



STUDY ON THE ABUNDANCE AND DISTRIBUTION OF *CULEX* (DIPTERA-CULICIDAE) MOSQUITOES IN GWAGWALADA AREA COUNCIL, ABUJA, NIGERIA

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Abstract

Culex is a genus of mosquitoes, distributed worldwide. They are vectors of major infections of zoonotic significance, which remain the most neglected agents of disease transmission in Gwagwalada Area Council, Abuja, Nigeria. This work was designed to ascertain the abundance and distribution of *Culex* mosquitoes in Gwagwalada Area Council, Abuja, Nigeria. Mosquitoes were collected from three different locations in Gwagwalada Area Council: New Kutunku, Passo and Kuje road using Center for Disease Control (CDC) light traps between January 2022 and July 2022. They were sorted out based on genera using morphological keys. A total of one thousand two hundred and sixty-three (1,263) mosquitoes, which included: *Culex*, *Anopheles* and *Aedes*, were collected from 3 different locations. *Culex* spp were more abundant, with 1,000/1263 (79.18%) compared to *Anopheles* spp and *Aedes* spp 151/1263 (11.96%) and 112/1263 (8.86%), respectively. Out of the 1000 *Culex* spp, 586/1000 (58.60%) were females. Mosquitoes collected from homes with livestock recorded the highest incidence of *Culex* mosquitoes, 604/1000 (60.40%) compared with those without livestock, 396/1000 (39.60%). The two homes examined in this study showed no statistically significant difference ($P \leq 0.05$). The three locations sampled showed *Culex* more abundantly distributed in New Kutunku 409 (40.90%) compared to other locations, Passo 293 (29.30%) and Kuje road 298 (29.80%). This study provides information on the abundance of *Culex* spp which has potential zoonotic significance.

Keywords: *Culex* spp, *Anopheles* spp, *Aedes* spp, Gwagwalada

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INTRODUCTION

Culex mosquitoes are responsible for sleeplessness and hypersensitivity in sensitive individuals (Motayo, *et al.*, 2016).

They are vectors of various arboviral diseases such as Encephalitides, Rift valley fever, West Nile fever, equine encephalitis, avian pox, avian malaria and lymphatic filariasis (Mohammed *et al.*, 2021). They are widely distributed throughout the world and utilize different water bodies for their breeding.

Additionally, they serve as major vectors in the transmission of various viral and parasitic diseases (Monath *et al.*, 2001).

Over 3,500 species of mosquitoes were reportedly identified, with many species breeding in both natural and artificial habitats such as pools, gutters, coconut shells, tree holes, septic tank etc. (Godwin *et al.*, 2021; Xia *et al.*, 2018). Among all mosquito species that have been recorded, about 10% are regarded as vectors of infectious agents, having a considerable effect on public health (Tandina *et al.*, 2018). The ecology, development, behavior, density, and survival of vectors are strongly influenced by climatic factors such as temperature, rainfall, and humidity (Negev *et al.*, 2015; Adeleke *et al.*, 2008). Members of this group are vectors that transmit important diseases globally (Nchoutpouen *et al.*, 2019). They mostly bite human when other animals are not available (Mohammed *et al.*, 2021). *Culex* mosquitoes are potential vectors of Rift Valley Fever (RVF), *Bancroftian filariasis*, yellow fever, West Nile Virus, and Dengue virus (Utah *et al.*, 2013; Farajollah *et al.*, 2011). *Wuchereria bancrofti*, avian malaria, and arboviruses such as Zika virus and West Nile virus are transmitted by this vector (Hill and Cornelly, 2009). *Culex* causes tremendous nocturnal discomfort and allergic responses due to its nuisance biting (David *et al.*, 2012). The nuisance biting usually affects a larger part of the population than the proportion harboring diseases transmitted by the mosquito species. Sometimes the nuisance level could be extremely high and intolerable.

However, despite the public health importance they are left understudied in North-central Nigeria, compared to Anophelines. Cases of endemic arboviral, malaria and typhoid infections has been reported in Nigeria (Oderinde *et al.*, 2020).

