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Anopheles and *Culex* Mosquito Species Diversity and Its Epidemiological Implications in the Makurdi Area of Benue State, North Central Nigeria

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ABSTRACT

A study to determine the species diversity of Anopheles and Culex mosquitoes was carried out in Makurdi in April, 2014. A total of 200 adult mosquitoes, representing two genera, were collected from four locations within the study area by Pyrethrum Spray Catches and Net Traps. The mosquito samples were identified using standard keys and Polymerase Chain Reaction. Morphological identification revealed three main species: Culex quinquefasciatus 105 (52.5%)>Anopheles gambiae complex 68 (34.0%)>Anopheles funestus complex 27 (13.5%). PCR confirmed two Anopheles gambiae sibling species as Anopheles gambiae s.s. 36 (52.9%) and Anopheles arabiensis 26 (38.2%) while 6 (8.9%) of the Anopheles gambiae complex did not amplify. Meanwhile, Multiple Comparison using Least Significant Difference showed no significant difference (P>0.05) between the occurrence of Anopheles gambiae s.s. and Anopheles arabiensis. However, the result revealed a significant difference (P<0.05) between the abundance of Culex and Anopheles species collected from the Makurdi area. The study showed that Anopheles and Culex mosquitoes abound in the study area with potential consequences in the transmission of Plasmodium species (malaria) and Wuchereria bancrofti (Lymphatic filariasis). The findings were intended to provide data on mosquito species diversity in the study area that would be useful in any future vector control interventions.

Keywords: Mosquito vectors, Malaria, Filariasis, Makurdi, Nigeria

INTRODUCTION

Mosquitoes are obnoxious and notorious blood-sucking insect pests that have been ravaging human population through malaria attacks, filariasis, yellow fever and other arboviruses [1]. Identification of *Anopheles* and *Culex* mosquito species in Makurdi is essential in understanding their occurrence and distribution, since the presence of these mosquitoes in the study area have serious public health implications. *Anopheles* and *Culex* mosquitoes have been reported to be important vectors of malaria and lymphatic filariasis [2]. According to Umaru et al., the abundance of *Anopheles* and *Culex* mosquitoes in a particular area is consequential in the transmission of malaria and filariasis all year round [3] identified in Jimeta-Yola metropolis, species of *Anopheles* and *Culex* mosquitoes and concluded that both species of mosquitoes abound in Yola with potential health consequences in the transmission of malaria and filariasis all year round.

Culex and complexes of *Anopheles gambiae* have being a common occurrence in Nigeria from different studies on these mosquito species [1,4,5]. These two species are epidemiologically significant as many people suffer incessant malaria attacks due to only Anopheles bites with predictions that Culex quinquefasciatus is a potential vector of bancroftian filariasis, yellow fever and other arboviruses [1,6].

This study is therefore, intended to determine the species of *Anopheles* and *Culex* mosquitoes within the Makurdi area and their epidemiological significance in the area. Data on these mosquito species would be relevant in predicting their public health implications and planning strategies that would help control diseases associated with these mosquito vectors in and around Makurdi.

MATERIALS AND METHODS

Study area

This study was carried out in Makurdi metropolis, the capital of Benue State. The town is located between latitudes 7.83º North and longitude 8.53º East with a land mass of about 800 km^2 (Ministry of Information and Orientation, 2012 personal communication). The town is divided by the River Benue into the North and South banks, which are connected by two bridges; the railway bridge and the new dual carriage bridge commissioned in 1978. The Makurdi climate is characterized by the tropical wet and dry seasons with an average rainfall estimated at 1152.2 mm of which approximately 88% falls between the months of April and October while dry season begins in November and ends in March [7]. The human population is estimated at 5,00,797 [8,9].

This study covered four localities: North Bank (University of Agriculture Makurdi), High-level, Gboko road and Wadata. A lot of mosquito breeding sites abound in Makurdi due to poor sanitation, many rainy months and optimum temperature [7]. Residential areas are scattered, though major wards are being planned and regulated by the Benue State Urban Development Board. There are a few drainages built to control erosion but are currently blocked. Makurdi is amongst the oldest town in Benue State and doubles as the Makurdi Local Government Headquarters. The prominent features of the study area have been depicted in Figure 1.

