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Diversity and relative density of larval mosquito species in Mubi metropolis, Adamawa state, Nigeria

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Abstract
Mosquitoes are widely distributed worldwide, utilizing various breeding sites which are influenced by various environmental factors. This study aimed at determining the distribution and relative abundance of mosquito species in Mubi metropolis. Three study sites (Barama, GRA and Tudun-Wada) were randomly selected and observed for the distribution and abundance of mosquito species larvae, mosquito larvae were identified into genera based on their resting position in water, as described by WHO standard. Direct counting of mosquito genera after ten (10) dips in each breeding sites was done and recorded. Data collected was analyzed using Shannon Wiener diversity index. The overall distribution of mosquitoes out of the 302 collected revealed that, mosquitoes population is higher in Tudun-Wada and the least was in GRA in the following order: Tudun-Wada (115)>Barama (111)>GRA (76). The finding from this study also revealed that *Anopheles* mosquitoes had the highest Relative Density (61.26%) than the *Culex* mosquitoes (38.74%). The diversity index (*H*) also revealed that *Anopheles* mosquitoes were more diversed (0.122512), when compared with the *Culex* mosquito species (-0.56084). Similar trend was observed in the species evenness (*E*), where *Anopheles* mosquito species had a significant higher value (1) than the *Culex* (-4.55964). Therefore necessary control strategies against mosquitoes should be put in place especially Tudun-Wada area, as the people living in the area are predisposed to mosquito borne diseases such as malaria.

Keywords: *Anopheles*, *culex*, diversity, larval, mosquitoes, mubi

Introduction
The abundance and distribution of mosquito species varies depending on the location [1, 2]. In warm and tropical regions of the world, climatic factors, seasonality, the geography of water supply and anthropogenic related factors have been associated with mosquito abundance and distribution [3, 4, 5]. *Anopheles gambiae* s. l., also referred to as *Anopheles gambiae* complex is widely distributed through Africa [6]. They are found in temperate, tropical, subtropical and terrestrial habitats [7]. In hot dry savanna region of Africa, *An. gambiae* s. l. disappears during the dry months of the year and reappears soon after the first rainfall [8]. They are predominant in the rainy season [9, 10, 11, 12, 13].
The larvae of *Anopheles* can be found associating with other mosquito species in fresh or salt water marshes, mangrove swamps, rice fields, grassy ditches, edges of streams as well as in small temporary water collection. Many species of mosquitoes prefer habitats either with or without vegetation. Some species like *Culex p. pipiens* and *Aedes aegypti* can breed in variety of small water containers like drums, tires, clay pots etc. [14]. The *Culex*, like the *Anopheles*, tends to favor standing water to lay its eggs; however, unlike the *Anopheles*, it does not necessarily opt for plant and wild life surroundings. Instead, it often breeds in the outdoor objects on your property, such as barrels, cans, garden pots, used tires, as well as other places where stagnant water can collect [14].
In Nigeria, some entomological surveys on the distributions of mosquito species have been conducted and reported. Awolola *et al.* [15, 16, 17] reported huge *Anopheles* populations in the south western parts and Okwa *et al.* [18] reported a higher (50.7%) population of *Anopheles* populations than the *Culex* (49.3%) populations in the coastal area of Lagos. Afolabi *et al.* [2] noticed 31 mosquito species in Akure, Ondo State, Southwest Nigeria between April, 2012 and March, 2013, and observed that *Culex* species were higher. Recently, Simon-Oke and Olofintoye [5] reported a similar trend of higher *Culex* species from the total of 11 mosquito

species recorded from Ekiti State, Southwest Nigeria. The same trend of higher *Culex* genera was also reported from the South- South [19], eastern [20] north east [21, 22] regions of the country. However, no such study was performed in Adamawa State on the distribution of mosquito species Therefore, this study attempted to determine the diversity and relative abundance of larval mosquito species in Mubi, Adamawa State, Nigeria.

Materials and methods

Study area

Mubi has an estimated population of about 300,000 people [23]. The area has tropical climate and it is found within the Sudan savanna zone [24]. Average temperature is about 32^0C, with a minimum of 15.2ºC, between December and January [24]. The area has an average relative humidity of 28% to 45% and annual rainfall of about 1050 mm [24, 25]. River Yedsaram also runs across the area seasonally, and the people engage in fishing. In some areas around the river, the inhabitants practice dry season farming.

