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Exploring (Diptera: Culicidae) Diversity in Suburban Regions: A Case Study of Biradar Colony, Basvakalyan Taluka, Bidar District, Karnataka

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Abstract
In terms of human health, mosquitoes are the most important single family of insects. Despite many attempts to control them, these remarkably evolved mosquitos continue to cohabit with humans, feasting on them and their domesticated animals. Aside from blood loss, mosquitoes can transmit a variety of diseases, such as filariasis, malaria, yellow fever, Japanese encephalitis, dengue fever, and others. Mosquitoes proliferate due to their ravenous feeding habits, high reproduction rate, dispersal potential, and successful environmental exploitation. As a result, it is critical to limit mosquito multiplication to reduce nuisance and vector-borne infections. To effectively control mosquitoes, it is necessary to understand the species composition, density of populations of different species of mosquitoes, distribution pattern, and behavioral expressions of the numerous mosquitoes found in that area. In this context, the current research work attempts to explore the bioecology and behavior of mosquito fauna in Biradar Colony, Basvakalyan Taluka, Bidar District, Karnataka, India.
In this study, the mosquito population peaked in March and subsequently climbed from April to May 2023. Source reduction is an effective method for the community to regulate the population of various mosquitos, eradication. The significance of this work cannot be overstated in developing control methods for this major mosquito vector through good environmental planning and management, which will aid in lowering breeding habitat.

Keywords: Mosquitos, Exploring, Diptera, Culicidae, Diversity, Habitat, Suburban Regions.

Introduction

Mosquitoes play an important function as possible vectors as well as nuisance pests throughout the world. People in tropical regions have been more affected by mosquito-borne diseases than those in temperate zones. Much of the prevalence in the tropical area is driven by biological and environmental factors that encourage high levels of diversity in hosts, vector mosquitoes, and illnesses, and treatment of these diseases looks to be challenging. In the tropics, the most

important component is the interplay of people, diseases, and mosquitos, which spread infectious from one person to another.

The coexistence of mosquitos with hosts and viruses allows them to proliferate and successfully spread diseases in the environment (Williams et al., 2003).

The diversity of mosquito species varies from place to place and is dependent on the presence of a range of breeding sites as well as the availability of diverse vertebrate hosts in addition to humans. The density of vector and non-vector mosquitoes shows a spatial variation because the density is modulated by several ambient factors. The density of diversity of mosquitoes alters the distribution pattern of different species of mosquitoes.

Mosquitoes are unquestionably the most significant insect on a global scale. Over 200 million people in more than a hundred subtropical nations throughout the world are currently at risk from mosquitoes. The World Health Organization (WHO) estimates that mosquitoes kill or contribute to the deaths of one to three million people every year, the majority of whom are children under the age of five. In general, the study of the insect's Entomology requires a broad heading.

Mosquito breeding sites range from vast bodies of water like marshes, rice fields, and ponds to small bodies of water like cesspits, sewers, and puddles. Many species breed in containers such as clay pots, water-storage jars, discarded kitchenware, water-filled eggshells, split coconut husks, bamboo stumps, leaf axils, pitcher plants, and so on. Species' preferences for water vary greatly as well. Few species like very polluted waterways, few prefer relatively clean water, and some fall somewhere in between the two extremities.

Mosquitoes (Diptera: Culicidae) are the most harmful vector because they transmit severe infections. Key mosquito species are transferred into new ecosystems by commerce and travel.

Hence, a systematic study of the biodiversity, density, and spatial distribution of patterns of mosquitoes is very vital for a better understanding of the bioecology of mosquitoes.

Mosquitoes can bite at any hour of the day or night, depending on their behavioral expressions. The majority of mosquitos eat at night; however, others are diurnal or crepuscular. Female mosquitoes feed only once, whereas many species feed in shifts or on many occasions during the night or day. The female of a vector mosquito feeds on the blood of a human or animal host, while females of some species have been observed supplementing their diet with plant carbohydrates. Most female mosquitos, however, require protein sources such as vertebrate blood. Understanding the epidemiology of mosquito-borne diseases of humans and animals, for which these mosquitos serve as vectors, requires a thorough understanding of the mosquito-host connection.

