# 4 *Prevalence of Infection and Disease due to Diurnally Subperiodic W. bancrofti and Frequency Distribution of Microfilariae*

## 4.1 Summary

*A cross sectional survey was carried out to assess the prevalence of microfilaraemia, chronic disease and to examine the frequency distribution of diurnally subperiodic W. bancrofti mf in Teressa Island, remotely located in the Nicobar district of Andaman and Nicobar Islands. Aborigine tribes predominantly inhabit this island. The overall endemicity rate observed was 17.1%. Mf carriers were found in all the villages with mf rates ranging from 5.11% to 25%. Mf rate increased gradually with age, reaching a peak in the age class 31-40 years and thereafter showed decreasing trend in age class above 40 years of age. Mf rate and disease rates were significantly higher (P<0.001) in males (14.7% and 5.2% respectively) than females (8.6% and 1.5% respectively). Chronic disease prevalence also showed a gradual increase with age, acute disease occurs only in the age group of 40 years and above. Hydrocele (84.6%) was the commonest disease manifestation among males whereas lymphoedema in limbs was the only manifestation encountered among females. The negative binomial distribution was fitted to the data on distribution of microfilarial counts and gave a perfect fit. The data having been fitted to the negative binomial, the expected mf prevalence could be determined as 16.82% as against an observed prevalence of 11.83%.*

## 4.2 Introduction

The clinical manifestations caused by nocturnally periodic *W. bancrofti* are well described (Sasa 1976; Manson-Bahr and Apted 1982; Dondero *et al.* 1976; Udonsi 1988; Kazura *et al.* 1984; Raccurt *et al.* 1984; Pani *et al.* 1989) and the relationship between microfilaraemia and the clinical disease has been reported (Pani *et al.* 1991), such relationship is not well understood for diurnally subperiodic form of filariasis. Earlier studies on diurnally subperiodic banroftian filariasis in these islands (Kalra 1974; Russel *et al.* 1975; Tewari *et al.* 1995) provided information on age and gender specific distribution of microfilaraemia and overall prevalence of disease. However, a major limitation of these studies is that they did not describe the age and gender specific prevalence of individual clinical manifestations such as hydrocele and lymphoedema etc.

The significance of host age to the population dynamics of helminth infections of humans has attracted considerable attention, in both empirical and theoretical studies (Hairston and Jachowski 1968; Dietz 1982 a, b; Anderson and May 1982, 1985 a, b; Crombie and Anderson 1985). The major conceptual tool for examining the age effects in the study of human helminthiases in the field is the construction of age-prevalence and age-intensity curves (Anderson and May 1982), which record respectively the proportion infected and the mean parasite burden throughout the host age profile. The interpretation of these patterns can yield valuable insights into the operation of underlying heterogeneities in parasite population processes with age, such as acquired immunity (Anderson and May 1985a). Such analyses have been particularly successful for parasites such as intestinal nematodes, where adult worm burden can be directly assessed (Anderson and May 1985b; Bundy 1988).

The statistical basis of these summary measures of parasite abundance is the frequency distribution of parasite numbers through the age structure of the host population. Apart from their importance in determining the properties of prevalence and intensity estimates, these age-frequency distributions are also of intrinsic epidemiological interest, since they measure the heterogeneity of

parasite dispersion between hosts. Many studies show that the negative binomial distribution (with parameters *m* and *k* which is an inverse measure of over dispersion) provides an excellent empirical description of parasite distributions (Dietz 1982b; Anderson and May 1985a; Pacala and Dobson 1988; Das *et al.* 1990). A particularly important result predicted by theory and confirmed in practice (Pacala and Dobson 1988), is that a decrease in the degree of over dispersion with age (measured by an increase in *k*) can indicate the operation of density–dependent constraints (such as host immunity or parasite-induced host mortality) on the parasite population.

Although theoretical models have also been advanced to describe the age distribution of filarial infections (Hairston and Jachowski 1968; Dietz 1982a ), the measurement of infection prevalence and intensity for lymphatic filariasis can only be carried out indirectly, via the measurement of levels of microfilariae (mf) in blood samples (Southgate and Hamilton 1974; Sasa 1976). Park (1988) pointed out that the frequency distribution of mf counts in samples (which supports all such measurements) can be described statistically by a compound Poisson distribution (again the negative binomial), which reflects Poisson sampling and an underlying (gamma) distribution of mf density in the blood of the human population. Grenfell *et al.* (1990) have since refined this analysis, proposing the use of zero truncated compound Poisson distribution to estimate the considerable proportion of hosts who appear to have no mf in their blood. This modification will therefore affect estimates of the prevalence (although not the intensity) of infection. Frequency distribution of mf counts of periodic *W. bancrofti* from a large database on the epidemiology of bancroftian filariasis in Pondicherry (Das *et al.* 1990) is successfully described by zero truncated negative binomial distributions.

