FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 4 No. 2, June, 2020, pp 414 - 419
DOI: https://doi.org/10.33003/fjs-2020-0402-153

DENSITY OF MOSQUITO SPECIES AND EFFECT OF SOME CLIMATIC PARAMETER IN AMINU KANO TEACHING HOSPITAL, KANO, NIGERIA

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ABSTRACT

There is a paucity of information on the species of mosquito in Kano City Northern Nigeria. Numerous mosquito control programs that had taken place in Kano State and its environs, mosquitoes remain a problem in the state; therefore a study was undertaken to the relationship between density ofmosquito species and the effect of some climatic parameters on the mosquito distribution in Aminu Kano Teaching Hospital, Kano, Nigeria. The mosquito species were collected using the CDC light trap method and climatic parameters such as temperature and relative humidity were recorded at every one hour of the experiments. A total of 26,652 mosquitoes were collected from January to July 2018. Out of the 26,652, 17444 (65.46%) were *Culex* speciesand 9208 (34.54%) were *Anopheles* mosquitoes. *Culex* species were observed to peak between 10:00 - 11:00 pm (5435) while *Anopheles* mosquito species were observed to attain their first peak at 3:00 – 4:00 am (3416). High collections of mosquitoes were obtained at 27.10^{o}C and relative humidity of 69.7% and 68.60% for Culicine and Anopheline mosquitoes respectively. This study provided information on the mosquito species diversity in respect to seasonal and periodic variation at AKTH and the effect of some climatic parameters.

Keywords: *Anopheles* species, *Culex* species, Population, Temperature, Relative Humidity.

INTRODUCTION

Mosquitoes are vectors of protozoan, nematodes, viruses, and parasites, causing infections such as yellow fever, dengue hemorrhagic fever, malaria, filariasis, and several forms of encephalitis (WHO, 2017). The disease transmitted by species of mosquitoes continues to cause morbidity and mortality in humans, domestic animals, and wildlife.

In Nigeria mosquito-borne diseases particularly malaria and some emerging and re-emerging infections such as Zika, dengue fever, yellow fever, constitute a big threat to public health. However, there is paucity of information on the species of mosquito in Kano City Northern Nigeria. Despite mosquito control programs that had taken place in this state and its environs, mosquitoes remain a problem in the state and there is little information on the relationship between mosquito species abundance and the effect of some climatic parameters on the mosquito distribution in the study area, Kano State.

Climatic changes were reported by several researchers, to have direct affect on the distribution of mosquito population (Ayanda et al., 2009). Climatic factors like temperature, rainfall and relative humidity most be conducive for the survival of the mosquito (Herekar et al., 2020). Tropical countries, including Nigeria have the optimal climatic condition for the survival of mosquitoes (Ayanda et a., 2009; Manyi et al., 2015). In a study done by Manyi et al. (2015) in North Central Nigeria they reported that mosquitoes population were found to be more abundance at optimal temperature of 29.5^{o}C – 38.2^{o}C and relative humidity of 44% - 86% (Manyi et al., 2015).

The collection of mosquitoes landing on human bait is considered the most direct and reliable method for determining human-biting activity since female mosquitoes are collected as they attempt to feed on human collectors (Jiang *et al.,* 2007). Human landing collection (HLC) is often considered as the sole standard in research study for estimating mosquito human contact, but its use is slowly declining due to ethical concerns, potential exposure of collectors to mosquito-borne pathogens, medical and legal considerations (Wong *et al.,* 2013; Lima *et al.,* 2014).

Transmitted estimate, based on the prevalence or density of human infection is susceptible to microheterogeneity caused by climatic factors and socioeconomic determinants of host-seeking behaviors. The study aimed to determine the density of mosquito species and effect of some climatic parameter in Aminu Kano Teaching Hospital, Kano, Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted at the College of Health Sciences Bayero University Kano, situated at Aminu Kano Teaching Hospital (AKTH). The hospital is located in Tarauni local Government area in the locality of UnguwaUku within the city of Kano. Geographically, AKTH lies between latitude 11º57' 31º N and longitude 8º 32'39.4ºN (Source?) and features a tropical savanna climate. Kano State has an average rainfall of about 980mm of precipitation per year, the bulk of which falls between June and September. The climatic condition of the area is characterized by hot temperature but from December to February it is tropically cold (Barau, 2007). The hospital is traversed by River Kundum, a swamp and astagnant water pond. The hospital environment contains natural vegetation, and ornamental plants, this predisposes them to the influx of mosquito species and increases malaria active mosquito breeding sites (Barau, 2007).

