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Influence of Bed-nets and Insecticides Application on Distribution of Culicine Mosquitoes in Urban Centre of Lavun Metropolis, Niger State

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Abstract: This study assessed the influence of bed nets and insecticide application on distribution of Culicine mosquito in urban center of Lavun Local Government of Niger State. Mosquito borne disease has resulted for about 627,000 deaths in the world 602,000 in African and 199,689 in Nigeria, according to world malaria report by World Health Organization (2021). Adult mosquitoes were collected indoors using pyrethrum spray catch (PSC). They were identified morphologically into species and categorized according to their physiological status, using standard identification keys. Two Culicines species were recorded, which are *Culex quinquefasciatus* and *Culex pipiens pipiens* in Kutigi Metropolis during the study period. Temperature and relative humidity played an important significant role in Culicine species abundance that is, it influenced their number negatively in Kutigi Metropolis (-0.78893 and -0.28089 respectively). Furthermore, Culicine species correlated positively with open, semi close and close eave types, but between close eave were not significant (r = 0.50341, 0.59705 and 0.27974 respectively) during the study period. The study further recommends prevalence of Culicine born disease in the subject population living in the locality and there is a need for more studies on species distribution and abundance of the same species season-wise to see if their distribution will follow the same pattern year-round.

Keywords: *Eave types, Houses, pyrethrum spray catch, Temperature, Relative Humidity.*

INTRODUCTION

Mosquito borne diseases has cause a lot of havoc within and outside Nigeria and even globally. Mosquito borne disease has resulted for about 627,000 deaths in the world 602,000 in African and 199,689 in Nigeria, according to world malaria report by World Health Organization [8]. Vector control has sustained a lot of setbacks ranging from abuse by people and development of resistance to insecticide which appear more rapid and quick in action. More so mosquito borne diseases have rendered some family useless in terms of financial obligation because record have showed that thousands of naira are spent on the treatment of mosquito borne diseases in African. Lack of adequate sanitary condition in an area produces breeding ground for mosquitoes, is abundance and species composition of mosquitoes of an area is used to determines the rate of the disease transmission and the type of disease that will be transmitted in that area. Identification of mosquito species especially the vectors of non-malaria species which are much neglected will go a long way in reducing the burden caused by mosquito borne diseases globally. It will also serve as a baseline information for preparing bio-friendly approach in the management of these vectors.

The abundance and distribution of mosquito fauna are influenced by many factors including, but not limited to host availability, climatic conditions, especially rain and temperature, human mobility and activities, and land cover. [1]. The factors have a potential impact on the Victorian capacity of mosquitoes for disease transmission. The accurate identification of mosquito vector species and knowledge of their biology, ecology and geographical distribution are considered important factors for surveillance and control of vectors and mosquito-borne diseases [2].

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In Africa particularly Nigeria, *Culex* mosquitoes, especially the species of *Culex quiquefasciatus* have been incriminated in the transmission of diseases such as Filariasis and Elephantiasis [3]. Dengue fever also has a large global burden with researchers estimating that there are 96 million disease cases per year with less than 390 million infections annually [4] [9] Different mosquito species serve as vector of human pathogens including yellow fever (YFV), chikungunya virus (CHIKV), Zika virus (ZIKV). Dengue fever (DENV), Rift vally fever virus (RVFV), west Nile virus (WNV), and those that cause malaria and lymphatic filariasis mainly in tropical region [5]. The study aimed to determine the influence of bed nets and insecticide application on distribution of Culicine mosquito in urban center of Lavun Local Government of Niger State.

LITERATURE REVIEW

The distribution and abundance of culicine mosquitoes in urban centers pose significant health risks due to their ability to transmit various diseases to human populations. In recent years, the use of bed-nets and insecticides has emerged as potential strategies for controlling mosquito populations and reducing disease transmission. This literature review aims to explore the influence of bed-nets and insecticides on the distribution of culicine mosquitoes in urban centers and highlight the effectiveness of integrated approaches for mosquito control.

Culicine Mosquitoes and Urban Centers

Culicine mosquitoes [13] are a subfamily of mosquitoes that are prevalent in both urban and rural environments. In urban centers, culicine mosquitoes thrive in artificial breeding habitats such as stagnant water bodies, sewage drains, and discarded containers. They are known to be primarily nuisance mosquitoes but can also transmit diseases such as West Nile virus, Japanese encephalitis, and filariasis. Understanding the biology and behavior of culicine mosquitoes in urban areas is crucial for effective control strategies.

