ECOLOGICAL ASSESSMENT OF OUTDOOR RESTING MOSQUITO SPECIES COMPOSITION IN UGBOWO CAMPUS, UNIVERSITY OF BENIN, BENIN CITY, NIGERIA

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FACULTY OF LIFE SCIENCES

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BENIN CITY

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A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF ANIMAL AND ENVIRONMENTAL BIOLOGY, FACULTY OF LIFE SCIENCES, UNIVERSITY OF BENIN, BENIN CITY, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE IN ANIMAL ENVIRONMENTAL BIOLOGY (BSCAEB).

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CERTIFICATION

This is to certify that this project work was carried out by OWOSANNI ESTHER OREOFE of the Department of Animal and Environmental Biology, Faculty of Life Science. University of Benin (UNIBEN). Benin City.

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(Project supervisor)

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PROF MRS. I. TONGO DATE

(Head Of department)

DEDICATION

I dedicate this work to the Almighty God who has been my source of Strength, Grace and Wisdom throughout the period of my course. I also dedicate this book to my parents, whose unwavering support and encouragement have been my constant source of strength.

ACKNOWLEDGEMENT

I am deeply grateful to the Almighty God and Most Merciful, for His guidance and protection throughout my period of study.

My sincere appreciation also goes to my supervisor, who, despite his busy schedule, devoted his time to supervise and direct me during the course of this project.

I am also thankful to my parents(Mr and Mrs Owosanni) and siblings(Blessing and John) for their moral support, financial assistance and unwavering love, which makes this project a success.

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ABSTRACT

Mosquitoes are common insect pests and are well known as major vectors responsible for transmitting important parasitic and arboviral diseases such as malaria, filariasis, dengue fever, chikungunya and Zika virus, which pose significant health risks to humans and animals. This study investigated the species composition, sex ratio and distribution of outdoor-resting mosquitoes on the Ugbowo Campus of the University of Benin, Nigeria. Adult mosquitoes were sampled using sweep nets across 14 selected outdoor sites between 3:00 p.m. and 6:00 p.m. from August to September 2025. Identification was carried out using standard morphological keys. A total of 244 adult mosquitoes were recorded, representing seven species: *Aedes albopictus (67.6%), Aedes infirmatus (2.87%), Aedes cretinus (0.4%), Aedes vexans (2.87%), Culex quinquefasciatus (25.4%), Coquillettidia fraseri (0.4%) and Mansonia sp. (0.4%). Aedes albopictu*s was the most abundant (67.6%) and the most widely distributed, occurring in all sampled locations except the Junior Staff Quarters farmland. *Aedes cretinus, Coquillettidia fraseri* and *Mansonia sp*. were the least represented, each accounting for 0.4%. The sex ratio showed a higher proportion of females (63.9%) than males (36.1%). The Junior Staff Quarters farmland had the highest mosquito abundance (17.6%), followed by the Faculty of Agriculture (11.5%) and the Ekosodin back gate (11.0%), while Hall 6 recorded the lowest abundance (2.5%). Species diversity was highest at the Faculty of Engineering, Basic Medical Sciences, and Hall 6, whereas the Department of Health Services and the Junior Staff Quarters plantain farm showed the lowest diversity.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Mosquitoes are widespread insect pests and are widely recognized as the primary vectors responsible for transmitting major parasitic and arboviral diseases, including malaria, filariasis, dengue fever, yellow fever, chikungunya and Zika virus, which pose serious health risks to humans and other animals (Aigbodion *et al*, 2011; Okorie *et al*.,2015; Service 2008). These mosquito species have also been reported to be capable of transmitting these deadly diseases to nearly two-fifths of the global population (Nour *et al*.,2012). Mosquitoes are widespread in all the tropical and subtropical regionals of the world, which extend into the Arctic circle but are absent in Antarctica (Srisuka *et al.*, 2022).

Mosquitoes belong to the family Culicidae under the order Diptera. The family includes two medically important subfamilies such as Anophelinae and culicinae (Azari-Hamidian *et al*., 2019)). Adult mosquitoes,like other insects, have three body regions such as the head ,the thorax and the abdomen (Burket- Cadena, 2013).

All mosquitoe species undergo four stages during their life cycles including Egg stage, larvae stage (wriggler), pupae stage (tumbler) and the adult stage which is the final stage, they have a complete metamorphosis known as Holometabola (Sahar, 2020).

Adult mosquitoes of both sexes typically feed on plant sugars(nectar) throughout their lives. However, females usually require a blood meal either before or after mating to develop their eggs. Many species draw on humans to get their meals from the blood and feed a little on human blood by preference for any other animals so these are called (Anthropophilic species in their dietary habits, while those that feed primarily on animals (mammals, reptile and birds) are animal lover zoophilic , and mosquitoes feeding on birds are called Ornithophilic (Sarwar, 2016).

The resting behaviour of mosquitoes is an essential component of their ecology, influencing their survival, reproductive success and interaction with control measures. Outdoor resting mosquitoes are those that seek refuge outside human dwellings, typically in shaded, humid environments such as dense vegetation, tree holes, animal shelters, drainage channels, refuse dumps, and other peri-domestic habitats (Mwandawiro *et al*., 2000; Okorie *et al*., 2011). Such habitats provide protection from desiccation, predation, wind and allow females to digest their blood meals and develop eggs.

These mosquitoes often escape control interventions by remaining outdoors, leading to residual transmission (Dieng *et al*., 2010). In Nigeria, the outdoor behaviour of *Anopheles* and *Culex* species has been reported to contribute significantly to the persistence of malaria and other mosquito-borne diseases despite ongoing control efforts (Adeleke *et al*., 2013; Okorie *et al*., 2015).

