CHAPTER- II

Density and Distribution of mosquitoes

Introduction

Mosquitoes are hematophagous arthropods, feed on vertebrates and transmit many diseases to man and animals. Though many methods are available to control these insects, still none of the control measures found successful. The vector abundance (Rodriguez - Figueroa et al. (1995) and the distribution pattern (Stephen et al. 2006) are some of the crucial factors, which determine the rapid spread of pathogens thus causing the appearance of outbreaks. The increase of vector density beyond the threshold level would cause the outbreak of vector – borne diseases.
Several ambient factors determine the density and distribution pattern of mosquitoes. The agricultural practices especially in rural areas and peripheral areas in the urban localities continuously provide vast breeding grounds and that support the vector mosquitoes to attain high density. In urbanized ecosystem, year round availability of open sewages and septic tanks acts as the ideal breeding habitats for Cx. \textit{quinquefasciatus} and other species of mosquitoes.

Rapid unplanned urbanization, improper sanitation, climatic factors such as rain, temperature, humidity etc. water supply practices, topographic condition of the land, are some of the important factors that determine the density and distribution of mosquitoes. As the density and distribution pattern of the mosquito species vary with different ecosystems, in-depth and systematic investigations are needed to understand these parameters (Pandian and Manoharan, 1994). Hence, an attempt was made to assess the density and to identify the distribution patterns of different mosquito species existing in the Tiruppuvanam Block area during the study period 2006 – 2008.

**Materials and Methods:**

To determine the density and distribution pattern of mosquitoes in the study area, adult mosquitoes were collected as per the methodology
adopted by Pandian and Chandrashekaran (1980). The adults were etherized and brought to the laboratory and identified. The density pattern was analyzed by the method adopted by Rydzanicz and Lonc (2003). The density of the mosquito species is expressed as percentage. The distribution pattern of different mosquitoes collected in the study area was worked by locating their occurrence on the map and the dots were linked to set a pattern. The details of the methods were provided in the Materials and Methods section.

**Results:**

Density and distribution pattern of mosquitoes are influenced by the presence of suitable hosts and the man-vector contact. This results in the rapid transmission of many pathogens and the spreading of the diseases from one place to another. In this context, density and distribution pattern of mosquitoes in the Tiruppuvanam Block area was studied. A total of 6,675 mosquitoes belonging to 4 genera; comprising 20 species was recorded in the Tiruppuvanam Bock area during the study period (2006 - 2008). The density of different species of mosquitoes collected in the study area was shown in Table 4 & Fig. 8. Table 5 showed the area wise mosquito density and the number of species recorded in different sites. The abundance of different species collected from each site was different, indicating a spatial variation in the density
of mosquitoes (Fig. 9). In addition, the spatial variation in the number of species was also noticed (Fig. 10). The existence of intergeneric variation in the density was observed among the four genera viz. *Culex*, *Aedes*, *Anopheles* and *Armigeres* (Fig. 11).

Among the *Culex* spp., *Culex tritaeniorhynchus* showed the highest density, which was followed by *Cx. quinquefasciatus*, *Cx. gelidus*, *Cx. vishnui*, *Cx. infula*, *Cx. pseudovishnui* and *Cx. bitaeniorhynchus* (Fig. 12).

*Aedes aegypti* was also found predominant among the *Aedes* spp., which was followed by *Ae. vexans*, *Ae. albopictus*, *Ae. vittatus*, *Ae. caecus* and *Ae. pallidostriatus* (Fig. 13). Being a member of the Aedini group, *Armigeres subalbatus* was detected in significant numbers like other *Aedes* species.

Among the *Anopheles* spp., *An. hyrcanus* showed a higher density than other species of *Anopheles*, which were in less number (Fig. 14).

Spatial variation in the density pattern of different species was observed among the eighteen selected sites (Fig. 15 – 20). *Culex tritaeniorhynchus* was the most predominant species in eleven sites (Puliyur, Keeladi, Elanthakulam, Melarangium, Enathi, Kilathari, Pethanendal, Kalloorani, Thirupacheti, Muthuvanthidal and Maranadu). *Cx. quinquefasciatus* was the most predominant species in five sites (Manalur, Tiruppuvanam, Indira Nagar, Madapuram and Odathur).
However, *Anopheles hyrcanus* was the dominant species in two sites (Mukudi and Thavatharendraal).

