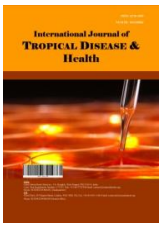

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Studies on Malaria Vector Population Density in Three Selected Areas in Sokoto Metropolitan, Sokoto State - Nigeria

F. A. Maikano[1*], S. Y. Lema[1], M. A. Yahaya[2], J. Suleiman[1] and J. Ibrahim[1]

[1]Department of Biological Sciences, Faculty of Science, Sokoto State University, Sokoto, Nigeria.
[2]Department of Biological Sciences, Faculty of Science, Usmanu Danfodiyo University, Sokoto, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

This study is conducted to determine the population density of mosquitoes in three selected area (Kofar Taramniya, Mabera and Bello Way) in Sokoto metropolis. To identified and count the population of mosquito, different breeding sites were investigated for the preferences of mosquitoes. Mosquito larvae were collected using dipper, ladle spoon from drainages, stagnant water, gutters, open wells, local pots, water tanks and cattle sheds. A total population of 4,764 mosquito larvae were collected and identified From the three (3) selected areas larvae and pupae were encounters in abundance. In Mabera area, a total of 1799 (37.7%) larvae are collected in which 1199 (45.8%) belonging to *Anopheles* genera and 600 (27.9%) belong to *culex* genera. In kofar Taramniya a total of 1649 (34.6%) larvae are collected in which 1000 (38.2%) belong to *Anopheles* genera and 649 (30.2%) belong to *culex* genera, in Bello Way, A total of 1317 (27.5%) larvae were collected, 417 (15.9%) belong to *Anopheles* genera and 900 (41.9%) belong to *culex* genera. Statistical analysis conducted indicated a significant difference ($p<0.05$) between the three

**Corresponding author: Email: fareedahmaikano@gmail.com;*

collections. Mosquitoes encountered belong to two genera of *Anopheles* and *Culex.* The predominant genus was *Anopheles* with a total of 2,615 larvae while *Culex* has a total of 2149 larvae in all the three study areas. Considering the medical importance of mosquitoes, the information provided from this study will serve as a basis for understanding the implication of mosquitoes nuisance and provide effective control strategies against the vector and to reduce mosquitoes born disease.

Keywords: Malaria vector; population density; mosquito larvae; mosquitoes.

1. INTRODUCTION

Mosquitoes are insects belonging to the Phylum Arthropoda and order Diptera [1,2]. There are 3,100 known species of mosquitoes belonging to 35 genera which are further arranged into two sub-families- *Anopheliae* and *Culicinae* [3]. The distribution and population density of adult mosquitoes depends on several factors. These factors include the behavioural patterns of the species, the prevailing climatic conditions of the area, the availability of breeding sites (i.e habitats) and food sources [4,5].

Mosquitoes are best known for their role in the transmission of diseases to man depending on the number of factors. Some of these factors are the vector potency of the anthropoid in the replication of parasites within its body cavity as well as its ability to transmit the parasite to human during a blood meal. Prevailing climatic conditions of the area as well as the availability of breeding sites which enhances mosquitoes ability to survive, breed and reproduce favourably [6].

Mosquitoes are vectors of a wide range of parasitic and viral diseases which mostly affect human and other animals. The introduction of mosquito-borne diseases has intimidates the lives of millions of people globally. World Health Organization reported that there are approximately about one million people died as a result of mosquito-borne disease and about 247 million people become ill as the result of the same diseases, especially in subtropical and tropical areas. Nigeria has been known for a high prevalence rate of malaria and the malaria parasite remain one of the leading cause of morbidity and mortality among children and pregnant women which result in low productivity and reduce school attendance in Nigerian schools [7].

Majority of the population of the world live in an area where there is the risk of insect-borne diseases, most of which spread through a mosquito. Mosquitoes are vectors of a wide range of parasitic and viral disease which mostly affect both human and other animals [8].

Nigeria has the largest burden of malaria vector and yet very little is known about the distribution of mosquitoes, the geographical distribution, of ecological parameters role in transmission and susceptibility to insecticide control and elimination of the vector mosquito [9].

This study aims to compile a database on the mosquitoes vectors of malaria including related information on species abundance, collection methods, morphology pathogenicity, vector control in Sokoto metropolis.

