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7.1 Summary

Transmission dynamics of subperiodic W. bancrofti was studied in Teressa Island for a period of one year by means of man landing catches of Oc. niveus. Annual biting and infective biting rates (ABR and AIBR) were estimated to be 21591 and 107 per person respectively. The Annual transmission potential (ATP) was 163. An estimated number of 3.71 infective stage larvae was available with the vector population during the study period to an individual at risk. The pattern of monthly transmission potential suggests that the intensity of transmission was high during summer months than the winter and monsoon months. Transmission is perennial. Transmission indices viz., ABR, AIBR and ATP observed in Oc. niveus are addressed in relation to the epidemiological importance of different ecosystems where foci of transmission is a likelihood, is being addressed in this chapter.

7.2 Introduction

Since the implication of *Oc. niveus* as the vector (Tewari *et al.* 1995) of this form of filariasis in these islands, no comprehensive study has been carried out to assess the transmission dynamics. Transmission dynamics of the parasites forms an important aspect in the epidemiology of filariasis.

Annual Biting Rate (ABR), Annual Infective Biting Rate (AIBR), Annual Transmission Index (ATI), Risk of Infection Index (RII) and Annual Transmission Potential (ATP), which reflect the dynamics and intensity of transmission of filariasis were computed from day man landing mosquito collection data. The present chapter highlights the transmission dynamics of filariasis during the study period.

7.3 Material and Methods

All the above-mentioned indices were calculated using the data obtained from day man landing collection from dawn to dusk, in all the three zones. The mosquitoes were kept hour wise and dissected the next morning. The method of dissection of mosquitoes and classification of various filarial stages are given in chapter 6.

Calculation of Indices

7.3.1 Annual Biting Rate

ABR is the number of mosquito bites a person receives during one-year period. The annual biting rate is the sum of 12 monthly biting rates, which can be calculated by multiplying the number of mosquitoes, biting man per day observed from dawn (04.00h) to dusk (18.00h) with number of days in a month in the respective month. A single collection carried out initially in one of the villages over a 24-hour period showed no *Oc. niveus* mosquitoes between 1800h and 0400 h.

7.3.2 Annual Infective Biting Rate

It is the estimated number of infective bites a person receives during one-year period. It is calculated by multiplying the Annual biting rate with proportion of infective mosquitoes in the biting population.

7.3.3 Annual Transmission Index

Annual transmission index was proposed by Beye and Gurian (1960) and is widely used in the measurement of intensity of transmission of filariasis. It can be calculated by the following formula.

Annual biting rate
X
Proportion of biting mosquitoes infective
X
Av. no. of infective larvae/infective mosquito

7.3.4 Risk of Infection Index

Risk of infection index takes into account three important parameters, viz., vector biting density, parity status and parasite load. It was proposed by De Meillon *et al.* (1967c). The formula to calculate this index is given below.

Biting density
X
Proportion of parous mosquitoes total dissected
X
Proportion infective to total parous mosquitoes

7.3.5 Annual Transmission Potential

Annual transmission potential was proposed by Walsh *et al.* (1978) to evaluate the impact of *Simulium* control in reducing the transmission of Onchocerciasis. The basic index to calculate the ATP is monthly transmission potential, which indicates the level of transmission of infective larvae to humans, during a month. The monthly transmission potential is calculated by using the following formula.

$$\frac{\text{Monthly biting rate X Total no. of infective larvae}}{\text{No. of mosquitoes dissected}}$$

The sum of 12 Monthly Transmission Potentials (MTP) gives the ATP. During the act of feeding infective larvae present not only in the head region and proboscis but also from the thorax and abdomen migrate towards proboscis, from where they get deposited on human skin (Jordan 1959; Zielke 1976). Hence, the total number of larvae present in the mosquito body was considered for the calculation of MTP. A similar procedure was adopted by Duke (1968).

7.4 Results

7.4.1 Annual Biting Rate

During the study period, the overall ABR or in other words the total number of *Oc. niveus* mosquitoes biting a single person was observed to be 21591. A person on average was bitten by 23046, 20290 and 21436 in the low mf zone, medium mf zone and the high mf zone respectively (Table 11).

7.4.2 Annual Infective Biting Rate

The AIBR observed was 107. A person received a total of 150 infective bites in the low mf zone area as against 60 in the medium mf zone and 90 in the high mf zone respectively.

