

**DISTRIBUTION AND SEASONAL ABUNDANCE OF
ANOPHELINE MOSQUITOES AND THEIR ASSOCIATION
WITH RAINFALL AROUND IRRIGATION AND NON
IRRIGATION AREAS, KOGI STATE, NIGERIA**

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ABSTRACT: We conducted an entomological survey to determine mosquito species diversity and abundance in relation to rainfall in Omi reservoir irrigation area, Nigeria. Adult mosquitoes were collected from 10 randomly selected residential houses using pyrethrum spray sheet and Human Landing Catch methods. The communities sampled were grouped into irrigated (intervention) and non-irrigated (control) communities. During the 12-month sampling period, a total of 4285 mosquitoes belonging to 10 species in 1 family were collected. The three most common species collected during this study were *Anopheles gambiae*, *Anopheles funestus* and *Culex quinquefasciatus*. Higher numbers of mosquitoes (69.4%) were collected in irrigated community as compared to those collected in non-irrigated community (32.0%). Comparing the two collection methods used, a greater number 2225(75.4%) of mosquitoes were collected with Pyrethrum spray sheet than those with Human Landing Catch method 724(24.6%). Relatively fewer numbers of mosquitoes were collected during the dry than wet season in all collection points. The lowest number was collected in February (114). However, the number increased, the highest occurring during the wet season particularly in July (445).

KEY WORDS: Mosquitoes, Omi reservoir, Collection method, Abundance, Kogi

Mosquitoes are responsible for the spread and transmission of several harmful diseases such as malaria and lymphatic filariasis. It is known to infect over 700 million people causing 1 million deaths each year especially in developing regions of the world including sub-Saharan Africa (WHO, 2016). In spite of years of control efforts, malaria continues to be a major threat to public health in parts of sub-Saharan Africa, Nigeria inclusive. About 97% of Nigeria's population is at risk of malaria where 60% of hospital outpatient visits and 30% of hospitalization among children under five years and pregnant women occur due to malaria (Nigeria Malaria Fact Sheet, 2011). Entomological studies focused on the diversity, density, behavioral patterns and temporal variations of *Anopheles* species have long been found to be beneficial in the identification and monitoring of malarial vectors (Tadei et al., 1998). A combination of factors that determine the capacity of a vector to transmit malaria include; abundance, anthropophily, zoophily, susceptibility to infection by the malaria parasite, infection rates and female longevity (Aniedu, 1992; Lounibos & Conne, 2000).

Recent studies have shown that the abundance of *anopheline* mosquito species is the most common entomological measurement used to determine the relationship between vectors and malaria incidence in any particular locality (Muturi et al., 2006; Zimmerman et al., 2006). Changes that occur in the environment especially in the area of climate have a great bearing on breeding habitats of different mosquito species that influences the population density of adult mosquitoes (Bashar & Tuno, 2014). Climatic factors such as rainfall affect adult mosquito abundance by drastically altering the quality and quantity of breeding habitats. To determine parasite activity levels and associated disease risk, the relationship between rainfall and mosquito abundance must be ascertained (Bashar & Tuno, 2014). A proper understanding of the relationship between rainfall and the abundance of mosquito vector will help to develop an efficient and feasible vector control program in the study communities hence the need to establish the seasonal abundance of mosquito population (Alten et al., 2000; Bashar & Tuno, 2014). There is no recorded information on the seasonal abundance of anopheline mosquitoes in Omi community, an agricultural irrigated area in Kogi State, north central Nigeria. Therefore, this study was conducted to investigate the species composition and seasonal population dynamics and their possible association with rainfall and disease transmission in the irrigated communities, prior to the implementation of a National malaria vector control.