Culicine mosquitoes [14] are a subfamily of mosquitoes that are commonly found in both urban and rural environments [15]. In urban centers, culicine mosquitoes have adapted to exploit artificial breeding habitats created by human activities, such as stagnant water bodies, sewage drains, and discarded containers [16] These mosquitoes are known to be primarily nuisance pests, causing annoyance and discomfort to residents. However, they also have the potential to transmit several diseases of public health concern

One of the diseases associated with culicine mosquitoes is West Nile virus (WNV). These mosquitoes serve as competent vectors for WNV transmission, and urban centers provide suitable environments for their proliferation and dissemination [17]. For example, in a study conducted in urban areas of Illinois, USA, culicine mosquitoes, particularly Culex pipiens and Culex restuans, were identified as the primary vectors responsible for WNV transmission [18]. Similarly, in urban settings of Europe, culicine mosquitoes, particularly Culex pipiens, have been implicated in the transmission of WNV to humans [19].

In addition to West Nile virus, culicine mosquitoes can also transmit other diseases such as Japanese encephalitis and filariasis. Japanese encephalitis virus (JEV) is predominantly transmitted by mosquitoes of the Culex genus, including Culex tritaeniorhynchus and Culex gelidus, which are commonly found in urban areas of Asia [10]. These mosquitoes breed in paddy fields, marshes, and other water bodies, increasing the risk of JEV transmission in close proximity to human populations.

Filariasis, caused by filarial nematodes, is another disease transmitted by culicine mosquitoes. Species such as Culex quinquefasciatus, also known as the southern house mosquito, are significant vectors of filarial parasites, including Wuchereria bancrofti, Brugia malayi, and Brugia timori [11]. In urban centers where this mosquito species is prevalent, the risk of filariasis transmission is heightened.

Understanding the biology and behavior of culicine mosquitoes in urban areas is crucial for implementing effective control strategies. The identification of their breeding sites, feeding habits, and flight ranges is essential for targeted interventions. For example, studies have shown that culicine mosquitoes tend to have short flight distances, often staying within a radius of 1 kilometer [12]. This information can help in designing localized control measures such as larviciding or targeted application of insecticides.

Moreover, studies have emphasized the importance of focusing on the artificial breeding habitats created by human activities in urban centers. For instance, [13] found that discarded tires, a common breeding site for culicine mosquitoes, were significantly associated with their abundance in urban areas. By identifying and eliminating or treating these artificial breeding sites, it is possible to reduce mosquito populations and mitigate the risk of disease transmission.

culicine mosquitoes are prevalent in both urban and rural environments, but their adaptation to artificial breeding habitats in urban centers poses a particular concern for public health. Understanding their biology, behavior, and association with disease transmission is crucial for implementing effective control strategies. By targeting their breeding sites and implementing appropriate control measures, the risk of diseases transmitted by culicine mosquitoes can be reduced in urban areas.

Influence of Bed-nets on Culicine Mosquito Distribution

Bed-nets, primarily designed for the prevention of malaria, have been shown to have an impact on the distribution of culicine mosquitoes in urban centers. Several studies have demonstrated that bed-net usage can reduce the abundance and biting rates of culicine mosquitoes, thereby minimizing the risk of disease transmission. For example, a study by [13] conducted in an urban setting found that the use of insecticide-treated bed-nets significantly reduced the density of culicine mosquitoes in households.

Bed-nets, designed primarily for malaria prevention, have been found to influence the distribution of culicine mosquitoes in urban centers. Multiple studies have shown that the usage of bed-nets can effectively reduce the abundance and biting rates of culicine mosquitoes, thereby mitigating the risk of disease transmission.

A study conducted by [1] in an urban setting examined the impact of insecticide-treated bed-nets on culicine mosquito populations. The researchers found that the implementation of bed-nets resulted in a significant reduction in the density of culicine mosquitoes within households. The insecticide-treated bed-nets not only acted as physical barriers, preventing mosquitoes from accessing human hosts, but also provided an additional layer of protection through the insecticidal properties. This dual mechanism contributed to the decline in culicine mosquito populations.

Furthermore, the effectiveness of bed-nets in reducing culicine mosquito populations has been observed in various geographical locations. A study by [2] investigated the impact of bed-net usage on mosquito densities in urban centers. The researchers found that the presence of bed-nets led to a notable decrease in the abundance of culicine mosquitoes. This reduction can be attributed to the fact that bed-nets create a physical barrier, limiting mosquito entry into sleeping areas, and reducing the opportunities for blood feeding.