Therefore, a cross sectional filarial survey incorporating parasitological and clinical aspects was carried out in Teressa Island to assess the mf and disease prevalence and to understand the relationship between microfilaraemia and clinical disease and its effect on age and gender and the methods developed by Grenfell *et al.* (1990) are being used to examine the frequency

distribution of mf counts.

The prevalence of microfilaraemia, effects of age and gender on the clinical consequence and frequency distribution of mf of subperiodic filariasis infection are dealt in this chapter.

## 4.3 Material and Methods

### *4.3.1 Parasitological and Cinical surveys*

The parasitological and clinical surveys were carried out in all the eleven villages in Teressa Island. Households were selected by systematic random sampling procedure selecting every alternate household. Thus 50% of the households were sampled. All the individuals present at the time of survey were screened for microfilaraemia and disease manifestations through house-to-house visits. During the survey, a social worker visited each house hold, informed the members about the purpose of the study, obtained consent a day prior to the visit. The survey was carried out between 1200h and 1700h. Thick blood smears were made from about 20 $mm^3$ obtained by finger prick method. The collected blood smears were dried, dehaemoglobinized and stained with Leishman's stain. All the people sampled for mf were also physically and clinically examined for clinical manifestations of lymphatic filariasis by trained male/female health workers. Manifestations were graded following WHO classification (1992). Leg lymphoedema was graded as stage I (pitting lymphoedema, reversible on elevation), stage II (non-pitting lymphoedema, not reversible on elevation) or stage III (evident elephantiasis with skin folds and papillomatous lesions). Information about duration of various clinical manifestations and history of adenolymphangitis during the last one year was also collected. Besides this adenolymphangitis presented during the survey were also recorded. The survey was carried out during the period December – January 1999 following standard criteria (Sasa 1976; Manson-Bahr and Apted 1982; Subramanian *et al.* 1989; WHO 1992).

The 95% confidence limits for the prevalence of microfilaraemia, disease

and endemicity rates i.e. number of individuals positive for microfilaraemia or disease and both were estimated. The significance of difference between the proportions was tested using chi-square test. Chi-square for trend was calculated to see the linearity of association between age and microfilaraemia and disease rates. Chi-square for trend was also calculated to study linear association between age and gender wise intensity of microfilaraemia profiles.

*4.3.2 Frequency Distribution of mf in Human Host*

*Statistical Analysis*

This aspect is described by fitting statistical distribution (negative binomial) to the frequency of mf in host as per the method of Grenfell *et al.* (1990). The observed mf frequency distribution was used to fit a zero-truncated negative binomial distribution by maximum likelihood. The parameters of this distribution, *m* and *k*, respectively characterize the mean and (inversely) the degree of over dispersion of the distribution of observed mf counts from individuals with a non-zero mean mf density in their blood. More flexible 3 parameters compound Poisson distributions such as the Sichel distribution (Grenfell *et al.* 1990) do not provide significantly better fits (in terms of chi-square), so that the negative binomial is retained as a simple measure of overdispersion. The estimated zero probability of the fitted distribution, $p'(0)$ can then be used to calculate $\sigma(0)$, the proportion of the age group which has 'true' zero count (in excess of the proportion due to blood sampling), from the equation .

$$\sigma(0) = [\, p\,(0) - p'(0)] \,/\, [1 - p'(0)\,]$$

where $p\,(0)$ is the actual proportion of negative samples. We can estimate the prevalence ($R$) of infection, corrected for sampling zeros by the equation, $R = 1 - \sigma(0)$.

*4.3.3 Ethical Considerations*

Approval was granted by the Institutional Ethical committee. Prior to the commencement of the survey, the object of the survey was explained in detail to all the village chieftains, pastors and village meetings were held to explain the purpose, methods, etc. The study was also explained to the respective head of each family and oral consent was sought from the subjects.

**4.4 Results**

*4.4.1 Parasitological and Clinical Surveys*

A total of 862 (44.6% coverage) individuals residing in different villages of the island were surveyed. The distribution of population and samples for all the villages is shown in Table 1. The population of the study villages varied between 31 and 464. The population was male biased (53.75%). By sampling 50% of the house holds, 23% to 53% of the population was blood sampled in different villages. The sampling for males and females was 43.94% and 45.25% respectively. This difference was not significant.

Of the 862 Nicobarese surveyed, mf were detected in 102 individuals which gives an overall infection prevalence of 11.83% (95% CI= 9.8-14.1). Mf carriers were found in all the villages with mf rate ranging from 5.11% (Kalasi) to 25.00% (Kanahinot) (Table 1). The youngest microfilaria carrier was 8 years old and oldest was 95 years.