Urbanization contributes significantly to the spread of vector-borne diseases by providing multiple sites for vector breeding, one of the primary goals of larval collections is to identify the primary larval habitats of man-biting mosquitos so that control measures can be implemented. (Babu et al., 2004). Periodic monitoring of feeding and breeding behaviours will aid in the reduction of the mosquito threat in both epidemic and endemic locations. Furthermore, the bioecology of mosquitoes in urban, suburban, and rural settings should be investigated regularly to monitor population dynamics and their impact on vector-borne disease transmission.

The biodiversity of mosquito habitat in Garhwal (Uttaranchal) , India, was investigated. The study was based on mosquito sampling in 450 sites throughout all three districts, each covering

252km and located at altitudes ranging from 300m to 3000m. The species richness was classified as most and least species by calculating the top and bottom five percentiles of species density in each grid cell. Between November 2000 and October 2002, 17 species of Anopheles, 13 species of Culex, and 15 species of Ades were documented. Furthermore, mosquito diversity was higher near riverine regions in densely wooded areas than in non-forested or thinly forested areas. However, biodiversity-rich areas were found at elevations of up to 1200 meters (Devi et al., 2005).

From 1990 to 1999, researchers evaluated culex epidermis seasonal abundance, diurnal
Resting behaviors, eating behaviors, larval habitats, and oviposition in Gorakhpur District,
Uttar Pradesh, India.

Perception on mosquito-borne illnesses in rural parts of Belagavi. Asha Bellad and Shirin Hukkeri conducted community-based cross-sectional research in 2019. This cross-sectional research focuses on measuring knowledge and attitudes. This cross-sectional research comprised 360 people from Primary Health Centres. According to the survey, the majority of the rural population is aware of mosquito-borne illnesses through hospitals and healthcare personnel.

MATERIAL AND METHODS

Study Area:

Bidar

Bidar is the northernmost district in India's Karnataka state. Bidar City serves as the district's administrative headquarters. Geographically, it resembles the "Crown of the State," which occupies the northeastern end. It is bordered on the east by Telangana's Kamareddy and Sangareddy districts, on the west by Maharashtra's Latur and Osmanabad districts, on the north by Maharashtra's Nanded district, and the south by Kalaburagi district.

Bidar district is constituted of eight Talukas:

Namely Bidar, Humnabad, Bhalki, Aurad, Hulsoor, Chitgoppa, Kamalnagar, and Basavakalyan with Bidar being the headquarters of the district. Bidar district is connected by the NH-2 and NH-218 highways.

Old Kalyani today called Basvakalyan, after Basaveshwara in Bidar district was the capital of Chalukyas, which were also called Kalyani Chalukyas after their capital. The
Kalachuris continued with Kalyani as their capital.

The total geographical area of the district as per the provisional figures computed by the Survey of India is 5,451 km^2 (2,105 sq mi), while the reporting area of the district for land-utilisation purposes, as worked out by the State Department of Survey Settlement and Land Records and local bodies, is 5,448 km^2 (2,103 sq mi).

Topography

The district stretches from latitude 17.35'N to 18.25'N and longitudes 76.42'E to 77.39'E[7], and is located in Karnataka's northern maidans, which give a rugged, treeless, broad plateau scenery. The old schistose rocks are protected by the Deccan Traps (Cretaceous Eocene). The most striking feature of these traps is their flawlessly horizontal arrangement. The traps weather with a distinctive spheroidal pattern, and the trap region is littered with countless dark-colored rocks of all shapes and sizes. The soils in this region range from black to deep brown and are rich in humus, making them some of the most prized agricultural lands in the country, ideal for growing pulses.

Physio graphically, the district may be split into two regions: northern lowlands and southern highlands. The southern highlands are generally known as the bidar plateau, which is composed of laterite. The ground heights range from 420 to 648 meters (2,100 to 2,244 feet) above sea level. The land is level, gently sloping to form large valleys and flat-topped hills. The terraced landscape is characterized by flat-topped hills with stepped sides. The sourthen portion of the area is a high plateau that rises around 715 meters above mean sea level and is well-drained.

Weather and climate

The area has a semi-arid climate with severe summers. Dust storms and strong heat waves are prevalent in the area throughout April and May. The coldest months are December and January. The temperature in the district ranges between 20 to 42 degrees Celsius. The summer season in Bidar begins in the first week of March and continues until mid-June. This is followed by the southwest monsoon, which lasts until late September, and Winter occurs from September to the end of January.