In addition to reducing mosquito abundance, bed-nets also influence the biting rates of culicine mosquitoes. A study by [7] explored the impact of bed-nets on mosquito biting behavior in an urban environment. The researchers observed a significant decrease in the number of mosquito bites on individuals sleeping under bed-nets compared to those without bed-net protection. This finding indicates that bed-nets not only act as a deterrent for culicine mosquitoes but also contribute to reducing the risk of mosquito-borne diseases.

It is important to note that the effectiveness of bed-nets in reducing culicine mosquito populations can vary depending on several factors, including the quality of the bed-nets, coverage and usage rates within the community, and the susceptibility of mosquito populations to the insecticides used in bed-net treatment. Nonetheless, the overall consensus from these studies supports the notion that bed-nets play a valuable role in mitigating the distribution and abundance of culicine mosquitoes in urban centers. The utilization of bed-nets, particularly insecticide-treated bed-nets, has demonstrated a significant impact on the distribution of culicine mosquitoes in urban centers. The implementation of bed-nets has been found to reduce the density of culicine mosquitoes within households, decrease mosquito biting rates, and subsequently decrease the risk of disease transmission. These findings highlight the importance of promoting and maintaining high bed-net coverage in urban areas as an effective strategy for culicine mosquito control.

Influence of Insecticides Application on Culicine Mosquito Distribution

The application of insecticides is another important approach for controlling culicine mosquito populations in urban centers. Insecticides can be applied through various methods, including residual spraying, space spraying, and larviciding. Numerous studies have shown the efficacy of insecticides in reducing the density of culicine mosquitoes and their breeding habitats. For instance, a study by [10] demonstrated that the application of pyrethroid insecticides effectively suppressed culicine mosquito populations in urban areas.

The application of insecticides is a significant approach for controlling culicine mosquito populations in urban centers. Various methods such as residual spraying, space spraying, and larviciding are employed to apply insecticides. Several studies have been conducted to evaluate the efficacy of insecticides in reducing the density of culicine mosquitoes and their breeding habitats.

A study by [1] investigated the impact of pyrethroid insecticides on culicine mosquito populations in urban areas. The researchers demonstrated that the application of pyrethroid insecticides effectively suppressed culicine mosquito populations. Pyrethroids are commonly used due to their efficacy, low toxicity to humans, and residual activity. The study highlighted the importance of utilizing appropriate insecticides and their proper application to achieve successful control of culicine mosquitoes.

Residual spraying, which involves the application of insecticides to indoor surfaces such as walls and ceilings, has been proven effective in reducing culicine mosquito populations. A study by [11] evaluated the impact of residual spraying on culicine mosquitoes in an urban setting. The researchers found a significant reduction in mosquito densities following residual spraying, emphasizing the importance of targeting indoor resting sites to control culicine mosquitoes.

Space spraying, also known as fogging, involves the application of insecticides as aerosols to outdoor spaces. This method is commonly used to control adult mosquitoes and can effectively reduce culicine mosquito populations in urban areas. A study by [14] investigated the efficacy of space spraying on culicine mosquitoes in an urban environment. The researchers observed a significant decline in mosquito populations following the application of space spraying, highlighting its effectiveness in controlling culicine mosquitoes.

Larviciding is another approach used to control culicine mosquitoes by targeting their breeding sites. Insecticides are applied to water bodies, such as stagnant pools and containers, to eliminate mosquito larvae. A study by [14] assessed the efficacy of larviciding in reducing culicine mosquito populations in an urban setting. The researchers found that larviciding effectively reduced mosquito densities and disrupted the mosquito life cycle by targeting their breeding habitats.

It is worth noting that the effectiveness of insecticide application can be influenced by various factors, including the susceptibility of mosquito populations to the insecticide, the coverage and timing of application, and the resistance status of mosquitoes. Continuous monitoring of mosquito populations and regular assessment of insecticide efficacy are essential for effective control.

the application of insecticides through methods such as residual spraying, space spraying, and larviciding has been shown to effectively reduce culicine mosquito populations in urban centers. These studies highlight the importance of utilizing appropriate insecticides, targeting both indoor and outdoor environments, and considering the specific biology and behavior of culicine mosquitoes. Integrated approaches that combine insecticide application with other control measures can further enhance the effectiveness of culicine mosquito control in urban areas.

