PRINT ISSN 1119-8362
Electronic ISSN 2659-1502

Full-text Available Online at
https://www.ajol.info/index.php/jasem
http://www.bioline.org.br/ja

J. Appl. Sci. Environ. Manage.
Vol. 27 (4) 787-791 April 2023

Distribution of the African Malaria Vectors (Anopheline Mosquitoes) in Kontagora, North Central Nigeria

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ABSTRACT Mosquitoes are responsible for the spread and transmission of several diseases including malaria, a dreaded disease that still affects nearly half of the world population. This study was conducted in Kontagora, a metropolitan urban settlement in North-Central Nigeria to evaluate the spartial and temporal distribution of Anopheline mosquitoes. Adult mosquitoes were collected from five (5) sampling sites widely located in Kwangwara, Tudun wada, Dadin kowa, Sabon gari and Usubu areas of Kontagora metropolis. The mosquitoes were morphologically identified to Anophelines using standard taxonomic keys with the aid of Trinocular Microscope. Data generated revealed that spartial distribution of Anopheline mosquitoes Mean ±SE across the study areas occurred in the following order of decreasing abundance; Kwangwara (11.25±1.03) > Tudun wada (9.30 ±0.77) > Sabon gari (8.96±0.78), > Dadin kowa (8.92±0.88) > Usubu (8.59±0.82) with no significant variation (P>0.05) between sampling locations. However, the monthly distribution of Anopheline mosquitoes revealed high abundance of Anopheline vectors Mean ±SE in August (14.00±2.91) and low abundance in March (3.80±1.57), with significant variation (p<0.05) between months. The distribution of Anopheline mosquitoes observed in the study area was more or less directly related to the distribution of breeding sites. Studies on vector distribution on a local scale was recommended for effective control intervention.

DOI: **https://dx.doi.org/10.4314/jasem.v27i4.21**

Cite this paper as: YUSUF GARBA. (2023). Distribution of the African Malaria Vectors (Anopheline Mosquitoes) in Kontagora, North Central Nigeria. *J. Appl. Sci. Environ. Manage.* 27 (4) 787-791

Dates: Received: 17 February 2023; Revised: 08 April 2023; Accepted: 16 April 2023
Published: 30 April 2023

Keywords: Malaria; Vectors; Anopheline; Mosquitoes.

Malaria is life-threatening parasitic disease transmitted from person to person through the bite of a female Anopheles mosquito (Oguoma *et al.*, 2010). A plethora of publications exist on the abundance, distribution and species composition of mosquitoes across several states in Nigeria (Ajayi *et al.*, 2010; Ajayi *et al.* 2011; Oduola *et al.*, 2016; Aigbodion and Uyi, 2013; Adeogun *et al*., 2017; Aju-Ameh *et al.*, 2017, Omoregle *et al*., 2019). Mosquitoes are important vectors of most deadly diseases such as malaria, lymphatic filariasis, dengue and yellow fever and many others in Nigeria (Oluwasoga *et al.*, 2016). Mosquitoes are distributed throughout the world. However, majority of mosquitoes are found in the tropics and subtropics. The warmer temperatures in the tropics allow them to be more active and the rainfall provides them with aquatic sites for larval and pupal stages. Seasonal alternation of cold and warm climates and the vast availability of larval breeding grounds for perpetual breeding of mosquito vectors is an important factor for the continued transmission of malaria and other mosquito borne diseases. The occurrence and distribution pattern depicted by mosquito vectors in any area is a function of the local ecological variables, and as such the pattern of vector distribution in one locality cannot be applied to the other. Several reports regarding the distribution of Anopheline vectors in different parts of Nigeria are available. But many malaria control interventions are applied without regards to vector density and distribution in endemic areas. Unfortunately however, not much is reported about the distribution of

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Anopheline vectors in Kontagora. This study therefore seeks to evaluate the spatial and temporal distribution pattern of malaria vectors in Kontagora town, North Central Nigeria.

MATERIALS AND METHODS

Study Area: Kontagora is a major town on the South bank of Kontagora River in the North -West of Niger State. The town is situated at 10.4 ^{0} North latitude, 5.47 ^{0} East longitude and 335 meters elevation above sea level with an estimated population of over 200,000 inhabitants. The area has a tropical climate with mean annual temperature, relative humidity and rainfall of 30.20^{o}C 61.00 % and 1334.00 mm, respectively. The climate presents two distinct seasons; a rainy season between May and October, and a dry season between November and April. The vegetation in the area is typically grass dominated Savannah with scattered trees.

