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Distribution and abundance of mosquitoes in selected areas of Coimbatore, Tamil Nadu, India

Indumathi G[1*], Manimegalai K[1], Daniel BA[2]

[1] Department of Zoology, Avinashilingam Institute for Home Science and Higher Education for Women, Coimbatore, Tamil Nadu, India

[2] Senior Scientist, Zoo Outreach Organization, Saravanampatti, Coimbatore, Tamil Nadu, India

Abstract

The entomological survey was carried out to record different mosquito species in the Coimbatore district. This study was undertaken from January 2018 to December 2019 in selected areas of Coimbatore. The adult mosquitoes were collected using a Biogent-mosquito trap and collected mosquitoes were identified using standard keys. Totally 2474 mosquitoes belong to eight species in four genera. The maximum number of mosquitoes was collected from the Ramalingam colony followed by Thudiyalur and Koundampalayam. A*edes aegypti*, *Aedes albopictus*, *Culex quinquefasicatus* and *Armigeres subalbatus* were consistently present throughout the study period. The diversity was found to be seasonal dependent, with some species being observed at a specific time point. Mosquitoes spatial relative abundance shows that *Culex quinquefasciatus* is the most abundant mosquito species independently of location. *Aedes aegypti* was predominant in Thudiyalur and Singanallur, *Ae. albopictus* was dominant in Ramanathapuram. *Armigeres subalbatus* were dominant in the Ramalingam colony respectively. The current study provides detailed information about the diversity of mosquito species in the selected areas of Coimbatore City. The species richness was high in Thudiyalur. Information on mosquito abundance can help to identify areas at higher risk of disease transmission.

Keywords: diversity, species composition, abundance, species richness, *cx. Quinquefasciatus*

Introduction

Diptera is one of the largest order of Insecta consisting of more than 85,000 species and it includes a large number of vectors. In this order, mosquitoes are predominant which are placed under the suborder Nematocera and family Culicidae. More than 3100 species of mosquitoes belonging to 34 genera have been recorded and arranged under three subfamilies namely, Anophelinae, Culicinae and Toxorhynchitinae [1].

The dynamics of changing mosquito populations provide essential data for assessing the risk potential for the transmission of mosquito-borne diseases [2, 3]. The breeding environment is essential for mosquito population dynamics because it is the place where many critical life cycle processes take place. The processes are the development of larva, the emergence of adults, resting, swarming and mating of adults [4]. Seasonal mosquito distribution is dependent on climatic conditions, indicating human survival strategies in response to climate variations [5]. Increasing human population, unplanned organization, rapid transportation, unreliable water supplies, and water storage practices result in the rapid spreading of mosquito species [6].Understanding diversity and faunal richness are essential for local authorities to provide an effective and efficient mosquito control program. The diversity and abundance of mosquito species are directly affected by environmental and ecological changes in the area. The diversity among the mosquito species offers insight into the density of vector species during the peak seasons and this understanding helps the authorities establish better prevention and control strategies to avoid the outbreak of diseases in the area [7].

Mosquito surveys provide valuable information on the occurrence, distribution, prevalence and species composition of many mosquitoes in an area that assumes significance due to their public health importance. Among the various infectious diseases, vector-borne diseases are the main burden today and may expect to represent the highest proportionate disease burden in the future [8]. The present study was to determine the abundance and species composition of mosquito vectors, thus providing updated information on the diverse mosquito fauna.

Materials and method

Study area

Different areas were randomly selected in Coimbatore district for present work namely Ramalingam colony, Koundampalayam, Thudiyalur, Singanallur, Ramanathapuram, Madukkarai during January 2018 to December 2018 (Fig.1).

Mosquito collection

Adult mosquitoes were collected using Biogent-Mosquito trap. Biogent mosquitaire trap is an excellent and eco-friendly tool to collect mosquitoes. The mosquitoes were collected at 6.00pm to 8.30 am. Collected mosquitoes were anesthetized using ethanol, examined under a stereo binocular microscope and sorted. The mosquitoes were identified using standard key Christopher [9] and Barraud [10]. During the study period, meteorological parameters such as temperature, relative humidity and rainfall were also recorded. Meteorological data were collected from the Agro Climate Research Centre, Tamil Nadu Agriculture University, Coimbatore.

