Mosquitoes are potential nuisance pests and also they play a major role in the transmission of pathogens, which are the causative agents of malaria, Japanese encephalitis, dengue fever, Chikungunya fever etc. The transmission of these pathogens to human has been estimated directly or indirectly by the diversity, density, distribution pattern of vector mosquitoes in their ecosystems and the feeding and breeding behaviour of the vector mosquitoes and as well by many ambient factors. The climatic and geographical changes due to rapid industrialization, unplanned urbanization, deforestation and other anthropogenic factors have an impact on the bionomics of mosquitoes and this in turn
increases the man-vector contact and subsequently helps the emergence of mosquito borne diseases elsewhere including India. Each state in India by in large is unique in its geographical, environmental, meteorological aspects including pattern of human settlements and agricultural practices and therefore, the incidence of mosquito borne diseases are associated with these parameters.

Tamil Nadu state, which is located almost in southern part of India, is socio-economically dominated by rural areas in addition to many urban places. Both wet and dry cultivations have been carried out throughout the state except some hilly terrains and several irrigation projects and methods enhance these agricultural activities. The conversion of agro-ecosystem into human settlement areas has a greater impact on the species diversity, density, distribution patterns and behaviour of existing mosquito species including vectors in a drastic manner. As these changes are taking place in a continuous way, it is mandatory to review the mosquito fauna and their bionomics in a systematic way to manage the proliferation of mosquitoes especially in the endemic and epidemic areas.

In this context, a systematic study was undertaken in the selected sites of Tiruppuvanam Block, Sivaganga district, Tamil Nadu, after proper stratification study sites selection. The standard methods have
been employed in this study to collect adequate and as well as appropriate information about mosquitoes and mosquito borne diseases. The major objectives of this study are to document diversity, density, distribution patterns and behavioural expressions of mosquitoes and to review the incidence of mosquito borne diseases and the steps taken by State Health Department and local community to control the mosquitoes and the mosquito borne diseases. The study was conducted from January 2006 to December 2008.

During the study period, twenty species of mosquitoes were recorded from the eighteen selected study sites comprising both rural and suburban areas in Tiruppuvanam Block. A high degree of biodiversity ($\alpha = 0.7$) was recorded as the mosquito species belong to four genera namely Aedes, Armigeres, Anopheles and Culex were found prevalent. Among the twenty species, Culex tritaeniorhynchus and Culex quinquefasciatus were recorded in many sites, indicating their dominance in their occurrence. The highest degree of biodiversity was recorded in Kilathari site ($\alpha = 0.76$), whereas the very low degree of biodiversity was observed in Madapuram site ($\alpha = 0.1$) and the rest of the sites showed a moderate biodiversity patterns. This indicated a spatial variation in the occurrences of species in a single geographically and environmentally identical area. Five patterns of occurrences of mosquito species such as constant, frequent, moderate, infrequent and sporadic patterns were
recorded in whole study period. Among the twenty species recorded, nine and two species showed sporadic and constant patterns respectively, indicating variation in the diversity of mosquito species.

To compare the diversity pattern and closeness of different species of mosquitoes, molecular biology tools were used for the analysis. By using PCR based DNA barcoding methodology, approximately 550 base pairs product of Cytochrome c oxidase -1 (CO1) gene region of the thirteen species of mosquitoes were amplified. Followed by nucleotide sequencing of the CO1 gene of the major vector species of mosquitoes, i.e. *Aedes aegypti*, *Ae. albopictus*, *Culex tritaeniorhynchus* and *Cx. quinquefasciatus* that were collected from the study area, which were morphologically identified at adult stage initially using standard keys, were compared and the dendogram was drawn to compare the closeness of these species. The nucleotide sequences of the CO1 gene of these four species were submitted to NCBI Genbank database and the accession numbers were obtained. Phylogenetic analysis clearly segregated the mosquito species tested with the other representative species and the results were found correlated with the conventional dichotomous tree.

The relative abundance of each mosquito species exhibited spatial variation in the study area. Further, the existence of both intergeneric and interspecific variations in the density was also observed among
Aedes spp., Anopheles spp., Armigeres sp., and Culex spp. The density of Culex tritaeniorhynchus was more than Cx. quinquefasciatus. Twelve, five and three species showed satellite, sub-dominant and dominant patterns of density respectively. Three spatial distribution patterns namely uniform (3 species), discontinuous (7 species) and restricted (10 species) patterns were observed with reference to the occurrence along with the density during the study period.

The analysis of host preference behaviour was done by using the blood fed mosquitoes, which were collected from the study area and these mosquitoes exhibited either anthropophilic pattern (preference towards human) or zoophilic (preference towards animals) feeding habit or combination of both habits. Aedes caecus, Ae. vexans and Culex quinquefasciatus showed anthropophilic feeding behaviour and Anopheles subpictus, Cx. infula, Cx. tritaeniorhynchus, Cx. vishnui and Cx. quinquefasciatus showed a preference to animals. The preferential host selection behavior seemed to be an adaptation for these mosquitoes to share the available hosts in the study area.

