5 *Changes in Population Dynamics of Oc. niveus*

5 .1 Summary

Mosquitoes belonging to 12 species were collected during the study period with Oc. niveus being the most predominant. The percentage of Oc. niveus in the total man landing collections was 89.7% followed by Ae. malayensis (3.4%). The changes in finite rate of increase (λ) during different months of the study period indicate that overall, the vector population showed increase. The pattern of increasing tendency as evidenced by λ values more than 1 for six months in the study period suggests the population has an increasing tendency. A similar pattern was observed among the parous and nulliparous population. The abundance of Oc. niveus was found to range between 2.0 (females per man-hour) during the month of December and 8.1 in February. Seasonal variations in biting densities are evident. The variations in the abundance during the study period are discussed in relation to the rainfall. Besides, feasibility of instituting vector control measures is examined in this chapter.

5. 2 Introduction

Any mosquito population living in a particular ecosystem is expected to grow at a certain rate, to live for a certain period, and to produce a certain number of progeny, usually spread over certain period of its life span. For any one species, each individual in the population will have its own particular rate of development, longevity, and fecundity at different ages in its life. More often than not it is usually more useful, to discuss the mean values for the population. There will be a mean rate of growth of individuals in the population; a mean longevity, which is more usefully considered as a distribution of ages at which different individuals die; a mean fecundity, which is more usefully considered as mean birth rates at different ages of the parent population. The values of these means are determined in part by the environment and in part by a certain innate ability of the mosquito itself. This ability of an insect is referred to *innate capacity for increase*. Nonetheless, the innate capacity for increase is a quality, which is just as characteristic of the species as is, for instance, its size. It is however, a character that is more difficult to measure and define, since it varies widely in different ecosystems. The analogy with size may be carried a little further, for it is well known that for some mosquito population the size may vary with such components of the environment as temperature, humidity, rainfall and so on. Nevertheless, as a rule, ordinary variations in the environment may not make much difference to the size of the insect. On the other hand, relatively small changes in one or another component of the environment may result in vast variations in the insect's innate capacity to increase; so when this factor is considered, it is always crucial to define very carefully the particular ecosystem, which the mosquito population inhabits.

Oc. niveus, the vector of diurnally subperiodic form of *W. bancrofti* in the Andaman and Nicobar islands and also in certain south east Asian countries, breeds extensively in tree holes in the wild ecological niche. Studies carried out so far in these islands have not attempted to describe the population dynamics of this mosquito. Hence the object of the present chapter is to discuss the dynamics of the changes in the vector population in terms of the finite rate of natural increase (Andrewartha and Birch 1954).

5.3 Materials and Methods

5.3.1 Meteorological Data

The meteorological data for the last seven years pertaining to the study area was obtained from the Kamorta observatory.

5.3.2 Monitoring of Changes in Adult Population

Day Man Landing Collection

Mosquito collections were done between the period November 1999 – October 2000. Day man landing collections from dawn to dusk were done at monthly intervals in fixed catching stations from the study sites. During the man landing collection, a human volunteer of the locality, who acted as bait, was made to sit with his normal clothing on the raised wooden platform which forms the part of the Nicobarese hut, adjoining the forest fringe. His exposed body surface was searched and the mosquitoes attempting to bite were collected using oral aspirators by an insect collector. In all day man landing collections, insect collectors worked in shifts, but the same person acted as bait. The hourwise mosquito collection was kept separately and brought alive to the field laboratory. The collected mosquitoes were anaesthetized with ether solvent and separated according to sex and identified (Barraud 1934; Christophers 1933; Knight and Harrison 1987). The species composition, finite rate of natural increase and density were assessed.

5.3.3 Calculation of the Finite Rate of Natural Increase (λ).

The finite rate of natural increase is the number of times a population multiplies in a unit time (Andrewartha and Birch 1954) and is denoted by the symbol λ. The finite rate of natural increase is calculated using the following formula

$$\lambda = e^{r_m}$$

where λ= the finite rate of increase
e= base of Naperian logs
r_m= innate capacity to increase or intrinsic rate of increase

The innate capacity to increase (r_m) is a 'statistic' and is the specific growth rate of a population of stable age distribution and widely used in studying the population dynamics (Southwood 1966; Andrewartha and Birch 1954). The r_m is calculated as follows

$$r_m = \frac{\ln Nt_2 - \ln Nt_1}{(t_2 - t_1)}$$

where

r_m= innate capacity to increase
t_1= population at time t_1
t_2 = population at time t_2

The value of λ = 1 indicates that the population is stable, the value <1 indicates negative growth and >1 indicates positive growth of the population.