7.4.3 Annual Transmission Index

ATI is the number of infective stages to which a person was exposed in a

Table 11. Annual Transmission Index (ATI) During the Study Period

Parameters		**ZONES**			
		Low mf	**Medium Mf**	**High mf**	**Overall**
1	Annual Biting rate	23046	20290	21436	21591
2	**Proportion of infective mosquitoes**	**0.0065**	**0.0029**	**0.0042**	**0.0050**
3	Av. No of L3/ infective mosquito	1.400	2.500	1.500	1.600
4	**ATI (1*2*3)**	**210.74**	**151.42**	**135.48**	**168.78**

year. The overall ATI observed in the study area was 168.77. The ATI ranged between 151.42 and 210.74 in the three mf zones. A high value of ATI observed in the low mf zone was mainly due to a high annual biting rate in comparison to the other two zones (Table 11).

7.4.4 Risk of Infection Index

The RII was 0.02332 in the study area (Table 12). As per De Meillon *et al* (1967 b) hypothesis, a total of 3.71 infective stage larvae was available with the vector population to be transmitted into a person's body during the study period (Table 13).

7.4.5 Annual Transmission Potential

The monthly biting rates and MTP in different zones are furnished in Table 14. The MTP is depicted in Figure 17. The general pattern of monthly transmission potential during the study period suggests that transmission was low, except for the months of January, February, April and November. The transmission potential was comparatively higher in the summer months than the other seasons of the year. Thus the transmission appears to be perennial though the level of transmission was found to be low in certain months of the year.

Table 12. Risk of Infection Index (RII) During the Study Period

Parameters		**ZONES**			
		Low mf	**Medium Mf**	**High mf**	**Overall**
1	Biting density	4.91	4.14	4.78	4.7
2	**Proportion of parous mosquitoes**	**0.2443**	**0.2209**	**0.2360**	**0.2367**
3	Proportion infective to total parous	0.0267	0.0135	0.0179	0.0210
4	**RII (1*2*3)**	**0.0321**	**0.0123**	**0.0201**	**0.0233**

Table 13. Number of Infective Stage Larvae Expected to Have Been Deposited on Human Skin and Entered to Human Body During the Study Period.

Zone	**AIBR**	**Infective stage larvae**			**No. entered into body**
		Ave. / infective mosquito	**Total**	**No. deposited on skin**	
Low mf	151	1.4	14	5.8	1.85
Med mf	**61**	2.5	**5**	2.07	**0.66**
High mf	90	1.5	9	3.73	1.19
Overall	**107**	**1.6**	**28**	**11.59**	**3.71**

AIBR – Annual infective biting rate
AIBR rounded to integer

Table 14. Monthly Biting Rates and Monthly Transmission Potential in Different Zones

Month	**LOW MF ZONE**					**MEDIUM MF ZONE**					**HIGH MF ZONE**				
	a	**b**	**c**	**d**	**e**	**a**	**b**	**c**	**d**	**e**	**a**	**b**	**c**	**d**	**e**
Jan	75	2325	2	4650	62	24	744	0	0	0	96	2976	2	5952	62
Feb	**237**	**6636**	**2**	**13272**	**56**	**85**	**2380**	**5**	**11900**	**140**	**227**	**6356**	**0**	**0**	**0**
Mar	184	5704	0	0	0	104	3224	0	0	0	88	2728	0	0	0
Apr	**259**	**7770**	**4**	**31080**	**120**	**44**	**1320**	**0**	**0**	**0**	**116**	**3480**	**0**	**0**	**0**
May	67	2077	2	4154	62	68	2108	0	0	0	155	4805	0	0	0
Jun	**101**	**3030**	**1**	**3030**	**30**	**94**	**2820**	**0**	**0**	**0**	**190**	**5700**	**1**	**5700**	**30**
Jul	73	2263	0	0	0	13	403	0	0	0	85	2635	0	0	0
Aug	**161**	**4991**	**0**	**0**	**0**	**54**	**1674**	**0**	**0**	**0**	**72**	**2232**	**0**	**0**	**0**
Sep	97	2910	0	0	0	42	1260	0	0	0	163	4890	2	9780	60
Oct	**57**	**1767**	**2**	**3534**	**62**	**44**	**1364**	**0**	**0**	**0**	**71**	**2201**	**0**	**0**	**0**
Nov	201	6030	0	0	0	45	1350	0	0	0	123	3690	4	14760	120
Dec	**19**	**589**	**1**	**589**	**31**	**53**	**1643**	**0**	**0**	**0**	**38**	**1178**	**0**	**0**	**0**
Total	**1531**	**46092**	**14**	**645288**	**423**	**670**	**20290**	**5**	**0**	**140**	**1424**	**42871**	**9**	**385839**	**272**