Outdoor resting mosquitoes are those that seek refuge outside human dwellings, typically in shaded and humid environments such as vegetation, trees holes, animal shelter, drainage channel, refuse damps and other peridomestic sites (Mwandawiro *et al*, 2000; Okorie *et al*.,2011). Ecological assessment of mosquitoes has to do with the systematic study of species composition, distribution, abundance and behavioural pattern within specific environments (Becker *et al*., 2010). Therefore, this study seeks to assess the species composition and outdoor resting behaviour of mosquitoes on the Ugbowo campus, university of Benin.

1.2 AIM AND OBJECTIVES

Aim

The aim of this research is to evaluate the species composition, abundance, and distribution of outdoor resting mosquitoes in the Ugbowo Campus of the University of Benin.

The specific objective of this research are:

1. To identify the type of mosquitoes species present at selected outdoor sites.

2. To compare the mosquito species across different locations.

3. To determine the sex ratio of outdoor adult mosquito species.

4. Compare the sex composition and abundance of mosquitoes across different outdoor resting sites within the study area.

CHAPTER TWO

LITERATURE REVIEW

Mosquitoes (family Culicidae) are among the most ecologically adaptive and medically significant insect vectors known to humankind. Their ability to transmit a broad range of parasitic and viral diseases such as malaria, lymphatic filariasis, dengue fever, chikungunya and Zika virus infections, places them at the center of global public health concerns (Akinleye, 2022; Oduola *et al*., 2021). The global burden of these mosquito borne diseases remains unusually high in tropical and subtropical regions, where climatic and ecological conditions such as high humidity, rainfall, cold temperature and vegetation density favour mosquito survival and reproduction.

In Nigeria, mosquitoes have continued to pose a significant epidemiological challenge. Diseases like malaria and yellow fever remain endemic, causing substantial morbidity, mortality, and socio-economic disruption (Ekanem *et al*., 2023). These diseases are sustained by the presence of vector species that thrive in both rural and urban environments due to poor waste management, blocked drainages, and stagnant water sources (Adeleke and Adekunle, 2020).

Mosquito ecology is widely tied to ecological and weather conditions such as rainfall, humidity, vegetation cover and temperature. These factors influence mosquito breeding, feeding, resting and survival patterns (Alabi *et al*., 2020). Knowing the ecological dynamics of outdoor-resting mosquitoes is crucial for effective vector control and disease prevention. This chapter reviews studies on thedistribution and species composition of outdoor-resting mosquitoes in Nigeria, highlighting the methodologies, findings and implications for vector control strategies.

Oguoma and Ikpeze (2008) sampled exophagic and anthropophilic mosquitoes between April 2007 and January 2008 during the planting season across four millet and guinea-corn irrigation fields within the Gezawa Agro-ecological Zone of North-central Nigeria. The fields Gezawa-1, Gezawa-2, Ketawa and Jogana accounted for 31.2%, 24.8%, 22.8%, and 21.2% respectively, of all mosquitoes collected in the area. The study recorded a higher abundance of the Anopheles gambiae complex (20.7%) compared to C. pipiens fatigans (9.0%), A. funestus complex (7.0%), Aedes aegypti (6.9%), A. albopictus (6.6%), C. pipiens pipiens (5.7%), Culex quinquefasciatus (11.8%), C. tigripes (5.0%), A. africanus (3.6%), A. taylori (3.4%), A. coustani (3.3%), A. luteocephalus (2.9%), A. rhodesiensis (2.1%),A. pharoensis (3.7%), Mansonia species (2.0%), A. simpsoni (1.9%) and Psorophora species (1.6%). Shannon–Wiener and Simpson's diversity indices for the mosquito community in the Gezawa Agricultural Zone were 1.1431 and 0.0925 respectively. The study further showed that A. gambiae exhibited the highest Shannon–Wiener diversity value (0.1415) and the highest Simpson's dominance index (0.0427).

Aigbodion *et al*. (2013) investigated the distribution and abundance of mosquito genera in the rapidly urbanizing town of Benin City, Nigeria. The study found that mosquitoes of the genus *Culex* were the most abundant, with seven species identified:*C. nebulosus, C. decens, C. tigripes, Culex quinquefasciatus, C. moucheti*, and *C. cinereus*. Among these, *Culex quinquefasciatus* was the most commonly encountered species. In a similar study, Dhimal *et al*. (2014) reported that in Nepal, *Culex* mosquitoes accounted for 29% of the total mosquito population, making them the second most abundant genus after *Anopheles* (55%). Among the collected Culex mosquitoes (n = 742), the primary vector of lymphatic filariasis, *C. quinquefasciatus*, accounted for 12%, while *Culex tritaeniorhynchus*, the vector of Japanese encephalitis virus, accounted for 31%.

Omoregie *et al*. (2019) conducted a study to determine the species distribution, composition, and sex ratio of mosquitoes in Benin City, Nigeria. Using sweep nets and aspirators, mosquitoes were collected from randomly selected school dormitories in three local government areas (Egor, Oredo and Ikpoba-oKha). A total of 766 mosquitoes belonging to two genera of the family Culicidae were identified, comprising *Anopheles* and *Culex* species. The species encountered included *Anopheles gambiae, Anopheles funestus, Culex quinquefasciatus,* and *Culex annulioris.* Among these, *Culex quinquefasciatus* was the most abundant, accounting for 94.5% of the total catch, followed by *Anopheles gambiae* (4.8%), *Culex annulioris* (0.5%), while *Anopheles funestus* occurred least with 0.1% representation. The authors concluded that *Culex quinquefasciatus* prevail dormitory habitats in Benin City, while *Anopheles* species occurred in lower proportions.

