6

Filarial Infection and Infectivity in Oc. niveus

6.1 Summary

Among the 12 species of mosquitoes dissected, only Oc. niveus was found to be naturally infected with W. bancrofti in Teressa Island. The infection rate was found to range between 1.05 (September) and 4.10 (January), while the infectivity ranged between 0 and 1.54 (January). Infection was found to be perennial whereas the infectivity was seen during most part of the year except February, July and August. The infected biting density was found to be the lowest in the winter months and then rise through the summer months and attain a peak during the monsoon months. A similar trend was noticed in the case of infective biting density. The results confirm active transmission by Oc. niveus in Teressa island. The present records of infection and infectivity pattern observed in Oc. niveus covering all seasons in the year is the first report. The host efficiency index of Oc. niveus, indicates that over 40% of the mf ingested were able to develop into infective stages.

6.2 Introduction

The vector infection rate is an indirect index of prevalence of microfilaraemia in human population (Sasa 1976). Also, infectivity rate is an important parameter that influences, in combination with vector density, the intensity of transmission of filariasis. These rates are also useful in assessing the endemicity level of filariasis in different areas (Rao 1976). The seasonal and area wise variations in infection and infectivity rates of *Oc. niveus* are analyzed. Besides, the seasonal variations in infected and infective biting densities of *Oc. niveus* are presented in this chapter. The distribution of the parasite load in the vector and the host efficiency of *Oc. niveus* were also studied.

6.3 Material and Methods

6.3.1 Selection of Sites For Studying Transmission Dynamics Through Year Long Entomological Studies

The results obtained from the cross sectional survey for assessing microfilaraemia prevalence and disease in Teressa Island, which has been described in detail in Chapter 4, were used for selecting index villages to study the transmission dynamics of LF. The demographic profile, topography, climatic conditions of the study area have been described in the Chapter 3.

Of the eleven villages in this island, five villages were selected randomly for year long entomological study. Based on mf prevalence, these five villages were grouped into low mf (Kalasi 5.11% and Bengali-8.9%), medium mf (Minyuk 10.47%) and high mf (Aloorang 13.57% and Chukmachi 14.52%) zones respectively. Based on natural infection, vector mosquito was identified and their relative role in transmission was quantified from rates of infection and infectivity, intensity of infection. Man biting rate, Annual Infective Biting rate (AIBR) and Annual Transmission potential (ATP) were computed. The data generated from this year long study was used to check whether transmission was perennial or seasonal in this island. These aspects have been described in detail in the respective chapters.

Data collected from the three zones were used for analysis. The mosquito collection method has been described in the previous chapter. The data obtained from these collections were used for assessing the infection and infectivity status. The infective and infected biting densities were computed. Seasonality in infection and infectivity rates of man landing mosquitoes were also assessed. The vector monitoring was done in these zones during the study period.

6.3.2 Dissection For Parasite Infection

Man landing mosquitoes collected from different zones were dissected to determine the filarial infection and infectivity rates. The mosquitoes were transported alive to the field laboratory where they were anaesthetized with ether solvent and the legs and wings were removed. Head, thorax and abdomen were separated and placed in separate drops of saline on a clean glass slide and teased finely and examined under the 10x magnification of a compound microscope. The filarial larvae present were categorized into mf, I stage, II stage and infective stage or L3 according to the method of Sasa (1976). The I stage larva is short, inactive sluggish and sausage shaped, whereas the II stage larva is longer and active compared to the stage I. Stage III larva is very active and long, relatively thin and found in any part of the mosquito body. The total number of different stages of larvae present in different parts of the mosquito body was recorded.

6.3.3 Calculation of Infection and Infectivity Rates

Infection Rate: The infection rate is calculated using the following formula

$$\text{Infection rate (\%)} = \frac{\text{No. of mosquitoes positive for any filarial stage}}{\text{No. dissected}} \times 100$$

Infectivity Rate: The infectivity rate is calculated using the following formula

$$\text{Infectivity rate (\%)} = \frac{\text{No. +ve for infective stage larvae}}{\text{No. dissected}} \times 100$$

6.3.4 Abundance of Infected and Infective Vector Mosquitoes

The infected biting density is a product of the biting density and the proportion of mosquitoes positive for any stage. Similarly the infective biting density is a product of the biting density and the proportion with infective stage larvae.

