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BREEDING SITES CHARACTERISTICS AND MOSQUITO ABUNDANCE IN SOME SELECTED LOCATIONS WITHIN KADUNA METROPOLIS

***[1]Oguche O. D, [1]Auta, I.K, [1]Ibrahim, B, and [1]Yayock, H. C, and [2]Johnson O.**

[1]Department of Biological Sciences, Kaduna State University, Kaduna State
[2]Department of Physiology, ABU Zaria, Kaduna State

*Corresponding authors' email: ogucheojo@gmail.com Phone: +2348034252623

ABSTRACT

Natural or artificial collection of water serves as an optimum habitat that supports mosquito's breeding, while savannah, grasslands or shady low woodlands supports their resting activities, swarming and mating. Samples were collected from breeding sites within some selected locations from January to June. Five hundred and thirty two mosquito larvae belonging to 3 genera *Culex, Anopheles* and *Aedes* were collected and seven species of mosquitoes were identified comprising; *Culex quinquefasciatus* 102 (19.17%), *Aedes aegypti* 345(64.84%), *Culex decens* 8 (1.50%), *Aedes vittatus* 49 (9.21%) *Culex simpsoni* 8(1.50%), *Culex tigripes* 17 (3.20%) and *Anopheles gambiae* 3(0.50%). *Aedes aegypti* was common in all the locations. Water samples were collected from seven different major breeding sites such as abandoned tyres 155(50.82%), Concrete gutters 50(16.39%), Pools 10 (3.27%) ponds 4 (1.31%), Plastic containers50 (16.39%), Potholes 6 (1.97%) and Metallic containers30 (9.84%) totaling 305 sampled breeding sites. The characteristics of breeding sites noted were the movement of water in the breeding places, the consistency of the presence of water in the breeding places, the existence of vegetation on the breeding and types of predators. Correlation analysis showed abundance of mosquitoes decreased with increase in physicochemical parameters. In conclusion, the common house mosquito (*Aedes aegypti*) was most abundant and occurring in abandoned tyres; while the physico-chemical parameters were all within the acceptable limits for mosquito breeding.

Keywords: Mosquito larvae, Abundance, Physio-chemical parameters, Breeding Sites, Kaduna

INTRODUCTION

Mosquitoes bite and noise nuisance have contributed to the cause of sleeplessness and disease transmission, thus seen as public enemies (Li *et al*., 2021). Many species of mosquitoes are vectors of diseases such as malaria, dengue fever, yellow fever, Japanese encephalitis, filariasis, Nile virus, Zika virus (WHO, 2018) in humans and they also transmit animal diseases like heart worm diseases of dogs, the fowl pox of poultry, rift –valley of fever of sheep and myxomatosis of rabbit (Adnan *et al*., 2021). In 2018, there were 228 million cases worldwide leading to an estimated 405,000 deaths (Hidayah, 2019). Nearly, 93% of the cases and 94% of deaths occurred in Africa and estimated to result in losses up to US$12 billion each year due to increased healthcare costs, loss of ability to work, and negative effects on tourism (WHO, 2018).

Their immature stages can survive in rice fields, ditches, marshes, temporary rain pools, streams, fresh or salt water, gutters (Grech *et al*., 2019). The farming and other anthropogenic activities, greatly affect physico-chemical states of their dwelling (Olayemi *et al*., 2014). Ecological and environmental modifications so as to improve agricultural activities and urbanization have resulted to increase in insecticides resistance in mosquitoes breeding species (Jeffrey *et al*., 2020). The coexistence of different mosquitos' larvae along with other biotic organisms such as frogs, fish, and dragonflies form a community in the share habitat requirements (Afolabi *et al*., 2010). Physico-chemical parameters such as temperature, turbidity, conductivity, and pH have significant influence on mosquito larval abundance (David *et al*., 2021). Natural or artificial collection of water serves as an optimum habitat that supports their production, oviposition, and emergence, while savannah, grasslands or shady low woodlands supports their resting activities, swarming and mating (Mbanzulu *et al*., 2020).

METHODOLOGY

Study Locations

The research was conducted in some selected locations within Kaduna Metropolis, and the locations are Goni-Gora, Ungwan Romi, and Ungwan Television (Fig1). The mosquito larval stages were sampled from various breeding sites which include abandoned tyres, concrete gutters, peridomestic runoff, stagnant pools / ponds, road side pot holes, soak away pits, rice fields, plastic and metallic containers that were found in the selected locations or behind houses. side pot holes, soak away pits, rice fields, plastic and metallic containers that were found in the selected locations or behind houses.