Mosquito sample collection

Two hundred (200) adult mosquitoes were collected from residential homes and surroundings within the study area using net traps and knocked down spray methods as described [10]. The knocked down spray method employs the use of indoor spray catches (Pyrethrum Spray Collection-PSC). Houses were randomly selected in the study area; the doors, windows and other openings were closed to prevent mosquitoes from escaping. Afterwards, white cotton sheets were spread on the floor so that knocked down mosquitoes could be seen and picked easily. Spraying was done in the morning hours (6-9am) when the mosquitoes were resting indoors. After spraying, the doors were closed for ten (10) minutes before they were opened for the mosquitoes to be collected. Mosquitoes were then picked with forceps and placed in Petri-dishes containing moist filter paper and were transported to the Advanced Biology Laboratory in the Department of Biological Sciences, Federal University of Agriculture Makurdi for identification.

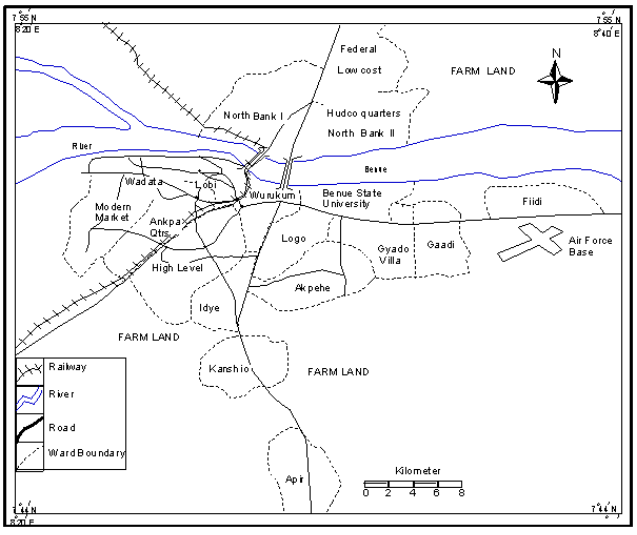

Figure 1: Map of Makurdi town showing the study localities (Benue State Ministry of Land and Survey, 2011)

Identification of mosquito samples

Dissecting microscope was used for detailed observations and identification of the mosquitoes with particular reference to the head, thorax, wings and hind-legs according to Gillies and Coetzee [11,12]. Morphological characteristics such as length of maxillary palps, wing spots, leg shape, mouthparts and abdominal end model as described by oguoma [5] were used to identify the mosquito species. Observations of the morphological features were made at 40x magnification of the microscope. The specimens were placed on a slide and viewed under the microscope after which they were kept dry in Eppendorf tubes containing silica gel. Polymerase Chain Reaction (PCR) was performed following the method adopted by Umaru et al. [3].

Data analysis

Data analyses on the results obtained were done using SPSS version 17. Data were analyzed using one way Analysis of Variance (ANOVA) and simple bar charts. A probability level of 5% was considered significant in all statistical inferences.

RESULTS

The results obtained in this investigation are presented in Tables 1 and 2 respectively. A total of 200 mosquitoes representing two genera were captured from four locations within the study area, these were *Anopheles funestus* 27 (13.5%), *Anopheles gambiae* complex 68 (34.0%) and *Culex quinquefasciatus* 105 (52.5%) in an increasing order of abundance.

Table 1: Species composition of mosquitoes morphologically identified in Makurdi. Values are means ± standard error of the means. Means followed by the same letters are not significantly different (P>0.05) by FLSD multiple test comparison.

Mosquito species	Number identified (%)
Culex quinquifasciatus	105 (52.50) ± 2.46^{a}
Anopheles gambiae s.l	68 (34.00) ± 2.46^{b}
Anopheles funestus	27 (13.50) ± 1.31^{c}
Total	200

The results showed that there was a significant difference (P<0.05) between the abundances of the species of mosquitoes collected. PCR analysis of the *Anopheles gambiae* complex indicated the presence of *Anopheles gambiae s.s.* 36 (52.9%), *Anopheles arabiensis* 26 (38.2%) while 6 (8.9%) of the mosquitoes did not amplify, with *Anopheles gambiae* s.s. being the most abundant *Anopheles gambiae* complex in the Makurdi area. However, the results revealed that there was no significant difference (P>0.05) between the abundance of Anopheles gambiae s.s. and *Anopheles arabiensis* in Makurdi.

