the rural site. Aedes species were collected in the rural site. The collections made indoors were higher than those made outdoors. The incidence of mosquitoes was higher in December for the pooled data but the peak occurrence differed from species to species. There was a bimodal pattern of biting behaviour in the twelve hour period of data collection. Peak collections were made during 22.00 to 24.00 hours and 02.00-04.00 hours.

keywords: :mosquitoes, night human biting, vectors, biting pattern, Batticaloa

1 Introduction

Arboviral and parasitic diseases transmitted by mosquitoes are a major problem in SriLanka. The major diseases are Malaria, bancroftian filariasis, dengue fever and Japanese encephalities. In SriLanka malaria is transmitted by *Anopheles culicifacies* Giles [1], *Anopheles tessellatus* Theobald [2], *Anopheles subpictus* Grassi [3] and *Anopheles annularis* Van der Wulp [4]. Dengue virus is transmitted by *Aedes aegytpti* Linnaeus *or Aedes albopictus* Skuse [5]. In SriLanka vector of filariasis caused by *Wuchereria bancrofti* Cobbold is *Culex quinquefasciatus* [6]. Filariasis caused by *Brugia malayi* is transmitted by *Mansonia* species [7]. The distribution of filariasis is limited to the Southern belt of SriLanka from Negambo to Kataragama [7]. Japanese encephalitis caused by the Japanese encephalitis virus is transmitted by *Culex tritaeniorhynchus* Giles, and *Culex fuscocephala* Theobald [8].

SriLanka can be divided into three climatic zones based on the monsoonal rainfall pattern. The dry zone in the northeast part of SriLanka gets the annual rainfall during the northeast monsoon (< 2000 *mm* rainfall). The wet zone receives rain from two monsoons: the northeast and southwest monsoon (annual rainfall > 2500 *mm*). The intermediate zone has mixed characters. Studies with regard to mosquito species have been done mostly in the southern part of SriLanka in the wet and intermediate zones. A total of 140 species belonging to 16 genera have been described in SriLanka [9]. The national survey carried out in the period 1970-1973 was carried out in Kandy and surrounding districts [10]. A total of 36 species of mosquitoes were recorded from the Udawattakela Forest reserve in the wet zone [11]. In the dry zone, a study was done in the Jaffna Peninsula [12] describing 4 genera and 7 species (*Aedes, Armigera, Anopheles and Culex*).

The aim of this study was to record the species of mosquitoes present in the Eastern coast, situated in the dry zone of Sri Lanka. In this study a comparison of the mosquito species diversity in an urban and rural location in the Batticaloa district during the northeast monsoonal period is made. Thirdly, the nocturnal human biting pattern with time was also observed.

The data obtained from the medical office of health at the general hospital Batticaloa for the period of 1993 and 1994, (Table 1) showed the presence of malaria, Japanese encephalitis (including 4 cases of death) and dengue fever. Bancroftian filariasis was not reported during the study period. Such mosquito borne diseases were predominantly found in the monsoonal period of October to January. Thus it is vital that mosquito species in the Batticaloa district is studied from an economical point of view as well as for taxonomic interest.

Table 1: Details of mosquito borne diseases in Batticaloa in 1993/94 (Medical Office of Health, Batticaloa) and the total monthly rainfall in the period January 1993 to February 1994 (Department Metrology, Batticaloa). (*number of mortalities)

DISEASE	YEAR	TOTAL no. OF CASES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Malaria	1993	149	150									35	47	67
	1994	150	150											
Japanese	1992	31												
encephalitis	1993	25	4	1	5	-	1	4	-	-	-	3+1*	2	3+1*
	1994	6	4+2	-	-	-	-	-	-	-	-	-	-	-
Dengue	1993	16	-	-	-	4	-	2	-	-	4	6	-	-
fever	1994	1	1	-	-	-	-	-	-	-	-	-	-	-
Total cases		**378**	**161**	**1**	**5**	**4**	**1**	**6**	**0**	**0**	**4**	**45**	**49**	**71**
Rainfall	1993		14.1	34.0	27.7	17.4	4.0	15.0	63.1	80.8	16.2	49.4	105.0	598.7
(mm)	1994		486	394.0										

2 Material and Methods

2.1 The study site

The district of Batticaloa is flat not exceeding 7.62 m in elevation with a temperature range of 23.6 to 35.1° C and an annual rainfall of 1626 mm in 1993 [13]. Mosquito collections were done at two sites in the Batticaloa district. One site is Batticaloa town, which is urban with a population density of 1370/$sq.km$. This site is also situated near the Batticaloa lagoon which is a brackish water body with salinities ranging from 0 gl^{-1} to 27 gl^{-1}. The rural site was at Vantharumoolai with a population density of 160/$sq.km$ (Figure 1). The collection here was made in the University premises situated in this village. The University has a population of about 1000 residing in the premises. This village is adjacent to paddy fields and numerous temporary ponds that form during the northeast monsoon.

