International Journal of Entomology Research
www.entomologyjournals.com
ISSN: 2455-4758
Received: 30-12-2023, Accepted: 14-01-2024, Published: 29-01-2024
Volume 9, Issue 1, 2024, Page No. 90-95

Study of seasonal and spatial variation of mosquito species in Kalyan, Maharashtra

Meena Poonja
Assistant Professor, Department of Zoology, Smt. Chandibai Himathmal Mansukhani College, University of Mumbai, Ulhasnagar, Maharashtra, India

Abstract
The present study is a rundown of seasonal and spatial variation in the mosquito species diversity in Kalyan city in Maharashtra state, India. The study was conducted between January to December 2021 and the findings disclosed that the mosquito fauna of Kalyan consists of a whooping 19 species of 5 genera: *Aedes, Anopheles, Culex, Armigeres, and Mansonia*. It was also resulted that *Culex* was the most common genus followed by *Armigeres and Anopheles* respectively in all the 5 studied zones and all the seasons. All population dynamics indices indicated that Mosquito species richness (H) was significantly higher ($p<0.05$) in winter than in the rainy season and summer, while the total number of individuals collected was significantly higher in the rainy season ($p< 0.05$) than in winter and summer. It was also found that abiotic factors are pivotal for mosquito population dynamics. The results of this study can be used as early warning indicators for mosquito-borne disease control programs at all government levels.

Keywords: Seasonal mosquito diversity, spatial mosquito diversity, kalyan, mosquito vector-borne disease

Introduction

The prevalence of mosquitoes and the diseases they carry has increased rapidly in recent years due to factors such as urbanization, deforestation, and resistance to insecticides. Despite many efforts to control mosquito populations, mosquitoes continue to coexist with humans and their pets [1, 2]. There are currently 3,539 mosquito species in 112 genera on Earth. These blood-sucking arthropods are known for their role as carriers of various pathogens that cause serious diseases such as malaria, dengue fever, yellow fever, lymphatic filariasis, Japanese encephalitis, and others [3, 4].

Mosquitoes thrive in warm, humid tropical climates that provide ideal conditions for their survival [5]. High temperatures allow them to be active year-round, while moderate rainfall creates puddles in their larval and pupal stages [6]. Considering the medical importance of mosquitoes, it is important to regularly study the diversity of mosquitoes in different regions [7]. This is the basis for studying the biology of vector species and their relationship with the environment and developing strategies to combat mosquito-borne diseases [8].

Land-use change has led to dramatic reductions in total forest area and increased isolation of forest remnants, leading to long-term declines in biodiversity, increased species extinctions, and changes in the characteristics of key ecosystem functions [9]. It leads to changes in land use and vegetation cover causing a decline in bird diversity and butterfly species in shrublands, wetlands, and dry grasslands [10]. Because the occurrence and species richness of some rodents are dependent on shrubby vegetation that provides shelter and food, their diversity is lower in meadows [11]. Therefore, changes in mosquito diversity due to land use changes can disrupt the transmission dynamics of emerging zoonotic diseases [12].

Studies focused on the evaluation of the effects of changes in land use patterns on medically important insect communities (e.g. mosquitoes) are rare [13]. Some of the studies suggest that human-induced land use changes have a positive effect on disease-transmitting insect populations by creating favorable breeding conditions for them. A lot of anthropogenic factors act as root causes of exacerbating mosquito-borne diseases. Some of the factors like clearing land for subsistence agriculture, building dams, and recreational activities often create new habitats for mosquitoes to breed [14].

Invasion allows mosquito populations to increase substantially, thereby increasing disease transmission in human settlements. Furthermore, quantifying responses of vector populations to different levels of anthropogenic disturbance or spatial disturbances is virtually non-existent, and not many studies are done in our targeted area [15]. Therefore, how mosquitoes and other vector communities respond to landscape changes is relevant in understanding the emergence of zoonotic pathogens and the prevalence of their diseases too [16]. Thus, studying the spatial disturbances plays a vital role in understanding of exact prevalence and aftermath of vector-borne diseases [17].