Statistical Analysis

Diversity studies (alpha diversity) were conducted by

calculating, Simpson's[11] Dominance Index (λ) = 1/Σ (Pi2) and Shannon-Wiener[12] Diversity Index (*H'*) = -Σ *pi* In (Pi) Shannon-Weaver diversity index is commonly used to characterize species diversity in a community, according to both abundance and evenness of the species present and Principal Component Analysis (PCA) was carried out using the software PAST (Paleontological Statistics Software package)[13].

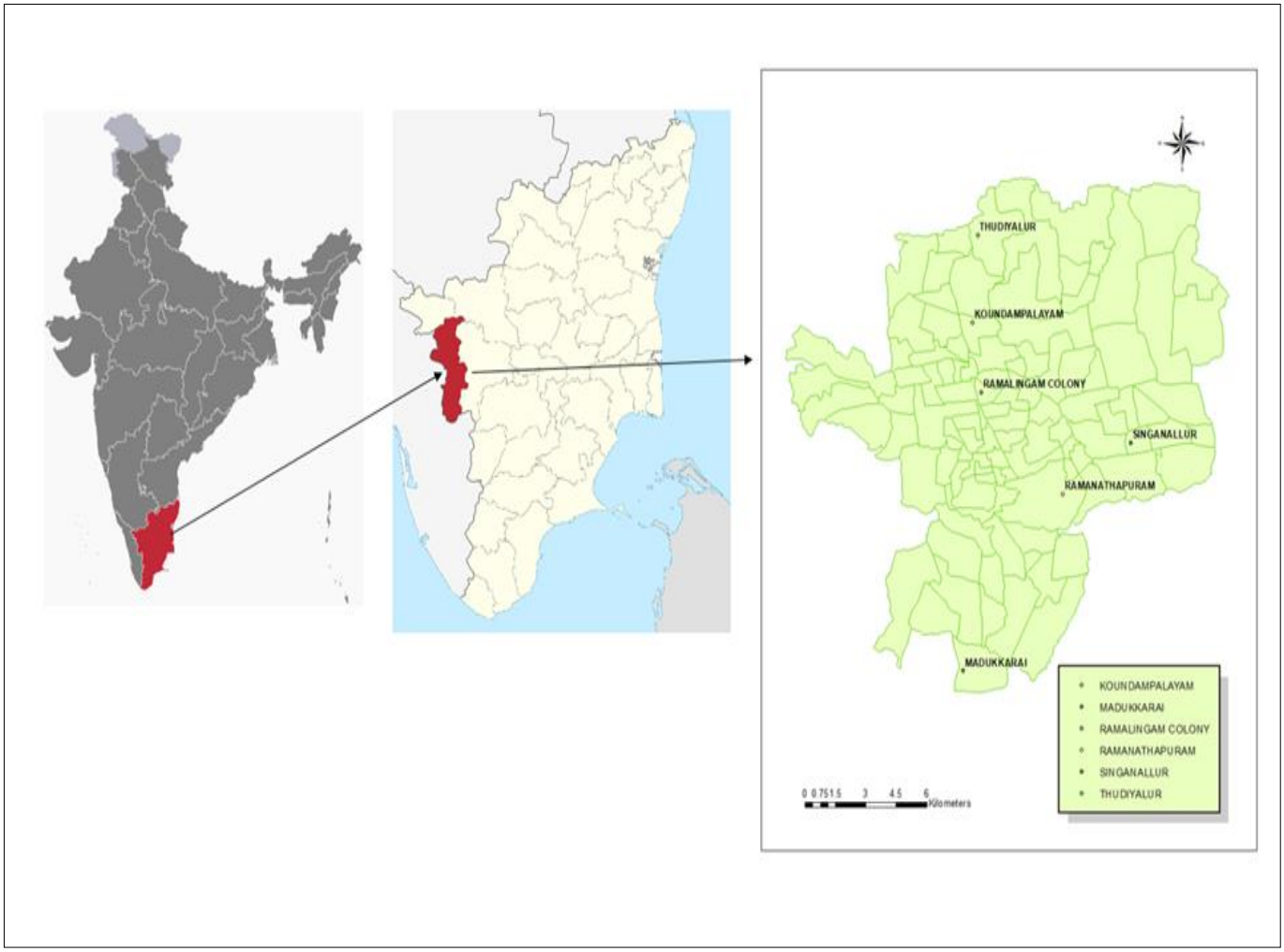

Fig 1: Location map of selected study areas in Coimbatore

Results

The diversity of mosquitoes recorded in the study showed eight mosquito species belong to four genera, namely *Anopheles*, *Aedes*, *Culex* and *Armigeres.* Totally 2474 individuals were collected from the selected areas, among these high mosquitoes population were exhibited in the Ramalingam colony (20.33%) followed by Koundampalayam (15.96%), Thudiyalur (19.88%), Singanallur (10.10%), Ramanathapuram (14.63%) and Madukkarai (19.07%). The four species of mosquitoes were constantly presented during the study period namely, *Ae. aegypti* 23.64% (n=585), *Ae. albopictus* 5.94% (n=147), *Cx. quinquefasciatus* 55.61 % (n=1376) and *Ar. subalbatus* 12.65% (n=313). Remaining species were recorded as infrequent, which included *An. vittatus* 0.68% (n=17), *Cx. vishnui* 0.36% (n=9), *Cx. gelidus* 0.84% (n=21) were illustrated in fig 2.

Culex quinquefasicatus was the predominant species in the Ramalingam colony (n=348) and Koundampalayam (n=237). *Aedes aegypti* was found to be the dominant species in Thudiyalur (n=160) followed by Singanallur (n=119) and *Ae. albopictus* was the most abundant species in Ramanathapuram (n=96) followed by Madukkarai (n=92). The maximum number of *Ae. aegypti* were collected in May (n=86), followed by June, 2018 (n=106) and the minimum number collected in October (n=18) and December 2018 (n=16). *Ar. subalbatus* was highly recorded in the month of March (n=50) and April 2018 (46) and less number in October (n=8). The adult population of *Cx. quinquefasicatus* was the peak in May (n=154) and December (n=152). *Ae. vittatus*, *Culex gelidus*, *Cx. vishnui* and *Cx. pseudovishnui* were found to be less in numbers but they present throughout the study period were depicted in Table-I.