Olajire *et al*. (2017) undertaken a study in three ecological zones of Ondo State to determine the abundance and spatial distribution of mosquitoes in the state. Twenty sampling sites were randomly selected across each ecological zone and sampled using aspirators, dippers, and pipettes. The study identified 12 mosquito species belonging to three genera: five species of Culex (*Cx. quinquefasciatus, Cx. pipiens, Cx. andersoni, Cx. duttoni* and *Cx. trigripis*), four species of Aedes (*Ae. aegypti, Ae. albopictus, Ae. vittatus,* and *Ae. palpalis*), and three species of Anopheles (An. arabiensis, *An. gambiae,* and *An. funestus*). The study further revealed that *Cx. quinquefasciatus* was the most predominant Culex species in Idanre and Ese Odo, whereas *Cx. andersoni* dominated in Ondo, Ifon and Ikare Akoko. Ae. aegypti was the most abundant Aedes species across all locations except Ese Odo. Among the Anopheles species, *An. gambiae* showed the highest occurrence in all ecological zones. The findings indicate that the study area is rich in mosquito fauna, and the high abundance of *An. gambiae* has significant public health implications.

Afolabi *et al*. (2019) investigated the distribution, abundance, and diversity of mosquitoes in Akure between April 2012 and March 2013. Twenty locations, randomly distributed across five geographical zones of the city, were sampled using sweep nets, aspirators, dippers, and pipettes. Habitats sampled included containers, stagnant pools, domestic run-offs, and gutters. Mosquito larvae collected were preserved in 70% ethanol and identified to species level using a X40 dissecting microscope and morphological keys. During the study, 30 mosquito species belonging to five genera were identified. The distribution and abundance of these species varied significantly ($p<0.05$). *Culex andersoni* was the most abundant species (23.1%), followed by *Culex fatigans* (21.9%), while *Toxorhynchites brevipalpis* was the least abundant (0.05%). Environmental and anthropogenic factors, including temperature, pH, dissolved oxygen, relative humidity, conductivity, and human-related activities, were found to influence mosquito abundance in the area. The presence of Aedes, Anopheles and Culex species indicates the potential prevalence of vector-borne diseases such as malaria, yellow fever, dengue fever, and filariasis. The authors recommended intensive vector control programs and public enlightenment campaigns targeting human activities that encourage mosquito breeding.

Eze *et al*. (2022) did a survey of mosquito breeding sites in Umunze community, Anambra State, from April to October 2018. The aim was to determine ecological parameters of mosquito breeding habitats in the community. Larva stages were collected using standard larval sampling methods. Ecological parameters of the breeding sites were determined such as temperature, pH, salinity, total dissolved solid, total suspended solid, dissolved oxygen, chemical oxygen demand, sulphate, and iron concentration using standard procedures. A total of 750 larvae and pupae were collected from 48 breeding sites: ground pools (20.3%), domestic containers (18.3%), tyres (17.1%), clay pots (15.5%), broken bucket/tins (14.7%)

and reservoir tanks (14.3%).According to the study, there was no significant difference in breeding habitat collections (P=0.626).The breeding characteristics of Aedes, Culex and Anopheles mosquitoes collected from this study, provide useful information for evidence-based control intervention against the vectors in the study area.

Studies have identified *Anopheles gambiae*, *Culex quinquefasciatus*, and *Aedes aegypti* as the most dominant mosquito species in southern Nigeria (Akinleye, 2022; Ekanem *et al*., 2023). These species have adapted to both natural and artificial environments, allowing them to persist throughout the year. Anopheles species are prevalent in rural and peri-urban areas with access to clean water, while Culex species dominate polluted urban habitats (Adeleke and Adekunle, 2020).

Larval and adult mosquitoes were collected from four study sites in Enugu State, Nigeria every other month between November 2017 and September 2018 to determine Aedes distributional data and potential distributional by (Omar *et al*., 2021). A total number of 2997 Aedes mosquitoes were collected and identified. Ecological Niche Models (ENMs) were used to estimate the current geographic distribution of Aedes specie in Enugu State, south-east Nigeria, and mosquito presence was used as a proxy for predicting risk of disease transmission. Maximum Entropy distribution modeling or "MaxEnt" was used for predicting the potential suitable habitats, using a portion of the occurrence records. A total of 23 environmental variables (19 bioclimatic and four topographic) were used to model the potential geographical distribution area under current climatic conditions. The most suitable habitat for Aedes spp. was predicted in the northern, central, and southeastern parts of Enugu State with some extensions in Anambra, Delta, and Edo States in the west, and Ebonyi State in the east. Seasonal temperature, precipitation of the wettest month, mean monthly temperature range, elevation, and precipitation of the driest months were the highest estimated main variable contributions associated with the distribution of Aedes spp. It was found that *Aedes spp*. prefer to be situated in environmental conditions where precipitation of wettest month ranged from 265 to 330 mm, precipitation of driest quarter ranged from 25 to 75 mm while precipitation of wettest quarter ranged from 650 to 950 mm.

Manzoor *et al.* (2020) carried out a study to determine the species composition of mosquitoes, including larvae, pupae, and adults, in ten towns of Lahore from September 2014 to August 2015. Mosquito larvae, pupae, and adults (male and female) were collected using dippers and aspirators from different sites across the towns, which included Iqbal, Aziz Bhatti, Data Ganj Baksh, Gulberg, Nishtar, Ravi, Samanabad, Shalimar, Wagah, and Lahore Cantonment. Identification of all life stages was performed using standard entomological keys, while the diversity, richness, and rarity of the mosquito fauna were analyzed using the Shannon, Simpson, and Margalef indices, respectively. A total of 8,656 mosquitoes were collected, belonging to four genera: *Anopheles, Culex, Aedes,* and *Mansonia.* Among the 15 species identified, *Culex quinquefasciatus* was the most abundant species, accounting for 25.8% relative abundance, whereas *Anopheles culicifacies s.l.* (sensu lato) was the least abundant at 0.22% relative abundance. The study reported the highest diversity of mosquitoes in August (H = 2.25) and the lowest diversity in June (H = 1.43). Areas with extensive sewage water supported the maximum abundance of *Culex quinquefasciatus* in urban regions of the city.