Table 2: PCR identification of the Anopheles gambiae complex. Values are means ± standard error of the means. Means followed by the same letters are not significantly different (P>0.05) by FLSD multiple test comparison.

Sibling species	Number identified (%)
Anopheles gambiae s.s.	36 (52.9) ± 0.91^{a}
Anopheles arabiensis	26 (38.2) ± 1.32^{a}
Unidentified	6 (8.9) ± 0.65^{b}
Total	68 (100)

DISCUSSION

The results of the present investigation revealed mosquito species belonging to two genera, *Culex* and *Anopheles*. Incidentally, these genera represent vectors of four human diseases including malaria, bancroftian filariasis, yellow fever and arboviruses [1]. It has been found that *Culex quinquefasciatus*, *Anopheles gambiae* s.l., *Anopheles funestus* and the other *Anopheles gambiae* sibling species that were captured in this study have implications for the health of

residents in Makurdi. The serious health implications of sampled species were the possibility of outbreaks of infectious diseases in Makurdi [3] also reported the occurrence of these species in Northern Nigeria.

Results of the present study showed that *Culex quinquefasciatus* was the most abundant mosquito species which is in contrast to the report [3,5]. This may be due to the fact that the sanitary condition of Makurdi metropolis is poor and as such favoured the breeding of this species. The presence of this mosquito species in Makurdi suggests the potential risk of transmission of filariasis in the area [13] reported that *Culex quinquefasciatus* is important in transmitting filariasis in urban areas while *Anopeles gambiae* and *Anopheles funestus* transmit *Wuchereria bancrofti* in the rural areas. In the study, *Anopheles gambiae* was the most important malaria vector and indeed a potential vector of yellow fever and arboviruses [1]. This suggests possibilities of malaria and yellow fever transmission in Makurdi- the study area.

The presence of various mosquito species in the study area is strongly attributed to the ecological features and climatic conditions of the area and the habits of the residents that favor rapid breeding of mosquitoes, this was a significant observation. A similar deduction on ecological reasons for observed mosquito species diversity has been reported [1].

Moreover, reported abundance of *Anopheles* and *Culex* mosquitoes in a particular area was consequential in the transmission of malaria and filariasis all year round; this suggested that the health of the people within the study area was implicated [3]. The residents of Makurdi stand to be most challenged by filarial infection other than malaria and yellow fever, though specific data on human infection with *Wuchereria bancrofti* in Makurdi are scanty [14], while malaria has been a burden with many adults and children exposed to the disease daily [15]. Records from the Epidemiology Unit of Benue State Ministry of Health and Human Services from 2011 to 2013 have shown a rapid increase in malaria cases with filariasis having only a rare occurrence. Hence Culex is presently regarded more of a biting nuisance than having epidemiology significance in Makurdi [6] suggested that *Culex* remains a potential vector for filariasis in Nigeria as can be seen in other countries; they reported the discovery of *Wuchereria bancrofti* larvae in *Culex antennatus* though this species has not being reported in Makurdi, and was not collected in the present study.

In Makurdi, poor drainage systems and water supply has posed a great threat as *Anopheles* mosquitoes breed in still water collected after rainfall but *Culex* mosquitoes prefer dirty and foul smelling water, which was a common occurrence in the study area.

In as much as the Benue State government is doing its best to improve on sanitation, it seems not effective as people continue to dispose of refuse into drainages and abuse public latrines.

CONCLUSION

The results showed that *Culex quinquefasciatus*, *Anopheles gambiae s.s.*, *Anopheles arabiens is* and *Anopheles funestus* that were captured in this study are known to have implications for vector disease transmission and the health of residents in Makurdi. Since the presence of these vectors is of apparent danger to public health, much attention should be targeted at vector control as reported [16]. It is therefore, recommended that there should be attitudinal change towards use of Insecticide Treated Nets (ITNs) and Long-lasting Insecticide Treated Nets (LLINs) and distribution should be for free or at highly subsidized rates. For effective prevention and control of diseases arising from these mosquito species, the Government, Non-Governmental Organizations (NGO's) and individuals must stand up to their responsibilities since prevention against mosquito bites is the first line of defense against mosquito-borne infections [16].

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