The warmest month is May, with an average daily minimum temperature of 16.4 °C.

The highest temperature recorded at Bidar was 43.3 °C on May 8, 1931, while the lowest was 3.9 °C on January 5, 1901.

The average annual precipitation in Bidar is 847mm (33.3in), with the majority of the rain failing during the monsoon season. The rainfall varies greatly from year to year , and the area is prone to drought. Basavakalyan Assembly Constituency is one of 224 seats in Karnataka, India's southern state. This is the Bidar Lok Sabha constituency.

According to the 2011 India Census, the city of Basavakalyan has a population of 69,717, with 36,116 men and 33,601 females. The bulk of the people speaks the Kannada language. Marathi, Hindi, and Urdu are all spoken in the town.

The population of children aged 0 to 6 was 9,949, accounting for 14.27% of Basavakalyan's total population (CMC). Basavakalyan's sex ratio was 930 females to 1,000 males, compared to the Karnataka state average of 973 females to 1,000 men. Furthermore, the child sex ratio in Basavakalyan was around 879, compared to the state average of 948. The literacy rate of Basavakalyan was 77.46%, higher than the state average of 75.36%. The male literacy rate was around 82.46%, while the female literacy rate was 72.13%.

STUDY PERIOD

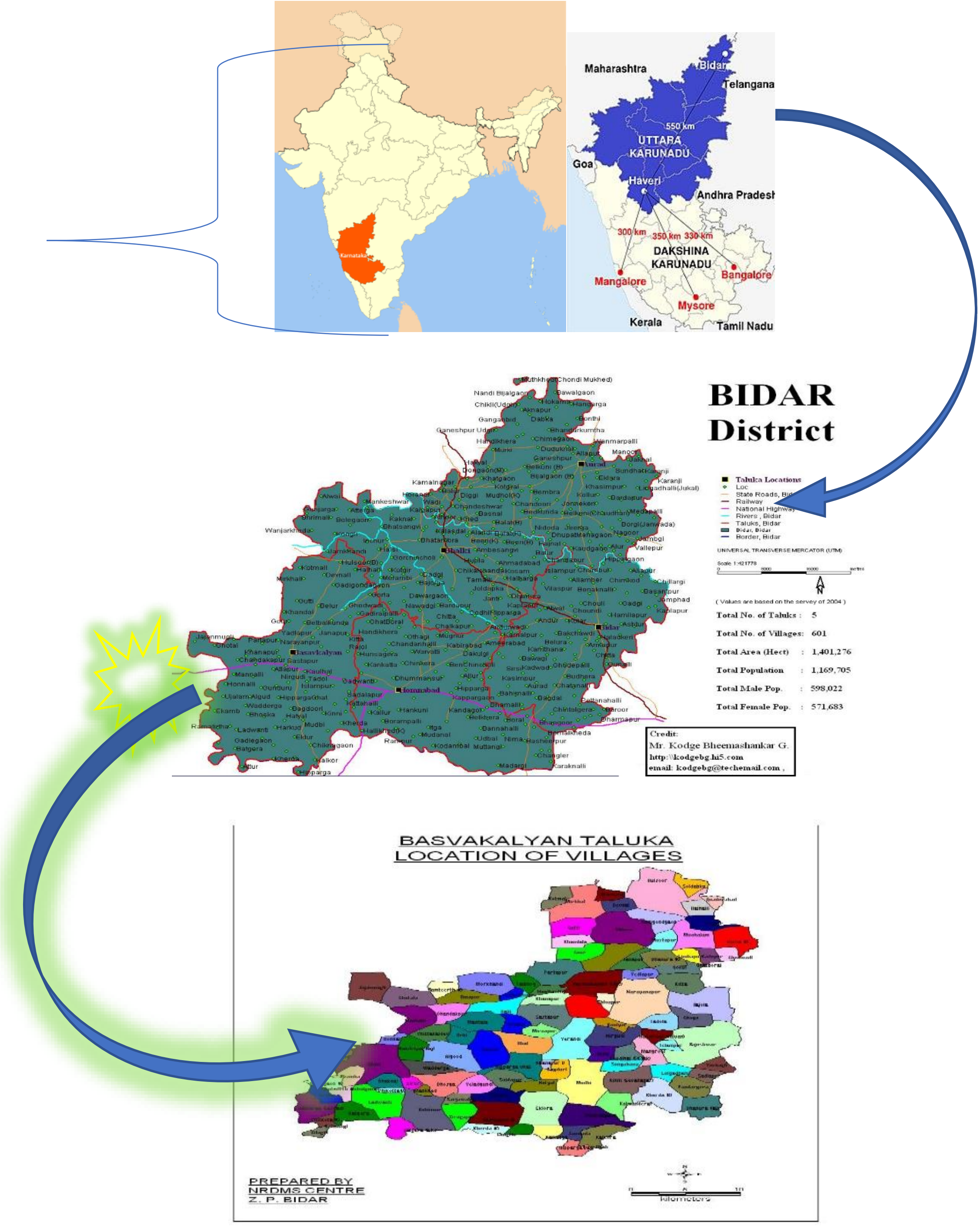
The field study was done at five selected sites in the suburban neighbourhoods of Biradar colony of Basvakalyan taluka from January 2023 to April 2023 in a methodical manner. Monsoon showers improve the breeding habitats of mosquitos in and around this region. In addition to stagnant sewage water bodies and countless containers filled with rain and storage water.