When the temporal pattern of biting behaviour of the mosquitoes in the study area was studied, both rhythmic and arrhythmic biting activity patterns were seen. The biting behaviour of the mosquitoes exhibited three patterns of rhythmic behaviour. Armigeres subalbatus showed
typical crepuscular rhythmic pattern. *Aedes aegypti* and *Ae. albopictus* showed diurnal rhythmic pattern and the remaining mosquitoes exhibited mainly nocturnal rhythmic pattern. However, the mid-point values of the rhythmic feeding activity of different species of mosquitoes showed a variation. This helped the mosquitoes to avoid competition and to co-exist among themselves in the diel cycle. In addition, *Aedes pallidostriatu*, *Anopheles pallidus*, *An. tessellatus* and *Culex bitaeniorhynchus* showed a restricted biting pattern in the diel cycle and therefore specific rhythmic pattern in their biting behaviour was not ascertained.

The survey on the location and confirmation of breeding habitats of the different species of mosquitoes was made and these habitats were located either on the ground or above the ground levels. Irrigated paddy field was the most predominant breeding habitat for many species. Further, sugarcane field, the irrigation canal and sewage water bodies were the other breeding habitats of *Anopheles* spp. and *Culex* spp. The discarded grinding stones around the human habitations, with fowl smelling water were the breeding habitat of *Armigeres subalbatus*. The above the ground habitats such as the man-made discarded containers, plastic containers, cement tank, discarded tyre and the grinding stones were the potential breeding habitats of *Aedes aegypti*. The study has identified the common potential key breeding habitats of the mosquitoes
during the survey, which would be helpful in implementing future vector control strategies and also for the containment of vector borne diseases in the study area.

The incidence and possibility of emergence or outbreaks of vector borne diseases were analyzed by three methods in the selected area from 2004 to 2008. The three methods are by reviewing of the health monitoring system, by analyzing the available secondary data regarding the incidence of diseases with state health department and private medical practitioners and by conducting knowledge, attitude and practices (KAP) study among a selected sample of individuals in the study area during the study period.

The existence of well organized structure of health monitoring system and its effective functioning reduced the incidence of mosquito borne diseases and the outbreak of any one of the mosquito borne diseases was immediately assessed and contained in the study area. The study area, Tiruppuvanam Block comes under the Sivaganga district, which is divided into Tiruppuvanam, Poovanthi, Konthagai and Palayanur primary health centers and each center comprises of several health sub-centers. These centres were under the control of able administrators and trained persons and therefore the incidence of
diseases was monitored and management was effectively done to prevent the epidemic outbreaks.

To assess the incidence of vector borne diseases such as dengue fever, malaria, JE, filariasis and chikungunya fever in the study area during the period, the data on human case incidence for Sivaganga district and Tiruppuvanam block area were collected from Sivaganga collectorate office. The findings clearly indicated that the density and circulation of the pathogens of malaria, dengue, filariasis and Chikungunya were kept at mild level in the study area during the study period and this may be due to the presence of the effective surveillance system and by the continuous monitoring of the vector borne diseases and to keep the vector population under control in order to prevent outbreak and resurgence of vector borne diseases. Keeping the incidence of diseases under manageable level was mainly due to the existence of an effective surveillance system and the efficient management of diseases by way of rapid diagnosis and prompt treatment. Private medical practitioners stated that the prevalence of dengue fever, malaria, Chikungunya fever and lymphatic filariasis cases in the study area was in very mild form. Though the diagnostic facility was not adequately available in the study area, the cases were sent immediately to Government general hospital and super specialty hospitals in Madurai, which is located nearby the study area.
Knowledge, attitude and practice studies were found very useful in controlling many vector borne diseases in different countries to understand the prevailing situation of vectors and vector borne diseases and to promote the participations of both the community and the Government in the management programmes. Therefore, the KAP study was conducted by using a well designed questionnaire, to collect the information about the demographic conditions of the respondents, knowledge and perceptions about mosquito borne infections, knowledge about the breeding and feeding behavior of mosquitoes, the efficacy of different mosquito repellents, the attitude of the community towards mosquito control and their involvement and the practices adopted by the community to reduce mosquito nuisance.

The demographic conditions, age, sex, educational background, housing pattern, vocation and their living conditions of the respondents showed variations among the respondents. The role of mosquitoes in the transmission of diseases and the bionomics of mosquitoes were well known by the respondents but the knowledge on role of specific mosquito species in the transmission of a particular disease was not properly understood by them. Media contributed a lot in the dissemination of knowledge of vector borne diseases among the respondents. They expressed the role of public and also the collective role of both the public and the government to manage the mosquitoes were essential. The
outcome of this KAP study clearly indicated the better knowledge, attitude and practices of the community in the study area. Probably this would have led to the reduction in the vector borne diseases during the study period.

The present study provides adequate information about the diversity of species, density, distribution patterns, breeding and feeding behaviour of the mosquitoes that are prevailing in the rural and suburban areas. Further, the incidence of mosquito borne diseases, the surveillance system and the knowledge, attitude and practices of the people in the study area would be easily understood and it is indicated that an ideal system should be present to monitor the mosquito borne diseases and to keep the disease burden under threshold level. It would be possible to reduce the mosquito menace, if an integrated approach is practiced.