Three, five and twelve species of mosquitoes showed the three types of density pattern such as dominant pattern, sub-dominant pattern and satellite pattern respectively in the study area during the study period (Table 6 and Fig. 21). Among *Culex* genera, *Cx. tritaeniorhynchus* and *Cx. quinquefasciatus* exhibited a dominant density pattern, whereas, *Cx. gelidus, Cx. vishnui* and *Cx. infula* showed sub-dominant density pattern and *Cx. pseudovishnui* and *Cx. bitaeniorhynchus* showed satellite density pattern (Fig. 22) in the study area. In the case of anophelines, *An. hyrcanus* group and *An. subpictus* exhibited dominant and sub-dominant density pattern, whereas, *An. vagus, An. barbirostris, An. pallidus* and *An. tessellatus* showed satellite density pattern (Fig. 22). *Armigeres subalbatus* showed sub-dominant density pattern. All *Aedes* species recorded i.e. *Ae. aegypti, Ae. vexans, Ae. albopictus, Ae. vittatus, Ae. caecus* and *Ae. pallidostrriatus* showed exclusively satellite density pattern in the study area (Fig. 22).

The distribution patterns of the recorded mosquito species in the study area during the study period was shown in Table 7 and Fig. 23, which showed three patterns of distribution i.e. uniform, discontinuous and restricted pattern. In the *Aedes* genera, *Aedes caecus, Ae.*
*pallidostriatus, Ae. albopictus, Ae. vexans, Ae. vittatus* (Fig. 24 and 25) exhibited restricted pattern in their distribution. However, *Ae. aegypti* showed discontinuous distribution pattern (Fig. 26). *Armigeres subalbatus* exhibited discontinuous pattern (Fig. 27). In the genera *Anopheles, Anopheles hyrcanus* group, *An. pallidus, An. barbirostris* exhibited discontinuous pattern of distribution, (Fig. 28) whereas, *An. vagus, An. tessellatus* (Fig. 29) and *An. subpictus* (Fig. 30) showed restricted and discontinuous pattern of distribution respectively. Two mosquito species namely *Cx. tritaeniorhynchus* and *Cx. quinquefasciatus* (Fig. 31 & 32) exhibited uniform distribution pattern. *Cx. bitaeniorhynchus* was found restricted in distribution in the study area (Fig. 33). Seven species comprising *Cx. gelidus, Cx. infula, Cx. pseudovishnui, Cx. vishnui* (Fig. 34 – 37) exhibited discontinuous pattern of distribution.

**Discussion:**

Mosquitoes causes severe nuisance and its density determines the ability to play its role as a vector in transmission of pathogen to human. Therefore, vector density is considered as an important parameter for surveillance of vector borne diseases, by which the risk of transmission of the pathogen could be predicted and appropriate control strategies can be implemented for the containment of concerned disease. The present survey revealed a spatial variation in the density of vector and non-vector
mosquitoes in the study sites. The factors such as vegetation, availability of breeding habitats and the availability of vertebrate hosts, which was expected to impose control over the spatial density of the mosquitoes recorded.

The study recorded the highest density of Cx. tritaeniorhynchus in the Tiruppuvanam Block area during the study period 2006 – 2008. This may be due to the prevalence of agro-ecosystems and the cultivation of paddy. Geevarghese et al. (1994) recorded the highest abundance of Cx. tritaeniorhynchus in Japanese encephalitis virus (JEV) affected areas in Mandya district, Karnataka, India, between 1983 and 1988. Recently, the high abundance of Cx. tritaeniorhynchus was recorded from Bellary district, Karnataka, India, which was an endemic area for JEV (Kanojia 2007). In Thailand, this again confirmed the availability of vast breeding habitats mainly the irrigated paddy fields existing in the rural and suburban areas in the study sites. The present findings in this study were supported by the earlier reports by Reuben et al. (1992) in southern India, where the irrigated rice ecosystem was found to support profuse breeding of JE vector mosquitoes. Similarly, Kanojia (2007) reported close association of paddy cultivation and population dynamics of Cx. tritaeniorhynchus. The effect of rice culture practices on the abundance of Culex mosquitoes was studied in Thailand. A spatial variation in the
density of three species namely *Cx. tritaeniorhynchus*, *Cx. vishnui* and *Cx. gelidus* has been observed (Takagi *et al.* 1997).

In Vietnam, the effect of host distribution on the density of JE vectors was studied. The results of the multivariate analyses revealed that positive correlation of *Cx. gelidus* density with both the host proximity to the breeding sites and cattle density. On the other hand, the density of *Cx. vishnui* subgroup was found correlated only with the cattle density (Hasegawa *et al.* 2008).