5.3.4 Ethical Aspects

The study protocol was reviewed and approved by the Scientific Advisory Committee of Regional Medical Research Centre (RMRC), Port Blair. The study was also reviewed and approved by the Institutional Ethical Committee of the RMRC, Port Blair. While conducting the man landing mosquito collections through out the study period, adequate care was taken that the mosquitoes did not bite the human bait.

5.4 Results

5.4.1 Meteorological Data

a. Temperature:

The average monthly mean maximum and mean minimum temperatures (^{0}C) for the years 1994-2000 are presented in Fig 7. The mean maximum temperature was found to be the lowest during the month of January and increased in the month of February and thereafter it plateaus for the rest of the months in the year. This pattern was more or less similar in almost all years.

During the period (1994-2000) the average monthly mean maximum temperature ranged from 15.2 to 34.5^0 C. The average monthly mean minimum temperature ranged from 12.0 to 29.4^0 C. The difference between the average mean minimum temperature and mean maximum temperature was in the range of 1.9 to 8.1^{0}C. However, there was no noticeable difference in the temperature between the colder and hotter months

b. Rainfall:

The rainfall during the first four months of the year was comparatively lower than the other months of the year (Fig 8). It was found to be negligible only from 1997 onwards. The rainfall increased gradually from April onwards. It was the highest during May, accounting for 16% of total rainfall. The mean annual rainfall for the different years is presented in Fig 9. A maximum mean annual rainfall of 273 mm was experienced in 1996, which was above the average.

c. Relative Humidity:

The average month-wise relative humidity is depicted in Fig 10. The average relative humidity ranged from 77.9 in December to 88.0% in February during the year 1996. The average relative humidity during (1994-2000) was found to range from 72. 9% to 88%.