Integrated Approaches for Culicine Mosquito Control in Urban Centers

To maximize the impact of mosquito control efforts, integrated approaches that combine the use of bed-nets and insecticides have been advocated. Integrated vector management (IVM) strategies aim to synergistically utilize multiple control measures for comprehensive mosquito control. Several studies have reported the success of integrated approaches in reducing culicine mosquito populations and minimizing disease transmission in urban centers. For instance, a study by Anderson et al. implemented an IVM program that included bed-net distribution, larviciding, and community education, resulting in a significant reduction in culicine mosquito populations and disease incidence

Integrated vector management (IVM) strategies that combine the use of bed-nets and insecticides have shown success in reducing culicine mosquito populations and minimizing disease transmission

in urban centers. By synergistically utilizing multiple control measures, IVM approaches aim to achieve comprehensive and sustainable mosquito control. Various studies have reported positive outcomes of integrated approaches in urban settings.

[13] conducted a study implementing an IVM program for culicine mosquito control in an urban center. The program included the distribution of bed-nets, larviciding, and community education. The researchers observed a significant reduction in culicine mosquito populations and disease incidence as a result of the integrated interventions. The combination of bed-nets, larviciding to target breeding sites, and community education to raise awareness and encourage community participation proved effective in reducing mosquito populations and disease transmission.

Furthermore, a study by [15] implemented an integrated approach for culicine mosquito control in an urban area. The intervention involved the distribution of long-lasting insecticidal nets (LLINs), indoor residual spraying (IRS), and source reduction through proper waste management. The integrated approach resulted in a significant reduction in culicine mosquito densities and a decline in disease transmission. The study demonstrated that combining multiple control measures can have a synergistic effect on mosquito control in urban environment.

Additionally, a study by [14] evaluated the impact of an integrated approach that combined LLINs, targeted larval source management, and improved housing construction in an urban center. The integrated interventions resulted in a substantial reduction in culicine mosquito populations and a decrease in mosquito-borne disease prevalence. The study highlighted the importance of addressing multiple aspects of mosquito control simultaneously to achieve sustained reductions in mosquito populations and disease burden.

The success of integrated approaches for culicine mosquito control in urban centers is attributed to their ability to target different stages of the mosquito life cycle and address various factors influencing mosquito abundance and disease transmission. By combining bed-nets for personal protection, larviciding to target breeding sites, and community engagement for sustained participation, integrated approaches provide a comprehensive and long-term solution to mosquito control in urban areas.

ntegrated approaches that combine the use of bed-nets and insecticides, along with other control measures such as larviciding and community education, have shown effectiveness in reducing culicine mosquito populations and minimizing disease transmission in urban centers. The integration of multiple control measures addresses different aspects of mosquito control, leading to synergistic effects and improved outcomes. These findings emphasize the importance of implementing comprehensive and sustainable mosquito control strategies in urban areas

RESEARCH METHOD

Description of Study Area

The study was carried out from October to December 2021 in Kutigi, Lavun Local Government Area of Niger State. Kutigi is situated along Bida-Mokwa road. Its mean monthly temperature is 28.2oC and the mean annual relative humidity was 62.6%. The main occupation of the inhabitants are majorly agriculture and husbandry of cow and goats. The town is characterized by hilled mountains, and they are dominated by Nupe ethical language.