Sampling locations: Adult mosquito samples were collected from five sampling sites located in Kwangwara, Sabon Gari, Tudun Wada, Dadin Kowa and Usubu areas of Kontagora town. Two houses were randomly selected per area, coded and used as sampling points for indoor and outdoor collections of adult mosquitoes. Two rooms were selected from each house for indoor collection and the number of occupants in each room determined.

Table 1: Global Positioning System (GPS) coordinates of the study sites

S/N	Study Sites	Latitude	Longitude
1.	Kwangwara	10.39	5.47
2.	Tudun Wada	10.39	5.48
3.	Dadin Kowa	10.40	5.49
4.	Sabon Gari	10.40	5.48
5.	Usubu	10.39	5.43

Adult Mosquito Collection and Preservation: Indoor resting mosquitoes were collected using the Pyrethrum Spray Catch (PSC) between the hours 06:00 am and 09:00 am in the study areas. Food items were covered properly and moveable furniture were taken care of before spraying. Large white sheets of clothes were spread from wall to wall to cover the floors of the room while all doors and windows were shut. All cracks and openings in walls were stocked with rag papers to prevent mosquitoes from escaping. After about 20 minutes, the spread cloths were carefully folded starting from the corners. Knock down mosquitoes were collected with forceps into a damp petri dish. Outdoor mosquitoes were collected using the Centre for Disease Control (CDC) light traps. These traps were set from 7.00 pm and retrieved at 7.00 am). Individual samples were preserved in dry silica gel in well labelled Eppendorf tubes (1.5 ml) prior to identification. This is to ensure preservation of delicate significant features that will be needed for morphological identification in the laboratory.

Identification of Mosquitoes: Morphological identification was carried out using a trinocular dissecting microscope (Amscope SZMT2/MU100010APTINA COLOR CMOS) with the aid of standard keys (Gillies and Coetzee, 1987; Gillies and De Meillon, 1968). The mosquitoes were identified using the gross morphology of the species, external morphology of the head, mouthparts, antennae, proboscis, patches of pale and black scales on the wings and legs and the terminal abdominal segments (Gillet and Smith, 1972

Data Analysis: Data generated were analysed using the Statistical Package for Social Scientists (SPSS) software version 20.3 and excel package. Relative abundance and distribution of Anopheline mosquitoes between sampling locations were processed using ANOVA, and Duncan multiple range test was used to compare the means. P-value <0.05 was considered statistically significant.

RESULTS AND DISCUSSION

The study reported a total of 4,492 Anopheline mosquitoes across the five sampling locations, with Kwangwara area having the highest vector density.

Table 2: Monthly distribution of Anopheline mosquitoes (Mean ±SE) in relation to sampling locations in Kontagora