The study was conducted in two periods, which covered the dry and hot summer period and the wet and cool winter period. The collection of mosquitoes during these two periods were made to find out whether there was an existence of variation in the diversity and density of mosquitoes during various months of the year. The first survey was made on weekly. A pilot study has been made from January to April in the study area in a random manner at various sites both in the urban and suburban areas.

SELECTION OF STUDY SITES IN VARIOUS REGIONS

Twenty sites were selected in the central, inner peripheral (urban) and outer peripheral (suburban) regions for this study. Each region has seventeen collection sites. These sites were selected on the basis of stratified random sampling method (Fig.1.). The selection of sites in the central, inner peripheral and outer peripheral regions of basvakalyan was uniform in number and the collections were made to study the diversity and density of mosquito fauna and their behavioural patterns with reference to their breeding and feeding. [add area names of your study location]

Fig.1: Location of study area on map.



COLLECTION OF SAMPLES

1. Identification of breeding habitats

Identification of breeding habitats Careful examinations were made both indoor and outdoor areas to locate breeding habitats of the mosquitoes. The water found in the natural and artificial habitats, which was used by the mosquitoes to breed, was examined very carefully to locate the presence of larvae of mosquitoes. Small pit and damaged road sides hold clear rain water, which remained for about ten days and therefore mosquitoes may choose these places for breeding (Pandian, 1997). Many household materials like pots, grinding stones, coconut shells when left undisturbed get filled with rainwater or other water with some leaves and sediments. These containers were also selected as the breeding places by the mosquitoes.

Apart from these habitats, cattle sheds, the places where the manure was dumped and water was kept stagnant also formed the best breeding places. Several such habitats were identified to find out the preference of the mosquitoes in choosing their ovipositing sites. Small pools and ponds were also checked for mosquito larvae and pupae.

One of the main purposes of larval collection was to identify the available and also the specific larval habitats of man-biting mosquitoes and so this information would help to undertake the control measures. Larval habitats were explored for the presence of immature stages, and the larval and pupal phases were collected using a tea filter.

The treated pipettes, which were ordinary glass pipettes with a wide opening, were also used to collect the larvae from container habitats. In addition, dipper method was used to collect larvae from the large water bodies. The collected larvae and pupae were stored in enamel trays and wide-mouthed bottles. The kind of habitat, date of collection, and location name were recorded on the label and taped to the container for future reference.

2. Method of collection of adult mosquitoes

To evaluate the mosquito diversity, density, dispersion pattern, and biting rhythm, adults were collected for 24 hours at five sites. As humans were the primary source of food, the bite rate served as an important population indicator. Pandian and Chandra Shekharan (1980) utilized this approach to record mosquitos that landed to bite. Biting captures were done at ground level, with one person sitting still and their legs below the knee exposed to be bitten. Clan vials were used to collect the landing mosquitos, which had been killed with ether, and kept in vials (4.5 X 2.5cm) labeled with the time, date, and collecting area. This procedure was continued over 24 hours.