The present study primarily focuses on understanding the response of mosquito species richness and abundance in different seasons and human settlements. The study also focused on understanding the community structure and composition of mosquito communities in different land use types. We conducted our study in Kalyan city which has a mixed land type. In our study, we hypothesized to intercept a vast mosquito diversity from urban areas to homogenous conditions which have simplified habitats and abundant resources for mosquito breeding.

It is found in some earlier studies that cities like Kalyan often favor the breeding of urban-adapted mosquito species and we expected a higher mosquito diversity in our study also. It was also speculated to counter a diverse mosquito community structure and dense composition of vector communities at all sites/zones. To understand the seasonal abundance, a pilot scale study was carried out during three defined seasons (summer, rainy, and winter) of the year. In our study, greater numbers and abundance of mosquito

variety were observed during the rainy season due to favorable environmental conditions for insect development.

Materials and Methods

Study Sites

The present study was carried out in and around Kalyan city of Maharashtra state. The location of Kalyan is 19° 13' 5.9880" N and 72° 58' 41.1168" E. For our proposed study, a total of 10 sites in Kalyan were selected for mosquito collection (Map-1). Sampling areas were selected by considering population density in the region, marshy and dry areas, gardens, Lakeshores, hilly areas, and forest areas along the slow-flowing shore of the Ulhas River in the city.

Mosquito Collection and Identification

Mosquitoes were collected at each site on the 10th day of each month of 2021. 20 randomly selected houses, cattle pens, and outdoor spaces were chosen from each of the 10 sampling areas. The sampling of mosquitoes was done using standard guidelines given for entomological surveillance in the manual of NMRI and between 4.00 to 6.00 pm on the sampling day. During sampling, consent was taken from the head of the household and other authorities. of the selected site. Sampled mosquitoes from all sites were put into BPA-free plastic vials and immediately frozen at 4 °C. All mosquitoes were identified using the standard identification keys of each genus [18-20].

Result and Discussion

a. Meteorological data

For studying the seasonal abundance, abiotic factors data was extracted from the Meteorological Department website, and monthly averages of maximum and minimum temperature; humidity, and average rainfall data are presented below (Table 1).

Table 1: Meteorological data of Thane District from Jan 20211 to Dec 2021

Month	Average Temp. (Max/Min in °C)	Average rainfall (mm)	Average humidity (Max/Min)
January	28/17	13.45	81/30
February	31/17	15.4	80/25
March	31/21	14.6	68/22
April	32/21	14.6	62/18
May	34/21	2.34	58/18
June	33/20	161.0	80/40
July	31/19	759.8	85/70
August	29/21	821.9	95/70
September	30/21	208.1	84/60
October	32120	129.0	81/43
November	30/17	2.4	84/38
December	24/13	5.8	87/36