Population sampled and distribution of *W. bancrofti* carriers, mf and disease prevalence with respect to age and sex is given in Table 2. The prevalence of mf was significantly higher in males (14.7%) than in females (8.6%, $\chi^2$ =7.46; p=0.006). The prevalence of microfilaraemia in males showed a steady rise with age ($\chi^2$ trend = 66.76; p=0.0000). The age specific pattern of microfilaraemia prevalence among females was similar to that in males ($\chi^2$ trend = 31.75; p=0.0000). Such patterns are typical of helminthes age-prevalence (Anderson and May 1985b; Das *et al.* 1990).

*Table 1 Coverage and Filariometric Indices in Different Villages of Teressa Island*

| Sl No | Village | Population | | | Sample | | | Coverage (%) | MF rate (%) | Disease rate (%) | Endemicity rate (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Male | Female | Total | Male | Female | Total | | | | |
| 1 | Aloora | 56 | 55 | 111 | 21 | 22 | 43 | 38 74 | 16 28 | 4 65 | 20 93 |
| 2 | Aloorang | 119 | 147 | 266 | 70 | 70 | 140 | 52.63 | 13.57 | 2.86 | 16.43 |
| 3 | Bengali | 283 | 181 | 464 | 114 | 77 | 191 | 41 16 | 8 90 | 5 24 | 14 14 |
| 4 | Chuk machi | 82 | 76 | 158 | 32 | 30 | 62 | 39.24 | 14.52 | 1.61 | 16.13 |
| 5 | Enam | 73 | 75 | 148 | 35 | 39 | 74 | 50 00 | 14 86 | 4 05 | 18 92 |
| 6 | Kalara | 15 | 16 | 31 | 5 | 2 | 7 | 22.58 | 14.29 | 14.29 | 28.57 |
| 7 | Kalasi | 174 | 152 | 326 | 70 | 67 | 137 | 42 02 | 5 11 | 6 57 | 11 68 |
| 8 | Kanahinot | 24 | 19 | 43 | 12 | 8 | 20 | 46.51 | 25.00 | 10.00 | 35.00 |
| 9 | Luxi | 92 | 70 | 162 | 42 | 44 | 86 | 53 09 | 16 28 | 9 30 | 25 58 |
| 10 | Minyuk | 106 | 84 | 190 | 49 | 37 | 86 | 45.26 | 10.47 | 5.81 | 16.28 |
| 11 | Safed Balu | 16 | 20 | 36 | 7 | 9 | 16 | 44 44 | 18 75 | 0 00 | 18 75 |
| | Total | 1040 | 895 | 1935 | 457 | 405 | 862 | 44.55 | 11.83 | 5.22 | 17.05 |

*Table 2: Population Sampled and Distribution of W. bancrofti Carriers, mf and Disease Rates According to Age and Sex Among the Nicobarese in Teressa Island*

| Age group (Years) | Male | | | | Female | | | | Total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Sample | | Mf rate (%) | Disease Rate (%) | Sample | | Mf rate (%) | Disease Rate (%) | Sample | | Mf rate | Disease Rate (%) |
| | No | % coverage | | | No | % coverage | | | No | % coverage | | |
| 0-10 | 115 | 49.8 | 0.9 | 0 | 109 | 52.9 | 1.8 | 0.00 | 224 | 51.3 | 1.3 | 0.00 |
| 11-20 | 124 | 59.6 | 1.6 | 3.23 | 101 | 60.8 | 5.9 | 0.00 | 225 | 60.2 | 3.5 | 1.77 |
| 21-30 | 84 | 29.6 | 16.7 | 8.33 | 87 | 33.5 | 8.0 | 1.50 | 171 | 31.4 | 12.3 | 4.67 |
| 31-40 | 57 | 37.3 | 36.8 | 10.5 | 62 | 55.4 | 16.1 | 0 00 | 119 | 44.9 | 26.1 | 5.04 |
| 41-50 | 35 | 41.7 | 37.1 | 17.1 | 21 | 25.6 | 23.8 | 0.00 | 56 | 33.7 | 32.1 | 10.71 |
| >=51 | 42 | 52.5 | 38.1 | 55.2 | 25 | 36.2 | 20.0 | 20.00 | 67 | 44.9 | 31.3 | 31.34 |
| Total | 457 | 43.9 | 14.7 | 6.5 | 405 | 45.3 | 8.6 | 1.48 | 862 | 44.5 | 11.8 | 3.22 |

A total of 2785 mf were detected in 102 microfilaraemia positive individuals with a mean parasite load of 27.30 per positive person (range: 1-318). The overall mean mf load showed an increase from 14.24 mf per person in the 21-30 age class and attain a peak at 35.45 mf per person in the 31- 40 age class and then steadies off in the other age classes (Table 3).

The age and gender wise intensity profiles of microfilaraemia is shown in Fig. 3. The overall mf intensity showed an increase from 0.52 mf per person in the 11-20 years age class and attain a peak at 9.24 mf per person in the 31-40 age class and then steadies off in the other age classes. Microfilaraemia intensity in males showed increase from 0.33 mf per person in 11-20 years age class and attains a peak at 16.93 mf per person in the 31-40 age class and then tended to decline ($\chi^2$ trend = 78.548, p=0.000). Microfilaraemia intensity was significantly higher in males (t=2.78, p=0.0006) compared to females. The age specific intensity pattern among the females was similar to that in males ($\chi^2$ trend= 20.230 p=0.000).