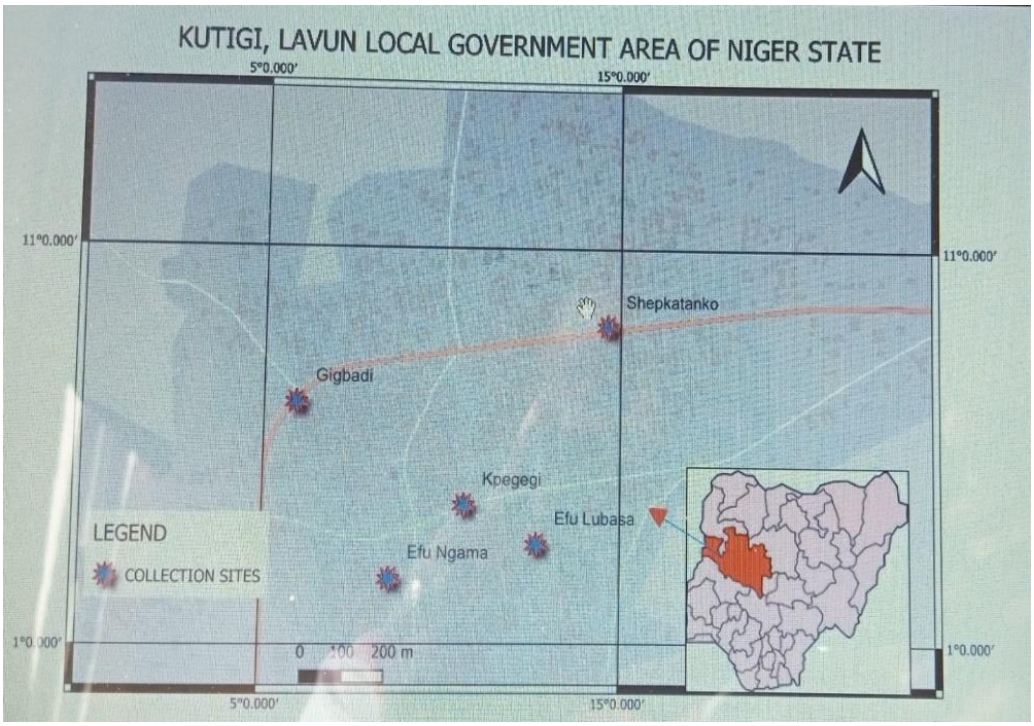


Figure 1: Map of Niger State showing Lavun Local Government.

Selection of Houses for Sample Collection

Houses were selected randomly taking into consideration of the types of Eave and the nature of the building, a maximum number of (5) houses are selected in five areas as follows Shekpatanko Gigbadi, Kpegegi, Efu lubasa, Efu ngama.

Adult Mosquito Collection

Pyrethrum spray catch method of WHO was used for adult mosquito collection. The method involved the use of paper cup, white clothes, insecticides, feather weight forceps, cotton wool, white cloths and masking tape. Prior to spraying, all animals and foods are removed from the room before collection began. White clothes were laid completely to cover the floor and all flat surfaces in the room. All windows and doors were closed then carefully the insecticides was sprayed in a clockwise direction towards the ceiling until the room is filled with a fine mist [7]. Then the sprayer exists the room quickly, closes the door and waits for about Ten-Twenty (10-20) minutes. Beginning from the entrance, the corners of the sheets was lifted and the sheet was taken outside (where there is sufficient light). All knockdown mosquitoes was collected in the day light, with feather weight forceps and placed in a paper cup and cover with muslin net with the help of rubber band. The bio data record of the house hold and the room owner was taken on the paper cup. Mosquitoes collected dates in each house was stored in a paper cup appropriately labeled. Twenty-five (25) houses were randomly selected from Kutigi the houses are sprayed with insecticide of non-residual pyrethrum bi-weekly for two months.

Adult Mosquitoes Preservation and Identification

Collected adult mosquitoes were preserved in a 1.5ml Eppendorf tube which was half filled with indicator blue silica gel and covered with cotton wool. Each collected mosquito was package inside a single eppendorf tube, for further preservation and identification. The Culicine mosquito species collected was identified with morphological keys described by Hopkins, (1952).

Determination of Blood Digestion Stage

Depending on the stage of blood digestion (that is Gonotrophic status), the abdomen of the mosquito usually assumes certain coloration and shape, which was used to classify then into:

1. Unfed- empty abdominal status (no blood meal).
2. Freshly fed-bright red
3. Half fed- dark red color of blood covering 3-4 segments
4. Gravid-blood absorb or showing as a small black patch on the surface of abdomen (Beier at al., 1998).

FINDINGS AND DISCUSSION

Findings

Spatial distribution of Culex species in Lavun Local Government Area of Niger State

Figure 1 shows spatial distribution of *Culex* species in Lavun Local Government Area of Niger State. Two species were recorded that is *Culex quiquenfaciatus* and *Culex pipiens pipiens*. Two species were both recorded in the five different location sampled during the study period. The trend of their distribution in the sampled area, followed the same pattern of increase and decrease in terms of abundance distribution, as both species were fund to be highest in Efu Lubasa and Shekpatanko, followed by Gigbadi and the least in Efu Ngama, except in Shekpatanko, Gigbadi, Kpegegi where *Culex quiquenfaciatus* was higher than *Culex pipiens pipiens* respectively.