Ethical Clearance

Ethical clearance was obtained from Aminu Kano Teaching Hospital ethical and research committee before the commencement of the study with reference number (AKTH/MAC/SUB/12A/P- 3/VI/2222).

Mosquito collection

The mosquitoes species were collected daily from the month of January to July, using the CDC light trap method. The light trap lamp was hung on a post, positioned at about 1.5 meters (6 feet) above the ground level, and a trap was switched on at 6 pm and switched off at 6 am. Mosquito activities towards the lamp were monitored and observations was recorded, then at each hour the traps were inspected and mosquitoes were collected into clear label collection pots and kept in the cool box for transportation to the laboratory (Cook *et al.,* 2007).

Climatic parameters such as temperature and relative humidity were recorded at every hour of the sampling period (Manger *et al.,* 2014).

Morphological Identification and Sorting

Collected mosquitoes were sorted and identified to species level according to standard morphological keys by Gillies and Coetzee (2013). Samples brought to the laboratory were sorted, non-mosquitoes were removed and each mosquito placed individually on a glass slide using forceps and placedunder a stereomicroscope and are identified using standard keys of Gillies and Coetzee (2013). The identification was done to species level. Morphological characteristics including the length of the palps concerning proboscis, the number of bands on both the palps and the proboscis, the antennae, wing spots (pale and dark areas), bands and speckles on the legs. These features were used in the identification of mosquito species that were caught in the study area. Sampled mosquitoes were classified as either culicines, anopheline or others (Gillies and Coetzee, 2013).

Statistical Analysis

The results were presented as Tables, Bars or Line Graphs and using statistical package for social sciences (SPSS) version 20.0 (IBM Inc, Armonk, New York, USA) at 95% confidence of interval.

RESULTS

A total of 26,652 mosquitoes were collected from January to July 2018, out of the 26,652, 17444 (65.46%) were *Culicine* and 9208 (34.54%) were *Anopheline* mosquitoes. The population of *Anopheline* mosquitoes increased in July to 2741 (29.76%) followed by 2085 (22.64%) in June but decreased in April and May 341(3.70%) and 356 (3.86%) respectively. The *Culicine* mosquito populations were observed to be higher in June and July 4062 (23.28%) and 3720 (21.35%) respectively (see Table 1).

Table 2 shows monthly abundance of mosquito species. *Anopheles gambiae* and *Anopheles funetuspopulations* increased in July to 1628 (29.01%) and 812 (31.19%) respectively while species of *Culexquinquefasciatus* were observed to be more abundant in June 4002 (24.12%). The least abundance of the mosquito species was in April and May.

The highest abundance of mosquito population was found at a temperature range between 22.30 – 27.10°C and a relative humidity range between 68.60% – 69.70%. The population dropped at a temperature range between 32.40 – 33.56°C and a relative humidity range between 4.3% – 6.2% (Table 3).

Table 1 Distribution and Abundance of Monthly Collection of mosquito species

Months	*Culex* n = 17444 (%)	*Anopheles* n =9208 (%)
January	3204 (18.37)	1025 (11.13)
February	2923 (16.76)	1754 (19.05)
March	2272 (13.02)	906 (9.84)
April	522 (2.99)	341 (3.70)
May	741 (4.25)	356 (3.87)
June	4062 (23.29)	2085 (22.64)
July	3720 (21.33)	2741 (29.77)
Total	**17444 (100)**	**9208 (100)**

Table 2: Monthly Abundance and distribution of Mosquito Species

Months	Anopheline species			Culicine species	
	An. gambiae n =5613(%)	*An. funestus* n =2603(%)	Others n =992(%)	*Culexquinquefasciatus* n =16508 (%)	Others n = 856(%)
January	604 (10.76)	303 (11.64)	118 (11.89)	3102 (18.70)	102 (11.91)
February	997 (17.76)	584 (22.43)	173 (17.43)	2622 (15.80)	301 (35.16)
March	558 (9.94)	280 (10.75	68 (6.85)	2202 (13.27)	70 (8.17)
April	210 (3.74)	106 (4.07)	25 (2.52)	512 (3.08)	10 (1.16)
May	226 (2.03)	92 (3.53)	38 (3.83)	628 (3.78)	113 (13.20)
June	1390 (24.76)	426 (16.36)	269 (27.11)	4002 (24.12)	60 (7.00)
July	1628 (29.01)	812 (31.19)	301 (30.34)	3520 (21.22)	200 (23.36)
Total	**5613 (100)**	**2603 (100)**	**992 (100)**	**16588 (100)**	**856 (100)**