Febrile illnesses caused by these infections and mostly all fever cases are categorized as malaria or typhoid unless confirmed through accurate laboratory investigations (Oderinde *et al.*, 2020; Okechukwu *et al.*, 2017). Studies have provided serological evidence for the occurrence of RVFV in some parts of the country such as Jigawa and Katsina (Adamu *et al.*, 2020), Oyo (Opayele *et al.*, 2018), Niger (Alhaji *et al.*, 2018), Lagos and Borno (Olaleye *et al.*, 1996), Kaduna and Sokoto States (Ezeifeke *et al.*, 1982). There is a dearth of information regarding the abundance and distribution of this vector in this area. The aim of this work is to determine the abundance and distribution of *Culex* mosquitoes, genus composition, sex ratio monthly seasonal distribution and livestock association in Gwagwalada Area Council, Abuja Nigeria.

MATERIALS AND METHODS

Study Area

Gwagwalada Area Council, one of the six councils of the Federal Capital Territory (FCT), Abuja – Nigeria. Located geographically in the central part of Nigeria between latitude 8°-25'' and 9°-9'' and longitude 6°-29'' and 7°-45'' east of the Greenwich. It has a Guinea Savannah type of vegetation, with rainy season stretching from April to October and dry season from November to March. Temperature ranges from 30-37°C yearly, with the highest temperature experienced in the month of March (Motayo *et al.*, 2016). Livestock population in Gwagwalada include cattle, sheep, goats, rabbits and birds. The study locations were in 3 urban residential areas, these are New kutunku, Passo and Kuje road, all situated within Gwagwalada Area Council, Abuja, Nigeria.

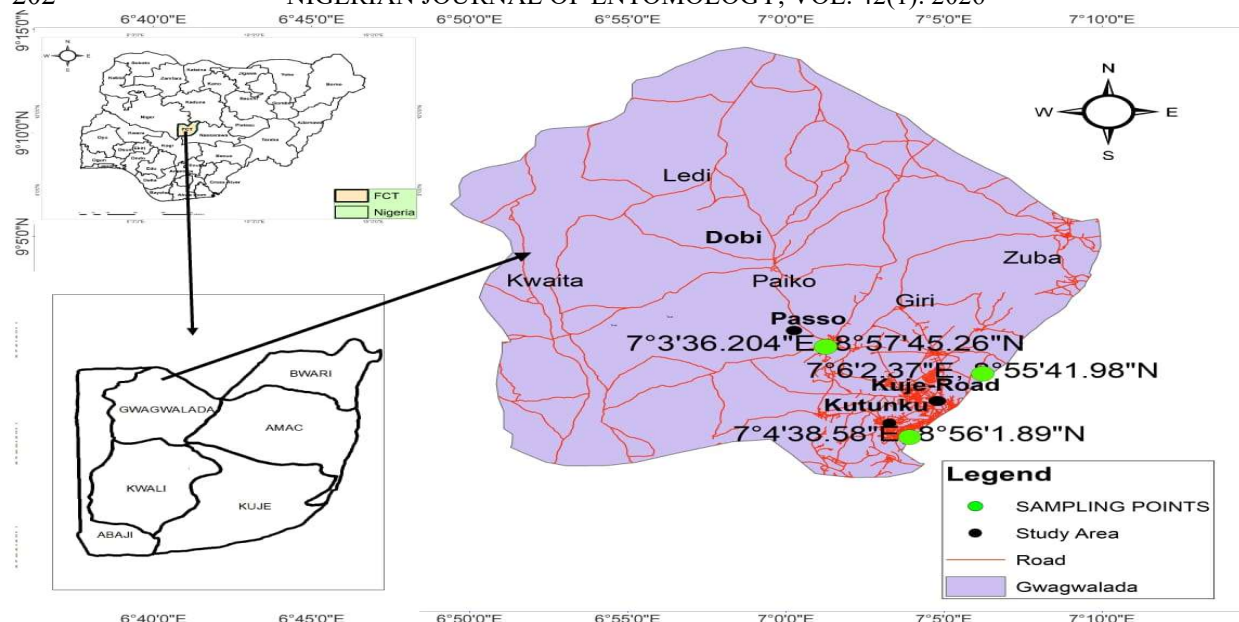


Figure 1: Map of Gwagwalada, showing the study area; Source: Department of Geography, University of Abuja