a= No. dissected ; b=Monthly Biting Rate; c= No. of Infective Larvae; d=b x c; e (Monthly Transmission Potential)=d/a

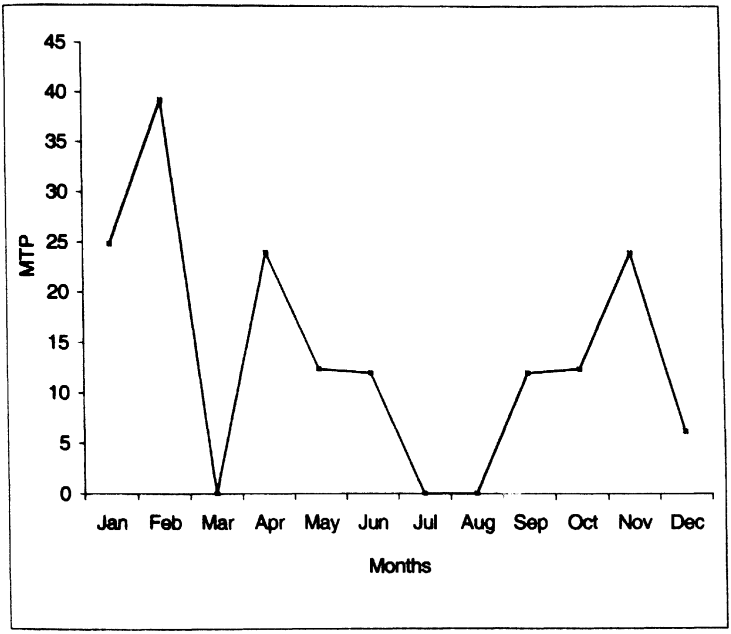

Figure 17. Monthly Transmission Potential During the Study Period

7.5 Discussion

In Teressa Island, it is estimated that overall a total of about 107 infective bites were received on an average by a person during the study period. De Meillon *et al.* (1967b) hypothesized that, a proportion of only 0.414 of infective stages in the mosquito body will be deposited on the skin during the act of feeding. Lindsay *et al.* (1984) reported that various microclimatic factors play an important role in the survival of the infective stages deposited on the skin. Ewert and Ho (1967) and Ho and Ewert (1967) based on experiments involving cats and *Brugia pahangi* concluded that only 32% of the deposited larvae will be able to penetrate the host skin. Assuming that above said deductions are true in the process of transmission of infective larvae from invertebrate host to the vertebrate host for *W. bancrofti*, the number of infective stages that would have been deposited on host skin and penetrated into the human body would be 3.71 in the current study.

The ABR and AIBR were estimated to be 21591 and 107 respectively. The ATP was 163. Studies from Samoa (Samarawickrema *et al.* 1987) have estimated annual biting, infective biting rates and the annual transmission potential for *Ae. polynesiensis*, the vector of diurnally subperiodic filariasis in the South Pacific Islands as 150268, 968 and 3433 respectively. The infective biting rate and the transmission potential depend upon the number of mosquitoes biting man, their longevity and the size of the availability of the reservoir of microfilariae. It is assumed that these parameters were high in Samoa and hence comparatively higher transmission indices were observed in *Ae. polynesiensis*

The present study showed that the RII in Teressa Island was 0.0233. The original estimates of risk of infection were made by Wharton (1962) on the intensity of transmission of *B. malayi* by *Mansonia* in Malaysia. Subsequent estimates for vectors such as *Cx. quinquefasciatus* and *An. gambiae* in several endemic areas include those given by Hairston and De Meillon (1968), Rozeboom *et al.* (1968), Gubler and Bhattacharya (1974), Wijers (1977), Self *et al.* (1978), Bushrod (1979), McMahon *et al.* (1981) and Ramaiah *et al.* (1992)

The index observed in the present study was found to be lower than that observed for *Cx. quinquefasciatus*, vector of periodic form of filariasis (Ramaiah *et al.* 1992) in Pondicherry (with similar sampling method).