MATERIALS AND METHODS

Study area

This study was conducted in Omi reservoir irrigation area and surrounding communities. Omi reservoir irrigation project is located in Yagba West Local Government Area (L.G.A) of Kogi State, north central Nigeria. It is about 146 km from Ilorin the capital of Kwara State. It lies between latitudes 8°34' N and longitudes 6°42' E (Araoye et al., 2004). The project is located in Omi village, a farming community of about 10,000 people (Oyeyinka et al., 2003). The primary aim of establishing this dam is to promote agriculture through irrigation activities involving more than 5,000 farming households both within and outside Yagba West Local Government Area. Ten communities were divided into two groups. The first group were communities close to the reservoir (Ogga, Iddo, Ogbo, Ejiba and Omi communities) which formed the Intervention study area. The second group were communities which were far away from the reservoir (at least 4Km away) which is greater than the flight of mosquitoes. The communities (Mopa, Okagi, Ilai, Amuro and Ijowa) formed the control study area. The study communities had very similar environmental factors with high relative humidity ranging between 85% and 90% with an annual mean daily temperature ranging between 28 °C and 35 °C. There are two main seasons in the area. The annual rainfall is between 1100 mm and 1300 mm. The vegetation is guinea savannah while the soil is hydromorphic, containing a mixture of coarse alluvial and colluvial deposits. Most of the inhabitants in the study area depended on the water body for drinking and for domestic use. The communities have schools, hospitals and dispensaries where the inhabitants seek treatment. Most of the houses have unscreened windows, holes in the walls, and large open eaves that provide easy entry for mosquitoes. The houses are separated from one another either by agricultural land or small patches of natural vegetation.

Mosquito collection and identification

Mosquitoes were collected once a month in 10 randomly selected houses in each community using pyrethrum spray sheet collection (WHO, 1975), for 12

months. During collection five of the ten selected houses were sprayed in the morning between 0600hrs and 0800hrs while the remaining five houses were sprayed the following day at the same time. In each house, food items and drinking water were temporarily removed. White sheets were then spread on the beds and floor before spraying the house with 0.3% solution of pyrethrum in paraffin. After 10 minutes, the knocked down mosquitoes from different households were picked up on the sheets, placed into labeled petri dishes lined with moist cotton wool and transported to the laboratory in a cool box for identification and dissection.

Mosquitoes were identified morphologically to species level using taxonomic keys of Gillett (1972) and Gillies & Coetzee (1987). They were further classified according to physiological status as unfed, blood-fed, half-gravid or gravid by examining the abdomen for the extent of distension (WHO, 1975).

Statistical analyses

Microsoft Office© Excel© was used for plotting all graphs. All statistical analyses were performed using SPSS software (Version 16.0 for windows, SPSS Inc., Chicago, IL). Analysis of variance (ANOVA) was used to assess level of significance in the proportion.

RESULTS

Species composition and abundance

A total of 4,285 female mosquitoes belonging to ten species were collected in the two study sites (Table 1 and Figure 1). Out of these, 2913 (68.0%) were collected in intervention communities and the rest 1372 (32.0%) in control communities. *A. gambiae s.l* was the most predominant species at both sites among the anophelines, whereas among culicines, *C. quinquefasciatus* was the most predominant species in both sites ($F=11.070, P<0.05$). Of the ten mosquito species that were collected, eight occurred in both sites while the remaining two (*A. moucheti* and *A. ziemani*) were collected from the intervention site. Overall, *A. gambiae*, *A. funestus* and *C. quinquefasciatus* were the most common species in both intervention and control communities.

Seasonal abundance of mosquitoes and their association with rainfall

A total of 4285 adult mosquitoes comprising 3073 *Anopheles* spp. and 1177 culicines were collected over the 12 month study period (Nov 2013 to Oct 2014). Relatively fewer numbers of mosquitoes were caught during the dry season (Nov 2013-March 2014) than wet season (April 2014-October 2014) (Figure 2). The lowest number was collected in February. However the number increased from May to July. The highest number in the wet season occurred in July.

A total of 2949 *A. gambiae s.l* and *A. funestus* mosquitoes were collected between November 2013 and October 2014. The numbers of mosquitoes collected were 2225(75.4%) using the PSC method and 724(24.6%) using the HLC method.