Mosquito Collection

Adult Mosquitoes were collected sequentially for three nights monthly between January 2022 and July 2022 (Smith and Fonseca, 2004) in each of the three (3) selected Area in Gwagwalada Area council North-central Nigeria using the CDC light traps (Model 512, J.W. Hock Ltd., Gainesville, Florida, USA) (Motayo *et al.*, 2016)

DESCRIPTION OF CATCH METHOD IN THE STUDY

CDC light trap was hung 1.5m above the floor from the roof or a nearby tree, close to the livestock pens (Motayo *et al.*, 2016). Collections were made between 18.00 h and 06:00 h at each collection site. The traps were improved with carbon-dioxide (CO₂) following an adaptation of Obenauer collection method (Obenauer *et al.*, 2013). Mosquitoes collected were transported in petri dishes to the laboratory section for morphological identification in the

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MORPHOLOGICAL IDENTIFICATION AND PRESERVATION

Mosquitoes collected were stored in petri dishes containing silica gel. Adult Mosquitoes were sorted into different genera; *Anopheles*, *Aedes* and *Culex* spp. according to the keys detailed by Becker (Becker *et al.*, 2012). *Culex* mosquitoes were sorted from other genera. They were identified using such morphological features as the body color, nature of the antennae, palps and the marking on the thorax. Male mosquitoes were differentiated from females using the hairy nature of antennae, and the length of the palps. Female *Culex* species were identified by their antennae and palp under the stereomicroscope (Motayo *et al.*, 2016).

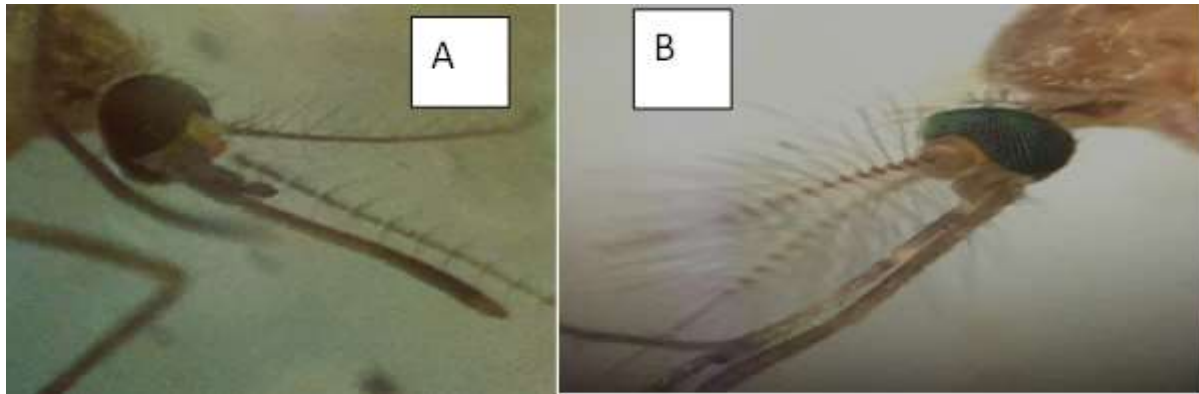


Plate 1: *Culex* spp (Mouthparts) **A** – Female mouth part **B** - Male mouth part

Bushy and hairy antennae, long hairy maxillary palps on either side of the proboscis and of similar length to the proboscis with a Large compound eyes.

Less hairy antennae, more needle- like proboscis for biting, slender stylets, maxillary palps and labial palps.



Plate 2: A (Female *Culex* spp) & B (Male *Culex* spp)

STATISTICAL ANALYSIS

The data gotten from the investigations were expressed as percentages and presented as tables and bar charts. Statistical Package for Social Sciences (SPSS Version 26.0) and Chi-square test association was used for the analysis and the $P \leq 0.05$ were considered

statistically significant in all statistical inferences.

RESULTS

One thousand two hundred and sixty three (n = 1,263) adult mosquitoes; *Culex*, *Anopheles* and *Aedes* were captured and collected. The

highest occurrences was reported for *Culex* spp. (n=1000), including 586 (58.60%) female and were 414 (41.40%) male, followed by *Anopheles* (n=151) species collected including 82 (54.30%) female and 69 (45.70%) male. Lowest number of *Aedes* (n=112) were reported; 74 (66.10%) female and 38(33.90%) male (**Table 2**).