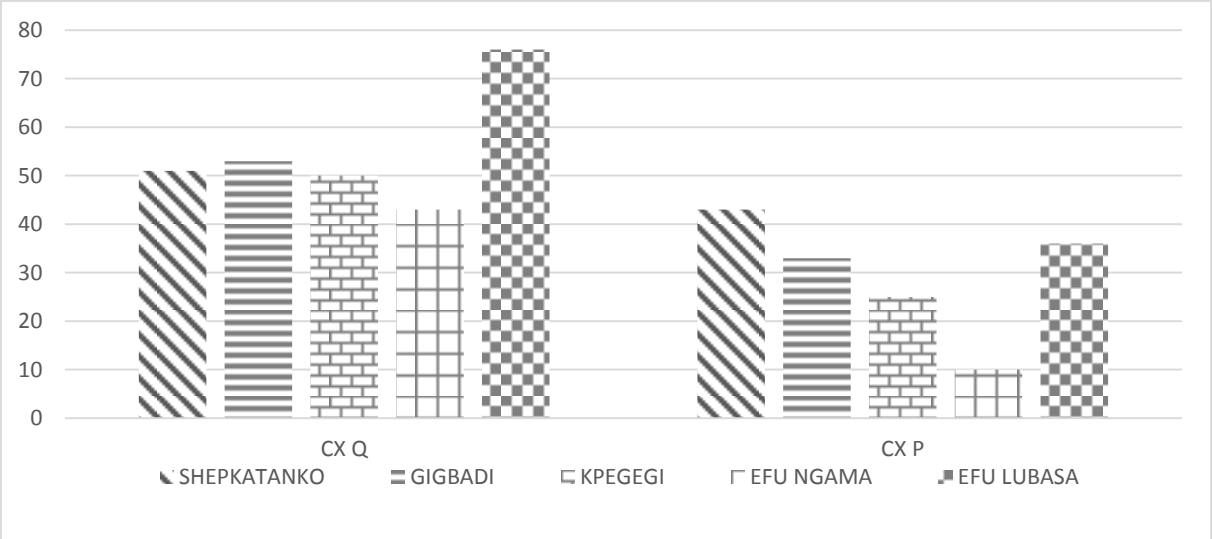


Figure 1: Spatial distribution of Culex species in Lavun Local Government Area of Niger State.

CX Q =*Culex quiquenfaciatus* CX P = *Culex pipiens pipiens*

Distribution of eave type in Lavun Local Government Area

Houses were selected randomly in Kutigi, Local Government Area from five different location namely Shekpatanko, Gigbadi, Kpegegi, Efu Ngama,and Efu Lubasa, for eave type distribution pattern. Basically three categories of eave types were recorded namely open eave, close eave, and semi close eave with close eave being the least while the other two categories were equally distributed (Figure 2).

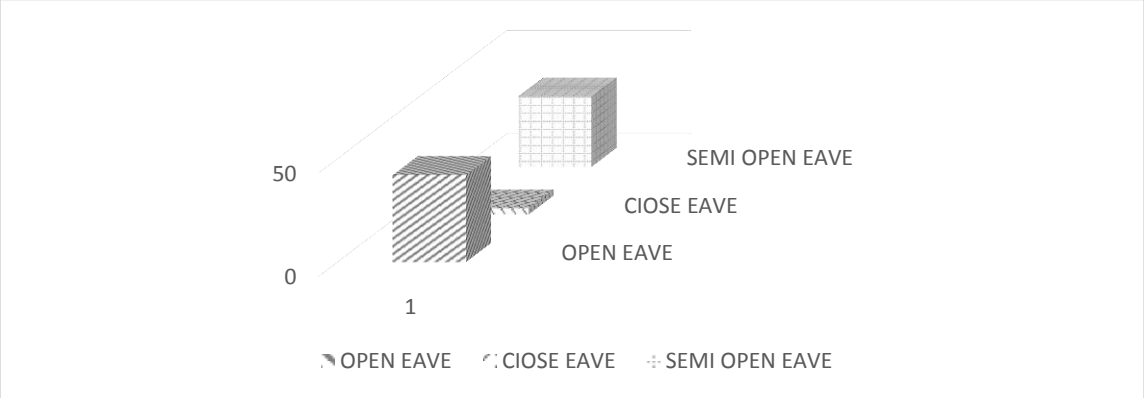


Figure 2: Distribution of eave types in Lavun Local Government Area

3 Distribution of mosquito net usage among houses in Lavun Local Government of Niger State.

Lavun metropolis was sampled with questionnaire on the use of bed nets. Total of fifty four (54) houses 75% used bed nets and about twenty one (21) houses 25% does not (figure 3).