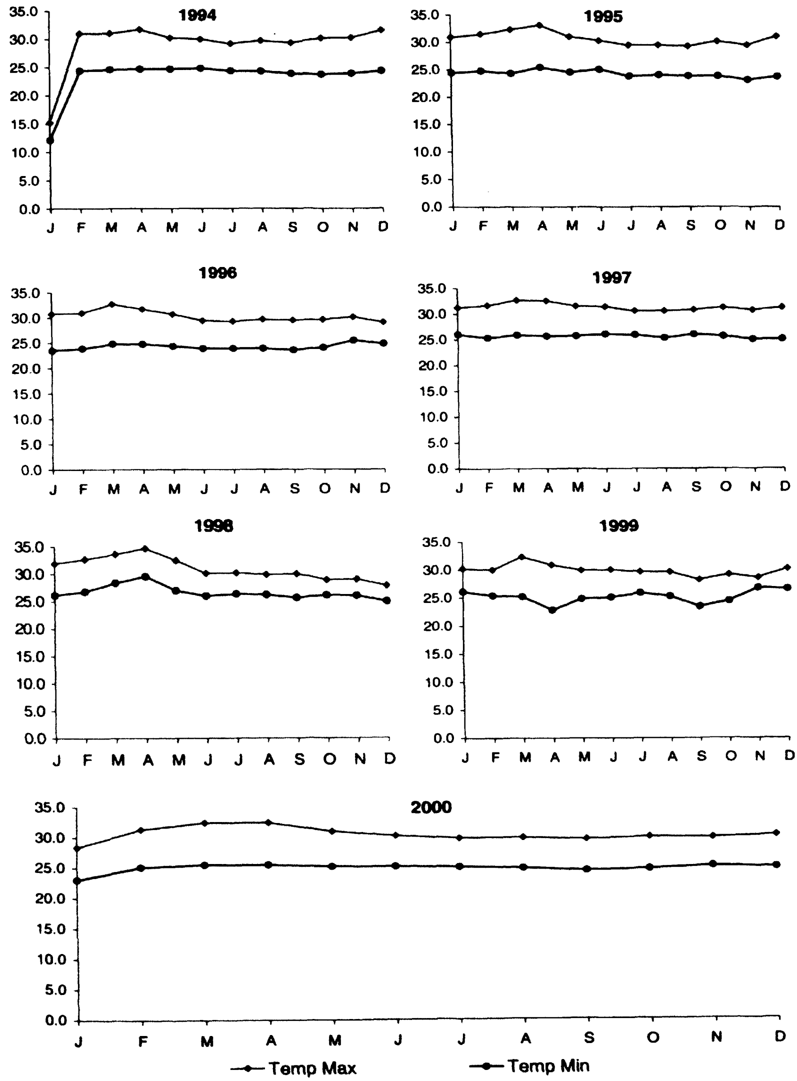

Fig 7: Average Monthly Mean Maximum and Mean Minimum Temperature (^0C) During Different Years.