DISTRIBUTION OF MOSQUITOES IN THE STUDY AREA

Monthly spread of *Culex* mosquitoes collected in the study area was obtained using Chi-square analysis of variance. One thousand *Culex* (1000) 79.18% collected were more than *Anopheles* 151 (11.96%) and *Aedes* 112 (8.86%) throughout the sampling period (**Figure 2**) (**Table 1**). In May, 305 *Culex* mosquitoes collected, comprising of

home with and without livestock which is higher than the number of *Culex* mosquitoes collected in every other month whereas the least *Culex* spp 60 collected was observed in the month of March (**Table 1**). Out of 1000 *Culex* spp collected, 586 (58.6%) were females and 414 (41.40%) were males. This means higher number of females over males were recorded (**Table 2**). New kutunku has the highest number of *Culex* spp 409 (40.90%) collected followed by Kuje road 298 (29.80%) and Passo 293 (29.30%) $P \leq 0.05$ (**Table 3**). *Culex* mosquitoes in homes that has the presence of livestock higher than those without livestock, throughout the collection periods (**Figure 3**). This genera of mosquito is very significant due to their public health importance.

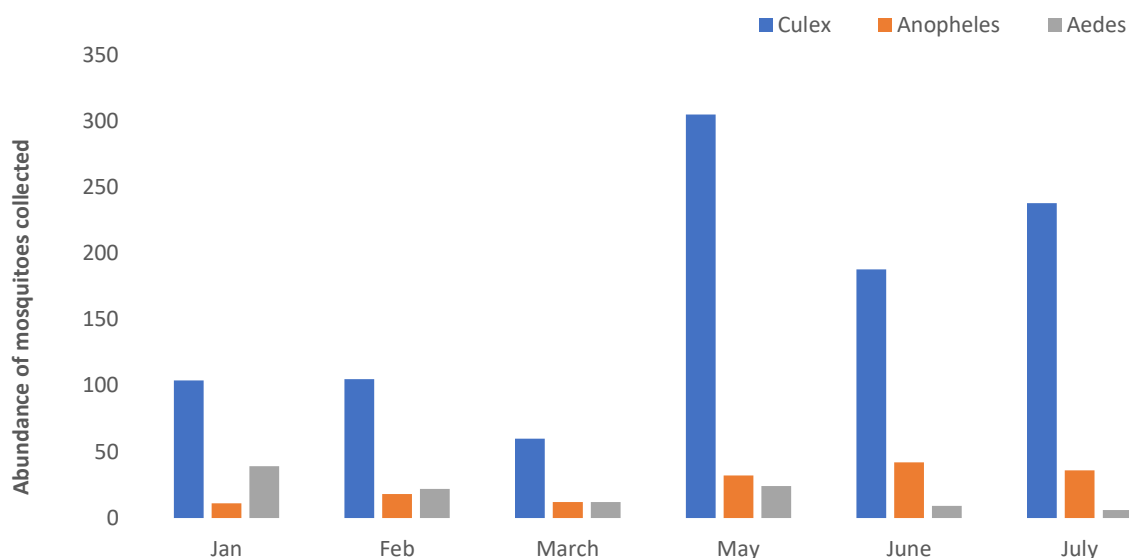


Figure 2: Relative Abundance and Monthly Distribution of mosquitoes base on genera

Table 1. Relative abundant and monthly distribution of mosquito base on Genera in the study area

Month	<i>Culex</i>	<i>Anopheles</i>	<i>Aedes</i>	Total	Test Statistics	
Jan	104(8.23%)	11(0.87%)	39(3.09%)	154(12.19%)	Chi-square	98.99
Feb	105(8.31%)	18(1.43%)	22(1.74%)	145(11.48%)	P value	<0.0001
March	60(4.75%)	12(0.95%)	12(0.95%)	84(6.65%)	P value summary	Strongly significant
May	305(24.15%)	32(2.53%)	24(1.90%)	361(28.58%)	Statistically sig. (P ≤ 0.05)?	Yes
June	188(14.89%)	42(3.33%)	9(0.71%)	239(18.92%)		
July	238(18.84%)	36(2.85%)	6(0.48%)	280(22.17%)		
Total	1000(79.18%)	151(11.96%)	112(8.86%)	1263(100.0%)		