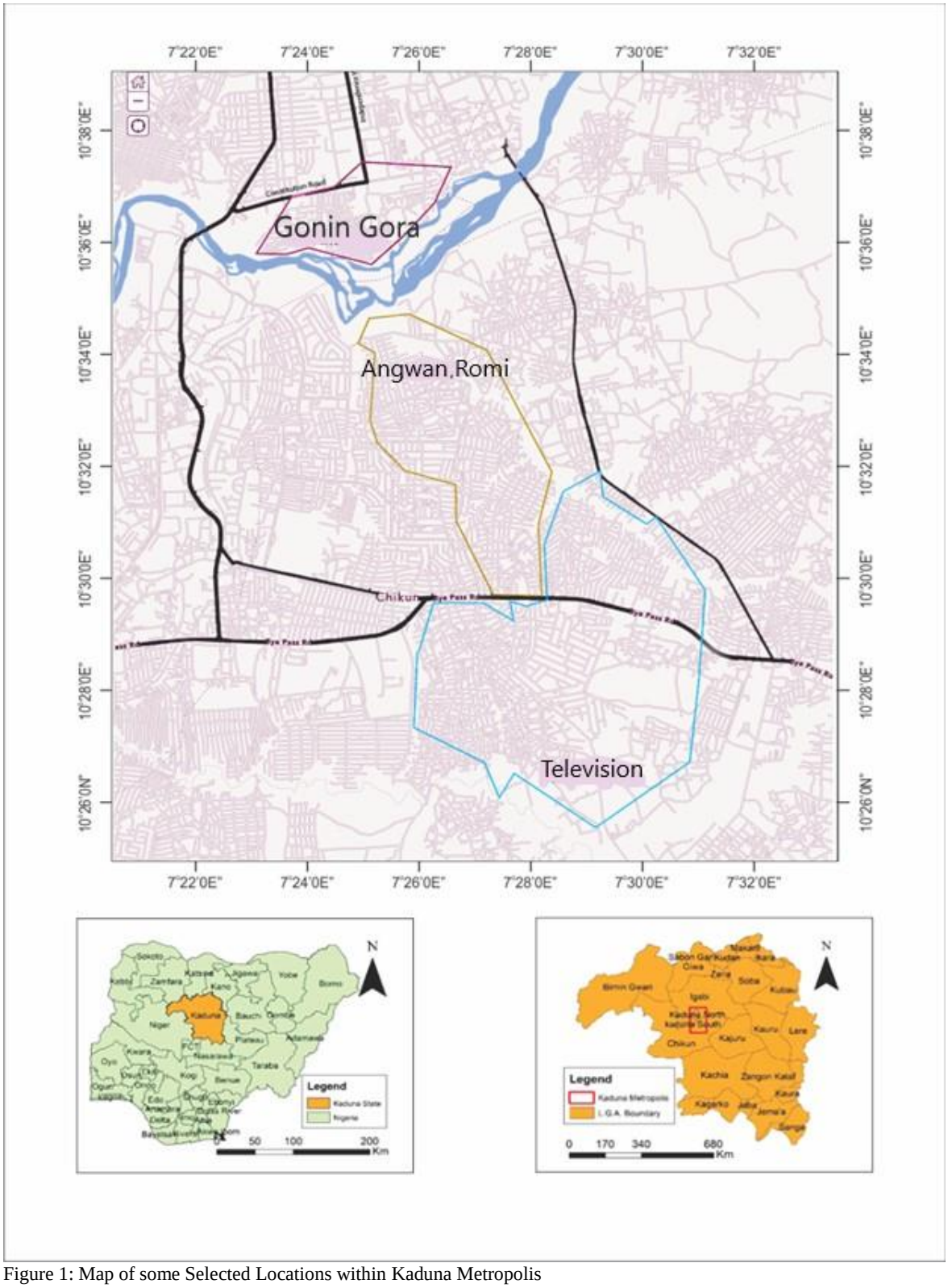

Figure 1: Map of some Selected Locations within Kaduna Metropolis

Sampling Techniques

Immature stages of mosquitoes were collected twice in a month at about 7.00am to 10.00am and from 4.00pm to 6.00pm from available breeding sites using a plastic dipper 7cm-8cm in diameter and depth of 5cm, with a 30cm long handle (Yayock *et al.*, 2014). Ten (10) dips were collected at each sampling sites and where the breeding sites do not allow 10 dips, the immature stages were carefully scooped, concreted, harvested and preserved in 70% ethanol in covered and labeled specimen bottles. Physical properties of the water, such as Temperature were determined at the spot with a thermometer device, while 200mls of water sample from the breeding sites were collected for the physico-chemical into a 250 ml storage container with a Lugol solution. All specimens were transported to the laboratories, for the various analyses and observations at the

Federal Ministry of Agriculture, Fertilizer Development Centre, Goni-Gora Kaduna.