3. Equipment used for studies

- Petroleum ether or Household Insecticide to narcotize adult mosquitoes
- Collection Containers: These are used to store collected mosquitoes and may include:
  - plastic tubes with lids
  - specimen bags
- Sampling Tools: Various tools can assist in the sampling process, including:
- Larval dippers or ladles for collecting mosquito larvae from water bodies
- Illumination device – Battery powered or Flashlight to attract mosquitoes
- Field Notebook and Data Recording Tools: To document collection details, environmental data, and observations, you'll need a field notebook or data sheets, along with pens, pencils, or markers.
- Laboratory Equipment – Binocular Microscope, Slides, Petridish, Forceps, Cover slips, Petroleum ether or formalin

RESULTS AND DISCUSSION:

The interplay of people, viruses, and vector mosquitoes that transfer illnesses from one person to another is the world's most significant issue. Mosquitoes are the major vectors accountable for the spread of many

vector-borne human illnesses.
Furthermore, mosquitoes are regarded as biting nuisance pests throughout the world. Several attempts have been made to suppress them, yet these highly adaptable insects continue to co-exist with humans. Because mosquitoes are proliferating in vast numbers everywhere, it is critical to conduct a periodic inventory of mosquito biodiversity and density in various locations (Pandian, 1998).
The diversity and density of mosquito species in a given location are affected by a variety of environmental conditions. In general, the natural environment has more species richness than created wetlands and other man-made artificial ecosystems. The study of mosquito diversity and pathogen ecology in a specific location could provide additional information on pathogen transmission patterns and their impact on human and animal disease occurrence in epidemic and endemic areas.
Rainwater and sewage water stagnation on the ground and above ground promotes the breeding of container vectors. Furthermore, man-made artificial ecosystems support a high level of biodiversity in mosquitoes. The frequency of mosquito-borne illnesses has grown in recent decades as a result of large-scale agricultural development projects, which have changed the nature and amount of water supplies and potential mosquito breeding locations.
As a result, many vector species reproduce. The agroecosystem has a high level of mosquito fauna biodiversity (Khan et al., 1992). The increased diversity of mosquitoes is mostly due to the presence and abundance of larval mosquito habitats such as permanent and temporary surface waters, tree holes, rock holes, and artificial containers. The larvae were gathered all year, with dry season larval development being restricted to constructed aquatic environments such as drainage ditches at communal water delivery points (Shililu et al., 2003).
Species belonging to various genera collected in two periods from the selected from sites were collected. From these collections, the occurrence of diversity in the species composition has been noticed.

Table No.1. Mosquito species were found in diverse parts of the research area between January 2023 and April 2023.

SI. No	Name of the species	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
1	Aedes aegypti	+	+	+	+	+	+
2	Aedes albopictus	+	+	-	+	-	+
3	Culex Vishnui	-	-	-	+	+	-
4	Culex quinquefasciatus	+	-	+	-	-	+
5	Anopheles stephensi	+	+	+	+	-	+
6	Anopheles culicformis	+	-	-	+	+	-