There has been a great deal of disagreement over the sites where the greatest amount of transmission of filariasis occurs in Samoa. In the Pacific (O' Connor 1923*)* it is the villages emphasized to be as hyper endemic foci of infection (Byrd *et al.* 1945 and Iyengar 1959e). On the other hand Jachowski and Otto (1952, 1953) were of the opinion that transmission of subperiodic *W. bancrofti* was much higher in the wild ecological niche than the villages *per se*. In Western Samoa (McCarthy and Fitzgerald 1956) and Fiji (Rakai *et al.* 1974) also most of the transmission occurred in the plantations, along paths leading to the water points, and in related situations.

In Teressa Island, the major proportion of the Nicobarese population, by native custom, spend considerable part of the day working in coconut plantations for harvesting the copra crops and other forest produce situated in deep forests, which necessitates them to stay for days in transitory huts. So it is quite possible for such a place to become a site of transmission.

ATP was extensively used in the evaluation of the effectiveness of Onchocerciasis Control Programme (OCP) in Africa. ATP is also useful in the measurement of intensity of transmission during different months. The monthly transmission potential obtained in the present study indicates that, the transmission appears to be perennial though the level of transmission was found to be low in during the monsoon months (May-October) of the year. Transmission was slightly more in summer (February-April) than winter season (November-January).

Ramaiah *et al.* (1994) proposed that ATP in the range of 96-105 as permissible levels of transmission, and below these levels no new infection may occur for *Cx. quinquefasciatus* - *W. bancrofti* combination in Pondicherry, South India. In the current study the overall ATP observed was 167, which is more than that of the threshold levels observed in Pondicherry. Assuming that the above deductions hold good for *Oc. niveus - W. bancrofti* combination, in the absence of any control measure, it is expected that transmission of infection would continue unabated.

The climate varies widely in different eco-geographical settings of the endemic regions and this factor influences the density pattern of the *Cx. quinquefasciatus*, vector of periodic *W. bancrofti*. Hence, one can expect geographical variations in the seasonal pattern of transmission of filariasis. For instance, Hati *et al.* (1989) reported seasonal variation in the transmission between the urban and rural areas of West Bengal, India. Transmission was very low and negligible in the rural areas in the summer season but significantly higher in urban Kolkata. Highest transmission occurred in the rainy season in both the areas. In Pondicherry, south India transmission was significantly more in the winter months than the monsoon months, whereas there was no transmission during the summer season (Ramaiah and Das 1992). In the current study transmission is perennial though the level of transmission was low during the monsoon months. Transmission was slightly more in summer than winter and monsoon season.

Vector control is one of the means of LF control. Prolonged vector control for about 5-8 years have shown sharp decline in the prevalence of microfilaraemia in the community (Remme *et al.* 1986; Webber 1977) for the elimination of *Anopheles*-borne filariasis. A five-year programme to control bancroftian filariasis, through the control of the vector, *Cx quinquefasciatus*, implemented in Pondicherry greatly reduced the quantum of transmission (Ramaiah *et al.* 1994). In filariasis transmitted by *Culex gelidus*, near eradication of the vector for 10 years resulted in the decline of mf prevalence from 14.0% to 0.50% and mf density from 79.1 to 12.0 (Sasa 1976).

From the stand point view vector control program, which may reduce or eliminate transmission in endemic tracts, is a difficult proposition and could prove to be cost prohibitive. Vector control measures are very difficult owing to their exophily and diurnal feeding behavior. Furthermore, the larvae are not amenable to larvicidal control because of many scattered, peculiar and inaccessible breeding habitats of the mosquitoes (Tewari *et al.* 1995), whereas the personal protective measures for control of filariasis would be cost prohibitive. Therefore in such epidemiological settings, the only alternative method of containing this infection is use of microfilaricidal drugs to liquidate the parasite load in the community, either through selective chemotherapy or periodic mass chemotherapy. Studies carried elsewhere indicate that chemotherapy is the best option to control this form of filariasis (Kimura *et al.* 1992).