Mosquito collection

Mosquito larvae were collected from Barama (Lat. N10°16'49.494" and Long.E13°17'58.90812"), GRA (Lat. N10°17'7.422" and Long. E13°16'21.29412"), and Tudun-Wada (Lat. N10°15'53.32464" and Long. E13°17'36.89376") locations, by dipping method. The sampling was done using a standardized dipper (15cm diameter and 500 ml capacity) which was dipped quickly in the mosquito breeding water at an angle of 45°. Proper care was taken while filling the dipper so that the larvae may not be washed out. If the dipper was immerged slowly, the larvae were disturbed and moved to the bottom with the result that they may escape in the collection. Very often the shadow of the hand of the mosquito collector approaching the site disturb the larvae, therefore, the site were approached carefully. Between each dip an interval of 2-3 minutes was given so that the 3rd and 4th instar larvae and pupae may return to the surface. For those places where the water surface was covered with dense floating vegetation or organic debris, it was first of all cleared and then watched for 3-5 minutes so that the larvae may come to the surface. The standardized dipper was dipped ten times in all the three locations.

Identification of mosquito larvae

The mosquito larvae were sorted out into different genera mainly *Anopheles* and *Culex*. The *Anopheles* mosquito larvae lie parallel in water, while *Culex* mosquito larvae lie diagonally in water at an angel of 45º as describe by WHO [26].

Data collection

Data were collected on the field by direct counting of the number of *Culex a*nd *Anopheles* larvae collected, after 10 dips in all the study areas.

Data analysis

Data collected was analyzed using Shannon Weiner diversity index in order to determine the diversity of mosquitoes in their breeding sites. Whereas percentage density was calculated using the number of species per 10 dips.

$$\% \text{ density} = \frac{\text{No.of larvae collected}}{\text{Total no of dips}} \times 100$$

While the density index of the two mosquito genera (*Anopheles* and *Culex*) larvae collected were calculated using the Shannon Wiener diversity index.

Results

Diversity and species distribution of mosquito species in Mubi.

A total of 302 mosquitoes comprising two species, *Anopheles* and *Culex* were sampled from three (3) study sites in Mubi, namely; GRA, Barama and Tudun-Wada. The relative abundance of mosquitoes was found to be higher in Tudun-Wada. *Anopheles* mosquitoes proved to be more abundant, as it recorded the highest population in all the three study sites. Meanwhile, the highest population (24.83%) was recorded in Tudun-Wada, while the least (14.90%) was recorded in GRA. Similar trend was noticed in GRA, where *Culex* mosquitoes were recorded least (10.26%), as shown in Table1.

Diversity and relative density of mosquito species in Mubi.

The species composition of mosquitoes in Mubi recorded only two mosquito genera viz; *Anopheles* and *Culex* out of 302 mosquitoes collected throughout the study, *Anopheles* mosquitoes were the highest (185). Highest number of *Anopheles* (75) was recorded in Tudun-Wada followed by Barama (65) and the least (45) was recorded in GRA. *Culex* mosquitoes was higher (46) in Barama and just like the *Anopheles* mosquitoes, *Culex* mosquitoes was least (31) in GRA as shown in Table 2.

The Shannon Wiener diversity index calculated revealed that *Anopheles* mosquitoes have the highest diversity (0.122512) than the *Culex* mosquitoes (-0.56084) in Mubi (Table 2). Similar result was observed in the relative density of the species recorded, where *Anopheles* was significantly higher (61.20%) than the *Culex* (38.74%). The evenness distribution also showed a similar result, as *Anopheles* mosquito had the highest distribution (1) than the *Culex* (-4.55964) as shown in Table 2.

Table 1: Percentage density and distribution of mosquito species in the three study sites in Mubi.

Study sites	Mosquito species	Day 1		Day 2		DAY 3		Total	
		No. of Mosq. Collected	Density (%)	No. of Mosq. Collected	Density (%)	No. of Mosq. Collected	Density (%)	No. of Mosq. collected	Density (%)
GRA	*Anopheles*	17	5.63	16	5.30	12	3.97	45	14.90
	Culex	10	3.31	9	2.98	12	3.97	31	10.26
Barama	*Anopheles*	23	7.62	17	5.63	25	8.28	65	21.52
	Culex	16	5.30	20	6.62	10	3.31	46	15.23
Tudun-Wada	*Anopheles*	33	10.93	25	8.28	17	5.63	75	24.83
	Culex	16	5.30	12	3.97	12	3.97	40	13.25
Total								302	100

Table 2: Diversity and relative density of larval mosquito species in Mubi.