2. MATERIALS AND METHODS

2.1 Study Area

Sokoto is a city located in the extreme North-West of Nigeria, near to the confluence of the Sokoto River and the Rima Rivers. Sokoto is the modern-day capital of Sokoto (and its predecessor the northwestern state). The name Sokoto (which is the modern version of the local name Sakkwato) is of Arab origin, representing suk market; is also known as Sakkwatto, BirninShehuda Bello or “Sokoto, capital of Shaihuand Bello”. Being the seat of the caliphate, the city is predominately Muslim and an important seat of Islamic learning in Nigeria [10].

Sokoto metropolis is geographically located between longitude 13°01’/13°05’ North and latitude 5°10’/5°18’ East. It covers a total land area 451 km^2 (20 sq m). It covers the two metropolitan local Government of Sokoto South and Sokoto North respectively, the area is boarded by Kwarelocal government to the North and Dange/Shunilocal governments to the South. While it also shares boundaries with Wamakkolocal government in the West and Rabahlocal government in the East. However, it is worthy to emphasize that parts of the above

mentioned Local Government fall within the area that makes the Sokoto metropolis. As seen in Fig. 1.

The area of SokotoState is characterized by Sahel savanna climate with an annual average temperature of 30°c. The climate shows along a dry season of 7-8 months i.e from October to April and short wet season of 4-5months i.e from May to September the rainy season is characterized by showery rainfall, sometimes with destructive storms, especially at the beginning of the season. The average annual density is between 750 and 1000 mm from the north to south. From October to February, the climate is usually described as the cold dry season, between late February and late May, it is usually described as hot dry season and between late May and October hot wet season [11].

The research was carried out within Sokoto metropolis study areas are Bello Way, KofarTaramniya and Mabera. Samples were collected randomly from an open well, open drainages, gutters, refuse dumps local pots, stagnant water, cattle sheds and water tanks.

2.2 Sample Collection

Mosquito larvae were collected by a standard dipping method with a dipper. Water samplings are accomplished with an old fashioned water dipper attached to a handle. Larvae were collected by ladle spoon, dipper and dropper from a different spot. The dipper is gently lowered in an angle of 45° just below the surface, dipper was held steadily until larvae were raised to the water surface in the dipper. At least 10 dips were taken per habitat in a different location where mosquito larvae can be expected in open well, open drainage, pond, ditches, gutters and local pots all the habitat were thoroughly searched for the presence of mosquito life cycle stages.