b. Mosquitoes Genera Distribution

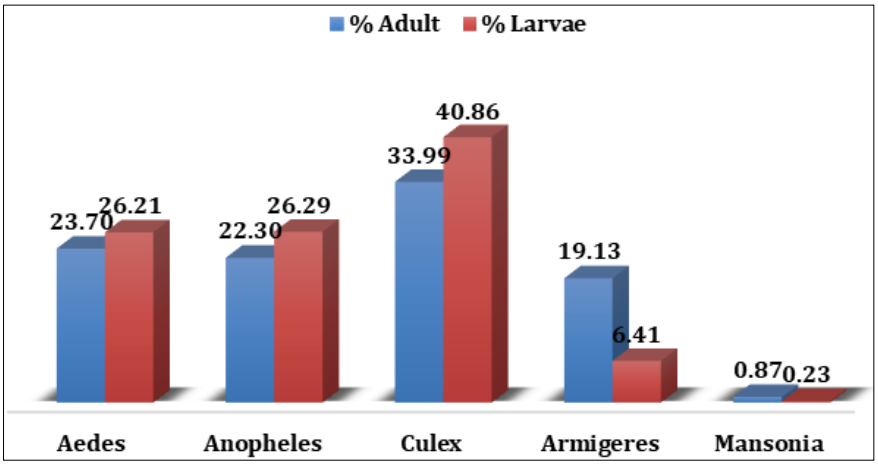

Fig 1: % total of Adult and Larval Mosquito

During our study, a total of 5143 adults and 54230 larval forms of mosquitoes were collected from different sites and in different seasons. The collected mosquitoes were identified by using standard keys meant for species identification given by the National Institute of Malaria Research (NIMR).

Our sampled mosquitoes belonged to five genera (*Aedes, Anopheles, Culex, Armigeres, and Mansonia* (Figure 1)) and nineteen species (Figure 2).

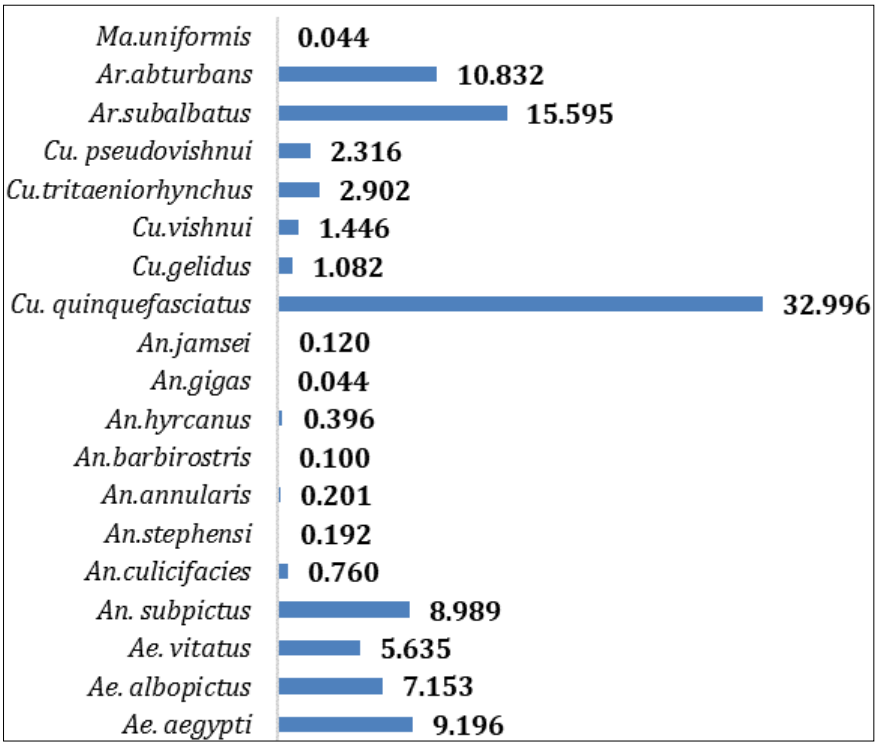

Fig 2: % Distribution of Mosquito Species

c. Species-level Mosquito distribution

When we studied the species-level distribution of all 5genera, the *Anopheles* genus dominated with 8 species, *Culex* 5, *Aedes* 3, *Armigeres* 2, and *Mansonia* representing only 1 species. Among 19 species of mosquitoes, the highest population was of C*x. quinquefasciatus* (32.2%) followed by *Ar. subalbatus* (15.5%) and *Ar. subpictus* (10.83%) respectively. The lowest population among five genera was *Mansonia* genera which showed only one species with 0.044% in the Kalyan Area (Figure 2).

