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Seasonal dynamics and taxonomic diversity of mosquitoes in Nanded, Maharashtra, India

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Abstract
Effective monitoring of mosquito populations is a cornerstone of public health because these insects are the primary vectors of numerous infectious diseases. This study, conducted over a two-year period from January 2024 to December 2025, investigated the diversity, abundance, and seasonal distribution patterns of mosquito genera across urban and peri-urban landscapes in Nanded City, Maharashtra, India. By employing standardized entomological sampling across five distinct sites—Anand Nagar, Shri Nagar, Vazirabad, Taroda, and Degloor Naka—we identified four primary genera: *Anopheles*, *Aedes*, *Culex*, and *Mansonia*. Our findings revealed a clear seasonal trend, with mosquito density peaking during the monsoon (June–August) and reaching its lowest point in winter (January–February). *Anopheles* emerged as the dominant genus, followed by *Aedes* and *Culex*, whereas *Mansonia* was found less frequently. Notably, we observed a slight 6% increase in the overall population density in 2025 compared to 2024, likely driven by year-to-year climatic variations. These results emphasize the profound influence of temperature, humidity, and rainfall on vector dynamics, underscoring the need for climate-integrated surveillance to refine the mosquito control strategies.

Keywords: Mosquito diversity, seasonal variation, nanded city, vector ecology, *Anopheles*, *Aedes*

Introduction
Globally, mosquitoes are among the most formidable vectors of human and animal pathogens, driving the spread of diseases such as malaria, dengue, chikungunya, and lymphatic filariasis (Manikandan *et al*., 2022) [2]. In tropical climates, such as India's, environmental factors and seasonal shifts play a decisive role in shaping the distribution and density of these populations (Annathurai *et al*., 2025) [3].
Nanded City, located in the tropical heart of Maharashtra, undergoes distinct seasonal changes that significantly impact the life cycles and reproductive success of various species of mosquitoes. Understanding these local ecological nuances is vital for anticipating potential outbreaks and tailoring vector-management efforts (Uliyathel *et al*., 2016) [6]. While broad regional research has established that *Anopheles*, *Aedes*, and *Culex* typically dominate the Indian subcontinent, localized long-term data are needed to account for specific microclimates and the effects of rapid urbanization (Shil *et al*., 2017) [7].

This study aims to:
1. Quantify the taxonomic diversity and relative abundance of mosquito genera in Nanded.
2. Characterize how population density fluctuates across different seasons.
3. Analyze interannual trends by comparing data from 2024 and 2025.
4. Provide a scientific foundation for enhancing local public health and vector control initiatives.

Materials and Methods
1. Study Area
The research focused on five diverse locations in Nanded City: Anand Nagar, Shri Nagar, Vazirabad, Taroda, and Degloor Naka. These sites were chosen to represent a spectrum of urban and peri-urban environments, each with varying levels of drainage infrastructure and natural vegetation cover.

2. Sampling and Collection
Mosquito specimens were collected monthly from January 2024 to December 2025. To ensure consistency across the board, we used standardized CO_2-baited traps and manual aspiration techniques. All sampling was performed under stable weather conditions to prevent short-term fluctuations from skewing the results.

3. Taxonomic Identification
Once collected, adult mosquitoes were brought to the laboratory and identified at the genus level using a microscope. This was performed using established morphological keys and standard entomological references.

4. Statistical Analysis
The total abundance and percentage composition of each genus were calculated. Additionally, we compared interannual and site-specific data to identify significant ecological trends over a two-year period.

Results
1. Genus Composition and Relative Abundance
Four mosquito genera were consistently observed throughout the study. *Anopheles* was the most prevalent, making up the largest share of the total collection. *Aedes* and *Culex* followed in abundance, whereas *Mansonia* was the rarest genus, appearing only sporadically in specific habitats.

2. Seasonal Dynamics
A distinct temporal pattern was evident throughout the observation period:
- **Winter (January–February):** Marked by the lowest levels of mosquito activity and abundance in the study area.
- **Pre-monsoon (March–May):** A gradual rise in population density was observed as temperatures began to increase.

- **Monsoon (June–August):** This season represented the peak of mosquito activity, coinciding with the highest rainfall.
- **Post-monsoon (September November):** Characterized by a steady decline in population as breeding sites began to dry out.

In 2025, the total mosquito population increased by approximately 6% compared to that in 2024. Despite this slight rise, the seasonal patterns and ratios between different genera remained remarkably consistent, indicating a stable ecological cycle influenced by yearly climate shifts.