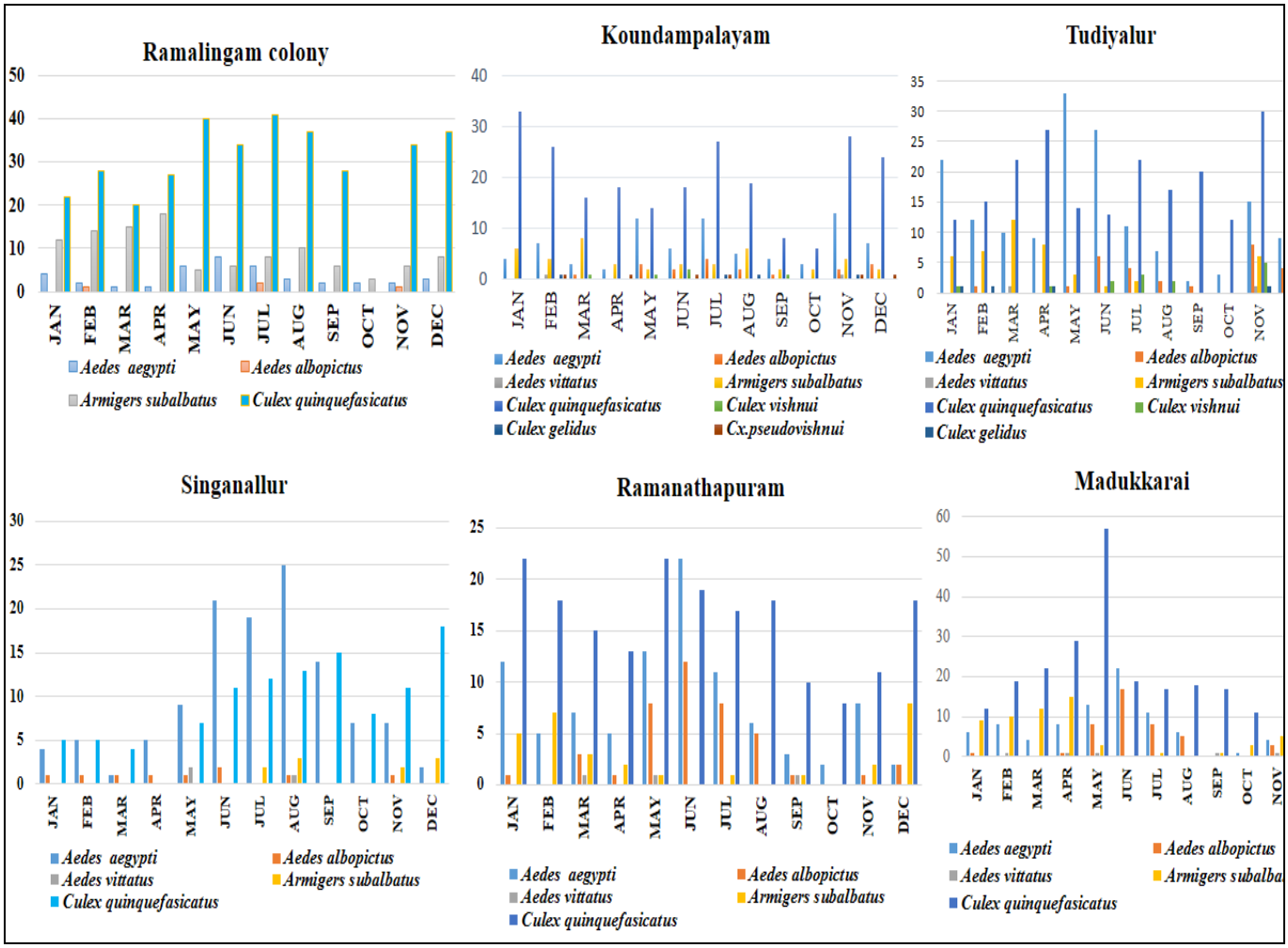

Fig 2: Distribution of Mosquitoes in selected areas during January, 2018 – December, 2018

Total mosquito abundance ranged from 6 to 1376. The monthly quantities of rainfall ranged from 0.00 mm to 259 mm, while the mean monthly maximum temperature ranged from 29.96°C to 35°C and minimum temperature ranged from 18.7 to 23.2. The mean monthly relative humidity ranged from 47.33% to 88.00% (Table-II). Mosquito density was maximum recorded in May (n= 280) and June, 2018 (n= 274) was observed the positive relationship between rainfall and abundance of *Aedes* mosquitoes. Less number of mosquitoes were collected in the month October (71) respectively, month-wise collection showed the relationship between Mosquitoes abundance and meteorological parameters (Table- I).