Abdulrasheed *et al*. (2016) reported on the mosquito species composition in Azare town, Katagum Local Government Area, Bauchi State, Nigeria. The study found that Culex mosquitoes were the most abundant species in the area. Out of six mosquito species sampled, the predominant species accounted for 91.38% of the total collection and included *Culex quinquefasciatus* (57.89%), *Cx. molestus* (25.87%), and *Cx. pipiens* (7.62%). *Aedes aegypti* and *Aedes vittatus* were rarely encountered, representing only 5.11% and 2.69% of the total collection, respectively.

CHAPTER THREE

METHODOLOGY

3.1 DESCRIPTION OF STUDY SITE.

The study was conducted in fourteen (14) selected locations on the Ugbowo Campus of the University of Benin, situated at Longitude 5.6099°E and Latitude 6.3998°N in Ovia North-East Local Government Area, Edo State, Nigeria. Benin City falls within the tropical rainforest region of Southern Nigeria and experiences temperatures ranging from 20°C to 36.5°C during the rainy season and 28°C to 36.5°C in the dry season. The University of Benin campus comprises residential hostels, classrooms, office complexes, bushy areas, stagnant water bodies, and shaded vegetation, many of which provide suitable breeding and resting habitats for mosquitoes.

3.2 DESCRIPTION OF SAMPLING AREAS

Mosquitoes were collected from fourteen (14) different locations within the University of Benin, Ugbowo campus, Benin city Edo state. The sites were selected due to their potential to support mosquitoes breeding and resting activities. The GPS coordinates, time and date of each location were recorded. The sampling locations are described below:

1. Botanical Garden: is a garden with lots of trees of different sizes, shrubs, abandoned containers and grasses. the vegetation here is dense where various species of plants are cultivated. The trees form a canopy shade within the garden making it cool and somewhat humid environment, shade, and presence of decaying organic matter

2. Faculty of Agriculture: is a garden with lots of trees of different sizes, shrubs, abandoned containers and grasses. the vegetation here is dense where various species of plants are cultivated. The trees form a canopy shade within the garden making it cool and somewhat humid environment, shade, and presence of decaying organic matter

3. Orchard: This area contains fruit trees, like orange, tangerine, and small grasses field and scattered vegetation that provide shaded spots and moderate humidity

4. Department of Health Services: The site comprises mostly grassy areas with very scanty very tall trees that provide shade and protection.

5. Junior staff quarters (JSQ) Farmland: a farmland of some sort, with cultivate food crops such as cassava, plantain, fruits like oranges, with cleared grass. This location is an agricultural field where crops are cultivated. The moist soil and presence of stagnant water.

6. School Eatery (Buka): This location consists of open surroundings near a food vendors' kitchen and surroundings, often with water containers and domestic and kitchen waste.

7. Joint universities preliminary examination board (JUPEB): A thick vegetation area with tall and short grasses, no trees and it is around a building of administerative and lecture theater building, with abundant shrubs and tall grasses.

8. JSQ Plantain farm: A plantain somewhat kind of farm. This farm is dominated by plantain trees that provide heavy canopy cover and cool or high humidity. This environment has humid, shaded sections.

9. Ekosodin Backgate: A densely vegetated bush located near the school campus boundary/perimeter fencing. No trees. It provides a natural shelter for resting mosquitoes and may serve as a site between the campus environment and Ekosodin community.

10. Senior Staff Quarters Grassland: This area is composed mainly of grasses, and the grass cover provides protection from wind and sunlight, No trees.

11. Tinubu hostel: This location is the surrounding around a residential area for students (Students hostel) with human activity, waste discharge, and drainage channels. Has grasses but no trees.

12. Faculty of Engineering: A bushy area with tall and short grasses near the administrative blocks and lecture theatres of a faculty. With occasional water stagnation. (M): The area has large tree and short and moderate height grassy surroundings that provide shade and moisture. Around the shopping complex of a faculty.

13. Basic medical Sciences (BMS): This site consists of open moderate height grassland with some tree cover. around student hostel area.

14. Hall 6 Grassland: This site consists of open grassland with large tree cover. The vegetation provides suitable shelter for resting mosquitoes, and sampling here helps assess the distribution of mosquitoes in open habitats.

Table 3.1: Sampling areas

S/N	LOCATION	GPS
1	Botanical garden	6°23'51" N 5°36'57" E
	Faculty of Agriculture	6°23'59" N 5°37'23" E
3	Orchard	6°24'16" N 5°37'21" E
4	Department of health services	6°24'14" N 5°37'27" E
5	JSQ farmland	6°23'41" N 5°37'11" E
6	School eatery	6°23'43" N 5°37'9" E
7	JUPEB	6°23'52" N 5°36'60" E
8	JSQ (plaintain farm)	6°23'38" N 5°37"14 E
9	Ekosodin Backgate	6°24'23" N 5°37'19" E
10	SSQ	6°24'15" N 5°36'53" E
11	Tinubu hostel	6°11'14" N 5°38"65" E
12	Faculty of Engineering	6°24'8" N 5°36'59" E
13	Basic medical science (BMS).	6°23'46" N 5°37'20" E
14	Hall 6	6°14'25"N 5°42'35" E

3.3 COLLECTION OF ADULT MOSQUITOES

Adult mosquitoes were collected from outdoor sites using a sweep net (plate1), measured 80cm in diameter and 30cm in depth with 1m wooden handle. Collection was carried out in the evening between 3:00pm to 6:00pm, when mosquitoes are most active or either at rest in shaded area after feeding. A cross-sectional study was conducted at each location, 20 sweeps of the net were performed, moving it gently through bushes, farmlands and other vegetated areas to catch mosquitoes resting on plants and outdoor surface. Whenever mosquitoes were trapped, the mouth of the sweep net was quickly twisted to prevent them from escaping. Sampling was conducted from August to September 2025.