Out of 862 persons examined, a total of 45 persons were found to have clinical manifestations of filariasis, accounting for a disease rate of 5.2% (95% CI= 3.9-6.9). The prevalence of hydrocele was 7.2%. The prevalence of lymphoedema among males and females was 2.8% and 1.5% respectively. The disease rate (5.2%) was significantly lower than mf prevalence (11.83) ($\chi^2$=23.3, p=0.000). The disease rate was also significantly ($\chi^2$=20.2, p=0.000) higher in males (8.5%) than females (1.5%). The overall endemicity rate was 17.1% (95% CI=13.9-18.8). The disease and endemicity rates ranged from 0.0% (Safed Balu) to 14.29% (Kalara) and 11.68% (Kalasi) to 35.0% (Kanahinot) respectively.

The clinical spectrum of diurnally subperiodic bancroftian filariasis is presented in Table 4. A total of 45 individuals had chronic manifestations, of which 39 were males and 6 females. In males, hydrocele was the predominant chronic presentation observed, accounting for 84.6% (33/39) of the cases followed by lymphoedema (13/39, 33.3%). Seven male members were affected

*Table 3: Mean Microfilarial Count According to Age and Sex Among the Nicobarese in Teressa Island.*

| Age group (Years) | Male | | | Female | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean Mf count | SD | Range | Mean Mf count | SD | Range | Mean Mf count | SD | Range |
| 0 - 10 | 15.00 | 0.00 | 15 | 21.50 | 19.09 | 8 -35 | 19.33 | 14.01 | 8 - 35 |
| 11-20 | 20.50 | 21.92 | 5 - 36 | 12.67 | 13.29 | 1 - 36 | 14.63 | 14.42 | 1-36 |
| 21 - 30 | 16.30 | 35.88 | 1 - 138 | 10.14 | 9.03 | 2 - 26 | 14.24 | 29.50 | 1 -27 |
| 31 - 40 | 45.95 | 72.59 | 1 - 318 | 13.40 | 9.45 | 2 - 30 | 35.45 | 61.47 | 1 - 318 |
| 41 - 50 | 35.46 | 57.63 | 1 - 201 | 13.60 | 12.12 | 2 - 31 | 29.39 | 49.80 | 1 - 201 |
| > = 51 | 31.56 | 32.30 | 1 - 96 | 35.60 | 71.79 | 1 - 164 | 32.52 | 42.62 | 1 - 164 |
| Total | 33.06 | 53.13 | 1 - 318 | 16.29 | 27.72 | 1 - 164 | 27.30 | 46.55 | 1 - 318 |

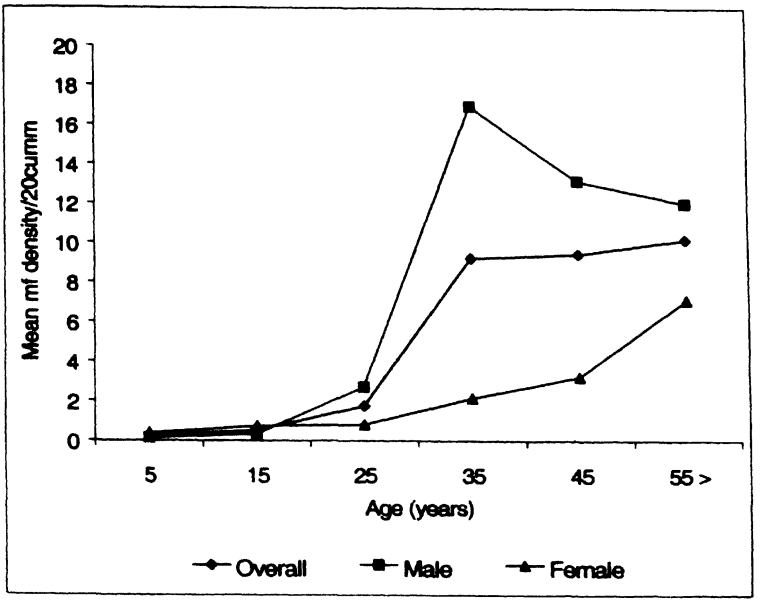



*Fig 3: Age and Gender Wise Intensity of Microfilaraemia*

*Table 4: Types of Clinical Manifestations of Subperiodic Filariasis in Relation to Gender*

| Clinical manifestations | Males (N=457) | Females (N=405) | Total |
|---|---|---|---|
| *Lymphoedema* | | | 19 (2.2) |
| Grade-1 | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Grade-2 | 2 (0.4) | 1 (0.2) | 3 (0.3) |
| Grade-3 | 11 (2.4) | 5 (1.2) | 16 (1.9) |
| *Hydrocele* | 33 (7.2) | "NA" | 33 (7.2) |
| Grade-1 | 14 (3.1) | "NA" | 14 (3.1) |
| Grade-2 | 14*(3.1) | "NA" | 14 (3.1) |
| Grade-3 | 5**(1.1) | "NA" | 5 (1.1) |
| *ADL* | 9 (1.9) | 1(0.2) | 10 (1.2) |