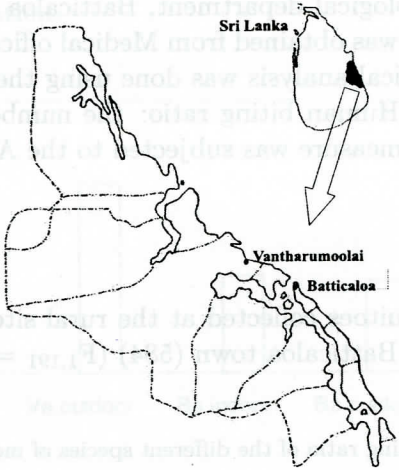

Figure 1: The map of Batticaloa district showing the two sites: Batticaloa -urban area and Vantharumoolai - rural area where sampling was done.

2.2 Mosquito collections

Collections were done twice a month. The study was conducted in the northeastern monsoon period of October 1993 to January 1994. The night human biting mosquitoes were collected by means of a two persons landing site: one indoor and the other outdoor. The outdoor collections were made 50 m from the indoor location. All mosquitoes landing on the exposed face, arms and legs of the seated human baits were collected. Collections were made from dusk to dawn from 18.00 to 06.00 $hours$.

A hand aspirator was used to collect mosquitoes landing on the human bait. The mosquito collection containers were a glass beaker (250-300 ml), which had a piece of mosquito netting fitted with the aid of rubber band. A piece of cotton wool was used as a stopper to prevent the escape of mosquitoes. Time and location were labelled on the beaker.

The female mosquitoes landing on the exposed limbs and trunks were collected by an aspirator and placed in the beakers. A separate beaker was used every half hour. At the end of every half hour the mosquitoes were etherised and transferred to small,labelled vials. Collections made every two hours were grouped together for later analysis: 18.00-20.00, 20.00-22.00, 22.00-24.00, 24.00-02.00, 02.00-04.00 and 04.00-06.00. The mosquitoes collected were then stored at $4°C$ until identification was done. Data from a total of 192 man biting hours were considered for the analysis. Identifications were done according to Amerasinghe [14] and Chelliah [15] and confirmed by the Institute of Fundamental Studies, Kandy. The rainfall data were obtained from the meteorological department, Batticaloa and the number of cases of mosquito borne diseases was obtained from Medical officer of health, General hospital of Batticaloa. Statistical analysis was done using the SAS package. The data were converted to HBR – Human biting ratio: the number of mosquitoes landing on one person/hour. This measure was subjected to the ANOVA.

3 Results

The total number of mosquitoes collected at the rural site Vantharumoolai (1480) was higher than that from Batticaloa town (584) ($F_{1,191} = 70.15$, $p = 0.0001$).

Table 2: The Human night biting ratio of the different species of mosquitoes in the two locations in the monsoon period. (**HBR**-Number of mosquitoes/person/hour)

	LOCATION	OCT (HBR)	NOV (HBR)	DEC (HBR)	JAN (HBR)	TOTAL NO.
1.*Cx.quinqufasciatus*	Vantharumoolai	2.2	6	8	13	1398
	Batticaloa	0.3	1.2	2	1.8	229
2.*Cx.fuscocephala*	Vantharumoolai	0	0.1	0	0	02
	Batticaloa	0.75	1.5	3.2	2.1	337
3.*Cx.sitiens*	Vantharumoolai	0.19	0.26	0.21	0.28	11
	Batticaloa	0.06	0.04	0.02	0.02	08
4.*Aedes* spp	Vantharumoolai	0.04	0.15	0.21	0.28	22
	Batticaloa	0	0	0	0	0
5.*Mansonia* spp	Vantharumoolai	0	0.3	0.05	0.1	45
	Batticaloa	0.02	0.14	0.04	0	10
6.*Anopheles* spp	Vantharumoolai	0	0	0	0	0
	Batticaloa	0.02	0.08	0.04	0.06	10
Total		**3.54**	**9.77**	**13.77**	**17.64**	