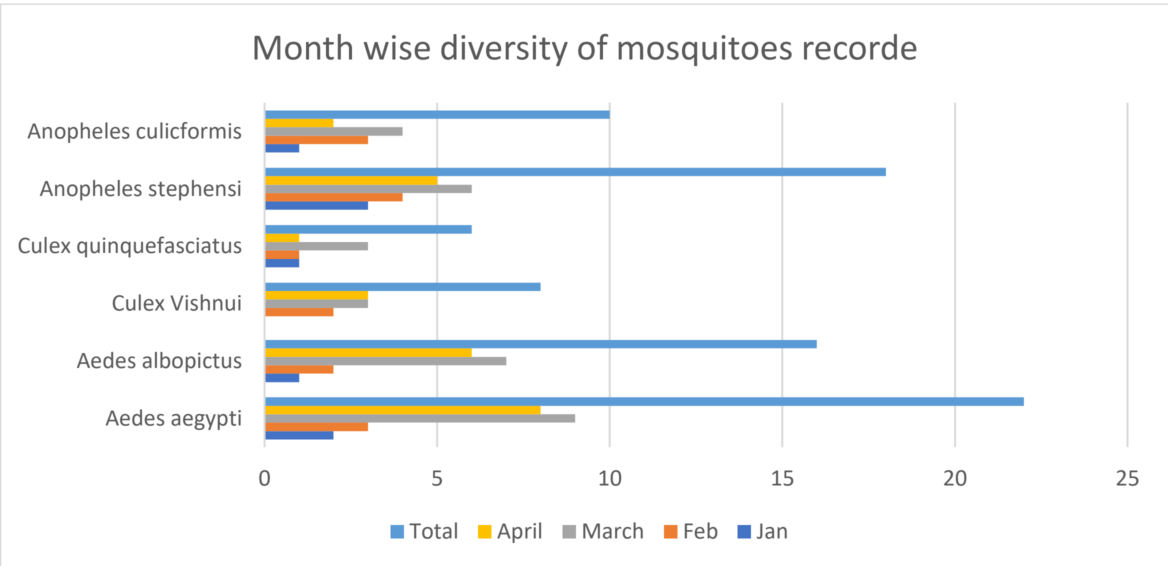
In the current study, we identified 6 mosquito species from three genera. Aedes, Anopheles, Culex, and Mansonia. The Aedes genera were represented by two species both manufactured and natural containers were investigated for possible mosquito breeding sites in Basvakalyan Taluka. The genus Culex was represented by two species in a single subgenus Culex. Six species were documented in the research, two had larval breeding sites, while the others were acquired as adults.

Aedes albopictus, Culex quinquefasciatus, and Aedes aegypti were the most common vector species in the morning collection. During the study, blood-fed females of these species were gathered from human habitations.

Arboviral Vector Aedes aegypti was detected in greater numbers than Aedes albopictus across the research region, reproducing in practically all types of freshwater holding containers. Polythene sheets were a prominent breeding site for Aedes albopictus in the research area's rural regions. Aedes albopictus was more prevalent than Aedes aegypti in the study regions' areas, although Aedes aegypti was found at significantly higher numbers in the areas. Plastic containers were the most common breeding environment discovered in the study (Table 1).

Table 2: Monthly mosquito variety documented in the research region from

January 2023 to April 2023. SI. No	Name of the species	Jan	Feb	March	April	Total
1	Aedes aegypti	2	3	9	8	22
2	Aedes albopictus	1	2	7	6	16
3	Culex Vishnui	0	2	3	3	08
4	Culex quinquefasciatus	1	1	3	1	06
5	Anopheles stephensi	3	4	6	5	18
6	Anopheles culicformis	1	3	4	2	10
	Total	8	15	32	25	86

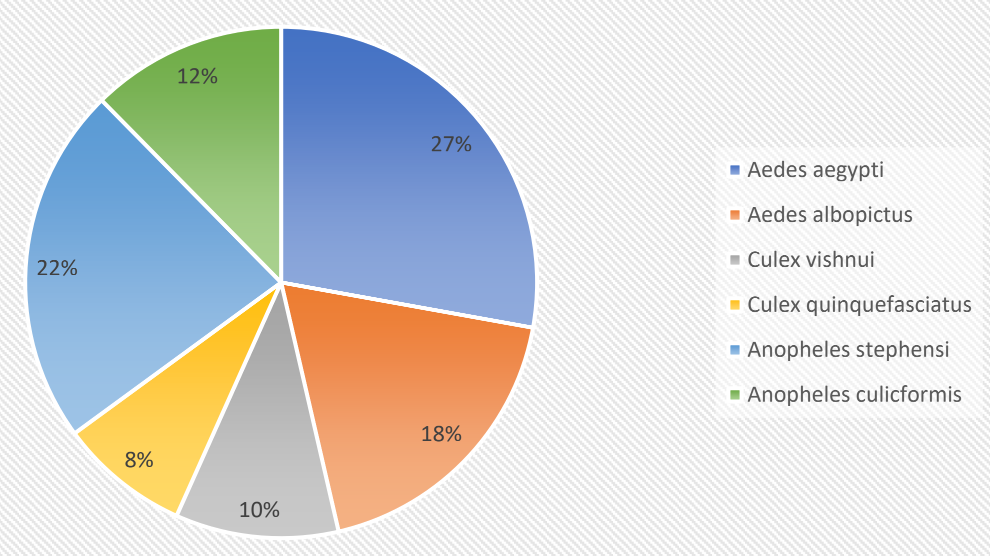


In this study, the species richness was shown to be highest in March 2023, followed by April, January, and February 2023, each with two species.