PLATE 3.1: SWEEP NET

3.4 KILLING AND PRESERVATION OF SPECIMEN

Following collection, mosquitoes captured in the sweep net were gently shaken to move them to the bottom of the net. The net was then carefully folded and placed into a killing jar (plate

2) containing absorbent tissue paper soaked with ethyl acetate, which prevented the mosquitoes from escaping during transfer. The specimens were transferred into a second killing jar, also containing ethyl acetate-soaked tissue paper, to ensure complete immobilization or death. Tissue paper was preferred over cotton wool to minimize damage to delicate structures such as wings, antennae, and legs, preserving the specimens for accurate identification.

Once the mosquitoes were killed, they were preserved in well labeled Eppendorf tube (plate 3) containing silica gel to prevent moistur*e*. A small piece of paper was placed over the silica gel and the mosquitoes were gently placed on the top of the paper to avoid direct contact with the silica gel. Each Eppendorf tube was labeled with detail such as location, date and time of collection for accurate records and later identification.

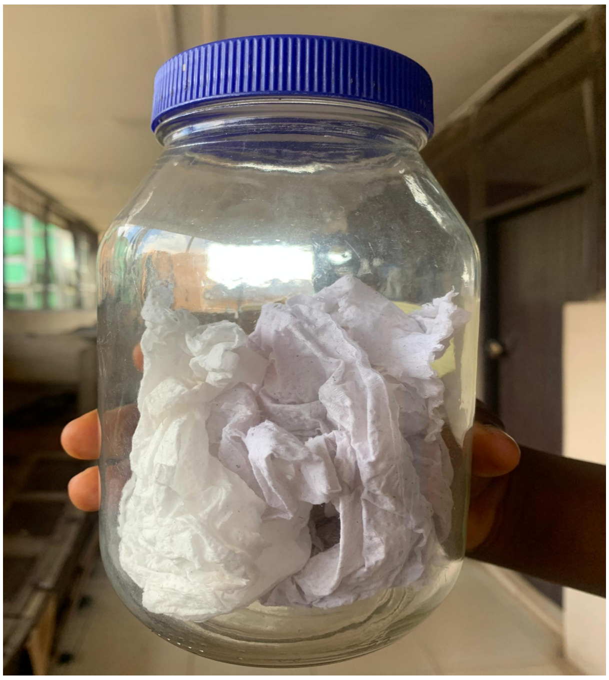

PLATE 3.2: KILLING JAR **PLATE 3.3: ENPENDORF TUBE**

3.5 TAXONOMIC IDENTIFICATION OF ADULT MOSQUITOES

Adult mosquitoes were identified in the Laboratory of the Department of Animal and Environmental Biology, using a dissecting microscope (Amscope trinocular Model). The microscope was carefully adjusted to obtain a clear view, and each mosquito specimen was placed on a Petri dish for examination at ×20 magnification. An entomological pin was used to position the specimens properly, allowing clear observation of morphological key. Mosquitoes were identified to genus, species and sex using standard taxonomic keys as described by Gillet and Smith (1972). Important morphological characters examined included the palps, proboscis, antennae, abdomen, thorax, scutellum, and leg bands. Male and female mosquitoes were distinguished based on differences in these structures, such as proboscis length, palp length, and the hairiness of the antennae.

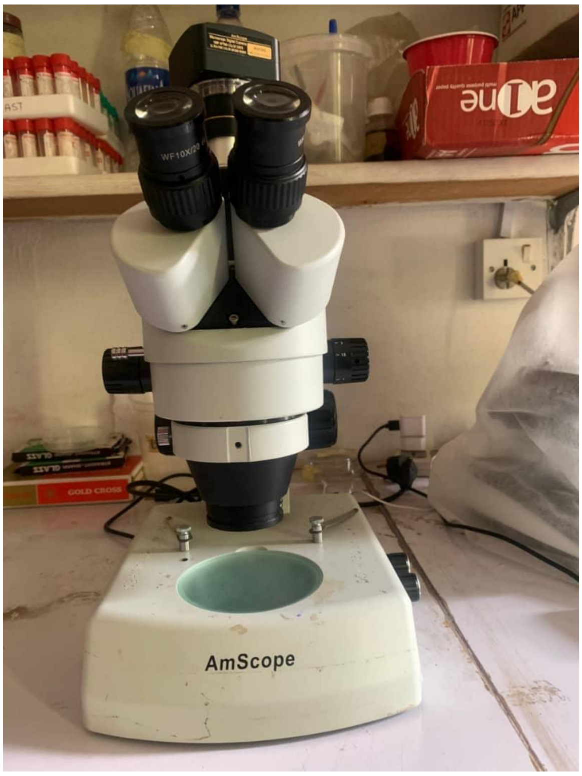

PLATE 3.4: DISSECTING MICROSCOPE

PLATE 3.5: PETRI DISH

3.6 STATISTICAL ANALYSIS

The data collected from the field were carefully stored, recorded and analyzed. The total number of mosquitoes collected from each location was counted and grouped according to species, sex and abundanc*e.* The relative abundance, Simpson diversity index and Shannon wiener's index of each species was calculated using simple percentages.

Relative abundance % = $\frac{Number\ of\ Individual\ species}{Total\ number\ of\ mosquitoes\ collected} \varepsilon x 100$

Simpson diversity index (D) =1- $\frac{En(n-1)}{N(N-1)}$

Shannon -wiener index (H) = - EpixIn(pi)

The sex ratio was calculated by comparing the total number of male and female mosquitoes collected. Data analysis was performed using Microsoft Excel 2016 and IBM SPSS version 27.0, using one-ways Analysis of Variance (ANOVA) and the Chi-square test. Statistical significance was set at $p < 0.01$. ANOVA was applied to assess differences in mosquito species abundance across the study locations, while the Chi-square (χ^2) test of independence was used to assess the association between mosquito distribution and the various sampling sites.