Identification of Mosquitoes Larvae

The mosquito pupae were sorted out and discarded while the larvae were identified in the laboratory using the Olympus dissecting microscope with objective lens identified 10x and 20x with the guide of pictorial keys by Hopkins (1952); Gillies and Coetzee (1987) using a simple taxonomic characters such as tiffs, gills, meta-pleural spines and tergal appendages. The larvae of species identified were recorded appropriately.

Physico-Chemical Parameters Determination of the Breeding Sites

Physico-chemical parameters were measured at major selected sites where mosquito breeding was encountered. The physical parameters such as Temperature was measured at site using a thermometer, P^H, turbidity, electrical conductivity and chemical parameters such as magnesium, iron, Sulphate and phosphate were determined using FAAS (Flame Atomic Absorption Spectrometer) at the Federal Ministry of Agriculture, Fertilizer Development Centre Goni-Gora Kaduna.

Data Analysis

The study was a descriptive observational study; which type is exploratory. The characteristics of the breeding sites of mosquitoes were described and displayed descriptively using tables, percentages. ANOVA was also used to analyze data obtained for mosquito abundance relative to Physico-chemical parameters in the breeding sites using SPSS software version 25.0. The significant difference between the physiochemical parameters were considered at $p< 0.05$.

RESULTS

Percentage Composition of Mosquito Species Sampled in Some Selected Locations within Kaduna Metropolis

A total of 532 immature mosquitoes belonging to 3 genera *Culex, Anopheles* and *Aedes* were collected and seven species of mosquitoes were identified comprising*; Culex quinquefasciatus 102* (19.17%), *Aedes aegypti* 345(64.84%), *Culex decens* 8 (1.50%), *Aedes vittatus* 49 (9.21%), *Culex simpsoni* 8(1.50%) *and Culex tigripes* 17 (3.20%), *Anopheles gambiae* 3(0.50%). Aedes aegypti was common in all the locations, followed by *Culex quinquefasciatus*, then *Aedes vittatus* and the least species is *Anopheles gambiae* as seen in Table 1. Water samples were collected from seven different major breeding sites such as abandoned tyres 155(50.82%), Concrete gutters 50(16.39%), Pools 10 (3.27%) ponds 4 (1.31%), Plastic containers50 (16.39%), Potholes 6 (1.97%) and Metallic containers30 (9.84%) totaling 305 sampled breeding sites. In Goni-Gora, 85 breeding sites were sampled and 43 (14.10%) positive for mosquito larvae, 94 breeding sites were sampled in Ungwan Romi and 57 (18.69%) positive for mosquito larvae, while 126 breeding sites were sampled in Ungwan Television and 80(26.23%) positive for mosquito larva as seen in Table 2.

Temperature and turbidity were not significant $p>0.05$ between sites but significant difference were observed in conductivity and this can be related to the larval abundance. However, the levels of SO_3, PO_4 and Mg/L were significant $p<0.05$ between the sites. However, the physicochemical parameters from the breeding sites are presented in Table 3.

Table 1. Percentage Composition of Mosquito Species Sampled in Some Selected Locations within Kaduna Metropolis

	Locations				
	Goni-Gora	**Ungwan Romi**	**Ungwan Television**	**Total**	**Percentage Composition**
Cq	19(30.16%)	31(21.53%)	52(17.63%)	102	19.17%
Ae	64(68.82%)	89(61.81%)	192(65.10%)	345	64.85%
Cd	1(1.08%)	3(3.23%)	4(1.36%)	8	1.50%
Av	3(3.23%)	17(11.81%)	29(9.83%)	49	9.21%
Ct	3(3.23%)	4(2.78%)	10(3.39%)	17	3.20%
Cs	2(2.15%)	0(0.00)	6(2.03%)	8	1.50%
Ag	1(1.08%)	0(0.00)	2(0.68%)	3	0.56%
Total	93	144	295	532	100