6.3.5 Host Efficiency of Oc. niveus

The ratio of the mean number of infective larvae to the mean number of microfilariae ingested per female mosquito i.e.

$$\frac{\bar{X}\,L3}{\bar{X}\,Mf}$$

was described as 'host efficiency index' (Kartman 1954). The index was calculated from the parasite counts observed by pooling the data on the mosquitoes attempting to bite from the three zones viz., low, medium and high mf zones respectively.

6.3.6 Statistical Analysis

The significance of difference in prevalence between zones for infection and infectivity rates during the study period was analyzed using the χ^2 test.

6. 4 Results

The dissection results of various species of mosquitoes are shown in the Table 7. Among the 12 species of mosquitoes dissected, only *Oc. niveus* was found to be infected with *W. bancrofti* larvae.

6.4.1 Infection Rate (%)

Out of 3625 *Oc. niveus* dissected, 96 were found to be positive for filarial

Table 7: Dissection Results of Mosquito Species

Sl. No	Species	No. collected	No. dissected	No. Infected	No. Infective	Infection rate (%)	Infectivity rate (%)
1	*Oc. niveus*	3625	3625	96	18	2.65	0.50
2	*Ae. malayensis*	138	138	0	0	0	0
3	*An. sundaicus*	29	29	0	0	0	0
4	*Ae. albopictus*	17	17	0	0	0	0
5	*Cx. quinquefasciatus*	69	69	0	0	0	0
6	*Cx.spp*	110	110	0	0	0	0
7	*An. theobaldi*	4	4	0	0	0	0
8	*Ar. subalbatus*	32	32	0	0	0	0
9	*An. tesselatus*	3	3	0	0	0	0
10	*An. maculatus*	7	7	0	0	0	0
11	*Ae. jamesi*	1	1	0	0	0	0
12	*Ae. fumidus*	4	4	0	0	0	0

infection. This gives an infection rate of 2.65%. The infection rate in *Oc. niveus* was 1.89, 5.52 and 2.11 for low, medium and high mf zones respectively. The infection rate was significantly higher in medium mf zone (χ^2=26.46, =0.000002) (Table 8).

The month wise infection rate of biting mosquitoes is presented in Table 8. The infection rate ranged from 0.50 in November to 4.00 in January in the low mf zone, from 0 in January to 9.57 in June for the medium mf zone and between zero during the month of August to 5.21 in January.

The infected mosquitoes were found throughout the year. Infection was the highest in January. Although there were some fluctuations in other months, the overall trend was a gradual increase after February up to April and then begins to steadily decrease until June, after which there is a rapid decline in July-August and a gradual increase thereafter. (Fig 15).

6.4.2 Infectivity Rate (%)

Out of 3625 dissected 18 were found positive for infective stage larvae. Thus the overall infectivity rate was 0.5%. The infectivity rate in *Oc. . niveus* was 0.65 in low, 0.3 in medium and 0.42 in high mf zones respectively. The infectivity rates were not statistically different in three zones (χ^2=1.45, p=0.4831).

The month-wise infectivity rate is represented in Table 9. There was no noticeable seasonal pattern in the infectivity rate during the study period observed in the three zones. Infectivity was observed to be highest in January (1.54%) and decreases in the month of February and then tends to zero during the month of March. Thereafter it begins to gradually rise to attain a small peak in the month of May (0.69%) and begins to fall down from the month of June (0.52%) to zero levels in July and August. Again it gradually ascends in September–November months (Fig 15).