Table 3: Effect of Temperature and Relative Humidity on Mosquito Species Distribution and Abundance

Months	Temperature (°C)	Relative Humidity (%)	Culicine	Anopheline
January	22.60	17.85	3204 (18.36)	1025 (11.13)
February	22.30	16.20	2923 (16.75)	1754 (19.04)
March	22.30	17.40	2272 (13.02)	906 (9.83)
April	33.56	4.3	522 (2.99)	341 (3.70)
May	32.40	6.2	741 (4.24)	356 (3.86)
June	27.10	69.70	4062 (23.28)	2085 (22.64)
July	27.10	68.60	3720 (21.32)	2741 (29.76)
		Total	**17444 (100)**	**9208 (100)**

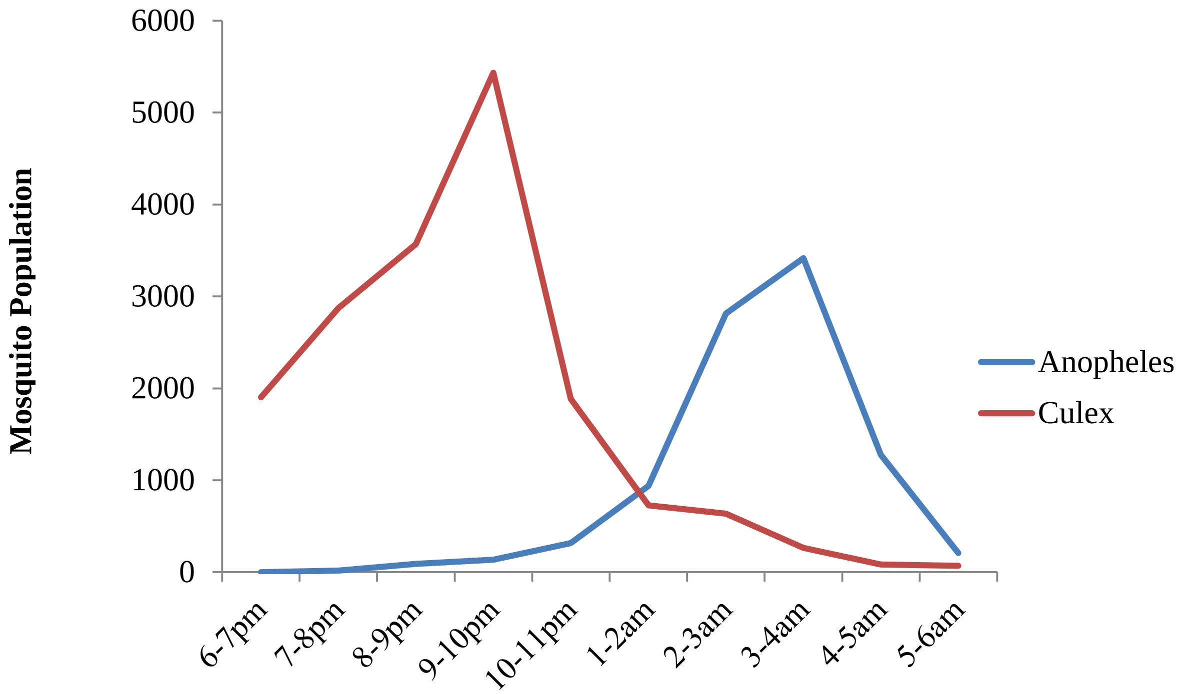

Figure 1: Periodic Variation in the Distribution of Mosquito Species

Figure 1 shows the periodic variation in the distribution of mosquito species. *Culicine* species were observed to have 2 peaks of abundance with the first peak at 9:00-10:00 pm and second peak at 10:00 – 11:00pm with a population of 3571 and5435 while *Anopheline* mosquito species were observed to attain their first peak at 2:00–3:00am with population of 2815 and second peak at 3:00 – 4:00am with population of 3416.