DISCUSSIONS

The results of this study showed the relative abundance and composition of mosquito vectors and its relationship with rainfall in Omi village an irrigated area in Kogi State, Nigeria. The presence of three genera of mosquitoes, *Anopheles*, *Aedes* and *Culex* in this study is an indication that the climatic and environmental conditions of Omi irrigation area are conducive for the survival and development of a wide range of mosquito species. Eight species from anopheline mosquitoes were encountered in the study, indicating that the species composition in Omi

irrigation area is reach, as (Depinay et al., 2004) have put the usual number at less than five within a given area, and this has been confirmed in different localities in Africa (Muturi et al., 2006; Manga et al., 1995; Appawu et al., 2004). The relatively higher number of anopheline species in the area may be as a result of the favorable tropical weather and breeding conditions. Of the eight anopheline species encountered in Omi, only two namely, *Anopheles gambiae* and *An. funestus* were vectors of malaria. The high abundance of malaria and filariasis vector (*Anopheles gambiae*) encountered in this study means that there is a risk of malaria and filariasis in Omi irrigation area and its environs. The unequal distribution of the *Anopheles* species within the area further suggests that the occurrence of the species truly varies according to macro and micro environmental differences exhibited by different bio-ecological areas, as was found in studies conducted by (Keateng et al., 2003). The environmental conditions of the area were favorable to support the continual breeding and survival of the mosquito vectors. The predominance of *An. gambiae* could be attributed to the adaptability of these species making it possible for them to survive in diverse environment as previously reported by (Dondorp et al., 2009). This result is similar to the findings of (Okwa et al., 2006) and (Oguoma & Ikpeze, 2008) who in Lagos and Kano respectively, reported that *Anopheles gambiae* was the most predominant species. However, this result is in contrast to the findings of (Simon-Oke & Ayeni, 2015) who reported high incidence of *Aedes aegypti* in Akure. The other species collected occurred in very low densities. The proximity of the intervention village to the Omi dam, could have accounted for the high density of the different mosquito species recovered. The prevalence of adult mosquitoes showed trend of twice increases in the intervention compared to the control villages.

Communities close to the Omi reservoir are prone to malaria infection since *Anopheles gambiae* has been incriminated as an efficient vector of malaria (Awolola et al., 2003).

In the present study, a significant correlation were found in the number of anophelines caught by the two methods, suggesting that human landing catch are adequate to monitor seasonal trends. However, the numbers caught in Human Landing Catch were significantly ($P < 0.05$) smaller than in Pyrethrum Spray Catch. This is consistent with the findings of (Yasmin and Curtis, 1992) in western Venezuela where similar result was observed. Significantly higher densities of mosquitoes were collected in the rainy (May-July) than the dry season (January-March). This is similar to the findings of (Lamidi, 2009) who reported that the highest number of *Anopheles* mosquito was recovered in the months of July. A study in Kenya opined that the rainy season presents favorable environmental conditions that enhance mosquito breeding and survival, through the proliferation of larval habitats and improved humidity respectively (Minakaw et al., 2002). Rainfall contributes to increasing the number of breeding sites (stagnant water, used containers, gutters) as *Anopheles* species need clean water with adequate oxygen and sunlight for breeding (Service, 1980). This is however not in agreement with the findings of (Shililu et al., 1998) in Western Kenya who reported no significant correlation between the monthly rainfall and relative densities of *Anopheles gambiae* s.l and *Anopheles funestus*. The study however confirms the fact that there is a correlation between rainfall and mosquito abundance.

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Table 1. Number of mosquitoes and species collected in the intervention and control villages.

Mosquito species	Intervention		Control	
	No collected	%	No collected	%
<i>Anopheles gambiae</i>	1565	(53.7)	782	(57.0)
<i>Anopheles funestus</i>	418	(14.3)	184	(13.4)
<i>Anopheles nili</i>	38	(1.3)	5	(0.4)
<i>Anopheles coustani</i>	17	(0.6)	14	(1.0)
<i>Anopheles rhodesiensis</i>	13	(0.4)	7	(0.5)
<i>Anopheles ziemani</i>	17	(0.6)	0	0
<i>Anopheles longipalis</i>	2	(0.07)	2	(0.1)
<i>Culex quinquefasciatus</i>	803	(27.6)	374	(27.3)
<i>Aedes aegypti</i>	11	(0.4)	4	(0.3)
<i>Anopheles moucheti</i>	29	(1.0)	0	0
Total	2913	100	1372	100

(F=11.070, P<0.05)

Table 2. Comparison of two method collection of anopheline mosquitoes in Yagba West Local Government Area, Kogi State, Nigeria, between November 2013 and October 2014.