Table 8 Month wise Infection Rates In Man Landing Oc niveus During the Study Period

Month	Low mf zone			Medium mf zone			High mf zone			Overall		
	No. dissected	No. infected	Infection rate (%)	No dissected	No. infected	Infection rate (%)	No. dissected	No. infected	Infection rate (%)	No dissected	No. infected	Infection rate (%)
Jan	75	3	4 00	24	0	0 00	96	5	5 21	195	8	4 10
Feb	**237**	**4**	**1.69**	**85**	**6**	**7.06**	**227**	**6**	**2.64**	**549**	**16**	**2.91**
Mar	184	3	1 63	104	8	7 69	88	1	1 14	376	12	3 19
Apr	**259**	**6**	**2.32**	**44**	**3**	**6.82**	**116**	**6**	**5.17**	**419**	**15**	**3.58**
May	67	2	2 99	68	4	5 88	155	4	2 58	290	10	3 45
Jun	**101**	**2**	**1.98**	**94**	**9**	**9.57**	**190**	**1**	**0.53**	**385**	**12**	**3.12**
Jul	73	1	1 37	13	0	0 00	85	1	1 18	171	2	1 17
Aug	**161**	**1**	**0.62**	**54**	**2**	**3.70**	**72**	**0**	**0.00**	**287**	**3**	**1.05**
Sep	97	2	2 06	42	1	2 38	163	2	1 23	302	5	1 66
Oct	**57**	**2**	**3.51**	**44**	**1**	**2.27**	**71**	**1**	**1.41**	**172**	**4**	**2.33**
Nov	201	1	0 50	45	2	4 44	123	3	2 44	369	6	1 63
Dec	**19**	**2**	**10.53**	**53**	**1**	**1.89**	**38**	**0**	**0.00**	**110**	**3**	**2.73**
Total	**1531**	**29**	**1.89**	**670**	**37**	**5.52**	**1424**	**30**	**2.11**	**3625**	**96**	**2.65**

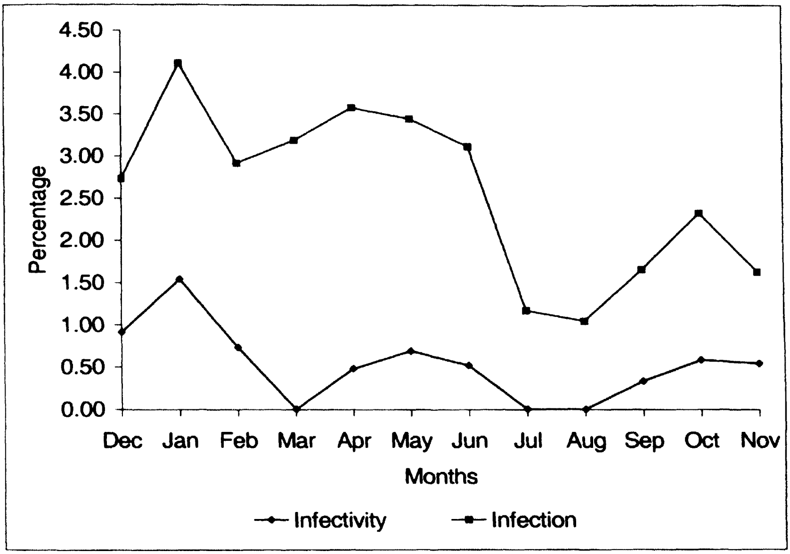


Fig 15. Overall Infection and Infectivity Pattern Observed in Oc. niveus During the Study Period

Table 9. Month wise Infectivity Rates In Man Landing Oc. niveus During the Study Period