DISCUSSION

The significant population of mosquitoes recorded in the study area may be attributed to the ecological features, climatic conditions, and activities of the residence which favor the rapid breeding of mosquitoes (Service, 1993). Braack *et al.* (2015) reported the increased tendency of mosquito populations may be due to changes caused by environment as aresult of shift in the behavior of mosquitoes, increase tendency to feed outdoor, bite earlier or late at night, and reduce anthrophagy in the presence of vector control measures (Braack *et al.,* 2015). The result also showed that *Culicine* mosquitoeswere more abundant during the collection; this can be associated with their resting and feeding habits, presence of stagnant pond, high vegetation, ornamental plants, and nearness to flowing river as well as the method employed in their collection (Odetoyinbo, 1969; Owino *et al.,* 2017). *Culicine*mosquitoesareknown to be fairly abundant with a wide geographical distribution in many parts of Africa including Nigeria, Zambia, South Africa, Kenya and Tanzania (Owino *et al.,* 2017), adapting to almost every climatic condition. The outcomes of this study reported the high abundance of *Culicine* as a potential secondary vector of other infections (Msugh-Ter *et al.,* 2017).

The result shows that there is a significant increase in *Anopheline*mosquitoes collected in June and July 2018. This may be a result of an increased in the rainfall which potentially increases breeding habitats of *Anopheline* mosquitoes. *Anopheline* mosquitoes in Africa typically breed in shallow water bodies, rice cultivation sites, and freshwater patches and increased in the flow of rivers (Lindsay *et al.,* 1998). Previous studies showed that *An. gambiae* prefers more humid areas, freshwater body and Rice cultivation site for their breeding, hence the predominance of *Anophelines*(Lindsay *et al.,* 1998). The significant decrease in *An. funestus* in January, February, March, April, and May (Table 2) may be due to decreased in sites which are characterized by high aquatic vegetation (Lindsay *et al.,* 1998). The high density of *An. gambiae* may be explained by the anthropophilic behavior and adaptation to the human environment (Fonadel *et al.,* 2013).

In this study it was found that mosquito species have their own specific time of abundance of which *Culicine* species were observed to have two peaks between 9:00 – 10:00 pm and secondly at 10:00 – 11:00 pm. This phenomenon can be attributed to their feeding behavior and gonotrophic cycle which coincide with human diurnal activities (Maliti *et al.,* 2016). The use of long-lasting insecticide net (LLINs) prompted vectors to shift their biting time to when people are not protected, such as early in the evening and or outdoor. However, it is uncertain whether this behavioral shift is due to phenotypic plasticity and ecological changes within communities that favor more exophilic species or involve genetical factors within vector species to limit their contact with LLINs (Maliti *et al.*, 2016).

The population of the *Anopheles* mosquitoes, attain peaks at 2:00–4:00 am, this may be associated with the endophilic feeding behavior of the mosquito species. Mosquito species abundance has been described to fluctuate with time and human activities, some exophilic species tend to be more abundant when human activity is more while the endophilic species become more inside human habitation (Gillies and Coetzee, 2013). Few studies have investigated the clock gene in *An. gambiaesl* and their association with diet activity such as blood-feeding (Bayoh *et al.*, 2014). *An. funestus* were more likely to bite in the evening, hence the abundance of *Anopheles* in the late night. Generally, the mosquito was classified into the phenotype of "early" 7 – 10 pm or "late" 4 – 7 am biting time and host-seeking indoor or outdoor (Braack *et al.*, 2015).

The result shows that there is a direct relationship between mosquitoes with temperature. Mosquito is known to prefer an optimum temperature for breeding activities. The highest abundance of mosquito population was between 22.60–27.10°C with a significant noticeable decline in the population at a high-temperature range of about 32.40 – 33.56°C. Local climatic parameters particularly temperature and relative humidity were found to play a vital role in the abundance of mosquito species in several studies (Ayanda, 2009; Beck-Johnson *et al.*, 2013).

The adverse effect of low relative humidity on mosquito abundance has been reported in the early studies (Killen, 2013). In this study also the survival of mosquito was intimately associated with changes in relative humidity in the environment. This agreed with the Study of Ayanda (2009) that reported relative humidity as an important feature that causes the abundance of mosquito populations (Ayanda, 2009).

CONCLUSION

In this study, high collections of mosquitoes were shown to be obtained at optimum temperature and relative humidity. This indicated that the highest abundance of mosquitoes was dependent on the climatic parameters. The study also provided information on the mosquito species population at AKTH.

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