Keys

Anopheles gambiae	=	*Ag*			
Culex simpsoni	=	*Cs*			
Culex quinquefasciatus	=	*Cq*	GG	=	Goni-Gora
Culex decens	=	*Cd*	UR	=	Ungwan Romi
Aedes aegypti	=	*Ae*	UT	=	Ungwan Television
Aedes vittatus	=	*Av*			
Culex tigripes	=	*Ct*			

Table 2: Mosquitoes Larval indices in Breeding Sites Sampled in Some Selected Locations within Kaduna Metropolis

Locations	**Breeding Sites No.**	**Breeding Sites Positive for Mosquito Larvae**	**Total (%)**
Goni-Gora	85(27.89%)	43(23.90%)	14.10
Ung Romi	94(30.81%)	57(31.66%)	18.69
Ung Television	126(41.30)	80(44.44%)	26.23
Total	305	180	59.02

Key
Ung Ungwan

Table 3: The Mean Physico-Chemical Parameters of Breeding Sites in Some Selected Locations within Kaduna Metropolis

Location	Temp(^{0}C)	pH	Turbidity (NTU)	Conductivity	Mg (Mg/L)	Fe_4(Mg/L)	$S0_3$(Mg/L	PO_4 (Mg/L
Goni-Gora	29.30-30.40	6.20-6.60	28.50-29.20	233.55-235.20	8.20-8.65	13.33-13.66	7.55-7.85	0.44-0.75
Ung Romi	26.00-31.00	6.00-6.50	22.40-28.20	231.50-336.30	7.60-8.30	13.57-13.82	7.40-7.65	0.36-0.78
Ung Television	28.40-29.50	7.50-7.80	24.00-26.50	235.60-236.20	7.88-8.80	13.50-14.00	7.50-7.59	0.40-0.60

Table 4: The Mean Physico-Chemical Parameters of Breeding Sites in Some Selected Locations within Kaduna Metropolis

Location	Temp(^{0}C)	pH	Turbidity (NTU)	Conductivity	Mg(Mg/L)	Fe_4(Mg/L)	$S0_3$(Mg/L	PO_4(Mg/L
Goni-Gora	29.30-30.40	6.20-6.60	28.50-29.20	233.55-235.20	8.20-8.65	13.33-13.66	7.55-7.85	0.44-0.75
Ung Romi	26.00-31.00	6.00-6.50	22.40-28.20	231.50-336.30	7.60-8.30	13.57-13.82	7.40-7.65	0.36-0.78
Ung Television	28.40-29.50	7.50-7.80	24.00-26.50	235.60-236.20	7.88-8.80	13.50-14.00	7.50-7.59	0.40-0.60

DISCUSSION

This study showed significant distribution and abundance of *Aedes aegypti, Culex quinquefasciatus and Culex decens* in abandoned tyres, pools and ponds in Ungwan Television, which appears to be driven by environmental factors such as washing of cooking utensils, clothes and motor-cycles into drainage, differences in biological and physical characters of breeding sites and coverage of study areas that creates favorable conditions for mosquito species. The dominance as observed in this study has been reported by similar works by Amini *et al*. (2020) in Ilorin, Simon *et al.* (2012) in Ekiti State, Olayemi *et al.,* (2014) in Minna, Mgbemena *et al.,* (2012) in Imo State. *Aedes species* of mosquitoes was also reported in the present study. Afolabi et al. (2010) observed that Aedes mosquito was predominant in Zaria and also Adeleke (2010) observed that *Ae. Aegypti* was generally predominant in Ikenne, Ogun State, Nigeria. The implication of this information on abandoned tyres may present this breeding site tyre as a public health threat, especially in area of disease (West Nile virus, Zika virus, Yellow fever virus, Dengue virus, Chikungunya virus and Malaria) outbreak by these disease vectors (Chinery, 1969).

Concrete gutters, potholes harboured *Aedes vittatus, Culex tigripes and Culex simpsoni* while plastic and metallic containers harboured *Anopheles gambiae*. The mosquito species reported in this study have also been reported by different researchers elsewhere in Nigeria like those of Afolabi *et al.,* (2013), Mgbemena *et al.,* (2012), Ogwoma and Ikpeze (2008), Olayemi et al (2014).