Months	Kwangwara	Tudun wada	Sabon Gari	Dadin Kowa	Usubu	Aggregate Mean
April 2017	$9.13\pm2.57_{b**}^{b*}$	$7.50\pm2.25_{bc}^{c}$	$5.25\pm0.69_{c}^{c}$	$6.63\pm1.98_{c}^{c}$	$4.63\pm1.94_{c}^{c}$	$7.50\pm1.99b_{c}^{c}$
May 2017	$11.88.\pm5.05_{b}^{ab}$	$7.88\pm3.79_{bc}^{c}$	$9.00\pm2.99_{b}^{bc}$	$9.25\pm3.69_{b}^{bc}$	$9.38\pm2.98_{b}^{bc}$	$9.48\pm3.75_{b}^{bc}$
June 2017	$15.00\pm3.11_{a}^{a}$	$9.63\pm1.65_{b}^{bc}$	$10.38\pm4.55_{b}^{b}$	$10.38\pm3.07_{b}^{b}$	$9.63\pm3.32_{b}^{bc}$	$11.50\pm3.36_{b}^{ab}$
July 2017	$13.50\pm2.23_{a}^{ab}$	$12.38\pm2.42_{b}^{b}$	$12.25\pm3.20_{b}^{a}$	$12.38\pm3.97_{b}^{ab}$	$12.25\pm2.3_{b}^{ab}$	$12.50\pm2.83_{b}^{ab}$
August 2017	$16.25\pm4.63_{a}^{a}$	$13.63\pm2.94_{a}^{a}$	$12.38\pm2.11_{b}^{a}$	$14.50\pm1.57_{a}^{a}$	$13.25\pm3.31_{a}^{a}$	$14.00\pm2.90_{a}^{a}$
September 2017	$14.38\pm1.70_{a}^{a}$	$13.00\pm2.36_{a}^{a}$	$12.38\pm0.83_{b}^{b}$	$12.13\pm5.01_{b}^{ab}$	$11.63\pm3.67_{b}^{b}$	$12.70\pm2.73_{b}^{ab}$
October 2017	$15.38\pm3.59_{a}^{a}$	$11.50\pm1.15_{b}^{b}$	$9.88\pm2.67_{b}^{bc}$	$9.63\pm4.51_{b}^{bc}$	$10.75\pm2.94_{b}^{b}$	$11.43\pm3.47_{b}^{ab}$
November 2017	$13.25\pm4.87_{a}^{ab}$	$10.75\pm4.79_{b}^{b}$	$12.63\pm1.1_{b}^{ab}$	$9.25\pm3.46_{bc}^{bc}$	$8.88\pm2.01_{c}^{bc}$	$10.95\pm3.4_{b}^{b}$
December 2017	$8.00\pm1.92_{bc}^{bc}$	$9.63\pm1.40_{b}^{bc}$	$7.63\pm1.11_{c}^{c}$	$8.63\pm1.24_{c}^{bc}$	$8.25\pm1.28_{c}^{bc}$	$8.43\pm1.40_{c}^{bc}$
January 2018	$6.38\pm1.25_{c}^{c}$	$6.50\pm1.15_{c}^{c}$	$5.13\pm0.49_{c}^{c}$	$4.52\pm0.87_{c}^{c}$	$5.50\pm1.14_{c}^{c}$	$5.61\pm1.12_{c}^{c}$
February 2018	$6.00\pm3.63_{c}^{c}$	$5.38\pm1.69_{c}^{c}$	$3.13\pm1.31_{b}^{b}$	$5.00\pm1.54_{c}^{c}$	$3.73\pm0.44_{c}^{c}$	$5.27\pm1.36_{c}^{c}$
March 2018	$10.50\pm1.18_{b}^{b}$	$4.13\pm0.88_{c}^{c}$	$4.88\pm1.69_{c}^{c}$	$4.88\pm2.01_{c}^{c}$	$5.13\pm2.12_{c}^{c}$	$3.80\pm1.57_{c}^{c}$
Aggr. Mean	$11.25\pm1.03_{ab}$	$9.30\pm0.77_{bc}$	$8.96\pm0.78_{bc}$	$8.92\pm0.88_{bc}$	$8.59\pm0.82_{bc}$	$9.40\pm0.90_{bc}$

**Values with the same superscript alphabets within a column are not significantly different at P>0.05*

***Values with the same subscript alphabet within a row are not significantly different at P>0.05*

The distribution of Anopheline mosquitoes Mean ±SE investigated across the five sampling locations in the study area occurred in the following order of decreasing abundance; Kwangwara (11.25±1.03) > Tudun wada (9.30 ±0.77) > Sabon gari (8.96±0.78), > Dadin kowa (8.92±0.88) > Usubu (8.59±0.82).

There was no significant variation (P>0.05) in the spatial distribution of Anopheline mosquitoes across the five sampling locations. However, the monthly mean distribution of Anopheline mosquitoes revealed the abundance of more vectors Mean ±SE in the month of August with an aggregate mean value of 14.00±2.91 and the month of March produced lower number of Anopheline mosquitoes 3.80±1.57. Although the monthly distribution of Anopheline mosquitoes in Kontagora varied significantly (p<0.05).