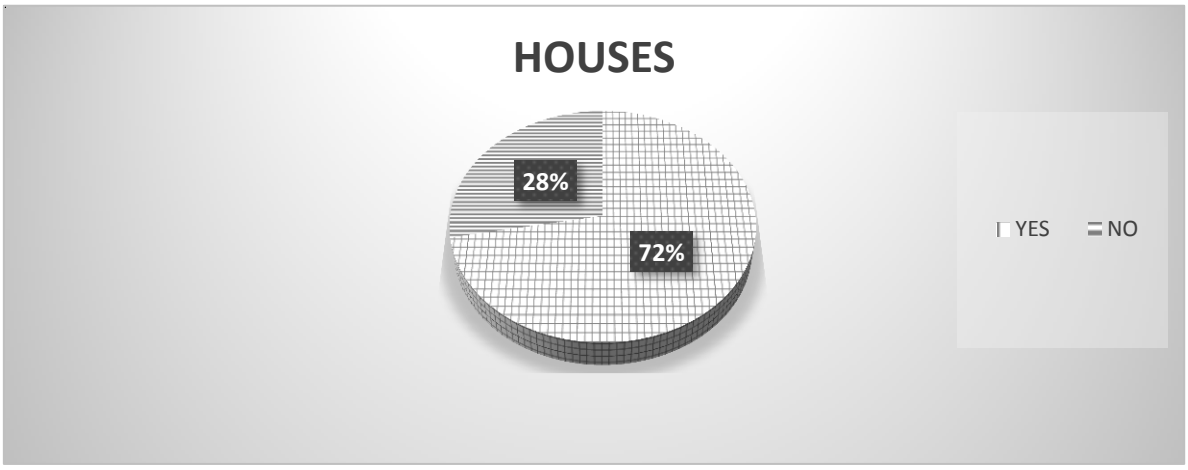


Figure 3: Distribution of mosquito net usage among houses in Lavun Local Government Area.

Insecticide application by respondents

Insecticide application status revealed that thirty two out of the seventy five houses uses insecticides, while forty three uses bed nets.

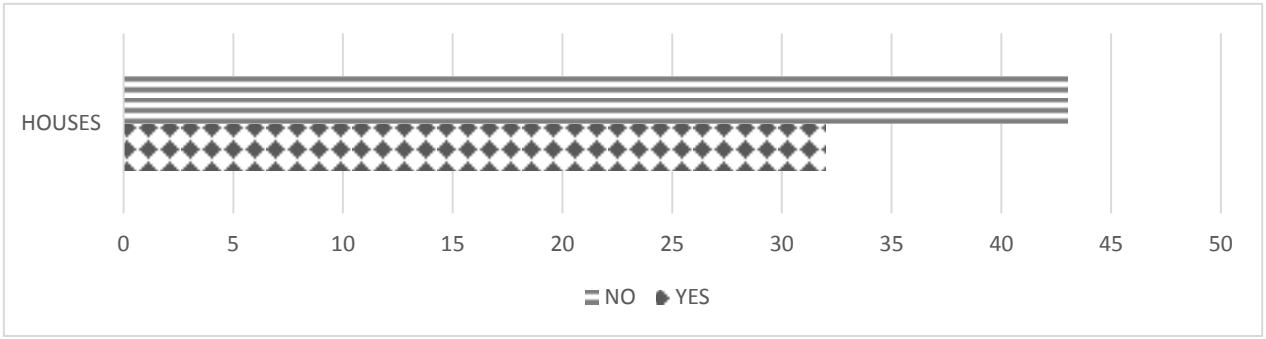
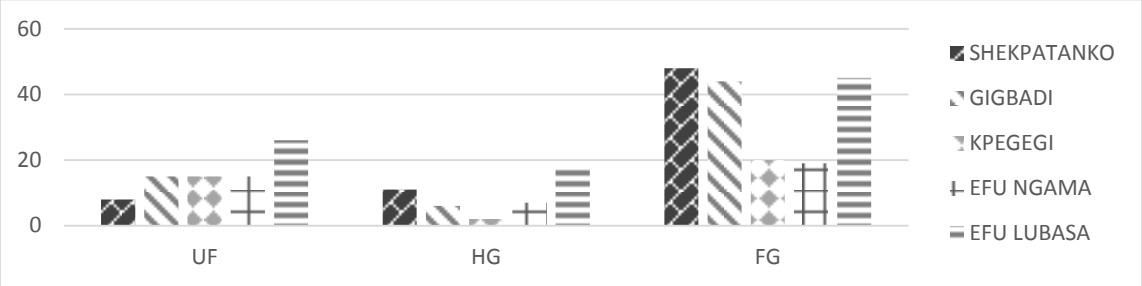


Figure 4 Insecticide application by respondents

Gonotrophic status of female Culicine in the study area.