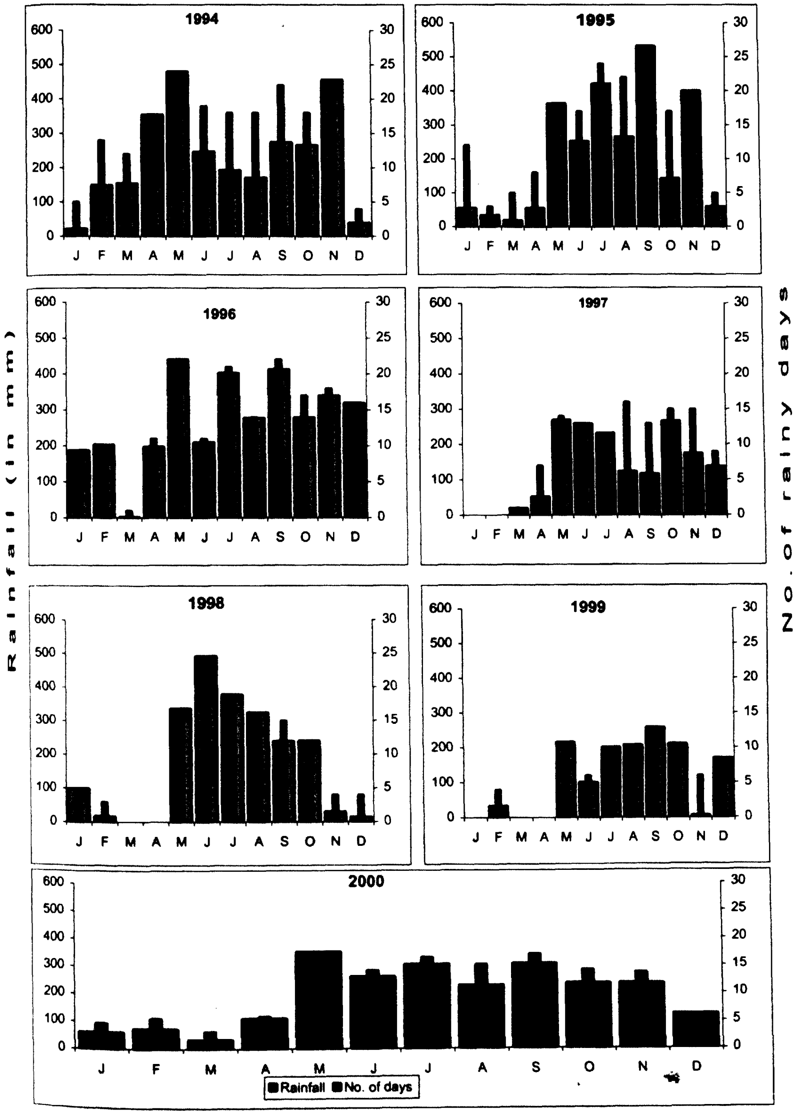

Fig 8: Month-wise rainfall (mm) and number of rainy days during different years

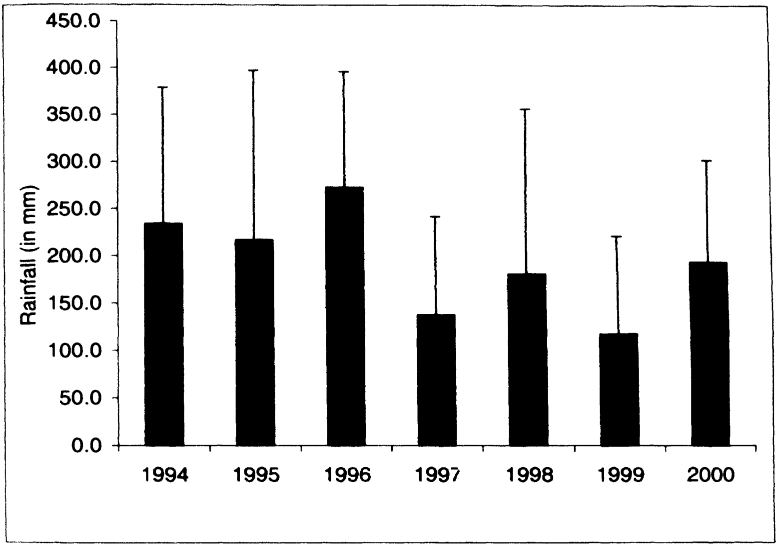

Fig 9: Mean Annual Rainfall (mm) During Different Years

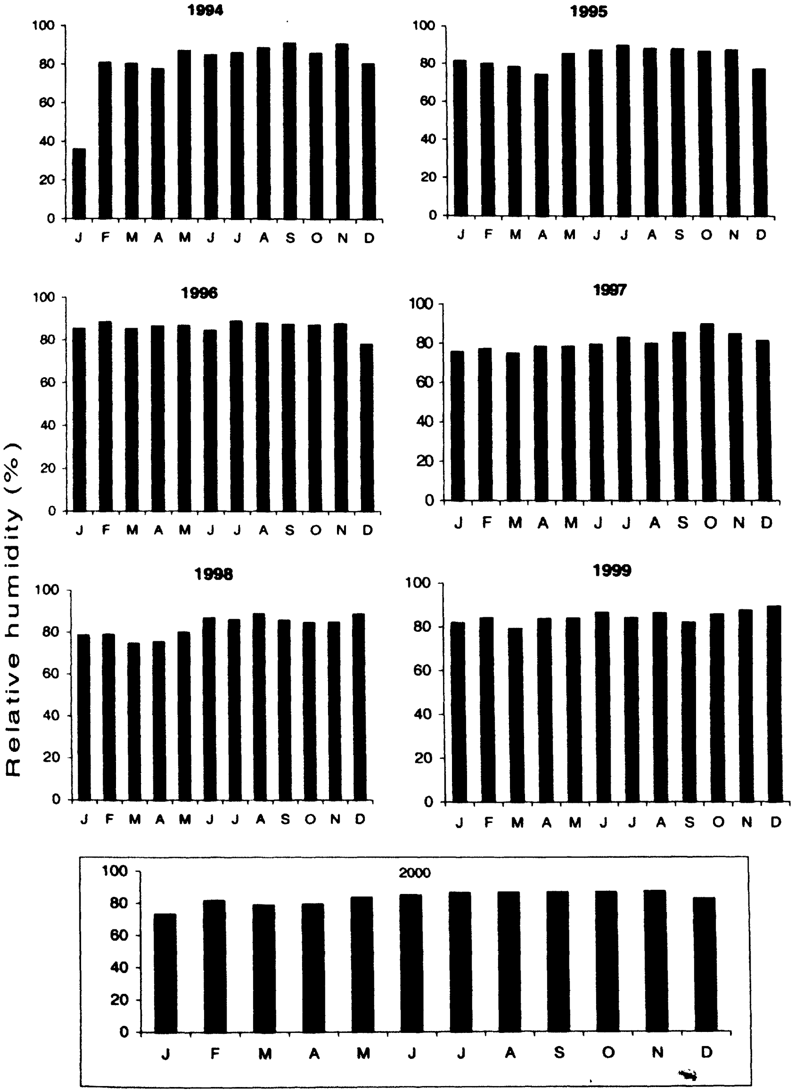

Fig 10: Month-wise relative humidity (%) during different years

5.4.2 Species Composition of the Man Landing Mosquito Fauna

Overall 4039 mosquitoes belonging to 12 species were collected during the study period. *Oc. niveus* predominated among all the mosquitoes collected. The percentage of *Oc. niveus* in the total biting mosquito population was 89.7% followed by *Ae. malayensis* (3.4%). *An. sundaicus, Anopheles theobaldi, Aedes.* (*Stegomyia*) *albopictus, Cx. quinquefasciatus, Cx. sp, Armigeres* (*Armigeres*) *subalbtus, Anopheles* (Cellia) *tesselatus, Anopheles (Cellia) maculatus, Aedes (aedimorphus) jamesi* and *Aedes* (*Lorraina*) *fumidus* formed the rest of the collection in very low percentages (Fig 11 & Table 6).