There was a difference in the distribution of species between the two locations. In Vantharumoolai all the mosquitoes collected were culicines whereas 98.32% was culicines in Batticaloa town and 1.68 were anophelenes. *Cx. quinquefasciatus* was the most prevalent species in Vantharumoolai (94.71 %), whereas *Cx. fuscocephala* was the predominant species in the urban site Batticaloa town (56.73 %) followed by *Cx. quinquefasciatus* (38.5 %). *Mansonia* spp, *Culex sitiens* Weidmann and *Anopheles* spp. The *Anopheles* spp collected included *Anopheles nigrrimus* Giles, *Anopheles subpictus* Grassi and *Anopheles jamesii* Theobald. The other species collected at the rural site Vantharumoolai include *Cx. sitiens* Weidman (3.04 %), *Mansonia* species (1.49 %), *Aedes* spp (0.074 %) and *Cx. fuscocephala* (0.135 %) (Table 2). The diversity of species (Shannon diversity index) between the two locations was significantly different (t test = 16.23, p<0.0001). Unfortunately we could not confirm the identity of *Mansonia* and *Aedes* to the species level as the wing scales were damaged while being transported to Institute of Fundamental Studies, Kandy to confirm identification.

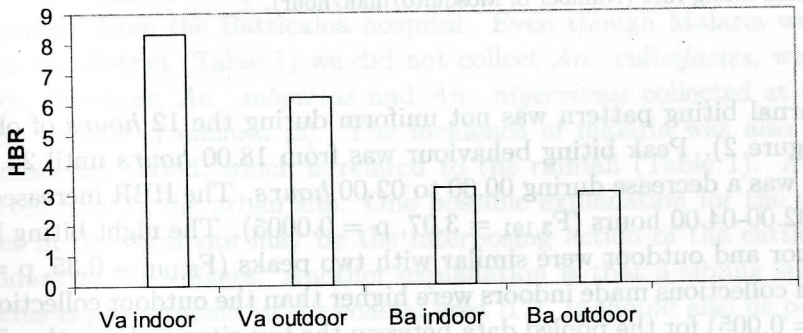

Figure 2: The Human biting ratio (Number of mosquitoes per person/hour) of the indoor and outdoor collections in the two sites Batticaloa (Ba) and Vantharumoolai (Va).

Collections were highest in the month of December (Table 2) for the pooled data ($F_{3,191}$ = 77.52, p = 0.0001). *Cx. quinquefasciatus* which is the most prevalent species in the village site gradually increased from October and peaked to a maximum in January ($F_{3,191}$ = 25.57, p = 0.0001). *Cx. fuscocephala,* the predominant species in the urban site was highest in the month of December ($F_{3,191}$ = 30.46, p = 0.0001). There was no difference in the collections made in the different months for *Aedes* spp and *Cx. sitiens* ($F_{3,191}$ = 1.44, p = 0.23, $F_{3,191}$ = 2.44, p = 0.07 respectively). The collection of *Mansonia* spp was high in November in the two locations ($F_{3,191}$ = 0.52, p = 0.0001).

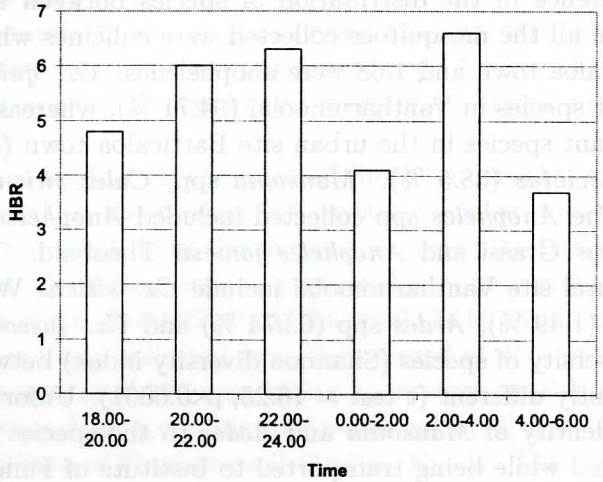

Figure 3: The nocturnal biting periodicity of mosquitoes in the two locations for the pooled data. (HBR - Human biting rate (Number of Mosquito/man/hour).