**Two had grade III and one had grade II lymphoedema*
***Four had grade III lymphoedema, "NA"=not applicable)*

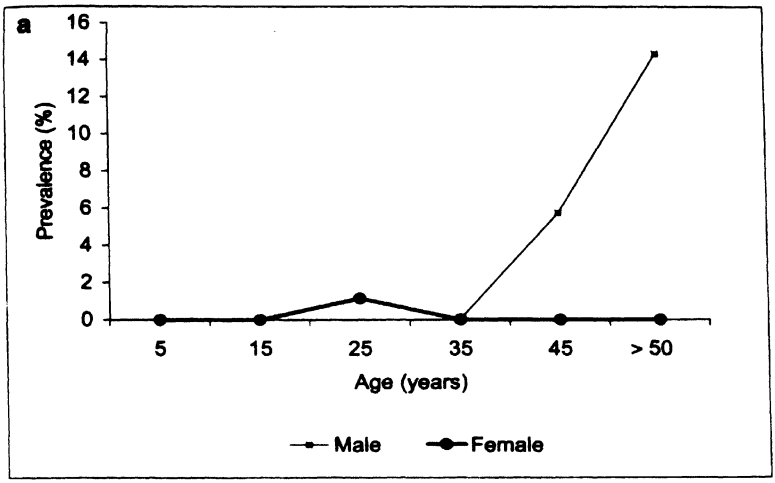
with both hydrocele and lymphoedema of lower limbs. Lymphoedema of the limbs was the only clinical manifestation encountered among females. Distribution of 19 cases with any grade of lymphoedema in relation to limbs affected showed that 9 had bilateral involvement of legs, 9 had unilateral involvement of leg, while one case showed bilateral involvement of legs and hands. Among the 45 chronic people, 10 (22.2%) of them gave the history of acute episodes of adenolymphangitis (ADL). All the ten people with history of ADL had lymphoedema (of any grade) of which five also had hydrocele. Among males, the acute signs were reported predominantly from 40 years onwards and its prevalence was also age dependent ($\chi^2$ trend = 21.67, p=0.0000) (fig-4a).

The age-wise prevalence of total disease in relation to gender (Table-2) showed that the prevalence of disease in males was clearly age–dependent, with a prevalence rate of 3.2% in the 11-20 years age class and 55.2% in persons aged 51 or more ($\chi^2$ trend = 62.3 p=0.0000). There was no disease observed below 40 years among females except for a very low prevalence (1.1%) in the 21-30 years age class. Higher disease rate observed among males was entirely due to the high prevalence of hydrocele. The age prevalence of specific clinical signs for both sexes is shown in Fig 4. The patterns of chronic irreversible (grade II and grade III) manifestations showed a gradual increase with age (fig-4b).

The median age of chronic lymphoedema cases was 46.0 years and 57.5 years for males and females respectively. Whereas, the median age of hydrocele was 45.0 years. The duration of disease was 20.4 years (SE=2.8) in cases with lymphoedema and 6.7 years (SE=1.3) for hydrocele. The duration of disease and its association with hydrocele and lymphoedema is shown in Fig 5. 72.7% of the hydrocele cases and 21.1% cases of lymphoedema had this condition since last five years while the remaining 27.35 of hydrocele cases and 78.9% of lymphoedema cases had this condition for more than five years.

### *4.4.2 Distribution Fits and Parameter Estimates*

More flexible 3 parameters compound Poisson distributions such as the



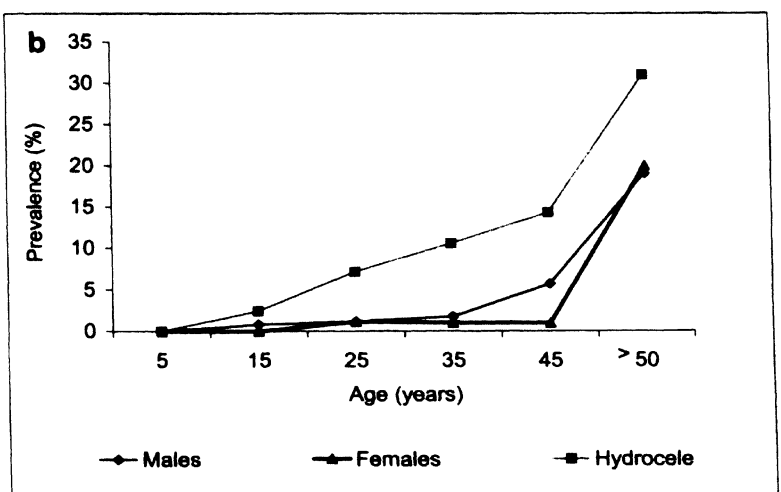




*Fig. 4: Age Wise Prevalence of Clinical Signs of Subperiodic Bancroftian Filariasis*