Table I: Month wise diversity of mosquitoes recorded in selected area during January, 2018 – December, 2018

Months	Maximum Temperature ('C)	Minimum temperature('C)	Relative Humidity (%)	Rain Fall (mm)	*Ae. aegypti*	*Ae. albopictus*	*Ae. vittatus*	*Cx. quinquefasicatus*	*Ar. subalbatus*	*Cx. gelidus*	*Cx. vishnui*	*Cx. pseudovishnui*	Total
January	30.3	18.7	66	2.2	52	3	0	106	38	1	1	0	201
February	32.4	19.5	63	0	39	3	2	111	42	2	0	1	200
March	34.3	22.3	62.5	18.2	26	5	2	99	50	0	1	0	183
April	35.5	24.8	71	45.4	30	3	1	114	46	1	1	1	197
May	32.8	23.5	74.5	259	86	21	2	154	14	0	1	0	278
June	30.3	23.7	75.5	54	106	39	0	114	10	0	4	1	274
July	30.3	23.3	74	73.4	70	26	1	136	17	1	3	1	255
August	30.2	22.9	74.5	60.4	52	15	0	122	19	1	2	0	211
September	32.8	22.4	70	115.7	25	3	3	98	10	0	1	0	140
October	30.4	21.9	75	151.6	18	0	0	45	8	0	0	0	71
November	29.1	21.5	75.5	57.1	49	16	3	125	25	2	5	1	226
December	30	20.8	71	8	32	13	3	152	34	1	2	1	238
Total					585	147	17	1376	313	9	21	6	2474

The highest Simpson's dominance index value of *Cx. quinquefasicatus* 0.3092 and *Ae. aegypti* 0.0558 was recorded. The highest Shannon-Weiner diversity value are recorded as *Ae. aegypti* (0.1480) and *Culex*

quinquefasciatus (0.1417) from January 2018 to December, 2018 (Table -II). The least value was recorded as *Cx. pseudovishnui* (0.0062) *and Cx. gelidus* (0.0090). The highest mosquitoes were observed in the Ramalingam colony and the least mosquitoes were observed in the Singanallur study site of Coimbatore district. From this study, it is clear that there are many chances of dengue and chikungunya viral infection spreading in the sampling sites. To study the spatial pattern, three different areas were selected in Coimbatore city.

The principal component analysis to measure the relationship between distributions of mosquito species with different selected areas. The cumulative variance was 85.71% for PC1 and 10.62% for PC2 loading of variables on species distribution in selected areas (Fig.3)

Table 2: Diversity index of the mosquitoes collected from selected areas during the study period (January 2018– December, 2018)

Name of the Mosquitoes	fi	fi log fi	Pi	Pi log Pi	Shannon Weiner Index H=(N log N - Σ fi log fi / N	Simpson's Index C=Σ (ni/N)2
Ae. aegypti	585	1618.78	0.2364	-0.1480	0.1480	0.0558
Ae. albopictus	147	318.59	0.0594	-0.0728	0.0728	0.0035
Ae. vittatus	17	20.93	0.0068	-0.0147	0.0147	0.0000
Ar. subalbatus	313	781.10	0.1265	-0.1135	0.1135	0.0160
Cx. quinquefasicatus	1376	4318.73	0.5561	-0.1417	0.1417	0.3092
Cx. vishnui	21	27.76	0.0084	-0.0174	0.0174	0.000
Culex gelidus	9	8.58	0.0036	-0.0090	0.0090	0.000
Cx. pseudovishnui	6	4.66	0.0024	-.0062	0.0062	0.000
Total	**2474**	**7099.13**	**0.9996**	**-0.5233**	**0.5233**	**0.3845**

fi: Abundance of species; *N*: Total number of individuals; Pi: Proportion of individuals found in the species; In*:* The natural (Naperian) logarithms (loge); (ni/N)2 = (Pi)2.