The nocturnal biting pattern was not uniform during the 12 *hours* of observation period (Figure 2). Peak biting behaviour was from 18.00 *hours* until 24.00 *hours*; then there was a decrease during 00.00 to 02.00 *hours*. The HBR increased again in period of 02.00-04.00 hours ($F_{3,191} = 3.07$, $p = 0.0005$). The night biting behaviour in the indoor and outdoor were similar with two peaks ($F_{5,191} = 0.35$, $p = 0.85$). The pooled collections made indoors were higher than the outdoor collections ($F_{1,191} = 8.21$, $p = 0.005$) for the pooled data between the two sites and months. There was also a significant interaction between the two sites and indoor-outdoor collections (Figure 3) ($F_{1,191} = 5.31$, $p = 0.02$). This is because the indoor collections were higher in the rural site. *Cx. quinquefasciatus,* which is the predominant species in the rural site seems to be endophilic.

4 Discussion

The species composition of the mosquitoes collected in the two sites in the East coast of Sri Lanka seem to differ from the previous study done in the Northern dry zone Sri Lanka. In the North the predominant genus was *Armigera* [12]. The other species recorded in the North belonged to the genus *Aedes.* Larval collections in the same area were composed of three genera: *Aedes, Anopheles* and *Cx. quinquefasciatus.* Collections in our study had specimens belonging to four genera and eight species of which three species were anophelenes. The predominant species in Batticaloa, in the East coast of Sri Lanka was *Cx quinquefasciatus* and *Cx. fuscocephala.* In the

wet zone in Udawattakele 36 species were recorded as adults and 17 species were recorded from the immature collections. The study done at Nikawehera [4], which is in the intermediate zone reported 13 anophelene species and 16 species of culicines. Thus the diversity of mosquito species seems to gradually decrease from the wet zone to the dry zone in general.

There also seems to be a difference in the species distribution in the Northern and Eastern part of the dry zone. The predominant species in the North is *Armigera* and *Aedes* whereas in the East *Cx. quinquefasciatus* is the predominant species in the rural area and *Cx. fuscocephala* and *Cx. quinquefasciatus* in the urban area and also near the lagoon system. Whereas *Culex* species was rare in the collections made in Jaffna.

The rainfall was the highest in December (Table 1). It decreased from January onwards. The peak count especially of *Cx. fuscocephala* in December may be attributed to the increased rainfall. *Cx. fuscocephala* immatures were observed in ground pools [11][16]. *Cx. quinquefasciatus,* which is a polluted water breeder was abundant in January. The presence of *Cx. fuscocephala* in the urban site is a possible vector for Japanese encephalitis [8]. This is one of the serious mosquito borne diseases reported from the Batticaloa hospital. Even though Malaria was of high incidence in the district (Table 1) we did not collect *An. culicifacies,* which is the usual vector. However, *An. subpictus* and *An. nigerrimus* collected at the urban site are also vectors of malaria [3]. The incidence of malaria was also high during the monsoonal period, which is related to the rainfall (Table 1). Anophelens were collected only in the urban site. One possible explanation for the absence of anophelenes in the rural site may be the interposing action of the cattle that are more abundant in the villages. Another explanation is that a sibling species B of *An. subpictus* is predominant in the coastal area [17]. It should also be pointed out that Malaria was more prevalent in the areas west to the Batticaloa lagoon (Medical Officer of Health, Batticaloa). This area is mainly composed of isolated villages among paddy fields. Mosquito collections could not be made in these villages due to the prevailing political instability in this area.

The mosquito species in our study showed a bimodal pattern of biting rhythm. Peak biting activity was observed from 18.00 – 00.00 *hours*, then a decline from 00.00 - 02.00 *hours* and then the biting increased again from 02.00 - 04.00 *hours*. In the study done at Nikawehera in the intermediate zone of Sri Lanka the biting rate of *An. culicifacies* peaked between 18.00 and 23.00 *hours* and *Cx. quinquefasciatus* showed peak biting between midnight and 06.00 *hours* [18]. *Anopheles dirus* Peyton and Harrison in Assam, India showed peak biting activity between 21.00-24.00 and then it gradually decreased till 05.00 *hours* [19]. It is possible that the biting behaviour varies with species and other factors such as time of sunrise. The predominant species in our study is *Cx. quinquefasciatus.* Amerasinghe and Munasinghe [20] have also reported a bimodal biting activity an hour after sunset and before

sunrise in *Culex tritaeniorhynchus*.
The presence of vectors such as *Cx. fuscocephala*, *Aedes* spp and anophelenes in Batticaloa especially the urban area with biting peaks after midnight calls for management measures such as the use of nets. Further studies on the breeding sites of the mosquitoes are important in understanding their distribution.

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