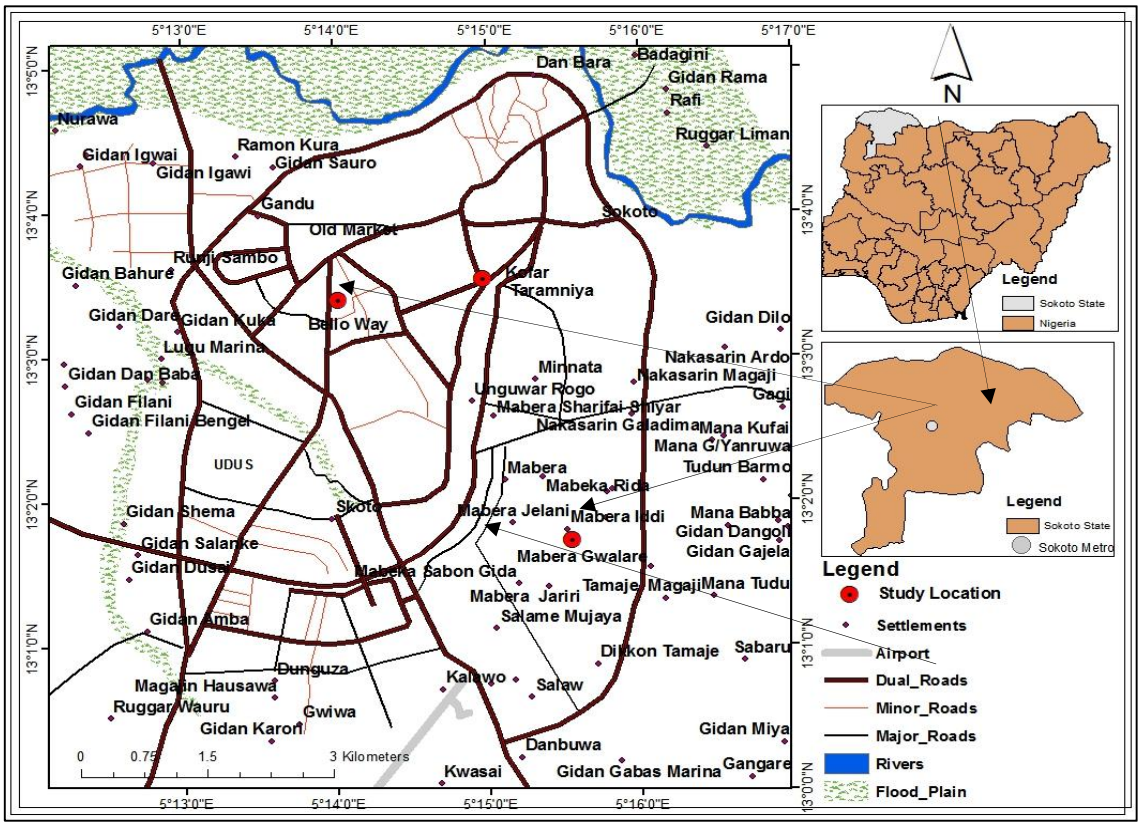

Fig. 1. The study location map
Source: GIS Lab, Department of Geography UDUS 2019

The larvae that are randomly collected were transferred into a plastic bucket and a bottle and then transported into the laboratory for further studies during the shipment care was taken so that the mosquito larvae do not shrink or squeezed [12].

2.3 Experimental Procedure

The experiment set up was monitor daily for one month on each day the number of larvae and pupae in the containers were collected and counted using dipping pipette into different containers. The larvae collected were transported to the laboratory. The bucket container was covered with nets, the net was tight so that emerge adult mosquito won't come out of the net, biscuit and yeast tablet were crush and given to the mosquito which helps in the full development of adult mosquito [13].

2.3.1 Adult mosquito

The emerge adult mosquito was collected from the bucket container and transfer to a transparent bucket and cover the bucket with a net so that the adult mosquito will not escape. A piece of cotton was a dip in a sugar solution and put at the top of the net where the male adult mosquito feed on while the female stay at the bottom of the container, the female normally feed on a blood meal. This method is used for separation of a male and female mosquito, morphological features and keys were also used.

2.3.2 Mosquito larvae

Larvae live in water and come to the surface to breathe. Larvae shed (moult) their skins four times growing larger after each moult. Most larvae have siphon tubes for breathing and hang upside down from the water surface.

2.4 Identification of Mosquito

Adult mosquito and larvae were identified by observing the morphological feature comparing with the reference book and albums or recorded of previously identified species of mosquito in the biology laboratory [14]. with the help of laboratory technologist

2.5 Population Density

$$Dp = N/A$$

Where Dp is the population density, N is the number of population and A is the area cover by the population in square meters.

2.6 Statistical Analysis

The population density of the species was expressed as the percentage of the total number of mosquitoes collected. Chi-square was used to analyze the population density and percentage of the mosquito in the study area as described by Okoli, (2016).

3. RESULTS

3.1 Mosquito Population in the Study Areas

The results of this study revealed that mosquito larvae belonging to *Anopheles* genera and *Culex*were identified. A total of 4,764 mosquito larvae were collected and identified from the three (3) study areas in Sokoto metropolis, larvae and pupae were encounters in abundance in gutters, drainages, stagnant water, refuse dump, water pot, water tanks and cattle sheds.

In KofarTaramniya, A total of 1649 (34.6%) larvae are collected in which 1000 (38.2%) belong to *Anopheles* genera and 649 (30.2%) belong to *Culex* genera 64%.

In Mabera, A total of 1799 (37.7%) larvae were collected among which 1199 (45.8%) were *Anopheles* and 600 (27.9%) were *Culex* 83.5%.

In Bello Way, A total of 1317 (27.5%) larvae were collected, 417 (15.9%) belong to *Anopheles* genera and 900 (41.9%) belong to *Culex* genera as seen in Table 1a.

