



Research Article

Prevalence and Phenotypic Identification of Mosquitoes Species within the University of Maiduguri Community, Maiduguri, Northeast Nigeria

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ABSTRACT

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Mosquitoes, characterized by their slender bodies, long legs, prominent eyes, and narrow wings adorned with fringe-bearing scales, play a vital role in public health as disease vectors. The prevalence of mosquitoes in an environment is influenced by a complex interplay of breeding conditions and environmental factors. This study, conducted from February to August 2019, aimed to assess the prevalence and distribution of mosquito genera in the University of Maiduguri area. A total of 903 mosquito specimens were collected using trapping methods, and morphological identification was performed based on specific characteristics. The indoor resting adults were categorized into three main genera based on morphological characteristics: *Anopheles* (546 individuals, 60.5%), *Culex* (312 individuals, 34.6%), and *Aedes* (45 individuals, 4.98%). Habitat sampling, conducted using dippers and pipettes, aimed to identify mosquito breeding sites in five categories: containers, stagnant pools, domestic run-offs, gutters, and tree-holes/leaf axils. The study documented the presence of mosquitoes throughout the year, highlighting the persistence of these vectors in the area. Analysis of mosquito species composition revealed *Anopheles* as the most prevalent genus (Male=199, Female=347), followed by *Culex* (Male=192, Female=120), and *Aedes* (Male=22, Female=23), with *Aedes* being the least abundant. Statistical analysis indicated a significant difference ($p \geq 0.05$) between *Anopheles* and the other two genera, suggesting that the University of Maiduguri offers favorable conditions for the breeding of *Anopheles* mosquitoes. Contributing factors to this observation include a rising human population, dense plant vegetation influencing humidity, and inadequately managed sewage drainage, fostering mosquito proliferation. The study emphasizes the critical need for ongoing monitoring and effective vector control measures in the University of Maiduguri area to mitigate the public health risks linked to mosquito-borne diseases.

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INTRODUCTION

Mosquitoes are characterized by small, slender bodies, six long legs, prominent eyes, and long narrow wings adorned with scales forming a fringe on the posterior margin. They lie flat over the abdomen at rest. Their mouthparts consist of a conspicuous forward-protruding elongated proboscis designed for piercing and sucking. It includes a long U-shaped fleshy labium containing paired maxillae, mandible, and a hypopharynx carrying a salivary duct that delivers an anticoagulant into the host tissue during feeding (Heffernan *et al.*, 2005). The maxillary palps exhibit variations in length and morphology across different species. Additionally, both sexes possess long filamentous segmented antennae, which are pilose in females and plumose in males (Josh *et al.*, 2010).

After a blood meal, female mosquitoes lay eggs on the water's surface, either individually (as observed in *Culex*) or in groups forming an egg raft. In other genera, the eggs are dark-colored, elongated or ovoid. In the *Anopheles* genus, they are boat-shaped and incapable of surviving desiccation (Vreysen *et al.*, 2007). Hatching is temperature-dependent and typically occurs after several days, although this duration can vary significantly among mosquito species. All larval stages are aquatic, featuring a distinct head with a pair of antennae, compound eyes, and a prominent mouth brush used for feeding on organic materials. Eggs lay on the water surface hatch in approximately 1-3 days with the precise time influenced by temperature. Some species deposit their eggs on damp soil or other substrates such as tree trunks and the incubation period varies with eggs hatching as soon as they come into contact with water whether through rainfall, melted snow or similar environmental conditions. All larval stages are aquatic, featuring a distinct head with a pair of antennae, compound eyes and a prominent mouth brush used for feeding on organic materials. Most larvae respire through a pair of spiracles located on the penultimate abdominal segment. In *Culex spp* these

spiracles are situated at the end of a small tube called the respiratory siphon. Larval maturation can extend from one week to several months with certain species overwintering in temperate regions (Chen *et al.*, 1995). Larval habitats exhibit considerable variation, ranging from small temporary water collections to extensive areas such as marshes. However, they are typically absent from large unbroken bodies of water such as lakes and fast-flowing streams or rivers (Service, 2004). Mosquitoes serve as vectors for human and animal disease pathogens either directly or indirectly by transmitting such pathogens. There are over 3,500 species belonging to 42 genera classified under three subfamilies, namely *Anophelinae*, *Culicinae*, and *Toxorhynchitinae*. Mosquitoes are well-known bloodsuckers that irritate mammals, birds, reptiles, and amphibians (Alaba and Alaba, 2010). Their blood-feeding habit grants them the ability to transmit pathogens responsible for fatal diseases including Filariasis, Malaria, Yellow Fever, Japanese Encephalitis and Dengue Fever among others (Hanson, 1995). The biodiversity of mosquitoes constitutes a critical aspect of medical and veterinary science, emerging as an integral component of human life. Among insects, mosquitoes hold particular significance due to their direct impact on human and livestock health and survival. Mosquito species diversity varies across geographical regions, a topic explored by several authors (Foote *et al.*, 2010). The prevalence and phenotypic identification of mosquitoes within the University of Maiduguri, Borno State, Nigeria, have not been previously reported. Therefore, it is imperative to study mosquito species within the University of Maiduguri; as such data are currently unavailable in the area. This research aims to provide essential insights into mosquito biodiversity and contribute to mosquito control within the University community.