Table 2. Sex distribution of mosquitoes caught in the study area

Genus	Mosquitoes collected	Sex			
		Female	(%)	Male	(%)
<i>Culex</i>	1000	586	58.60	414	41.40
<i>Anopheles</i>	151	82	54.30	69	45.70
<i>Aedes</i>	112	74	66.10	38	33.90
Total	1263				

Table 3: Location distribution of *Culex* species base on season in Gwagwalada Area Council, FCT

Location	Month	Season (Dry)	Month	Season (Rainy)	Total	Test Statistics	
New Kutunku	Jan	104(10.40%)	May	305(30.50%)	409(40.90%)	Chi-square	19.29
Passo	Feb	105(10.50%)	June	188(18.80%)	293(29.30%)	P value	0.0001
Kuje Road	March	60(6.00%)	July	238(23.80%)	298(29.80%)	P value summary	
Total		269(26.90%)		731(73.10%)	1000(100.0%)	Statistically sig (P ≤ 0.05)?	Yes

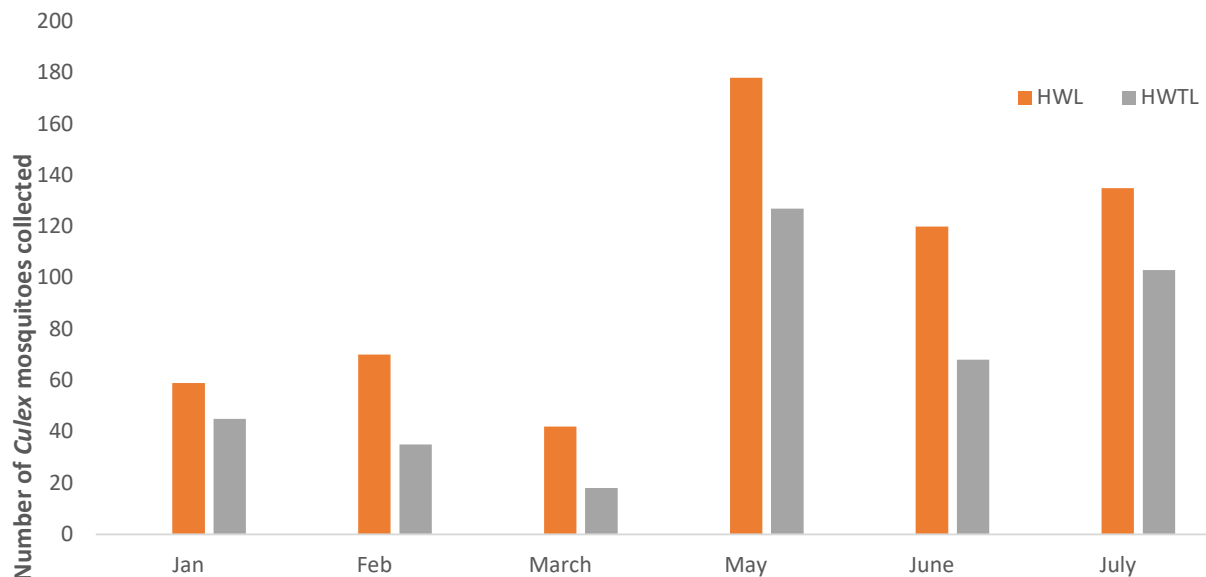


Figure 3: Monthly distribution of *Culex* species base on house with livestock (HWL) and house without livestock (HWTL).