Month	Low mf zone			Medium mf zone			High mf zone			Overall		
	No. dissected	No. infective	Infectivity rate (%)	No. dissected	No. infective	Infectivity rate (%)	No. dissected	No. infective	Infectivity rate (%)	No. dissected	No. infective	Infectivity rate (%)
Jan	75	1	1.33	24	0	0.00	96	2	2.08	195	3	1.54
Feb	237	2	0.84	85	2	2.35	227	0	0.00	549	4	0.73
Mar	184	0	0.00	104	0	0.00	88	0	0.00	376	0	0.00
Apr	259	2	0.77	44	0	0.00	116	0	0.00	419	2	0.48
May	67	2	2.99	68	0	0.00	155	0	0.00	290	2	0.69
Jun	101	1	0.99	94	0	0.00	190	1	0.53	385	2	0.52
Jul	73	0	0.00	13	0	0.00	85	0	0.00	171	0	0.00
Aug	161	0	0.00	54	0	0.00	72	0	0.00	287	0	0.00
Sep	97	0	0.00	42	0	0.00	163	1	0.61	302	1	0.33
Oct	57	1	1.75	44	0	0.00	71	0	0.00	172	1	0.58
Nov	201	0	0.00	45	0	0.00	123	2	1.63	369	2	0.54
Dec	19	1	5.26	53	0	0.00	38	0	0.00	110	1	0.91
Total	**1531**	**10**	**0.65**	**670**	**2**	**0.30**	**1424**	**6**	**0.42**	**3625**	**18**	**0.50**

6.4.3 Distribution of Different Stages of Parasite in Oc. niveus

The parasite distribution observed in *Oc. niveus* showed that among the 96 mosquitoes found to be infected, 23 harbored 84 mf, 29 harbored 74-L1, 38 harbored 77-L2 and 18 harbored 28-L3 stages with stage specific parasite load per mosquito as 3.65 mf, 2.55-L1, 2.03-L2 and 1.56-L3 larvae respectively.

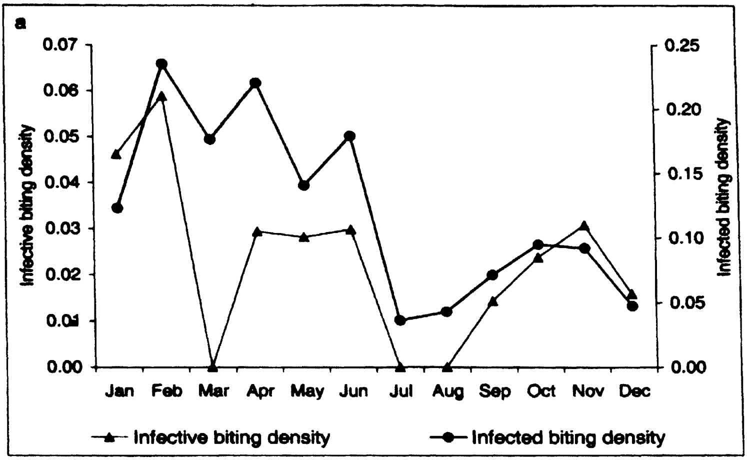
From the day man landing collections done during the one-year study period, 18 mosquitoes were found harboring infective stage larvae. From these infective mosquitoes a total of 28 infective stage larvae were found giving an average of 1.6 L3 per infective mosquito. A maximum number of 4 L3 larvae were found in a single mosquito. Out of 28 larvae, 15 (53.57%) were found in thorax region, 6 (21.43%) in abdomen region and 7 (25%) in the head region of the mosquitoes.

6.4.4 Abundance of Infected and Infective Vector Mosquitoes

The frequency of infected mosquitoes was found throughout the year. Infected biting density was the highest in February. Although there were some fluctuations in other months, the overall trend in the infected biting density shows a decline after the month of February up to July-August and a gradual increase afterwards. The frequency of infective biting mosquitoes was the highest in the months January-February (Fig 16a). However, when the data were pooled season wise, the infected biting density was found to be the lowest in the winter months and then rise through the summer months and peak during the monsoon months. A similar trend was noticed in the case of infective biting density (Fig 16b).

6.4.5 Host Efficiency of Oc. niveus

The host efficiency index of *Oc. niveus* was found to be 0.43 which means that a little over 40% of the mf ingested were able to develop into infective stages (Table 10).