5.4.3 The Finite Rate of Natural Increase (λ) in Man Landing Population of Oc. niveus

The changes in λ during different months of the study period are presented in the Fig. 12a. Overall, the vector population showed increase and the value of λ was 1 for six months in the year. A similar pattern was also observed in the parous and nulliparous populations (Fig 12b).

5.4.4. Abundance of Oc. niveus

Monthly analysis of data suggests the occurrence of variations in the biting density of *Oc. niveus*. The biting density of *Oc. niveus* was found to range between 2.0 (females per man-hour) during the month of December and 8.1 in February. The density ascended sharply in the early summer month of February and thereafter fluctuated through the other summer months (March-April) and monsoon (May –October) months of the year with a rise in June. In November (winter) there was another similar rise as noticed during the month of June and then descended to the lowest in December (Fig 13). Biting density in relation to rainfall and rainy days (Fig 14) shows that the biting density fluctuates as the rainfall and number of rainy days increase. There was no significant difference in biting densities observed in the three zones.

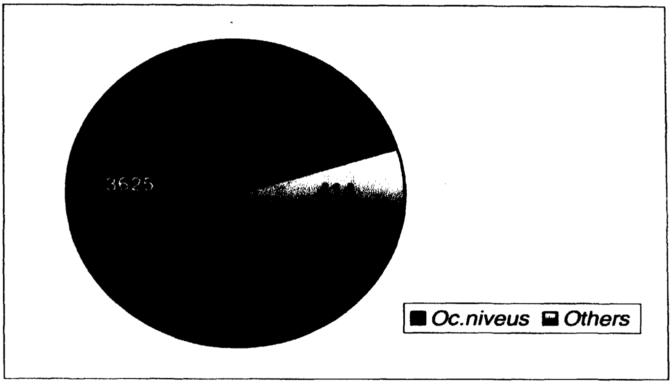

Fig 11: Species Composition of Man Landing Mosquito Fauna

Table 6: Mosquito Species Collected

Species	Number collected	%
Oc. niveus	**3625**	**89.7**
Others		
Ae. malayensis	138	3.4
Culex sp.	110	2.7
Cx. quinquefasciatus	69	1.7
Ar. subalbatus	32	0.8
An. sundaicus	29	0.7
Ae. albopictus	17	0.4
An. maculatus	7	0.2
An. theobaldi	4	0.1
Ae. fumidus	4	0.1
An. tesselatus	3	0.1
Ae. jamesi	1	0.0
Total	**414**	**10.3**

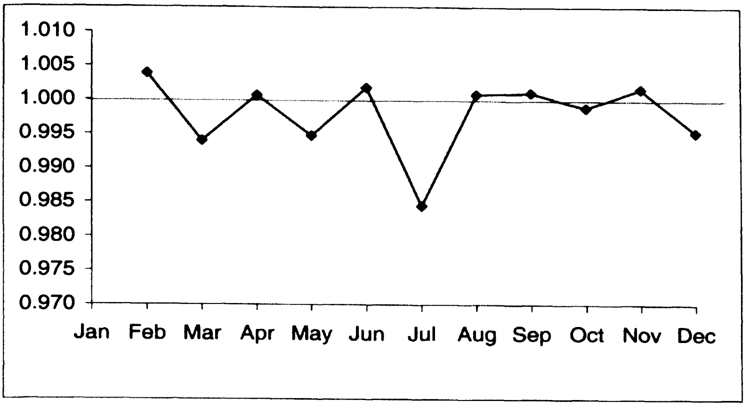

Fig 12a. The Finite Rate of Natural Increase in Man Landing Population of Oc. niveus During Different Months of the Study Period