MATERIALS and Methods**Study area**

The University of Maiduguri, established in 1975 as one of the second-generation universities, was a key component of the Third National Development Plan (1975-80) initiated by the Federal Military Government under the leadership of General Murtala Ramat Mohammed. Initially the university lacked physical infrastructure but in April 1976 it assumed ownership of the premises formerly held by the North-East College of Arts and Sciences (NECAS). Situated in Maiduguri the capital of Borno state in the northeastern region of Nigeria, the university finds itself in proximity to Adamawa State to the east, Yobe State to the west and Gombe State to the north, the five successor states of the defunct northeastern states. This locale boasts abundant human, animal and natural resources.

Adult Mosquito Collection

Mosquitoes were collected between February to March and July to August 2022, during morning (5:00 am to 6:00 am) and evening (6:00 pm to 8:00 pm) hours, twice a week. Mosquito resting on vegetation were collected using a sucking tube (a pipette tip with balloon collection center and a 3-5meter tube end for suctioning), a hand net (of 15x 45 square Cm with a drop net and a handle of 2 meters). Indoor resting mosquitoes in sleeping room were sprayed with an insecticide (Dichlovos, at 20mls concentration in 1 liter of water sprayed) and the dead mosquitoes were then picked up using a thumb forceps and were packed into a container. This process took 3-5

hours, allowing the room windows to remain open for ventilation and the escape of residual substances to ensure sleeper safety. Collected mosquitoes were transported to the laboratory in well-labelled sample bottles and stored in a refrigerator at -20°C before identification. Larvae were collected in a transparent plastic container (5x10cm with a depth of 5cm) and transported to the Veterinary Parasitology and Entomology laboratory along with their breeding water. They were raised to adults, covered with a hanging net, and collected under laboratory conditions.

Morphological Identification of Mosquitoes

Mosquito identification was conducted using the identification keys of Hopkins (1952), Highton (1983), and Snell (2005), with a stereomicroscope (model: SMZ-140 series, 10x magnification). Based on key features such as palps, scales, proboscis, and banding, among other features, mosquitoes were grouped into different genera (*Aedes*, *Anopheles*, and *Culex*) with the guidance of an entomologist. A total of 903 mosquitoes were identified and pooled. For confirmation, some mosquitoes were referred to be identified by other entomologists in the Department of Zoology, Faculty of Life Science, and were confirmed as such.

Data Analysis

Data analysis and description were based on concepts found in theoretical analytical tools. In this attempt, relative frequencies (percentages) were used for the presentation of data in tabular forms Mosquito diversity was statistically analyzed using Simpson's Index with the formula.

$$D = 1 - \left(\frac{\sum n(n-1)}{N(N-1)} \right)$$

Where D means Diversity

N means Total number of mosquitoes

n means Total number of particular Species mosquito

RESULTS

The prevalence of mosquito genera within the University of Maiduguri Community is revealed in Table 1 *Anopheles*, *Culex*, and

Aedes species were identified with prevalence rates of 60.5% (M=22.0, F=38.5), 34.6% (M=21.3, F=13.3), and 4.98%

(M=2.44, F=2.54) respectively ($p < 0.05$). Table 1 also shows the prevalence of mosquitoes among the study sites with respect to sex. Students' hostels have the highest prevalence of 62.2%, followed by the

lecture halls with 30.0%, and staff residential areas with 7.75%, respectively ($p < 0.05$). Additionally, female mosquitoes had a higher prevalence of 54.3% compared to males with 45.7% ($p > 0.05$).

Table 1: Prevalence of mosquito genera within University of Maiduguri Community

Locations	Mosquito genera						Total
	<i>Culex</i>		<i>Aedes</i>		<i>Anopheles</i>		
	Male	Female	Male	Female	Male	Female	
Lecture Halls	62	42	8	10	52	97	271
Staff residential areas	10	7	0	1	24	28	70
Students hostels	120	71	14	12	123	222	562
Total	192	120	22	23	199	347	903

Table 2 illustrates the range of mosquito genera diversity in the University of Maiduguri Community, determined through the computation of Simpson's index. In this context, values ≤ 0 are considered indicative of low diversity, while those ≥ 1 signify high diversity, as presented in the table. Notably,

the female *Anopheles* exhibits the highest diversity, recording a value of 1.83 in the student hostel. In contrast, female *Aedes* demonstrates the lowest diversity in the staff quarters, registering a value of 0.33. These findings hold statistical significance ($p \geq 0.05$).