d. Zone-wise Mosquitoes distribution

When we studied the zone-wise species-level distribution of all five genera in Kalyan city, the *Anopheles* genus dominated with eight species, *Culex* five, *Aedes* three, *Armigeres* two, and *Mansonia* representing only one species. Among 19 species, the population of *Cx. quinquefasciatus* was most abundant in the populated zone followed by *Ar. Subalbatus* and *Ar. abturbans*. *subpictus*. All the genera were abundant in all five zones but the maximum mosquito species were found in densely populated zones followed by humid, shore area zones and

dry zones where temperature was maximum. A minimum mosquito population was observed in plain zones where human settlements were not dense and little development was observed. In Zone-2, the humid zone showed a high abundance of all five genera of mosquitoes in Kalyan city (Table 2.)

Table 2: Density of Mosquitoes in Zones

	Zones of Sampling				
Species	**Z-1 (Dry)**	**Z-2(Humid)**	**Z-3(Shore)**	**Z-4(Plain)**	**Z-5 (Populated)**
Ae. aegypti	+	++	+	++	+
Ae. albopictus	+	++	+	+	+
Ae. vitatus	+	+	+	+	+
An. subpictus	+	+	+	+	+
An. culicifacies	+	+	+++	+	++
An. stephensi	-	-	-	-	-
An. annularis	+	+	+	+	+
An. barbirostris	++	++	++	++	+++
An. hyrcanus	+	+	+	+	+
An. gigas	++	+	+	+	+
An. jamsei	+	+	+	+	+
Cu. quinquefasciatus	+++	+++	+++	++	++++
Cu. gelidus	+	+	++	+	+
Cu. vishnui	+	+	+	+	++
Cu. tritaeniorhynchus	+	+	+	+	+
Cu. pseudovishnui	+	+	+	+	+
Ar. subalbatus	+++	+	++	++	++++
Ar. abturbans	++	+++	+	+	++++
Ma. uniformis	-	-	-	+	-

e. Seasonal distribution of mosquito species

In seasonal distributional studies, it was noticed that the maximum density of all five mosquito species occurred in the post-monsoon season. We studied the abundance of all five genera throughout 2021. Throughout the year in all seasons, the abundance of *Culex* was maximum followed by *Aedes and Anopheles* respectively. The maximum number of mosquitoes of all genera were observed in September and October month of 2021 which was the post-monsoon season. A similar trend was observed in all the five zones for all the five genera.