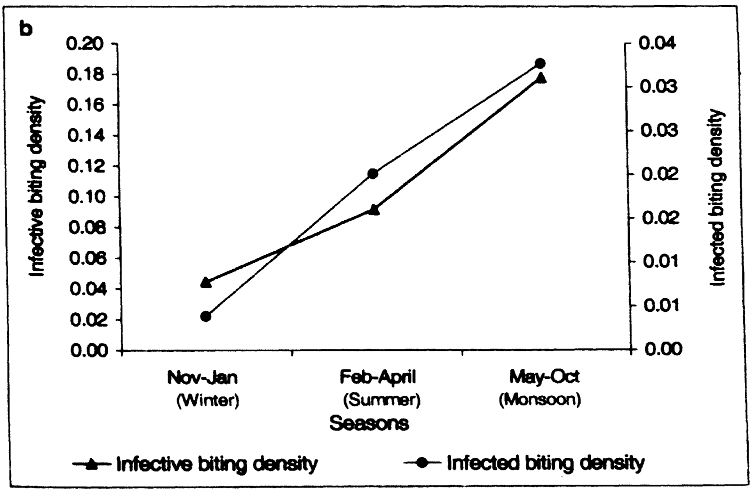


Fig 16: Abundance of Infected and Infective Oc. niveus

a) Month wise b) Season wise

Table 10. Host Efficiency of Oc. niveus During Different Months

Months	Mean		Efficiency
	MF	**L3**	**L3/MF**
January	0	1.33	0
February	2	1.75	0.88
March	4.71	0	0
April	2.5	2	0.80
May	3	1	0.33
June	2.86	1	0.35
July	0	0	0
August	5	0	0
September	0	2	0
October	0	2	0
November	7	2	0.29
December	0	1	0
Overall	**3.65**	**1.56**	**0.43**

6.5 Discussion

Earlier workers could not undertake intensive entomological studies probably because of poor accessibility of the area, inadequate infrastructure and the inherent hardships involved. All the studies were only point surveys. This is the first study in Andaman and Nicobar Islands that has ever been undertaken covering all seasons of the year, thus elucidating the infection and infectivity pattern in *Oc. niveus*. At least four mosquito species/species groups viz., *Oc. niveus*, *Ae. scutellaris* group, *Ma. dives* and *An. sundaicus* were reported to bite the aborigine tribes in the jungles of Nancowry group of Nicobar islands (Kalra 1974; Russel *et al.* 1975). Neither of these authors could definitely incriminate the vector species, because only few mosquitoes could be collected in the dry season when their studies were made and only one specimen of *Oc. niveus* group of mosquitoes was found infected, but none was found with infective stage larvae. Carriers of the periodic form of *W. bancrofti* who were settlers from the mainland have been reported from the Nancowry group (Das *et al.* 1975; Russel *et al.* 1975) and Kalra (1974) suggested that both forms of *W. bancrofti* might be present in settlement areas and administrative headquarters, where settlers and local people reside. A single specimen of *Cx. quinquefasciatus* was found naturally infected in one such area (Nancowry headquarters) by Russel *et al.* (1975) and there are earlier records (Basu 1958) from islands where settlers were predominant, though it is not clear where the infected *Cx. quinquefasciatus* was obtained. Both Kalra (1974) and Russel *et al.* (1975) showed experimentally that *Cx. quinquefasciatus* was an inefficient vector of subperiodic *W. bancrofti*, but still could play a role as a minor vector, as it does in the South Pacific region where *Ae. polynesiensis* is the main vector (Sasa 1976).

In the present study the density of *Cx. quinquefasciatus* was very low and the only species found naturally infected was *Oc. niveus*. *Oc. niveus* predominated among the mosquitoes collected. The study also highlights that only *Oc. niveus* is involved in the transmission of filariasis amongst the 12 mosquito species found to bite man in peri-domestic locations of this island.

The human biting activity of 12 species in this area has been recorded for the first time through this year long study.