*a. History of ADL in Males and Females*
*b. Chronic Lymphodema (all grades) for Males and Females and Hydrocele for Males*

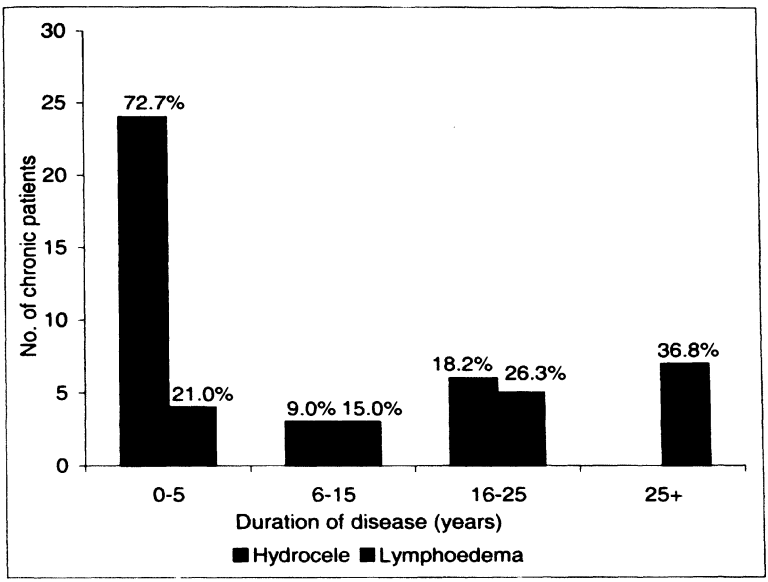



*Fig. 5 : Relationship Between Duration of Disease and Proportion of Cases with Chronic Manifestations of Filariasis*

Sichel distribution (Grenfell *et al.* 1990) do not provide significantly better fits (in terms of chi-square), so that the negative binomial is retained as a simple measure of overdispersion. Table 5 summarizes the results of fitting the truncated negative binomial distribution to the parasitological survey data. Since the number of mf positives were less, the data was were summed across the sexes and age groups. The goodness of fit of the expected non-zero distributions (as indicated by chi square) is satisfactory for the summed up age classes. This close match between observed and expected frequencies is illustrated in Fig 6.

*Table 5: Parameters and Statistics Arising from Fits of Observed Microfilarial Count By Age to the Negative Binomial Distribution and its Goodness of Fit.*

| Parameters | | | | Goodness of fit | | | Mf prevalence (%) | |
|---|---|---|---|---|---|---|---|---|
| m | S.E | k | S.E | $X^2$ | D.F | P | Observed | Expected |
| 18.874 | 4.23 | 0.2883 | 0.01075 | 15.84 | 13 | 0.258 | 11.83 | 16.82 |

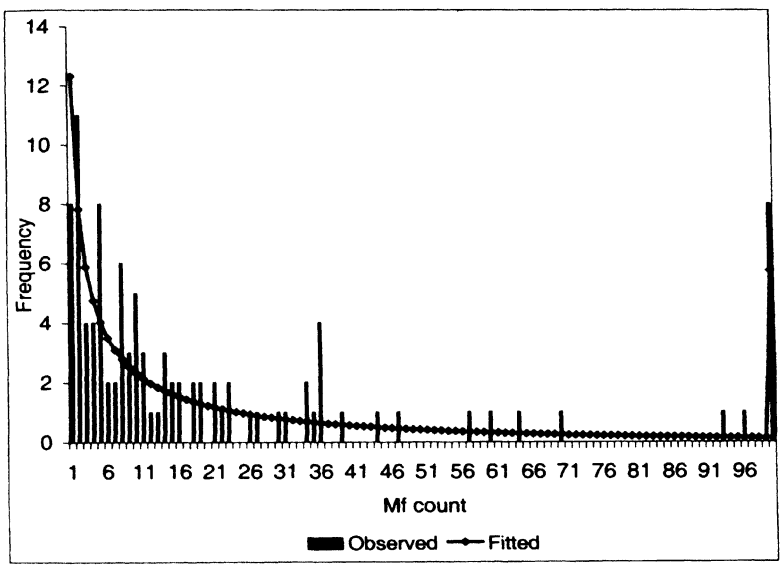



*Fig 6: Observed and Fitted Microfilarial Count Frequencies from Zero Truncated Negative Binomial Distribution*