CHAPTER FOUR

RESULTS

A total number of 244 mosquitoes representing four (4) genera within the family Culicidae*:* *Aedes, Culex, Mansonia and Coquillettidia* which include *Aedes albopitus, Aedes infirmatus, Aedes vexan, Aedes cretinus, Culex quiquesfasciatus, Mansonia spp and Coquillettidia fraseri* were collected. Out of seven (7) species of mosquitoes collected, *Aedes albopitus* was the most dominant (67.6%), followed by *Culex quiquesfasciatus* (25.4%), *Aedes infirmatus* and *Aedes vexan* (2.87%) and *Aedes cretinus, Mansonia spp* and *Coquillettidia fraseri* which occurred least with a percentage 0.4% (tab 2). Chi-square (χ^2) test of independence revealed statistically significant association between the localities, χ^2 (11) = 53.93, P<0.001, indicating that the distribution of mosquito total across the studied categories is not random, there no significant different in mosquito count among the group. Furthermore, A one-way ANOVA revealed a highly significant difference in square-root-transformed mosquito counts across the groups, $F(6, 91) = 21.86$, $p < 0.001$.

4.1 SPECIES COMPOSITION AND ABUNDANCE .

The number of mosquitoes collected varied across the fourteen 14 location. *Aedes albopitus (165 individuals)* were more abundant, followed by *Culex* quiquesfasciatus (62 individuals). *Aedes vexan* and *Aedes infirmatus* were less abundant each 7 individuals respectively and the least abundance *Aedes cretinus, Mansonia* and coquillettidia 1, as shown in table 4.1

TABLE 4.1 SPECIES COMPOSITION AND ABUNDANCE OF ADULT MOSQUITOES COLLECTED FROM DIFFERENT LOCATIONS.

Location	***Ae. albopitus***	***Ae. Vexan***	***Ae. infirmatus***	***Ae. cretinus***	***Culex quiquesfasciatus***	***Mansonia***	***Coquillettidia fraseri***	**Total**
Botanical garden	18	0	0	0	3	0	1	22
Faculty of Agriculture	28	0	0	0	0	0	0	28
Orchard	17	0	0	0	1	0	0	18
Department of health	17	0	0	0	0	0	0	17

center								
JSQ farmland	16	0	0	0	26	1	0	43
School eatery	6	0	0	1	2	0	0	9
JUPEB	6	0	0	0	5	0	0	11
JSQ plantain farm	0	0	0	0	9	0	0	9
Ekosodin Backgate	25	0	0	0	2	0	0	27
SSQ	19	0	0	0	1	0	0	20

Tinubu hostel	2	0	3	0	7	0	0	12
Faculty of Engineering	3	0	3	0	3	0	0	9
BMS	6	4	1	0	2	0	0	13
Hall 6	2	3	0	0	1	0	0	6
Total	165	7	7	1	62	1	1	244

4.2 PERCENTAGE COMPOSITION OF MOSQUITO SPECIES

Aedes albopitus was the most dominant species (67.6%), followed by *Culex quiquesfasciatus* (25.4%). *Aedes vexan* and *Aedes infirmatus* were less abundant (2.87%) respectively and then the least abundant species were *Mansonia*, *Aedes cretinus* and *coquillettidia fraseri* (0.4%) as presented in Table 4.2.

Table 4.2 Percentage composition of mosquito species collected.

Species	Numbers collected	Percentage
Aedes albopitus	165	67.6%
Aedes vexan	7	2.87%
Aedes infirmatus	7	2.87%
Aedes cretinus	1	0.4%
Culex *quiquesfasciatus*	62	25.4%
Mansonia sp	1	0.4%
Coquillettidia fraseri	1	0.4%

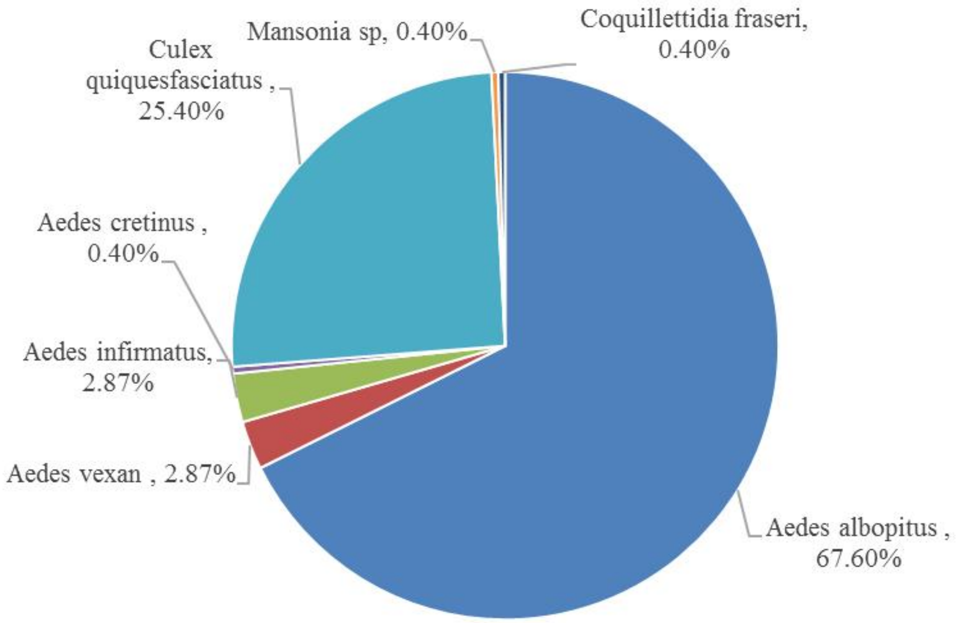

Figure 4.1: The Distribution pattern of the mosquito species sampled.

4.3: SEX RATIO OF MOSQUITOES SPECIES.