Table No.3 Species richness of mosquitoes in Basava Kalyan Taluka during January 2023 to April 2023

SI. No.	Species	Total	%
1	Aedes aegypti	26	27
2	Aedes albopictus	18	18
3	Culex Vishnui	10	10
4	Culex quinquefasciatus	8	8
5	Anopheles stephensi	22	22
6	Anophele culicformis	12	12
Total		96	100

Fig. 1. Species richness of in Study area



Changes in local ecosystems and microclimates cause mosquito species' nesting and feeding patterns to shift. Anopheles stephensi was discovered to breed in plastic containers, as reported in prior investigations. Anopheles stephensi accounted for 22% of the total anopheline female mosquitoes collected in the research, whereas Aedes aegypti was the most represented species at 27%. Aedes albopictus accounts for 18%, followed by Anopheles culicformis (12%), Culex Vishnui (10%), and Culex quinque fasciatus (8%). Aedes albopictus and Aedes aegypti coexisted in surroundings, but rural breeding sites promoted Aedes albopictus breeding, resulting in the exclusion of Aedes aegypti, as observed in earlier investigations.

The knowledge of faunal composition and seasonal variations of the mosquito fauna in a particular region is quite important as mosquitoes are the vectors of many important diseases of man and animals (Service, 1983).

The faunal composition could be better studied by measuring species richness. The biodiversity index (α) is used to quantify the species richness in a given area.

The species diversity in the study area is comparatively high and the biodiversity index is 0.9. and the high index may be due to the availability of different types of breeding habitats.

Sharing of the habitat and exhibition of preferential habitat selection behavior are the two predominant factors that augment the species diversity in a given area. It is the general belief that there is a tendency of culicids to diminish diversity in ecosystems with environmental changes (Tsubaki et al., 2004). Similar fluctuation has been reported during various seasons in the present work.
This work demonstrated that diversity indices, which are commonly used in environmental assessments to track changes in organismal variety, may be used to monitor mosquito species.
Diversity indices should be used to monitor mosquito vector species across several locations in connection to habitat type, latitude, and land use, and the databases gathered during monitoring should be utilized to anticipate the impacts of environmental changes on mosquito populations. Changes in adult mosquito species abundance are strongly controlled by the addition or removal of breeding sites in the study habitats. More research on the factors that influence immature mosquito dynamics in the region is also necessary.

Conclusion

Mosquitoes are the most essential family of insects for human health. Despite several attempts to suppress them, these wonderfully adapted mosquitos continue to live with people, feeding on them and their domesticated animals. Aside from blood loss, mosquitos may spread a range of illnesses, including filariasis, malaria, yellow fever, Japanese encephalitis, dengue fever, and others.
Mosquitoes proliferate due to their ravenous feeding habits, high reproduction rate, dispersal potential, and successful environmental exploitation. As a result, it is critical to limit mosquito multiplication to reduce nuisance and vector-borne infections. To effectively control mosquitoes, it is necessary to understand the species composition, density of populations of different species of mosquitoes, distribution pattern, and behavioral expressions of the numerous mosquitoes found in that area. In this context, the current research work attempts to explore the bioecology and behavior of mosquito fauna in Biradar Colony, Basvakalyan Taluka, Bidar District, Karnataka, India.
In this study, the highest mosquito population was documented in March, and the population progressively grew from April to May 2023. Source reduction is a method for the community to regulate the populations of various mosquitos.
The removal of mosquito breeding containers or breeding sites in and around living and working areas should be considered, as the presence of water in containers is likely the most important factor in determining mosquito breeding, particularly Aedes spp.
The significance of this study cannot be overstated in developing control methods against this major mosquito vector through effective environmental planning and management, which will aid in lowering breeding habitat. Adequate knowledge of mosquito populations, diversity
Preferential habitat selection of vector species and their distribution will aid in the development of an appropriate strategy to control mosquito populations and as a result, prevent the outbreak of mosquito-borne diseases such as dengue, chikungunya, and others.

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