Secondly, the urban mosquito, *Cx. quinquefasciatus* was found dominant when compared to the density of other *Culex* species. However, this species was recorded as the most abundant in Bellary district of southern India (Kanojia 2007). The dominance of *Cx. quinquefasciatus* recorded in the present study indicates the rapid conversion of agro-ecosystem into suburban localities in recent times which could make the availability of different breeding habitats that supported the abundant breeding of the mosquitoes. This could also be reasoned by the easy adaptability of the immature stages of this mosquito in a vast breeding habitat mainly available with polluted stagnant water in rural and suburban ecosystems for proliferation of *Cx. quinquefasciatus*. Moreover, the rapid conversion of rural areas into suburban and urban areas with lack of infrastructure facilities such as
poor waste water disposal system, mainly depend on open drainage system which potentially enhance the breeding surface areas for this species and make it a cosmopolitan mosquito. The abundance of *Cx. quinquefasciatus* was noticed in certain study sites viz. Manalur, Tiruppuvanam, Madapuram and Odathur during the study period. These areas were having a mixed localities including typical rural and suburban areas and which were located very close to the Rameshwaram highway (except Odathur). The observation of spatial variation in the density denotes the strong impact of different ecosystem on the abundance of mosquitoes in the environment.

Similarly, the highest abundance of *Cx. quinquefasciatus* was observed by Gleiser and Zalazar (2009) in Córdoba city and suburbs during 2005 to 2006. This mosquito was recorded from 92% of the sites. The study observed a significant correlation between land cover characteristics and the abundance of other members of the genera *Cx. apicinus*, *Cx. interfor* and *Cx. maxi* that were consistent with previous knowledge about their larval habitat and domestic preferences. This information would be useful for targeting vector control operations.

The density of *Cx. gelidus* was found relatively high in Puliyur area, where paddy cultivation was more during the study period. Similarly, the high abundance of *Cx. gelidus* was documented in three suburban
community\'s in Thailand. The study reported the isolation of seven JEV isolates from *Cx. gelidus* and the greatest abundance of the vector mosquitoes was proposed as a risk factor of the transmission of JEV (Gingrich et al. 1992).

The abundant detection of urban vector mosquito *Ae. aegypti* in rural and suburban areas in the study sites undoubtedly indicated the rapid expansion and succession of this mosquito species in the rural and suburban environment, which pose a serious public health threat to human, as this *Ae. aegypti* is the principle vector of dengue and Chikungunya viruses. Several studies have documented the role of *Ae. aegypti* in the transmission of dengue in rural areas in southern India Myers et al. (1970); Victor et al. (2002); Arunachalam et al. (2004); Tewari et al. (2004) and Paramasivan et al. (2006 b).

*Aedes aegypti* was found outnumbered in density while comparing with the other species i.e. *Ae. vexans, Ae. albopictus, Ae. vittatus, Ae. caecus* and *Ae. pallidostriatu*. The survey has also recorded the occurrence of *Ae. albopictus* in Thirupacheti area during the study period. This was due to the availability of tree holes and other breeding habitat for the breeding of the mosquito in the study site.
The uniform distribution of *Cx. tritaeniorhynchus* and *Cx. quinquefasciatus* in the study sites indicates the availability of suitable mosquitogenic conditions, which include stagnant polluted and unpolluted breeding surfaces equally for proliferation. The discontinuous distribution pattern exhibited by *Cx. gelidus*, *Cx. infula*, *Cx. pseudovishnui*, *Cx. vishnui*, *Ar. subalbatus*, *An. hyrcanus* group, *An. subpictus* and *Ae. aegypti* showed the favourable existence of breeding habitats in different sites and not everywhere in the study area.

A restricted pattern of distribution was exhibited by *Ae. caecus*, *Ae. pallidostriatus*, *Ae. albopictus*, *Ae. vexans*, *Ae. vittatus*, *An. pallidus*, *An. barbirostris*, *An. vagus*, *An. tessellatus* and *Cx. bitaeniorhynchus* and this indicated the non-adaptability of these mosquitoes to the breeding habitat available in the study area.

The findings of the study revealed positive correlation of the density of mosquitoes to the available breeding habitats, host availability and other environmental factors in the study area. The data on the density and distribution of vector and non-vector mosquitoes in the rural and suburban areas showed a remarkable diversity in the abundance and distribution of several species of mosquitoes in the study area during the study period.