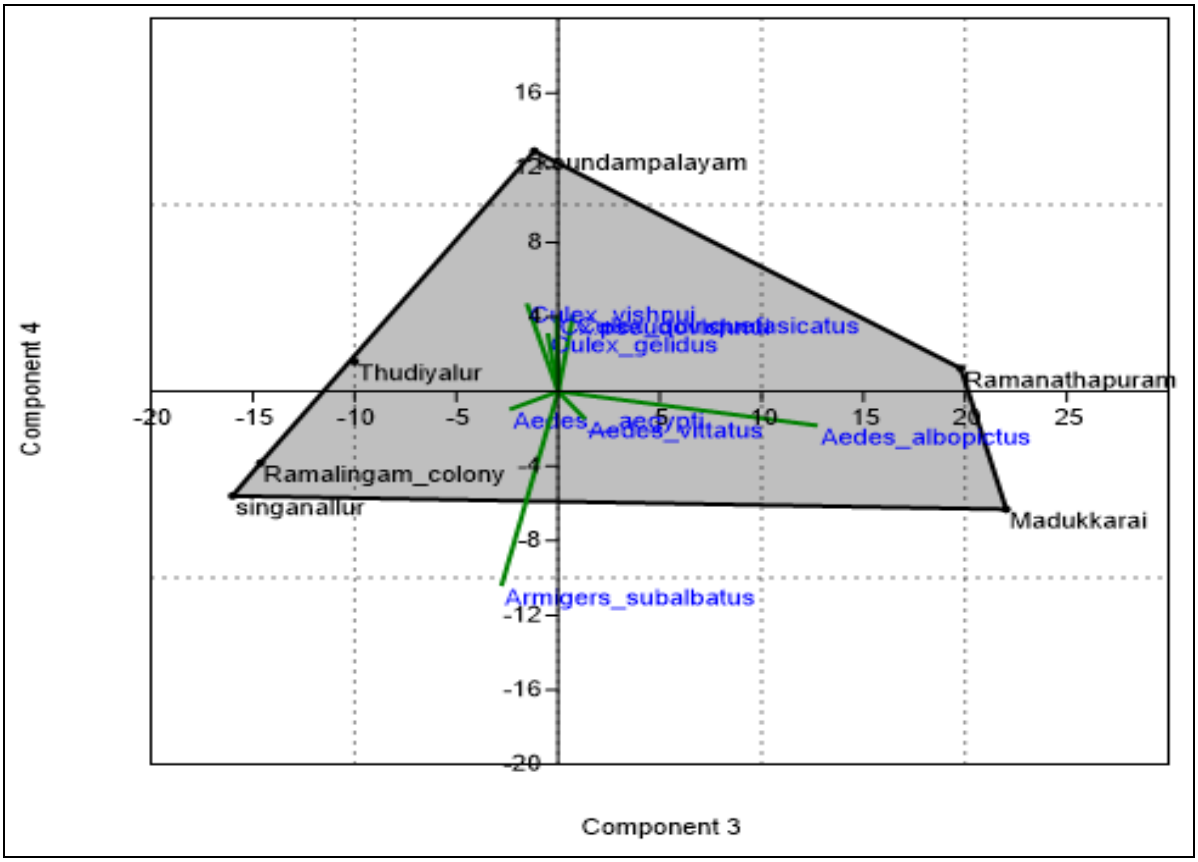

Fig 3: Principal component analysis showed the abundance of mosquitoes in selected Sampling site

Discussion

The present study was conducted to indicate the prevalent mosquito vectors and their distribution in selected areas of Coimbatore. The survey revealed the prevalence of eight mosquito species namely, *Ae. aegypti, Ae. albopictus, Ae. vittatus, Armigeres subalbatus*, *Cx. quinquefasciatus*, *Cx. vishnui, Cx. pseudovishnui*, and *Cx. gelidus*. The results highlight the potential risk of vector-borne diseases in the selected areas. Wild species breed in rock holes and tree holes in forest areas, but due to deforestation, these mosquitoes now adapted to breed in discarded tires in many parts of India [14]. Among the genus *Culex*, the *Cx. vishnui* is zoophilic and outdoor resting and is considered a JE vector in India, Malaysia and Taiwan and widely distributed in rural areas [15].

Culex species prefer to live in sewage canals, ditches, cattle sheds, rice fields and open drainage systems at outdoor habitats. In the present study, *Cx. quinquefasciatus* was recorded as the dominant species and they are the principal vector of bancroftian filariasis. The lack of adequate wastewater disposal and poor sanitation provides a rich source of this mosquito's breeding places. This mosquito was abundant throughout the study period, being the main species collected in the dry season. These results are also consistent with several [16, 17]. Skovmand *et al.* [18] have revealed that *Cx. quinquefasciatus* is more common in urban areas and also considered the most dominant species in almost all cities in West Africa.