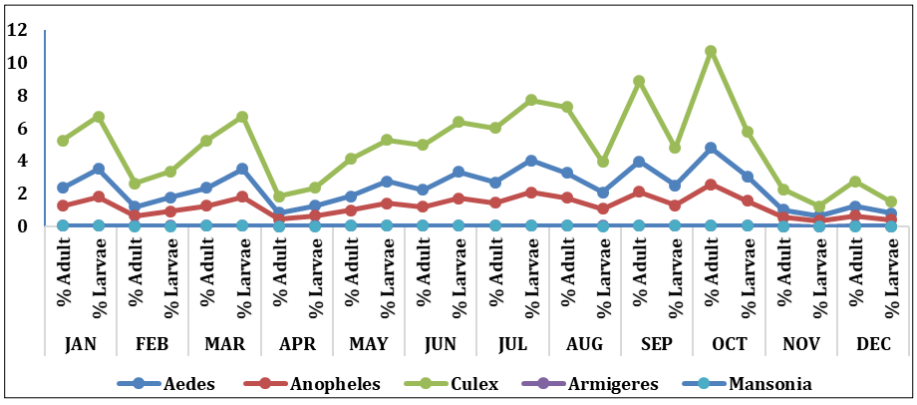

Fig 3: Seasonal Distribution of Mosquitoes Species

f. VBD cases in Kalyan city

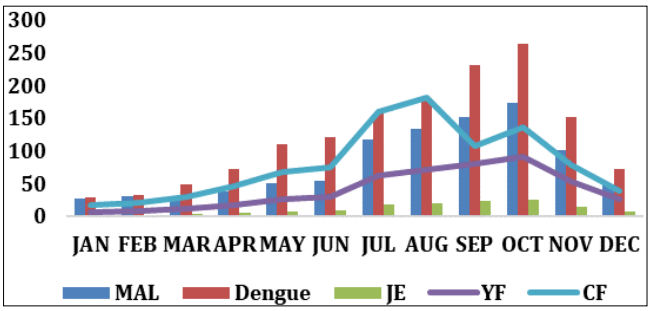

Fig 4: VBD cases in Kalyan City in 2021

The epidemiological data of Thane District city for 2021-22 indicates a high prevalence of mosquito-borne diseases (Figure 4) which correlates with the vector species observed in the area.

The occurrence of lymphatic filarial cases in the Kalyan coincides with a high population of vector *Cx. Quinquefasciatus* in populated areas of Kalyan city and surrounding villages. This may be attributed to poor sanitation, and open drainage systems causing an increase in the density of this species. Water storage in residential areas and continuous use of water coolers may serve as breeding sites throughout the summer for all species of mosquitoes.

g. Species Diversity indices

For studying the mosquito diversity and its population dynamics, indices were calculated as shown below: indices such as the Shannon-Weaver index, Simpson's index, species richness [21-25] like the Margalef index, and evenness as the Pielou index were calculated for three different seasons. The Shannon-Weaver index was highest in winter followed by the rainy season and lowest in the summer season. The Margalef index was found highest in winter at 2.423 and lowest in the rainy season. The evenness index showed a similar trend and was highest in winter and lowest in summer (Table 3.) The total number of observed adult and larval mosquitoes was the highest in the rainy season (1984), followed by the winter season (1741), and the summer season (714). The maximum population of mosquito species was observed during the rainy season of 2021 when the environmental conditions were favorable. The study found significant variations in mosquito density and species richness across different study zones. It was found that environmental parameters around these levels can be used as early warning signs for mosquito population outbreaks, which are directly related to mosquito vector-borne diseases.

Table 3: Biostatic indexes for Season-wise abundance of mosquito species

S.No.	Index	Summer	Rainy	Winter
1	Total no. of species (S)	16	19	19
2	Total no. of individuals(N)	714	1984	1741
3	Natural log of species (In S)	2.741	2.987	2.741
4	Natural log of individuals (In N)	5.841	8.134	7.114
5	Margalef's index (M)	2.124	2.549	2.174
6	Simpson's index (1/D)	5.669	7.668	8.227
7	Shannon-Weaner index (H)	2.124	2.475	2.579
8	Pielou's index (J)	0.784	0.985	0.875

Discussion

This study found that climatic factors affect the mosquito population, which in turn affects the prevalence of mosquito-borne diseases. The study can help determine the appropriate time for mosquito breeding and the abundance of different mosquito species. Molecular techniques can be used to identify mosquito species and bacteria from their guts. The data shows that mosquito species diversity and abundance vary by season, locality, and breeding source. The study can aid in formulating strategies to control mosquito-borne diseases.

Acknowledgments

The authors wish to thank Mr. Tapan Barik, NMRI Delhi for the help in identifying the mosquitoes.

References

1. Abeyasingha RR, Yapabanadara AM, Kusumawathie PHD, Perera D, Peiris BSL, Hewawitharane HMP *et al*. Guideline for entomological surveillance of malaria vectors in Srilanka, anti-malaria campaign, 2009, 1-67.
2. Christophers SR. Family Culicidae, Tribe Anophelini, the fauna of British India, including Ceylon and Burma Diptera Taylor and Francis, London,1933:4:1-271.
3. Dewi M Yuliani, Upik Kusumawathie Hadi, Susi Soviana, EB Retnani. Diversity and Abundance of Outdoor Mosquitoes and Their Relationship to Rainfall Index in Binong Village, Tangerang District Advances in Biological Sciences Research, International Conference, and the 10th Congress of the Entomological Society of Indonesia (ICCESI), 2019, 8.
4. Edillo FE, Toure YT, Lanzaro GC, Dolo G, Taylor CE. Survivorship and distribution of immature Anopheles gambiae (Diptera: Culicidae) in Banambani village, Mali. Journal Med. Ent,2004:41(3):333-339.
5. Gautam A, Pramanic MK, Saha GK. Larval habitats and species composition of mosquitoes in Darjeeling Himalayas, India. Journal of Vector Borne Dis,2006:43:7-15.
6. Gillett JD. The behavior of mosquitoes and the transmission of human disease. Pestic. Sci,1972:3:493-497.