The study area had abundant mosquito breeding sites which might be responsible for the proliferation of Anopheline mosquitoes in the area. The distribution of Anopheline mosquitoes observed in the study area is more or less directly related to the distribution of breeding sites. Data from spatial distribution of Anopheline mosquitoes Mean ±SE revealed that Kwangwara area had recorded an aggregate mean value of (11.25±1.03), followed by Tudun wada (9.30 ±0.77) while Sabon gari, Dadin kowa and Usubu areas recorded (8.96±0.78), (8.92±0.88) and (8.59±0.82) respectively. There was no significant variation (P>0.05) in the spatial distribution of Anopheline mosquitoes across the five sampling locations. The high density of Anopheline vectors observed in Kwangwara area was perhaps the result of favourable breeding sites for immature mosquitoes. Similar findings were earlier reported by Arun (2021) in the semi-arid district of Rajastan, India. Moreover, Increase in human development, construction and agriculture activities generate diverse larval habitats which account for mosquito abundance in the study areas. Lamidi *et al.,* (2017) reported a similar observation in Taraba State, North - Eastern Nigeria when they conducted an investigation on the abundance of Anopheline mosquitoes in three study areas (Ardo Kola, Bali and Donga). Their findings showed that Ardo Kola had the highest 1180(35.0%) followed by Bali 1107(32.9%) and Donga 1082(32.1%) out of the 3,369 indoor resting mosquitoes collected. In another study, Oluwasogo *et al*., (2016) reported incidence of *Anopheles* mosquito species with in seven (7) human settlements in Ogbomoso, South – Western Nigeria with no significant difference in vector abundance between the study areas (p>0.05). However, human activities and behaviours of mosquito of different species affects the population of indoor-resting mosquitoes (Ototo *et al.,* 2015). Monthly variation in Anopheline vector distribution showed that the months of July, August and September seems favourable for mosquito vector proliferation in Kontagora, perhaps because of stable rainfall and moderate temperature. The month of September has the highest abundance of Anopheline mosquitoes Mean ±SE (14.00±2.90). The preponderance of Anopheline mosquitoes in July and August is in line with the reports of Atting and Akpan (2016) in Uyo and Mgbemina *et al*. (2012) in Minna respectively. However, mosquitoes were more abundant during the dry months of December, January and February compared to the wet months of March, April, May, June and July. (Okorie *et al*., 2014). Furthermore, (Ombugadu *et al.* (2022) while reporting on vector distribution in a semi urban community in Lafiya, Nasarawa State, observed that early wet season had the highest number of mosquitoes then late dry and early dry seasons respectively. Spatial and monthly variation in the distribution of Anopheline mosquitoes observed in this study had also been reported in various Nigerian cities (Ebenezer *et al.,* 2014; Lamidi *et al.,* 2017). The distribution of Anopheline mosquitoes in Kontagora did not appear to follow a particular pattern, but it was observed to be generally low in dry season and high in wet season. This is in line with the findings of Bagoro *et al.,* (2014). The high proportion of mosquitoes during wet season could be associated to the increase of breeding sites created by rainfall which may possibly account for more vector-borne diseases during the wet season. The occurrence of Anopheline mosquitoes throughout the year could be attributed to possible mosquito aestivation/diapause especially during unfavourable breeding season. Anopheline species were also reported to be present almost throughout the year in Iran with a major peak in April and a smaller peak in October. (Alireza, Moussa and Sayed, 2019)

Although, in some cases the abundance of mosquito has not always been dependent on rainfall as (Oduola *et al.,* 2016) observed mosquito abundance in Kwara State in the month of April. Lamidi *et al.,* (2017) also reported thus; Monthly distribution of *Anopheles* species in Ardo Kola showed that Anopheles mosquitoes were most abundant in the months of May 95(14.8 %), February 85(13.2 %) and April 74(11.5 %). Indoor resting *Anopheles* were least recorded in the months of November 19(3.0 %), September 31(4.8 %) and July 40(6.2 %). In Ardo Kola the *Anopheles* species peaked at the end of dry season and at the onset of wet season and the least was at the end of wet season and in dry months. In Bali, the *Anopheles* species population was highest in the middle of wet season (June, July and August) but lowest in the end of wet season and dry months (December, October and February). The highest peaks of the female Anopheline species in February and the smallest peaks during September, as observed in Ardo Kola study area. Combination of trends of *Anopheles* abundance in both Ardo Kola and Bali was observed in Donga in which Anopheles species, had the highest population observed in some dry months (February, March), in the middle of wet month (June) and the lowest at the end of wet months (September and October).

Conclusion: The study revealed the presence and distribution of Anopheline mosquitoes all year round in different parts of Kontagora town. The presence Anopheline mosquitoes in the study locations strongly expose the inhabitants to mosquito-borne diseases such as filariasis and malaria amongst many others. It is necessary to plan for regular evaluation and implementation of vector control measures.

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