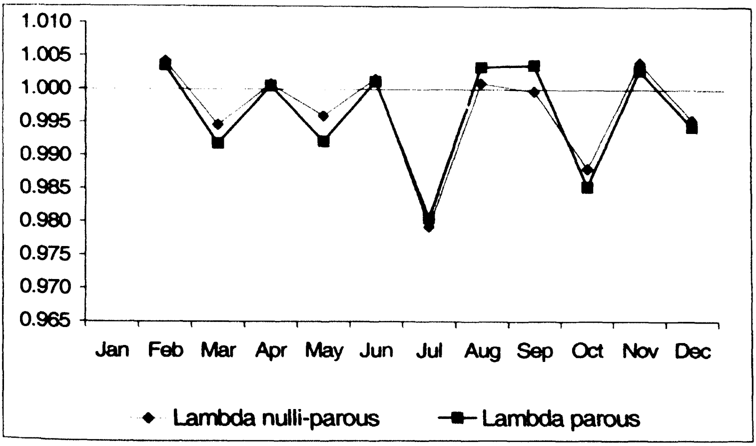

Fig 12b. The Finite Rate of Natural Increase in Parous and Nulliparous Population of Oc. niveus

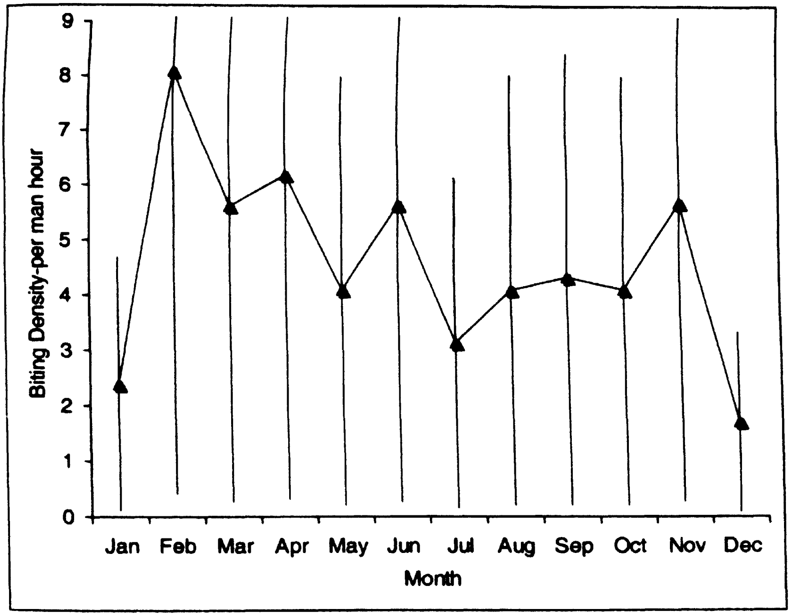

Fig 13: Abundance of Oc. niveus in Each Month (with 95% Confidence Interval)