## 4.5 Discussion

Earlier studies have recorded the nocturnally periodic form of *W. bancrofti*, transmitted by *Cx. quinquefasciatus*, in the Andaman Islands. These Islands are populated by settlers from the mainland. Whereas, Nancowry group of islands, in the Nicobar district comprises of seven remotely located islands, viz., Bompoka, Chowra, Kamorta, Katchal, Nancowry, Teressa and Trinket. These seven islands have a population of about 20000 people, predominantly constituted by the indigenous Nicobarese. They are, endemic for diurnally subperiodic *W. bancrofti*, which have been documented by periodicity studies undertaken earlier (Kalra 1974; Russel *et al.* 1975; Tewari *et al.* 1995). This is further supported by the fact that no *W. bancrofti* infection was detected in *Cx. quinquefasciatus*, which has been discussed in the chapter 6

The findings of the present survey indicate that diurnally subperiodic LF is an important public health problem in Teressa Island, where a population of approximately 2000 is at the risk of infection. Only Nicobarese tribes have been found infected. Uniform coverage could not be achieved in all the villages and both genders. This was mainly due to the inaccessibility of the houses, and non-availability of the male members at the time of survey, as most of the men spend considerable time in the forests to collect forest produce. Earlier surveys carried out in Nancowry group of islands have reported an overall mf prevalence of 11.4% (Kalra 1974), 9.4% (Russel *et al.* 1975) and 12.0% (Tewari *et al.* 1995). The microfilaraemia prevalence of 11.83%, observed in the present study, is comparable with that of earlier reports. On the other hand, all the earlier studies have reported very low overall disease prevalence in these islands. The disease prevalence (5.2%) observed in the present study, which covered all the villages in Teressa island, is significantly higher than 1.6% reported by Russel *et al.* (1975) and 1.9% reported by Tewari *et al.* (1995). The lower prevalence reported by Tewari *et al.* (1995) could be attributed to the methodological differences as only those individuals with visible edema of extremities and those reporting hydrocele were considered as diseased individuals, whereas in the present study, all the subjects were clinically examined by trained health

workers. Both the earlier studies have reported elephantiasis of lower extremities as the commonest clinical manifestation while hydrocele accounted for a small proportion, whereas in the present study about 85% of the diseased men had hydrocele. This further suggests lesser emphasis on physical examination of the subjects in earlier studies. Kalra (1974) reported disease prevalence of 4.5%. However, his findings were based on the examination of 88 individuals from two most remotely located villages in Kamorta Island. More so, the prevalence was based only on cases of elephantiasis. Age and gender specific pattern of disease observed in earlier studies was similar in the present study. However, history of ADL and lymphoedema of upper limbs are being reported for the first time in this island. The current study provides the first report on the prevalence of mf and disease, which covered all the villages in Teressa Island.

Sex wise comparison showed that microfilaraemia and disease prevalence in males was significantly higher when compared to females. This could be attributed to the degree of exposure. Though both the sexes among the Nicobarese are involved in outdoor activities like working in coconut plantation and collection of forest produce, males spend major proportion of their time in the jungles during which they get exposed to mosquito bites. Besides, the males are scantily dressed during their stay in the forest as compared to females; thereby males stand exposed to more quantum of bites than the females. This could probably explain the prevalence of significantly higher proportion of mf and disease cases in the males. Jachowski and Otto (1955) working on subperiodic *W. bancrofti* infection in American Samoa had made similar observations. Elsewhere on the mainland India, this finding corroborates with the general pattern observed by Rao (1977), Rath *et al.* (1984) and Putatunda and Singh (1967) in periodic *W. bancrofti* infection. The present study also showed that the prevalence of acute and chronic signs of filarial disease was age dependent in both sexes.

Adequate comparative data on age–specific prevalence of microfilaraemia and disease are available for the periodic form in India viz., the islands of Laccadive archipelago (Nair 1961), Sitapur (Singh *et al.* 1963) and

Pondicherry (Pani *et al.* 1991). In these three studies subjects were examined for microfilaraemia using the conventional 20-$mm^3$ smear technique as in the present study and, most importantly, were given full clinical examination. The patterns of microfilaraemia and disease observed in the present study were more or less qualitatively similar to that of the periodic form present in mainland India.

Variations in clinical presentations of filariasis are known to occur in different ecogeographical settings. It has been suggested that, in periodic form of *W. bancrofti* infections, genital involvement is the most common and predominantly encountered manifestation (Sarma *et al.* 1987; Pani *et al.* 1989). The results of the present study also showed genital involvement in the form of hydrocele as predominant clinical presentation, accounting for 73.3% of the disease in the community, which is at the risk of sub-periodic form of *W. bancrofti*. Hydrocele as the predominant clinical manifestation has also been reported from South Pacific islands, an endemic tract for subperiodic form of filariasis (Kimura *et al.* 1985)

In the present study, it was observed that about 73% of patients with hydrocele had developed the condition in last five years whereas about 79% of the people with lymphoedema had this condition for more than five years. The mean duration of lymphoedema (20.4 years) was significantly longer than the mean duration of hydrocele (6.7 years). These findings apparently suggest that lymphoedema appear much early in the course of illness in subperiodic filariasis, whereas hydrocele manifests in the later years of illness. However, the age prevalence pattern of hydrocele and lymphoedema showed that hydrocele occurrence in males is earlier compared to lymphoedema. This apparent contradiction could probably be due to the recall history of both the manifestations. It is likely that the community recall about the appearance of symptom is not reliable in the case of hydrocele as compared to lymphoedema. Since the occurrence of lymphoedema is more obvious compared to scrotal swelling, which is often not noticed unless it becomes large, it is possible that the recall for duration of hydrocele is not reflected as actually observed in the

prevalence data.