Table 1a. Larval sampling of *Anopheles* mosquito in the study areas

Area		No. of larvae collected	Percentage (%)	Population density (N/A)
K. Taramniya		1000	38.2	0.01431
Mabera		1198	45.8	0.00021
Bello Way		417	15.9	0.00076
Total	=	2,615	100	0.01528

x^2_c = 14.48, df = 2, p-value = 0.0007, LS= 0.05

Table 1b. Larval sampling of *Culex* mosquito in the study areas

Area		No. of larvae collected	Percentage (%)	Population density (N/A)
K. Taramniya		649	30.2	0.00929
Mabera		600	27.9	0.00011
Bello Way		900	41.9	0.00165
Total	=	2,149	100	0.01105

$x^2_c = 3.44$, *Df = 2, P.value = 0.1791, L.S= 0.05*

4. DISCUSSION

The results of this research show that mosquito has preferential oviposition habitats, water collection and human activities and behaviour such as discarding of empty containers, planting ornamental plant around houses, cattle rearing may potentially encourage the breeding of mosquitoes [15].

Bates (1940) found some *Anopheles* and *Aedes* to show a pronounced preference for a dark background, colours, *Anopheles* mosquito prefers natural habitat for breeding [16]. Tephen and Anoviak (2001) also showed *Anopheles* colonize tree holes and places were cattle were reared.

Anopheles like many other grancile species of aquatic insect, females flies over the water, bobbing up and down in the water surface and dropping eggs more or less single. They are roughly cigar-shaped and have floated down their sides [17].

Members of the genus *Mansonia*, lay their eggs in arrays, attached usually to the under-surface of waterlily pads. Their close relatives the genus *Conquilletidia* lay their eggs similarity, but not attached to plants. Instead, eggs from layers called rafts that float on water.

Culex is known for the habit, plant materials were found to be good oviposition for mosquitoes. The female *Culex*settles carefully on still water with its hind legs crossed and its lays egg one by one, it twitches to arrange them into a head-drawn array that sticks together to form the raft [18].

Aedes eggs in diapause tend to hatch irregularly over an extended period. This makes it much more difficult to control such species than those mosquitoes whose larvae can be killed all together as they are hatch female. *Aedes* drop their eggs singles in damp mud or other surfaces near the water edge such oviposition site commonly the wall of the cavity, hollow stump and container bucked or vehicle tire [19].

Majority of breeding habitats were those found to contain some amount of water or moisture in or around them in which water, gutter, open well, open drainage, pond, ditches were found in abundance in the study area. The observation agrees with the finding of Yahaya (2016) and Adams (2000) in their studies on mosquito breeding habitats in Sokotometropolis where they opined that climatic conditions such as moisture and relative humidity are factors that influence the survival and population of mosquitoes in an environment. Statistical analysis conducted indicated a significant difference ($p<0.05$) between the three collections.

In the result of the collection of different developmental stages of mosquito in the study area and the study site. The sample collected from mosquitoes breeding and thriving habitats, two genera of mosquito were identified in this study which are potential vectors of medical importance in Nigeria. Species of mosquito belonging to genera *Anopheles* genera are vectors of malaria while those belonging to genera *Culex*are responsible for elephantiasis among other mosquito-borne diseases.

5. CONCLUSION

Mosquito is one of the insects that have come to know by many especially in homes for their bites which elicit the formation of anti-bodies. One of the most interesting observations from this study was two (2) genera of mosquito were identified throughout the research period which was the *Anopheles* and *Culex*. The predominance *Anopheles* mosquitoes a vector of malaria and *Culex* mosquitos vector of *Elephantiasis*. These means there is a risk of both malaria and *Elephantiasis* outbreak in high. In the view of the findings from this research, stagnant water, open well, open drainages, gutters, or any place were

water stand and cattle shed attracts mosquitoes. These should be avoided for various day to day activities, residents and the government should take necessary measures to reduce the breeding of *Anopheles* and *Culex* genera in the areas as such the risk of malaria and elephantiasis will be avoided.

6. RECOMMENDATIONS

Based on the results obtained from this study. The following recommendations are made.

1. There is need for KofarTaramniya, Maberaand Bello Way to embark on massive mobilization on the importance of standard environmental sanitation to prevent mosquito bite using spraying, environmental cleanliness as well as preventing young children in the area who have not yet developed immunity from getting the disease that is caused by mosquitoes bite.
2. There is a need for construction and maintenance of an adequate drainage system and gutters to avoid having stagnant water which is known to favour the development and survival of mosquitoes.
3. The government should strengthen community enlightenment on the preventive measures against mosquito population abundance and risk of contracting diseases caused by mosquitoes.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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