7. Jaid EL, Nikam SV, More BV, Bhandari JC. Diversity of Mosquitoes in Jalna Urban, Maharashtra State, India. Journal of Experimental Sciences,2011:2:11-12.
8. Knight KL, Stone A. A catalog of the mosquitoes of the World. Entomological Society of America, Maryland,1977:6:1-621.
9. Knight KL, Stone A. A catalog of the mosquitoes of the World. Entomological Society of America, Maryland,1977:6:1-621.
10. Moses N, Saidu H, Philimon J, Mohammed S, Abubakar K. Study of man biting rate of mosquito (Diptera: Culicidae): A case study of Gombe State University of Nigeria, ARASET,2006:3:10-20.
11. Nagpal BN, Srivastava A, Saxena R, Ansari MA, Dash AP, Das SC. Pictorial identification key for Indian Anophelines, 2005, 1-38.
12. National Vector Borne Disease Control Programme. Annual technical report, 2019.
13. Pandian RS. Biodiversity of mosquito fauna and efficacy biopesticides against mosquitoes in an urban area in Tamilnadu. Indian Journal of Environmental Science,1998:2:7-10.
14. Poh KC, Chaves LF, Nava MR, Roberts CM, Fredregill C, Bueno R, *et al*. The influence of weather and weather variability on mosquito abundance and infection with West Nile virus in Harris County, Texas, USA, Sci. Total Environ,2019:675:260-272.
15. Qutbuddin M. Mosquito studies in the Indian subregion, Part I Taxonomy-A brief review, Pacific International Journal of Entomology Research www.entomologyjournals.com 19 Insects,1960:2(2):133-147.
16. Reinert JF, Harbach RE, Kitching I. Phylogeny and classification of Aedinii (Diptera: Culicidae), based on morphological characters of all life stages. Zoological Journal of Linnean Society,2004:142:289-368.
17. Reiter P, Cordelier R, Ouma JO, Crop BC, Savage H. First recorded outbreak of yellow fever in Kenya. 1992-1993-II. Entomologic investigation. American Journal of Tropical Medicine and Hyg,1998:59:650-656.
18. Sathe TV, Girhe BV. Biodiversity of mosquito in Kolhapur, Maharashtra. Rivista D Parassitologia,2001:18:193-198.
19. Shannon CE, Weaver W. The mathematical theory of communication. University of Illinois Press, Urbana, 1949.
20. Shinde LV, Thete KD, Chavan RJ, Biradar SG. Vector mosquito diversity in association with environmental factors. The ecoscan,2011:1:191-194.
21. Simpson EH. Measurement of diversity. Nature, 163, 638- 688.
22. Sirivanakarn S. A revision of the subgenus Culex in the oriental region (Diptera: Culicidae). Contributions of American Entomological Institute,1976:12(2):1-272.
23. Sirivanakarn S. A revision of the subgenus Culex in the oriental region (Diptera: Culicidae). Contributions of American Entomological Institute,1976:12(2):1-272.
24. World Health Organization. Malaria entomology and vector control, tutors guide,2003:18:1-41.
25. World Health Organization. Manual on practical entomology in malaria, Part II. Methods and techniques, Geneva, 1975, 1-169.