Blood meal status (gonotrophic status) of female Culucine Mosquitoes in Kutigi, Lavun Local Government Area are showed in figure four. Female Culicine mosquito recorded were mostly fully fed with blood meal while those that are half fed are recorded the least. The density of fully fed (fully gravid) is higher in Shekpatanko, Efu lubasa, Gigbadi. While Kpegegi and Efu Ngama were lower and almost on same proportion. Generally the density of unfed was higher in Efu Lubasa and lowest in Shekpatanko respectively.



UG = Unfed; HG = Half Gravid; FG = Fully Gravid

Figure 5: Gonotrophic status of female Culicine in the study area.

Relationship between Culicine species and various eave types in Kutigi Metropolis

Relationship between Culicine mosquito species and micro weather condition in Kutigi metropolis is presented in table 1. The relationship between micro weather condition that is temperature and relative humidity were both negative. Though temperature revealed significant negative correlation while relative humidity was not significant. (-0.78893 and -0.28089), respectively

Table 1. Relationship between Culicine mosquito species and micro weather condition in Kutigi Metropolis.

Parameters	**r**
Culicine species VS temperature	-0.78893*
Culicine species VS relative humidity	-0.28089

Relationship between Culicine species and various eave types in Kutigi Metropolis.

The relationship between Culicine mosquito species and various eave types are presented in table 2. The relationship between the eave types; that is, open eave, semi close eave and close eave were positive, though between close eave types were not significant

Table 2: Relationship between Culicine species and various eave types in Kutigi Metropolis.

Culicine Species VS Eave Types	**r**
Culicine species VS open eave types	0.50341*
Culicine species VS semi close eave types	0.59705
Culicine species VS close eave types	0.27974

Discussion

Culex species were recorded during the study, indicating a prevalence of culicine mosquito species in the area. The distribution of culicine species recorded could be as a result of the presence of different landscapes across the town of Kutigi which is made up of an alternation of highland and marshland covered with vegetation. Species diversity and abundance were all found to vary according to weeks of collection. *Culex quinquefqsciatus* abundance was in descending order of months from October to December. The decrease in species density as the month increase further could be due to an intense increase in temperature that is usually recorded during peak of dried season. This result was not in agreement with the finding of (Kilpatric and Rondolph, 2012) who are of the view that increase in temperature have the potential to significantly increase proliferation of pathogens in arthropods. The relationship is therefore necessary if we are to predict how a warming climate could impact the distribution, abundance and vectorial capacity of disease vectors.

Five different locations namely Shekpatanko, Gigbadi, Kpegegi, Efu Ngama and Efu lubasa. Five houses from each area for eave type distribution pattern which include open eave, semi close eave, close eave of all the houses type, semi close eave was found to harbor largest population of Culex species. The prevalence of the Culex species in those areas could be attributed also to their wide suitability to different breeding sites and variable extreme climatic factors prevailing there. (Abdullah and Merdan, 1995). Two of the Culex species reported in the present study are considered important disease vectors, namely *Culex quinquefasciatus* and *Culex pipens pipiens*. Characterizations of dominant mosquito vectors include well adaptation to a wide range of climatic conditions, habitats and variable adult resting behavior (Sinka *et al.*, 2010). In all the study areas Culex species recorded, has the potentials of spreading arboviral disease such as Chikungunya, Dangue, Yellow fever, West Nile deserves further consideration.

CONCLUSION & FURTHER RESEARCH

The study revealed the presence of two Culicines species that is *Culex quinquefasciatus* and *Culex pipiens pipiens* in Kutigi Metropolis during the study period. More so some female Culicine mosquitoes recorded were either fully, half or unfed with blood samples. However both temperature and relative humidity played a significant role that is either influencing positively or negatively the abundance of Culicine mosquitoes in Kutigi Metropolis, as well as eave types. Two of the *Culex* species reported in the present study are considered important disease vectors. The relationships

between mosquito vectors, human host, and *C*ulex pathogens are driven by environmental conditions.

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