Aedes albopictus recorded the highest number of individuals, with a female-biased sex ratio of 1:2, which was statistically significant. *Aedes vexans* exhibited a nearly balanced sex ratio with no significant difference between males and females. Similarly*, Culex quinquefasciatus* showed no statistically significant variation in sex ratio. Other species, including *Aedes infirmatus, Aedes cretinus, Mansonia sp.,* and *Coquillettidia fraseri*, consisted exclusively of female individuals; hence, statistical analysis of sex ratio could not be applied to these species, as shown in table 4.3.

4.3: Sex ratio of mosquitoes species collected from different sampling location

Species	Male	Female	Sex ratio	Chi-square	P-value
Aedes albopitus	57	108	1:2	15.764	<0.01
Aedes vexan	5	2	5:2	1.286	0.257
Aedes infirmatus	0	7	0:7	-	-
Aedes cretinus	0	1	0:1	-	-
Culex quiquesfasciatus	26	36	1:1:4	1.613	0.204
Mansonia sp.	0	1	0:1	-	-
Coquillettidia fraseri	0	1	0:1	-	-

4.4 VEGETATION / MICROHABITAT STRATA

The abundance of mosquitoes varied among the different habitat types sampled. Cultivated mosaic habitats recorded the largest mosquitoes count (n = 112), followed by shaded vegetative areas (n = 82) and anthropogenic open areas (n = 50). Among the species identified, *Aedes albopitus* was the most dominant in the cultivated mosaic habitat (n = 80), while *Culex quiquesfasciatus* had a notable presence with 28 individuals in the same habitat, as presented in table 4.4.

4.4 Species composition of outdoor resting mosquitoes across vegetation /Micro-habitat strata

Vegetation/ Micro-habitat	*Aedes albopitus*	*Aedes infirmatus*	*Aedes vexan*	*Aedes cretinus*	*Culex quiquesfasciatus*	*Mansonia sp*	*Coquillettidia fraseri*
Shaded vegetative	55	1	4	0	21	0	1
Cultivated mosaic	80	0	3	0	28	1	0
Anthropogenic open	30	6	0	1	13	0	0

4.5 DIVERSITY INDICES OF OUTDOOR RESTING MOSQUITOES ACROSS LOCATION.

The highest species diversity was recorded at BMS and the Faculty of Engineering, while Tinubu Hostel, the School Eatery, and the JUPEB area exhibited moderate diversity, as presented in table 4.5.

4.5 Diversity indices of outdoor resting mosquitoes across sampling area

Location	Total mosquito	No. Of species	Simpson index (D)	Shannon wiener index (H)
Botanical garden	22	3	0.33	0.58
Faculty of Agriculture	28	1	0	0
Orchard	18	2	0.11	0.22
Department of health service	17	1	0	0
JSQ farmland	43	3	0.51	0.76
School eatery	9	3	0.56	1.10
JUPEB	11	2	0.55	0.69
JSQ plantain farm	9	1	0	0
Ekosodin Backgate	27	2	0.14	0.26
SSQ	20	2	0.1	0.20
Tinubu hostel	12	3	0.62	0.96
Faculty of Engineering	9	3	0.75	1.10
BMS	13	4	0.72	1.21
Hall 6	6	3	0.73	1.01

CHAPTER FIVE

5.0 DISCUSSION

This study examined the abundance, species composition and sex ratio of outdoor-resting adult mosquitoes on the Ugbowo Campus of the University of Benin. A total of 244 adult mosquitoes were recorded, representing four genera within the family Culicidae: Aedes, Culex, Mansonia sp and Coquillettidia. The species identified included Aedes albopictus, Aedes infirmatus, Aedes vexans, Aedes cretinus, Culex quinquefasciatus, Mansonia species and Coquillettidia fraseri. Out of the mosquitoes collected, *Aedes albopitus* was the most dominant with 165 individuals (67.6%), this high abundance may be due to the species strong adaptability to diverse breeding sites including artificial containers and tires .Aedes albopitus is an aggressive day-biting mosquitoes that readily colonizes artificial containers in both urban and semi-urban environment (Konkon *et al*.,2025). Adeleke *et al*. (2010), reported the predominance of *Aedes albopitus* in area with high human activity and scattered water-holding containers.*Culex quinquefasciatus* was the second most abundant species with 62 individuals (25.4 %). The high prevalence of *Culex* mosquitoes is closely associated with their ability to breed in polluted and stagnant water bodies, such as gutters and blocked drains. According to Becker *et al*. (2010), Culex species are well adapted to polluted urban habitats, which makes them the most frequently encountered mosquitoes in residential areas, similarly Omoregie *et al.* (2019), also found *Culex quinquefasciatus* to be the most dominant species (94.5 %) in boarding school dormitories in Benin City, linking its abundance to poor drainage and waste management conditions. Other *Aedes* species, such as *Aedes vexans* and *Aedes infirmatus*, were less abundant (a total of 7 individuals, 2.87 % each) due to their preference for temporary ground pools, which might have been scarce during the sampling period. *Aedes vexans* populations are known to fluctuate seasonally with rainfall patterns (Mweya .,2022)). *Mansonia spp., Aedes cretinus*, and *Coquillettidia fraseri* were the least represented species, with one individual (0.4 %) each. Their scarcity could be attributed to the absence of aquatic vegetation such as *Pistia stratiotes* or *Eichhornia crassipes*, which are essential for larval respiration and attachment.Similarly Okorie *et al*. (2014) also reported the rarity of *Mansonia* and *Coquillettidia* species in areas lacking aquatic macrophytes.

