6. SUMMARY

6.1. Ecology and Population dynamics of Mansonioides:

A systematic attempt was made to study different aspects of ecology of the adult populations of Mansonioides mosquitoes viz., Manoncia annulifera, M. uniformis and M. indiana, as a prerequisite for launching an efficient control strategy against these vectors of Malayan filariasis in Shertallai region. Besides, these mosquitoes offered an unique topic of an ecological study due to their peculiar adaptations to the aquatic weeds during their immature stages of life and to Brugia malayi parasite in the imaginal stage. The inferences derived from this study are summarized below:

The immature period of these mosquitoes lasted for 19 to 21 days. The breeding habitats were either perennial or seasonal (July-December). The former included approximately 75,000 ponds / closed channels (area : 5.40 Km²), while the latter consisted of inundated fallow lands (7.10 Km²), paddy fields (1.41 Km²), canals (1.42 Km²) and the littoral zone of Vembanattu Lake (0.40 Km²). M. annulifera was chiefly contributed by Pistia stratiotes infested (q=6.76; P<0.01), coconut husk retting (polluted) (q=6.41; P<0.01) habitats, M. uniformis by Isachne miliacea infested clean habitats (seasonal fallow lands) and M. indiana by Eichhornia crassipes infested (q=4.69; P<0.01), polluted (q=7.01; P<0.01)
habitats. The total daily adult emergence (annual average) estimated for the taluk was 45.60 Lakhs (M. annulifera - 21.44 Lakhs, M. uniformis - 20.65 Lakhs and M. indiana - 0.41 Lakhs).

M. annulifera was the most abundant species in both the resting and biting collections. Besides, this species was predominant in all months. M. uniformis was abundant only in the post monsoon season, when its preferred breeding habitats were prevalent. M. indiana was always recorded in less numbers. The average man biting rate (MBR - per man per night) and the indoor resting densities (PMD - per man per hour) registered for these species were 24.67, 12.73, & 0.47 and 3.29, 0.25 & 0.01 respectively. The seasonal biting and resting densities had a linear correlation for both M. annulifera (r=0.7595; P=0.0042) and M. uniformis (r=0.8736; P=0.0002).

The peak of emergence of M. annulifera was recorded in the post midnight hours (24.00 - 03.00). All the three species of Mansonioides mosquitoes were found to be stenogamous. Matings occurred mostly within 24 hours of emergence in the vicinity of host or wherever a chance occurs.

Among the indoor resting population of Mansonioides, 85.90% constituted M. annulifera. However, in the outdoor resting population M. uniformis predominated (98.00%). The statistical analysis of the proportion of these mosquitoes in different biotopes also showed a
significant difference (M. annulifera, \( z=29.75; \ P<0.05 \) and M. uniformis, \( z=31.17; \ P<0.05 \)) in these biotopes, indicating the endophily of the former and the exophily of the latter species. Analysis of the abdominal conditions of the indoor resting and the exit trap collections also confirmed the exophily of M. uniformis. Indoor resting populations sampled during day and different hours of night and the analyses of their abdominal conditions made to discern the house frequenting behaviour of M. uniformis revealed an influx of this species in dusk hours to human dwellings for feeding and an exodus in the dusk hours on the subsequent night of feeding, in search of resting sites, outdoor.

First blood feeding was observed on the succeeding night of emergence for majority of individuals. Host preference studies revealed the zoophily of all the three species (man : cattle biting ratio: M. annulifera - 1.0:4.7, M. uniformis - 1.0:8.5, and M. indiana - 1.0:2.6). However, the host selection studies revealed that M. annulifera is anthropophilic and M. uniformis is zoophilic, their anthropophilic indices being 0.98 and 0.38 respectively. The differences noticed in host preference and selection studies could be clearly attributed to the less cattle : human (1.0:4.4) population of this region. M. annulifera preferred to bite more indoors (endophagic), while M. uniformis outdoors (exophagic). There were two peaks (bimodal) of biting activity for M. annulifera, the major one at midnight hours and the minor one during predawn hours. An unimodal
biting periodicity was recorded for _M. uniformis_, with the peak at dusk hours. A bimodal rhythm was also observed for _M. indiana_, the major peak just after dusk and a minor just before dawn.

The first gonotrophic cycle of _M. annulifera_ lasted for an average of four days (three in hotter and five in cooler months). Durations for the subsequent gonotrophic cycles were three days. The mean fecundity recorded for the first and the consecutive gonotrophic cycles was 134.9±7.3, 130.2±9.0, 109.3±9.0 and 97.3±19.9 respectively. Oviposition activity of this species commenced just after sunset and continued till noon on the subsequent day. The peak of activity (MN 29.91%) was recorded in the last quarter of night i.e., 03.00 hr to 06.00 hr.