Mosquito abundance varied during the study period in response to prevailing weather conditions. Since insect vectors are poikilothermic and subject to the fluctuating effects of abiotic factors in their environment, of which weather is significant [19]. Increased rainfall promotes favorable habitats for developing insect vectors, particularly

the larval stage [20], thus favoring population growth [21]. In our study, the highest mosquito abundance was recorded during the month of May with the highest rainfall. A similar finding was reported in the study of Uttah *et al*. [22] in Imo State, Nigeria, where a decline in mosquito abundance was found in the months with the highest rainfall during the first year of their study. However, the highest abundance of mosquitoes was recorded during the month, with the highest rainfall in the second year of their study. Ravikumar *et al*. [23] reported that the maximum number of dengue vector *Ae. aegypti* and *Ae. albopictus* are recorded at Mettupalayam during pre-monsoon and post-monsoon season. Similar results were found in the present study, *Ae. aegypti* and *Ae. albopictus* was recorded during the Pre-monsoon and post-monsoon seasons.

Temperature is also an essential factor in the dynamics of mosquito populations. An increase in environmental temperature has been observed to causes a decrease in mosquito generation time, longevity and life expectancy. It increases the growth rate of vector populations and decreases the extrinsic incubation period and increases the pathogen transmission period's length [20]. In the present study, the mosquitoes were present throughout the year, but some species may available during the seasons. Pascual *et al*. [24] support our studies, and the climate-driven response temperature-dependent population dynamic model demonstrates a slight change in mean temperature increase in mosquito abundance.

Urbanization is a continuous process in developing countries like India, which has naturally led to population aggregation. Due to rapid industrialization, large numbers of laborers migrate from rural to urban areas searching for job opportunities. It has resulted in the development of many slums with no proper sanitary and wastewater disposal arrangements. Due to unplanned town expansion, the peripheral areas of towns bordering villages have become semi-urbanized and this process continues unchecked. The results are environmental changes, including the creation of water bodies highly conductive to breed mosquitoes. The increasing breeding potential at these ubiquitous mosquitoes can thus be attributed to the development process [25, 26].

Several studies suggest that the lower the biodiversity, the higher the potential of transmission of diseases. The decline of biodiversity might lead to a faster rate of emergence and re-emergence of infectious diseases and therefore, the infection of a more significant proportion of the human population [27, 28]. Changes in the land use pattern, deforestation, and rapid urbanization result in the proliferation of vector species, thereby promoting infectious disease transmission [29, 30].

In the present study, mosquitoes spatial relative abundance shows that *Cx. quinquefasciatus* is the most abundant mosquito species independently of location. *Ae. aegypti* were predominant in Thudiyalur and Singanallur. Aedes albopictus was abundant in Ramanathapuram. *Ar. subalbatus* were dominant in the Ramalingam colony, respectively. Information on mosquito abundance can help to identify areas at higher risk of disease transmission. These findings warn local health authorities to initiate better surveillance of vector species to prevent their prolife.

Conclusion

In total, four genera of mosquitoes, *Culex, Aedes, Anopheles, Armigeres,* were collected during our study. These genera were composed of eight mosquitoes species, *Culex quinquefasciatus, Aedes aegypti* and *Armigeres subalbatus* being the most abundant. *Culex* was the most frequent and abundant mosquito genus reported in the city independently of season and location. Adequate knowledge of the diversity of mosquito population, preferential habitat selection of vector species, and their distribution will help evolve a suitable strategy to control the mosquito population, thereby preventing mosquito-borne diseases dengue, malaria and Chikungunya, etc. The current study was carried out only in selected areas and recommends further studies to be carried out to explore the remaining areas of Coimbatore city for a detailed checklist of mosquito composition.

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