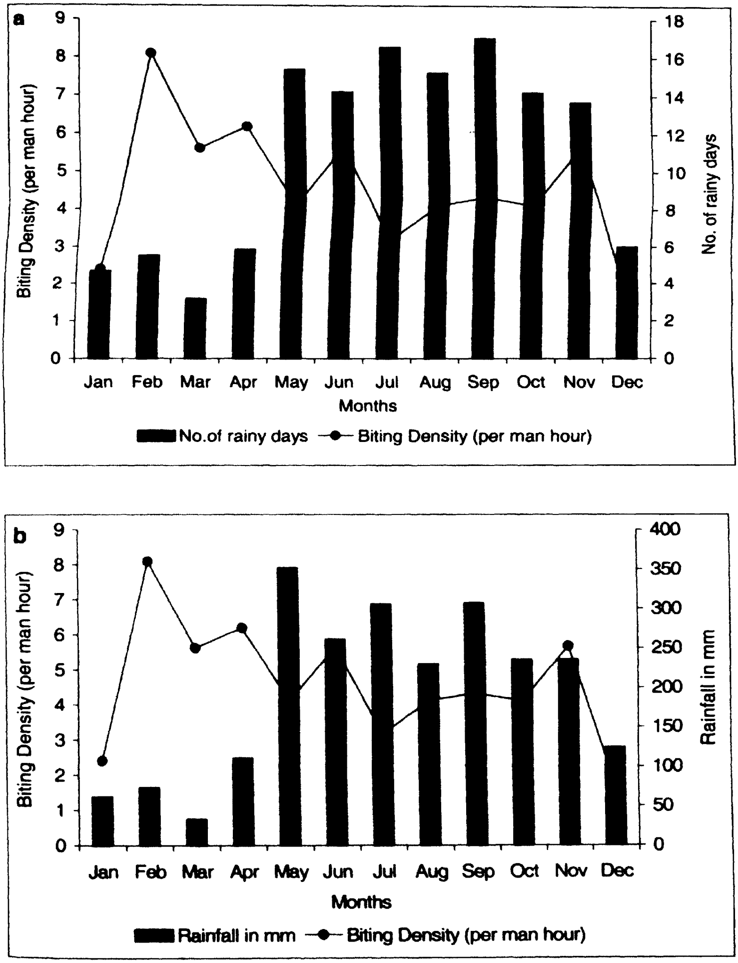

Fig 14: Abundance in Relation to a) Rainfall (mm) *b) Rainy days*

5.5 Discussion

The meteorological data obtained for the seven years (1994-2000) suggest that the year could be divided into three seasons-summer (Feb to Apr), when the temperature begins to rise up to 29^0 C, monsoon (May to Oct), when the rains are substantial and the relatively cool winter (Nov - Jan) with temperatures below 28^0 C.

In the present study, *Oc. niveus* was predominant among the mosquitoes collected in the man landing catches. Tewari *et al.* (1995) recorded five species of mosquitoes viz., *Oc. niveus*, *Ae. malayensis*, *Cx. quinquefasciatus*, *Aedes aegypti* and *Anopheles barbirostris* in the man landing collections. The record of twelve species biting the native aboriginal tribes made in this study, is probably due to the year long observation.

The present information on the changes in population dynamics of biting *Oc. niveus* is the first of its kind in Andaman and Nicobar Islands. The changes in λ during different months of the study period indicate that overall, the vector population shows increase. The pattern of increasing and decreasing tendency as evidenced by λ values on or around at 1 for six months in the year indicates that the *Oc. niveus* population is stable, which is probably due to the absence of control pressure on the wild mosquito population in nature.

The seasonal changes for *Cx. quinquefasciatus* with respect to biting (Ramaiah and Das 1992) and resting (Rajagopalan *et al.* 1977) populations have been documented. Earlier studies carried out by Kalra (1974) Tewari *et al.* (1995) on diurnally subperiodic filariasis in these islands were point studies and hence the pattern of abundance covering all seasons could not be understood. The present study reports for the first time fluctuations observed in the biting density covering all seasons of the year. The overall pattern of biting density of *Oc. niveus* observed in the current study showed that the biting is year round though with some fluctuations.

The relatively low biting density observed from March, April (summer) to May (beginning of monsoon season) in the present study could be attributed due to the drying up of tree holes and decline in adult survival. The onset of monsoon during the month of May aids in filling up the tree holes which had hitherto dried up during the summer months, providing favorable conditions for the eggs to hatch thus facilitating population build up. Subsequently, when the monsoon intensifies and the resultant heavy downpour of rains could as well flush the tree holes thus bringing the population to lower levels and also inputs of adults into the population. When the conditions begin to stabilize the density begins to rise in the month of November (winter) and then dips during December (winter).

Taking into account the exophilic nature of *Oc. niveus* it would be very cumbersome to carry out resting collections in the diffuse forest setting. In such circumstances the only option left with us for estimating the density is by means of carrying out man landing collections. In the present study it is observed that the innate capacity for increase in the parous and nulliparous populations of biting *Oc. niveus* are comparable, which means that both the groups of the population have a tendency to follow a similar pattern in their increase and decrease. Thus it appears that the usage of man landing collection data for such analysis looks to be promising and hence it is proposed that in settings where the vector mosquitoes are exophilic, carrying out resting collections are really cumbersome, man-landing collection could be routinely used to measure density changes. However, more field studies should be undertaken to validate these observations. In a filarial endemic area, such studies carried out on regular basis could yield valuable information. To acquire a full understanding of the population dynamics of this species, intensive studies will be necessary, to cover parameters not accounted for in this study.

From the perspective of control of tree hole mosquitoes, Bonnet and Chapman (1956) in Tahiti, demonstrated the use of cement mortar as a permanent means to control *Ae. polynesiensis,* a prolific tree hole breeding mosquito. This method is excellent for urban areas where the numbers of trees are small, but it is not feasible in diffuse rural sylvan ecosystem like the ones prevailing in these islands. As this area is inhabited exclusively by tribal community who are economically weak this method will prove to be cost prohibitive owing to the cost of materials involved.