Location	Mosquito species		Total
	Anopheles	***Culex***	
G.R.A	45	31	76
Barama	65	46	111
Tudun Wada	75	40	115
N	185	117	302
RD	61.26	38.74	100.00
H	0.122512	-0.56084	1
E	1	-4.55964	

Data analysis

$$RD = \frac{NA}{N} \times 100 \quad \ldots\ldots \quad (1)$$

Where RD = relative density of species
NA = number of all specimens of each species collected at each altitude
N = the number of specimens of all species collected at each Location

$$H' = -\sum_i \frac{ni}{n} \ln \frac{ni}{n}, \quad E = \frac{H}{H_{max}} \quad \ldots\ldots. \quad (2)$$

Where H′ = Shannon diversity index
ni= number of species
ni = total number of samples
E = evenness
H_{max} *= Maximum Diversity possible*

Discussion

The result of study showed that two species composition of mosquito genera were found namely; *Anopheles* and *Culex*, which are capable of transmitting malaria, lymphatic filariasis, west nile virus *Wuchereria bancrofti* Saint Louis Encephalitis and Eastern Equine Encephalitis [27, 28]. No *Aedes* mosquito larvae were encountered, which is the vector of dengue fever [29]. The absence of *Aedes* mosquito larvae in this study could be as a result of the nature/ characteristics of the breeding habitats used for the study, where majority were shallow sun lit fresh water, rice fields, puddles and ponds etc. *Aedes* mosquitoes breed in artificial and natural containers, such as ant traps, earthen jars, flower pots, drums, concrete tanks, coconut shells and discarded tires [29, 30]. *Anopheles* mosquitoes breed in transient habitat such as shallow sun lit fresh water, pools, rice fields, puddles, ponds and other human made habitats, while *Culex* are known to breed in a polluted water such as gutters, including drain water and floated pit latrine [31].

Like in many places in sun Saharan Africa such as Nigeria [28], *Anopheles* species is the most common mosquitoes in Mubi. The result also reveals that *Anopheles* species (61.26%) was significantly higher than *Culex* species (38.74%) in all the three study sites in Mubi. The variation in the abundance of *Anopheles* and *Culex* larval mosquitoes can be attributed to the difference in their breeding habitat requirements. Increase in human development, such as in the areas of construction and agricultural activities, can make available diverse temporary mosquito breeding habitats. The preponderance of *Anopheles* species in the three study sites could be attributed to series of factors such as, their association with human dwellings, and their anthropophilic nature [32], since most of the breeding sites were cited closely to human dwellings. The higher number of *Anopheles* species recorded could be as a result of favorable conditions that favor breeding conditions of the *Anopheles* species [33]. It could also be because of their adaptability nature, making them to be successful in diverse environments, or they are resistant to factors that impede their development [33, 34]. Based on the findings of this study, it could be deduced that Mubi and its environs are highly predisposed to malaria and filariasis. There is also an indication that climatic and environmental conditions of Mubi from diurnal and ambient temperatures are conducive to support the survival and development of *Anopheles* larvae in Mubi, which could result to widespread of *Anopheles* species [35].

This study has provided vital information to distribution and abundance of mosquito larvae within the metropolis. A combination of factors of abundance rainfall, tropics temperature, high relative humidity, breakdown of public pipe borne water systems enhances the reason why *Anopheles* are highly distributed and abundant in the study areas than *Culex*. And it has been reported that *Anopheles* mosquitoes are most predominant in the sub-Saharan Africa [36, 37]. This poses a serious health implication as the species are found to be identified as important malaria and lymphatic filariasis vector in Nigeria [38, 39].

Conclusion

In conclusion, *Anopheles* mosquito species is found to be the most abundant and most distributed species of mosquitoes found in the three study areas. Meanwhile Tudun-Wada area had the highest mosquito population. This is as a result of the availability stagnant pools of water across the area. The result of the study is of public health concern as the species of mosquitoes encountered have known for transmission of diseases of one form to the other.

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