Table 1: Monthly Mosquito Distribution by Genus in 2024

Genus	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
Anopheles	40	45	55	65	75	95	119	131	96	77	68	52	918	35.64
Aedes	30	35	45	55	70	85	103	113	74	69	59	58	796	30.91
Culex	45	50	55	60	70	105	101	104	59	55	46	34	784	30.44
Mansonia	5	5	5	5	5	15	12	8	6	3	2	0	71	2.76
Total	120	135	160	185	220	300	335	356	235	204	175	144	2569	100

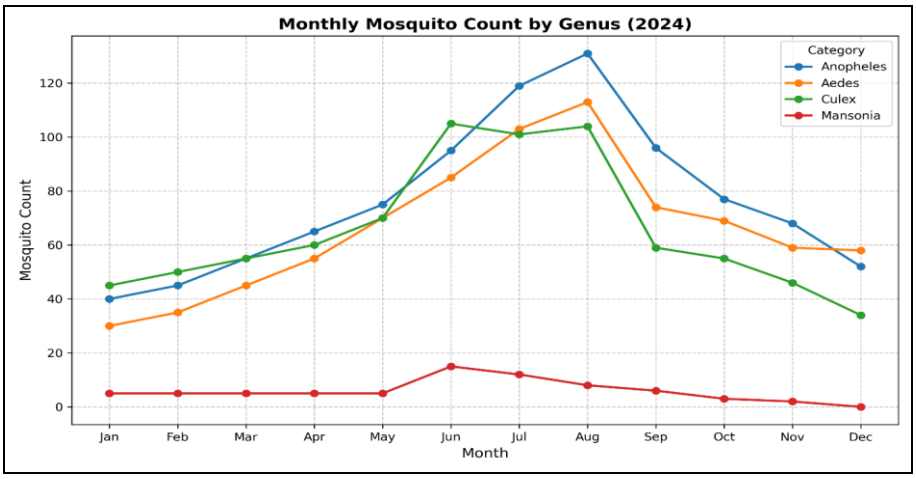
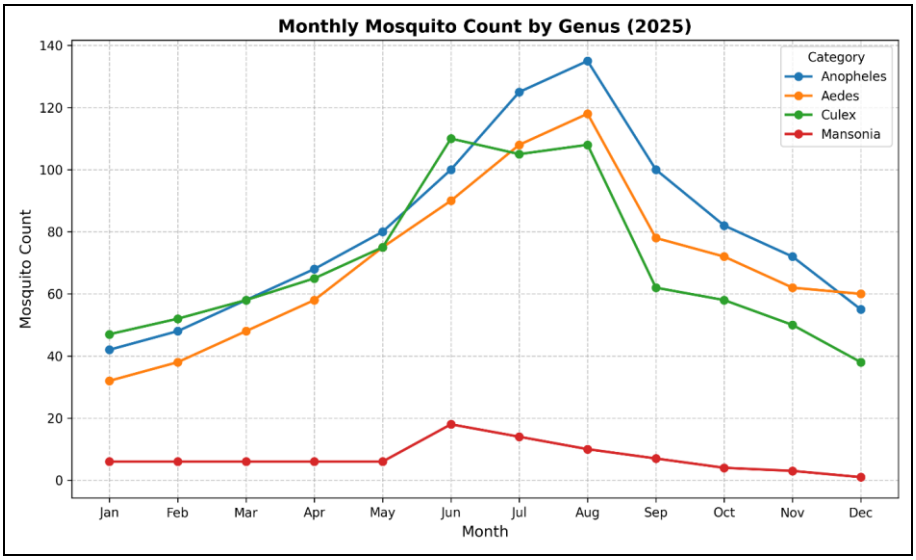


Table 2: Monthly Mosquito Distribution by Genus in 2025

Genus	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	%
Anopheles	42	48	58	68	80	100	125	135	100	82	72	55	965	35.89
Aedes	32	38	48	58	75	90	108	118	78	72	62	60	839	31.21
Culex	47	52	58	65	75	110	105	108	62	58	50	38	828	30.80
Mansonia	6	6	6	6	6	18	14	10	7	4	3	1	87	3.23
Total	127	144	170	197	236	318	352	371	247	216	187	154	2719	100



Discussion

This study clearly demonstrates the strong correlation between seasonal transitions and mosquito population dynamics in Nanded. The surge in numbers during the monsoon is primarily fueled by the proliferation of stagnant water and favorable humidity levels, which create perfect breeding grounds for larval development (Shil *et al*., 2017) [7].

The high prevalence of *Anopheles* mosquitoes indicates an environment well-suited for malaria vectors, posing a

significant public health challenge for the city. Similarly, the widespread presence of *Aedes*, particularly in bustling urban centers like Vazirabad, signals a high risk for dengue and chikungunya—often intensified by man-made containers that collect water (Annathurai *et al*., 2025) [3]. Meanwhile, *Culex* species remained consistently present throughout the year, showcasing their remarkable ability to adapt to polluted urban drainage and sewage systems. The rarity of *Mansonia* is likely due to its unique need for specific aquatic plants (Uliyathel *et al*., 2016) [6].

Meteorological factors, such as rainfall patterns and diurnal temperature ranges, act as the primary governors of these populations. More stable, lower temperature ranges during the monsoon foster higher abundance, while the sharp temperature swings and dry air of winter naturally limit population growth. The 6% increase observed in 2025 suggests that even minor annual climate shifts can impact vector density, highlighting the necessity of adaptive and responsive public health strategies.

Conclusion

The mosquito landscape in Nanded is characterized by sharp seasonal fluctuations and the presence of several medically significant species.

The dominance of *Anopheles* and *Aedes* mosquitoes emphasizes the urgent need for integrated vector control programs that focus on removing larval sources and improving community sanitation. Moving forward, continuous entomological monitoringcoupled with local weather datawill be the most effective strategy for managing and reducing the risk of mosquito-borne diseases in the region.

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