The sex ratio analysis revealed a higher number of females (156 individuals; 63.9 %) compared to males (88 individuals; 36.1 %). This female predominance is consistent with previous findings by Becker *et al*. (2010) and Gillies and Coetzee (1987), who explained that females are more frequently collected during resting catches because they seek shelter after blood meals to digest and develop eggs, while males are shorter-lived and typically remain near breeding sites. Similarly, Abdullahi *et al*., (2024) found a higher proportion of female mosquitoes in outdoor collections in Kano State, suggesting that females are more likely to be found in resting habitats due to their reproductive behaviour. The chi-square analysis ($\chi^2 = 53.93$, df = 11, $p < 0.001$) revealed a significant association between mosquito species and localities, indicating that distribution was not random. This implies that environmental characteristics such as vegetation type, shade, moisture, and human activity influenced mosquito distribution. Also, Abdullahi *et al*. (2024) observed that mosquito density varied significantly across ecological zones due to vegetation cover and humidity levels. mosquitoes species also showed significant variation in mosquito abundance across sampling sites, further confirming that vegetation and microclimate differences strongly affect mosquito abundance.

The JSQ farmland site recorded the highest number of mosquitoes, likely because its vegetation, moisture, and shaded spots provide favourable resting habitats. This finding aligns with reports by Odiere et al. (2007) and Mmbando et al. (2021), who also observed increased mosquito densities in humid, vegetated environments

compared to dry, open areas.

The diversity indices revealed that the Botanical Garden recorded the highest mosquito species diversity (H = 1.21, D = 0.72), followed by the Faculty of Engineering (H = 1.10, D = 0.75), School Eatery (H = 1.10, D = 0.56), and Hall 6 (H = 1.01, D = 0.73). These sites exhibited moderate to high species diversity, suggesting that the combination of vegetation cover, shade, and moisture provided suitable microhabitats for multiple mosquito species to coexist.In contrast, Department of Health Services and JSQ Plantain Farm recorded the lowest diversity (H = 0, D = 0), indicating dominance by a single species, most likely Aedes albopictus.Similarly, Ekosodin Backgate (H = 0.26, D = 0.14) and SSQ (H = 0.20, D = 0.10) showed low species diversity, implying that environmental conditions in these sites favored only a few dominant species.studied reported by Abdullahi *et al*. (2024) in Kano State, Nigeria, where outdoor resting mosquito diversity varied significantly between vegetated and non-vegetated areas. Sites with dense vegetation and high humidity recorded greater mosquito species diversity compared to open or dry environments. Similarly Odiere *et al*. (2007) found that mosquito abundance and diversity were higher in shaded and humid farmlands than in exposed residential areas in western Kenya.In addition, Okorie *et al.* (2014) observed that mosquito species diversity was strongly influenced by vegetation density and proximity to breeding sites in southern Nigeria. The high population of female mosquito indicate active breeding population and potential vector risk for arboviral and filarial disease, emphasizing the need for environmental sanitation and mosquito control around the campus.

5.1 CONCLUSION

The findings of this study show that mosquitoes were widely distributed across the study locations, with Aedes albopictus emerging as the most dominant species, followed by Culex quinquefasciatus. The very low numbers of Mansonia species and Coquillettidia fraseri indicate that suitable breeding habitats for these species were scarce in the area. The higher proportion of female mosquitoes suggests active breeding and blood-feeding activity, which may elevate the risk of mosquito-borne disease transmission on campus.The detection of Aedes albopictus, a known vector of yellow fever, dengue, and chikungunya viruses, underscores the public health relevance of the study. Likewise, Culex quinquefasciatus is an important vector of lymphatic filariasis and West Nile virus, while Mansonia species are associated with filarial parasite transmission. Although Coquillettidia fraseri occurred in low numbers, its presence still points to a degree of vector diversity within the environment. To reduce mosquito breeding and lower the risk of disease transmission in and around the campus, continuous entomological surveillance, improved sanitation, and effective environmental management practices are strongly recommended.

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APPENDIX

ANOVA

Sqrt_Mosq.Count

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	73.835	6	12.306	21.855	.000
Within Groups	51.240	91	.563		
Total	125.075	97			

Sqrt_Mosq.Count

Mosq.Sp	N	1	2	3
Ae. cretinus	14	.7441		
Mansonia sp.	14	.7441		
Coqui.	14	.7441		
Ae. vexans	14	.8912		
Ae. infirmatus	14	.9103		
Cx. quinque	14		1.9205	
Ae. albopictus	14			3.2088
Sig.		.610	1.000	1.000

.

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
MosqTotalintheStudy	244	22.84	11.286	6	43

	Observed N	Expected N	Residual
6	6	20.3	-14.3
9	27	20.3	6.7
11	11	20.3	-9.3
12	12	20.3	-8.3
13	13	20.3	-7.3
17	17	20.3	-3.3
18	18	20.3	-2.3
20	20	20.3	-.3
22	22	20.3	1.7
27	27	20.3	6.7
28	28	20.3	7.7
43	43	20.3	22.7
Total	244		

Chi-Square	53.934[a]
df	11
Asymp. Sig.	.000

A.albop

	Observed N	Expected N	Residual
57	57	82.5	-25.5
108	108	82.5	25.5
Total	165		

	A.albop

Chi-Square	15.764[a]
Df	1
Asymp. Sig.	.000

Ae.vex

	Observed N	Expected N	Residual
2	2	3.5	-1.5
5	5	3.5	1.5
Total	7		

Test Statistics

	Ae.vex
Chi-Square	1.286[a]
Df	1
Asymp. Sig.	.257

Ae.infir

	Observed N	Expected N	Residual
7	7	7.0	.0
Total	7[a]		

Cx.quin

	Observed N	Expected N	Residual
26	26	31.0	-5.0
36	36	31.0	5.0
Total	62		

Test Statistics

	Cx.quin
Chi-Square	1.613[a]
Df	1
Asymp. Sig.	.204

ANOVA

Sqrt_Count

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	111.436	6	18.573	23.956	.000
Within Groups	10.854	14	.775		
Total	122.289	20			

MosqSpinVegVariants	N	1	2	3
Man.sp	3	.8797		
Coq.fr	3	.8797		
Ae.cret	3	.8797		
Ae.inf	3	1.4938		
Ae.vex	3	1.5664		
Cx.quin	3		4.5499	
Ae.alb	3			7.3149
Sig.		.400	1.000	1.000