The occurrence of infection with diurnally subperiodic *W. bancrofti* has been known in the South Pacific Islands since the beginning of the century (Thorpe 1896). Transmission studies in these islands (Samarawickrema *et al.* 1987) have shown less infection and infectivity rates in *Ae. polynesiensis*, a day biting vector for this form of filariasis. The low infection and infectivity in the vectors were attributed to the very low microfilaraemia prevalence in the community, which was achieved by institution of nationwide DEC mass chemotherapy between 1965 and 1987.

The community microfilaraemia prevalence is best reflected in the mosquitoes collected from resting collections, mainly because such collections are carried out in different locations of a village which is representative of the village. Whereas in the present setting carrying out resting collections is not practicable owing to the exophilic nature of the vector. Hence, in the present study man-landing collection was carried out in peridomestic location, thus reflecting the infection of that particular site and immediate surroundings in which the collections were made *vis a vis* to that of the resting collections. This justifies for the lack in relationship observed in the infection and infectivity rates between the three mf zones. However, infection in Teressa Island is perennial, whereas the infectivity was seen during most part of the year except February, July and August. Infection of filaria vectors depends on the microfilarial rate and the microfilarial density in the community. The results of the present study confirm active transmission by Oc. *niveus* as observed by Tewari *et al.* (1995) in the Nancowry group of islands.

In the current study only a total of 18 mosquitoes were found to harbor infective stage larvae, of which 61.1% (11/18) were found to have one infective stage larva whereas only 38.9% (7/18) had two or more infective stages. A maximum of 53.6% (15/28) of the infective larvae were found in the thorax region and 25% (7/28) were found in the head region of the mosquito. However, Jordan (1952) reported that the infective larvae present in any part of the mosquito body could pass into the vertebrate body during the act of blood feeding. Comparison studies on the occurrence of maximum number of infective stages in the thorax region for the vector of subperiodic filariasis are lacking. However, De Meillon *et al.* (1967b) have also reported a maximum proportion of 35.9% infective larvae in the thorax region of the mosquito and 24.0% from the head region in experimental infection studies involving *Cx. quinquefasciatus.* Zielke (1975) reported a large number of larvae in the head region of *An. gambiae*. There are divergent reports (De Meillon *et al.* 1967b; Lavoipierre and Ho 1973; Zielke 1977) on the mechanism, which elicit the migration of the infective larvae from different sites in the mosquito body to the proboscis region and their escape into the host skin.

From the frequency of the infective mosquitoes it appears that transmission is absent only during the months of March (summer month) and July-August (monsoon season). This is due to the absence of infective mosquitoes during these months. The quantum of transmission, as evidenced by infective biting density (Fig 16a) was the highest during February (summer) and late winter month of January. However, from the season wise analysis (Fig 16b) it can be inferred that the quantum of transmission was the highest during the monsoon months (May - Oct). The higher transmission recorded in the summer season, which comprised of only three months, than in the monsoon season is rather due to higher numbers of infective stage larvae in the biting females.

The host efficiency index for *Oc. niveus* suggests that more than 40% of the mf ingested were able to develop into infective stages. The index for the known vectors of subperiodic form of filariasis is not available. However, Rozeboom *et al.* (1968) observed that under laboratory conditions, the index for Calcutta strain of *Cx. quinquefasciatus*, vector of nocturnally periodic *W. bancrofti* was 0.3, while in the wild caught *Cx. quinquefasciatus* of Pondicherry strain the host efficiency index was found to be 0.28 (Ramaiah 1990). The index obtained for *Oc. niveus* is comparatively higher than that observed for *Cx. quinquefasciatus*, the vector of nocturnally periodic bancroftian filariasis, indicating that the former vector is as competent as *Cx. quinquefasciatus* in the transmission of infection. A comparison of mean number of mf ingested and mean number of infective stage larvae developed, during different months, gives an idea of capability of *Oc. niveus* to develop mf into infective stage larvae, during different seasons. The host efficiency was high during the months of February (0.88) and April (0.80) and comparatively low (0.35 & 0.29) during the months of June and November respectively, suggesting that the climatic conditions are optimum during February-April months of the year.