Table 2: Diversity of Mosquito genera within University of Maiduguri Community Using Simpson's index value for Mosquito species

Locations	Mosquito genera						Total
	<i>Culex</i>		<i>Aedes</i>		<i>Anopheles</i>		
	Male	Female	Male	Female	Male	Female	
Lecture Halls	0.99	0.98	0.09	0.62	1.01	1.32	
Staff residential areas	0.98	0.98	0.99	0.33	1	1.5	
Students hostels	1	1	1.11	0.76	1.47	1,83	

The D value ranges from 0 -1

0 = Low diversity

1 = High diversity

DISCUSSION

The composition of mosquitoes in the study area revealed three genera: *Anopheles* (Male=199, Female=347), *Culex* (Male=192, Female=120), and *Aedes* (Male=22, Female=23) ($p < 0.05$), as observed in this study, which has not been previously reported in the University of Maiduguri, Borno State, Nigeria. Although several workers (Igbinsosa, 1989; Mafiana *et al.*, 1998; Aigbodion and Odiachi, 2003; Okogun *et al.*, 2005; Anosike *et al.*, 2007) in Nigeria have reported the presence of all species encountered in this

study, no document has reported the presence, diversity, and composition of mosquito species in any part of Borno State.

Mosquito species occurred in all student hostels, lecture halls, and reading premises sampled in this study, and the populations of these mosquitoes were relatively abundant throughout the season, with peak populations observed in July through August/September, probably due to the central sewage draining system of the university located around the works department of the university. This area constantly spilled water and is surrounded by

thick vegetation, making the environment favorable for year-round mosquito breeding. The months of July to October are usually the rainy (wet) season in Northeast Nigeria, characterized by high humidity, high rainfall, and an average temperature of 26.5°C, which is conducive to mosquito survival and growth. A combination of these factors may be responsible for the higher larval abundances recorded during the rainy season. The strong positive correlation between water bodies and the abundance of the three mosquito genera justifies the explanations given above. The increases in mosquito populations during the wet seasons have been previously reported in Nigeria (Igbinsola, 1989; Anosike *et al.*, 2007; Adeleke *et al.*, 2008) and elsewhere (Dossou-Yovo *et al.*, 1995; Koenraadt *et al.*, 2004).

Environmental factors such as temperature, relative humidity, seasonality, and water quality have been found to be promising predictors of mosquito distribution (Pemola and Jauhari, 2005; Stoops *et al.*, 2007; Impoinvil *et al.*, 2008; Muturi *et al.*, 2008). The availability of water collections in gutters and dams in student hostels, blocked drainages in staff resident areas, improper waste disposal from lecture halls, and suitable flora around the environment of some hostels and houses, along with physicochemical composition, is a major limiting factor for oviposition and breeding of mosquito species.

The persistent monthly occurrence of all three mosquito genera in the study area may be due to increased and variable human activities, an increased number of students and staff,

urbanization, and other related anthropogenic factors that create different natural and artificial habitats as sources of water for oviposition and breeding sites for several mosquito species. Mosquito breeding sites were frequently observed in the study area during this study. Also, poor economic conditions, low awareness, poor sanitation levels, indiscriminate disposal of wastes (including discarded household materials, cans, plastic, and metal containers), abundant numbers of abandoned construction sites, uncontrolled domestic run-offs, and poor maintenance of gutters and drainages may, in part, be responsible for the increase in mosquito breeding sites in the study area.

The consequence of one or a combination of these factors is the increase in mosquito vector abundance and vectorial capacity (Dossou-Yovo *et al.*, 1995; Ezike *et al.*, 2001; Aigbodion and Odiachi, 2003; Okogun *et al.*, 2005; Adeleke *et al.*, 2008; Impoinvil *et al.*, 2008; Akram *et al.*, 2009). In this study, *Anopheles* genera were the most abundant while *Aedes* was the least. The significant difference between *Anopheles* and the other two genera showed that the University of Maiduguri is a good breeding ground for *Anopheles* mosquito genera.

CONCLUSION

In conclusion, this study revealed that inadequate drainage systems and sewage spills, among other factors, have prompted the study area to a high level of mosquito breeding, hence the high abundance of mosquitoes in the study area.

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