For _M. annulifera_ eggs took an average of 5.5 days to hatch. The duration of immatures ranged from 19 (summer months) to 21 (winter months) days. The probability of immature survival was 7.09% for the former, and 8.97% for the latter season. The daily adult survival estimated from parity status varied from 55.03% (May) to 82.45% (January), the average being 78.01%. Survival rates estimated from infection status also revealed a similar trend.

The net reproductive rates (_R_*) computed from life and 0 fecundity tables constructed using immature duration and survival, fecundity, sex ratio, duration of gonotrophic cycles and adult
survival and longevity through different months for _M. annulifera_ were more than 'one', indicating an increase in the population in all months except for May (the last month of summer season), and June (the first month of the monsoon season). The mean generation time ('T') ranged from 29.55 (May) to 34.32 days (December). The intrinsic rate of natural increase was maximum (0.0477) in the month of April. The finite rate of increase ranged from 0.99 in May to 1.0490 in April. The doubling time estimated in days varied from 14.52 (April) to 49.50 (September). Slight deviations were noted between the observed values of finite rate of increase (estimated from indoor resting densities) and the expected values described above. This might be due to the 'environmental resistance' which prevent the biotic potential from being realized.

6.2. Vectorial Potential:

The natural infection and infectivity rates (%) recorded for _M. annulifera, M. uniformis_ and _M. indiana_ were 1.61 & 0.41, 1.64 & 0.24 and 1.00 & 0.33 respectively.

The host efficiency index worked out using a slightly modified method advocated by Kartman (1954) was 0.51 and 0.50 for _M. annulifera_ and _M. uniformis_ respectively. A modified host efficiency index is proposed by the present author to estimate the efficiency of the vectors in nature, using the data obtained from
resting collections. This index estimated for _M. annulifera_ and _M. uniformis_ was 0.1231 and 0.0767, clearly displaying the more efficient role of the former species.

The indices of transmission, such as the Annual Transmission Index (ATI), Risk of Infection Index (RII), Annual Transmission Potential (ATP) and the Annual Infective Biting Rate (AIBR) computed for the three species of _Mansonioides_. All these transmission indices were markedly higher for _M. annulifera_ compared to _M. uniformis_, illustrating the major role played by the former species in the transmission of Malayan filariasis. _M. indiana_ is only a minor vector due to its less abundance. The number of infective bites of _Mansonioides_ required for a patent infection of Malayan filariasis in this region is comparatively less (45.4) unlike the vector of Bancroftian filariasis (Rajagopalan et al., 1977b), revealing a relatively high efficiency of the vectors.

6.3. _Mansonioides_ control - strategies envisaged:

The control of _Mansonioides_ mosquitoes, towards the containment of Malayan filariasis is at present within the realm of possibility if managed by environmental methods, through source reduction coupled with biological or chemical measures. The breeding habitats of _M. annulifera_, the most important vector species are discrete and well defined as evidenced by the studies on adult emergence pattern.
Thus larvicidal operations could yield promising results in control of this species. The efficacy of *Bacillus sphaericus* briquettes in the control of immatures of *Mansonoides* has already been demonstrated through small scale field trials (Pradeeep Kumar et al., 1989). It has also been observed that Baytex (Fenthion) granules (2%) in 0.20 ppm concentration is effective in controlling *Mansonoides* in their breeding habitats (VCRC Annual Report, 1989). The adults of *M. annulifera* are susceptible to HCH (Chandrasekharan et al., 1982). This species being endophilic in its resting behaviour, is vulnerable to adulticidal measures also. A recent experimental trial with Deltamethrin (K-Othrine) in an area of Shertallai region, has revealed a suppression of indoor resting mosquitoes of *M. annulifera* up to a period of two months (Kalyanasundaram et al., 1990). Environmental measures such as removal of weeds from breeding habitats and converting these to fish culture ponds had been implemented in Shertallai region. The community acceptance will also be high for such a programme where the benefits are multifaceted, besides vector control (Panicker and Sabesan, 1990). *M. uniformis* with its versatility in adaptation to a wide variety of host plants and its vast breeding habitats, poses a problem in the control of this species. Since inundated fallow lands during monsoon / postmonsoon season are the most important breeding habitats of these mosquitoes, suitable amendments in civic laws especially through Agriculture Department, against keeping paddy fields uncultivated /undercultivated is highly warranted. Though *M. uniformis* is still
susceptible to HCH and Malathion, adulticidal measures as indoor residual spray is not a practical proposition, due to its exophily and 'opportunistic' feeding habit. *H. indiana*, the less prevalent species, has not yet established as an important vector of Malayan filariasis in this region due to its less abundance.