The effective use of any measure of infection incidence in the study of filariasis depends critically on an understanding of its statistical properties underlying distribution pattern. The current analysis has applied the methods described by Grenfell *et al.* (1990). A similar approach was also adopted by Das *et al.* (1990) for examining the effects of host age on frequency distribution of microfilarial counts in periodic *W. bancrofti.* This model was tested and proved to be satisfactory as a more precise alternative for estimating true mf prevalence. Although the computation is intricate, this method can be used to estimate the expected prevalence, an estimation which was also verified in the present study. The expected mf prevalence was 16.82% in the survey population when the 20-$mm^3$ thick smear method was employed. The frequency distribution generally fits the expected distribution, a truncated negative binomial, very closely. As recorded by Grenfell *et al.* (1990), the total mf distribution across ages is better represented by the more flexible (but less tractable), *Sichel* distribution. This analysis shows that fitting distribution for summed up age produces a simpler statistical description of the observed data. This probably implies heterogeneity in mf distributions with host age. The parameter estimates arising from the fits indicate a probable evidence of a decrease in the degree of over dispersion of the non-zero counts with age. Although the results need to be carefully interpreted, it does provide indirect operation of density dependent limitations on parasite burden, as resulted in mf counts. However, this observation must be validated by a larger dataset. The present analysis is the first demonstration for diurnally subperiodic LF of the operation of such an effect at population level. Whether it is caused by acquired immunity to infection, or the operation of other non-linearities, is unclear. More theoretical (Grenfell *et al.* 1990), epidemiological (Vanamail *et al.* 1990) and imunological studies (Otteson 1984) are obviously required to clarify the implications of this observation.

The fits also allow an approximate estimate of the proportion of false negatives attributable to the blood sampling process, and those which represent

genuinely mf negative individuals. As pointed by Grenfell *et al.* (1990) the zeroes due to sampling may represent around 5% of the total mf negative counts. However, Das *et al.* (1990) demonstrated that even this 5% proportion is enough to increase the estimated total and sex specific mf prevalence by over 50% in periodic *W. bancrofti*. The present analysis estimates the total microfilaraemia prevalence by 42.2%, which is comparable to the observations made by Das *et al.* (1990).

In terms of future research, it is believed that an analysis of the epidemiological processes, which generate observed microfilarial distributions (Grenfell *et al.* 1990) would provide important information about the dynamics of the subperiodic filariasis and in particular, the epidemiological manifestations of acquired immunity. On a more realistic note, this analysis indicates that estimates of mf age-prevalence should take into account of the available distributional information (and its variation with age) to avoid seriously under estimating the prevalence of infection.

Information on the prevalence and distribution of any disease is necessary for determining its public health importance and the subsequent planning of any control programme. Estimates of the burden of lymphatic filariasis have considered only mf carriers and cases of chronic disease. Likewise estimates of the burden of diurnally subperiodic LF in the Nicobar Islands have in the past been based mainly on finger prick method obtained from 20 cu.mm blood samples. Nicobar district has a population of about 39,000. Of the 13 islands in this district, information on the prevalence of filariasis is available only for four islands of Nancowry group of islands. The situation in the rest of the nine islands of this district, with a population of nearly 33,500 is yet to be explored. From the earlier surveys (Tewari *et al.* 1995), it is evident that at least 5562 people are at the risk of this infection in four known endemic islands of Nancowry group. Area specific extrapolation of survey results showed that there were 793 mf carriers and 71 patients in the known endemic islands of Nancowry group (Tewari *et al.* 1995). Elsewhere, the immunochromatographic (ICT) card test (Weil *et al.* 1997) and the ultrasound image of adult worms (Dreyer *et al.*

1996) have indicated infection in a considerable proportion of amicrofilaraemic and asymptomatic endemic population. Studies in Egypt (Weil *et al.* 1996) and India (Pani *et al.* 2000) revealed that 17% of the endemic normals exhibit blood antigenemia, an indication of adult worm presence (Chanteau *et al.* 1994). With these estimates, it is expected that more than 6,660 endemic normal population in the Nicobar Islands might also be infected with adult worms. It is thus evident that subperiodic LF is an important public health problem among the tribal population residing in Nicobar district.