DISCUSSION

This study addresses the previous lack of information on the abundance and occurrence of *Culex* mosquitoes in Gwagwalada area Council have been provided. Morphological characteristics of this specie of mosquito showed that the females are usually larger in size than the males, males possess bushier antennae while the females have fewer shorter hairs. The palps on either side of the proboscis in female are longer and similar in length to the proboscis in males. There are pincer-like claspers at the end of the abdomen in males and there more complex proboscis in female *Culex* mosquitoes than males as seen in **plate 1 and 2**. Long sucking and piercing mouth path called proboscis, differentiate them from other flies (Mehiorn, 2001). The morphology of the adult mosquitoes is a representation of flies in the suborder nematocera having the head, thorax, and abdomen clearly stated and the two forewings held horizontally over the abdomen when at rest (Mike, 2008). Second

pair of wings is reduced and modified into tiny, unnoticeable halteres in all diptera(flies). *Culex* mosquitoes are vectors that transmit disease of wildlife and are limited to habitats heavily populated by human (Eastwood *et al.*, 2011).

Amid the mosquitoes collected, it was observed that more of *Culex* mosquitoes were collected than *Aedes* and *Anopheles* (**Table 1**) ($P < 0.05$). This is similar to the findings of Madara and Abdulraheem (Madara *et al.*, 2013) from the North-Central Nigeria but differs from the report of Monsuru (Monsuru *et al.*, 2013) in Osogbo, Imo state (Mgbemena *et al.*, 2012) and Akure (Joseph *et al.*, 2013), where five genera were recorded in their study. *Culex* spp. had the highest incidence, with 1000 spp. collected. Females had the highest incidence, 586 (58.60%), while 414 (41.40%) was reported for males. A similar higher prevalence were recorded for *Culex* spp. (52.5%) in Makurdi, Nigeria (Msugh-Ter *et al.*, 2017) and (59.70%) in Kano Nigeria (Mohammed *et al.*, 2021) but lower compare to the results

reported in Minna, Nigeria (24%) (Rabiu, and Ahmed, 2019). This may be as a result of different ecotype systems, the micro climatic conditions of the study area, different sampling techniques and also breeding sites created by human activities (Sachrama *et al.*, 2020; Wilke *et al.*, 2019)).

This study showed the abundance of *Culex* mosquitoes and their distribution in Gwagwalada Area Council, Abuja, North-central Nigeria.

The reduction in the number of mosquitoes collected in March, which later increased in May and was followed by a sharp decline in June is similar to the finding of Motayo *et al.* (25) (**Table 1**). This might be as a result of heavy rainfall that occur at the peak of rainy season, thus washing away breeding sites, strand larvae and damage mosquito eggs, therefore causing a reduction in the abundance of adult mosquitoes (Oluwayelu *et al.*, 2018).

This study showed a higher number of females than males (**Table 2**). This may be due to their feeding behavior, resting habit, and attraction to collection methods. They feed on blood and actively seek for humans and other animals, more active around their hosts, which increase the probability of encountering the traps. Males are less attractive to vertebrate host but primarily fed on plant-derived sugars (Madara and Ebuzoeme, 2022; Kayondo *et al.*, 2021)). New Kutunku has the highest number of *Culex* mosquitoes collected compared to other locations (**Table 3**). Higher number of *Culex* mosquitoes was recorded in homes with livestock compared to homes without livestock throughout the sampling period (**Fig.3**). This may be due to the presence of livestock which attracts culicines into a compound. (Motayo *et al.*, 2016; Kirby *et al.*, 2008). Although this may not represent the true picture as one constraint was the inability to collect all captured mosquitoes, as some

escaped from the trap before daybreak. The abundance of *Culex* mosquitoes encountered in the study area should pose a threat to people and government of Gwagwalada Area Council Abuja.

It was observed that more of the *Culex* mosquitoes were collected compare to *Aedes* (**Table 1**). This may be because the former is active from dusk to dawn (a night-biting species) compared to the later which is mostly a day-biting species (WHO, 2020). Further study to identify to specie level using molecular means and to harvest this virus from the identified vector using Real Time – Polymerase Chain Reaction (RT-PCR), to determine or otherwise the presence of the Rift Valley Virus in the study area is advisable.

CONCLUSION

The current study has shown the existence of *Culex* mosquitoes as well as their abundance and distribution in three different locations sampled in Gwagwalada Area Council, FCT. It has also demonstrated the dominance of *Culex* species of mosquito in the study location. They are zoonotic agents, transmitting disease between man and animals. The discovery from this study will help to have a better understanding of the epidemiology of mosquito borne diseases within the study area.

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