Village	Anopheline species	Collection method		Total
		HLC	PSC	
Intervention	<i>Anopheles gambiae s.l</i>	253(12.8)	1312(66.2)	1565(78.9)
	<i>An. funestus</i>	114 (5.7)	304(14.3)	418(21.1)
Control	<i>An. gambiae s.l</i>	284(29.4)	498(51.6)	782(81.0)
	<i>An. funestus</i>	73(7.6)	111(11.5)	184(19.0)
OVERALL		724 (24.6)	2225(75.4)	

(F=3.37, df=1, P>0.05)

HLC: Human Landing Catch

PSC: Pyrethrum Spray Catch

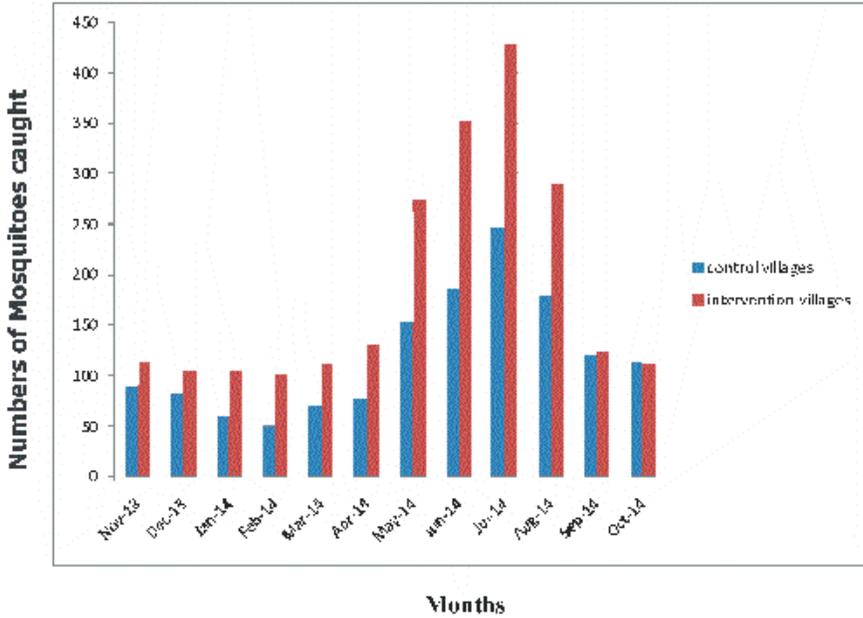


Figure 1. Monthly distribution of mosquitoes in intervention and control communities in Yagba West Local Government Area of Kogi State, Nigeria.

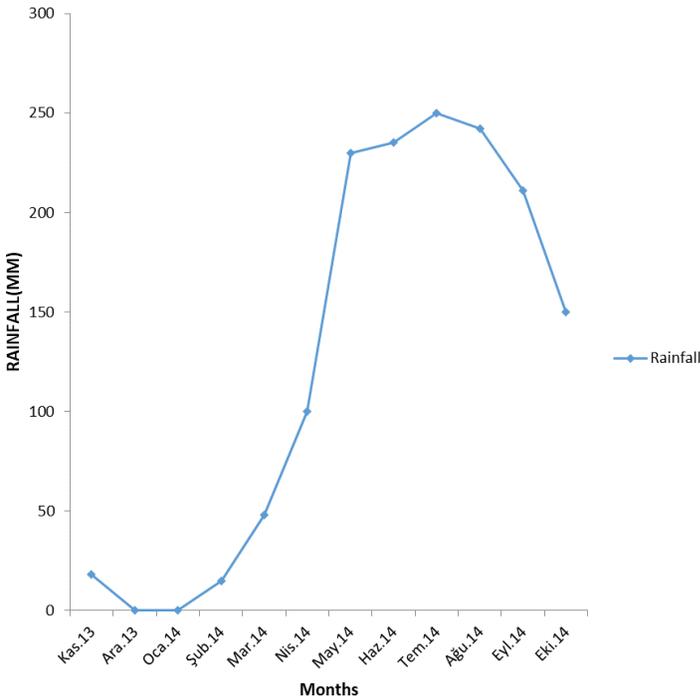


Figure 2. Monthly distribution of rainfall in intervention communities.