Three hundred and five breeding sites were sampled and 180 breeding sites were positive for mosquito larvae with 59.02% indice while 125 breeding sites did not have mosquito larvae with 40.98% indice. The breeding sites positivity for mosquito larvae was due to the dissolved concentration of ions like iron (Fe_4), magnesium (Mg), nitrate etc. Dissolved ions was highest in Ungwan Television with iron (Fe_4), ranging from 13.57 to 13.82 and lowest in Goni-Gora 7.40 to 7.65. Turbidity was high and was caused by silt, mud, algae, plant pieces, wood ashes, saw dust, which increases temperature by absorbing more heat. This means that mosquito immature will have a relative shorter time span to reach the adult stage. Turbidity was highest in Goni-Gora (28.50-29.20) and lowest in Ungwan Romi (20.10-22.00) (Watsenga *et al.,* 2021). The implication of this information on abandoned tyres may present this breeding site tyre as a public health threat, especially in area of disease (West Nile virus, Zika virus, Yellow fever virus, Dengue virus, Chikungunya virus and Malaria) outbreak by these disease vectors.

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The Physical parameters of mosquito breeding sites are important in determining mosquito oviposition (Puntasecca *et al*., 2021). In this study, habitats sampled had temperatures between 26.00 -31.00(^{0}C). Although, Olayemi *et al. (*2016) reported that the species survived within temperature range of 28-34(^{0}C), 30(^{0}C), seem to favor development of mosquito species most. In this study, Goni-Gora had temperature range of 29.30-30.40(^{0}C) which was proficient in producing mosquitoes efficient in transmitting diseases (West Nile virus, Zika virus, Yellow fever virus, Dengue virus, Chikungunya virus and Malaria). The hydrogen ion concentration of a habitat is amount of available nutrients in that habitat (Olayemi *et al*., 2010). The present study revealed that most of the breeding sites had pH had level of 6 and 8. Similar values have been reported by Oloruniyi *et al*. (2016) in Lagos, Mgbemena *et al*. (2009) in Imo State. Adebote et al., (2016) said *Aedes* breed in water with pH 7.4, Okogun *et al*., (2005) showed that pH of 6.8 to 7.2 is suitable for the weakling of the egg shells for the first in star larval to emerge. Similar results were recorded by Service (1993) that P^H less than 5.0 and higher 7.4 have lethal effect on mosquito species. In this study, Ungwan Television had pH range of 7.50 to 7.80 due to the location of motor garage in that create room mosquitoes breeding that attract mosquito oviposition. The findings showed that temperature, pH, conductivity, magnesium were positively associated and important in explaining the presence and abundance of *Culex*, Adebote et al., (2016) said *Aedes* breed in water with pH 7.4, Okogun *et al*., (2005). Electrical conductivity in this study was 231.50-236.20 supported the growth and development of mosquitoes in all breeding sites. Nwosu *et al.,* (2010), reported similar association of conductivity with *Culex quinquefasciatus* larvae. Abundance of *Aedes* species showed positive association with conductivity as is the measurement of the accumulation of ions in a solution, but Rim-Rukeh *et al.,* 2013 reported negative association of conductivity with *Culex quinquefasciatus* larval presence. *Aedes aegypti* was found in turbid water than clear water for oviposition. This could be due to the rainy season, turbid water favors *Aedes aegypti*, but during the dry season, as there was no or rare turbid waters created by rain water pools it exist in the clear water. The

predominance of *Aedes* species over *Culex* mosquitoes in that area may be associated to the variation in larval habitat requirements of the species. *Aedes and Culex* species usually breed profusely in polluted gutters, abandoned tyres, and abandoned pools/ponds with organic matters (Hidayah, 2019). There were 3 presence of Anophele species because Anopheles prefers clean ground pools and man-made containers. The study areas have many polluted gutters, abandoned tyres, pools/ponds, plastic and metallic containers which could have provided conducive environment for the breeding of Culex and Aedes species (Luza *et al.,* 2021). *Culex species* were negatively associated with magnesium, iron and Sulphate respectively.

CONCLUSION

The results obtained from this study showed that the breeding habitats support mosquito species abundance and composition in the selected locations within Kaduna Metropolis. Two of the species *Culex quinquefasciatus* and *Aedes aegypti* are known vectors of human diseases. Lack of good drainage and sewage disposal contributed to the abundance, distribution and composition of mosquito species in study areas. Tyres were the most productive habitats which may pose epidemiological threat to the human population in the study areas with respect to mosquito borne diseases.

Habitat characterizations and Physico-Chemical Parameters of the breeding habitats in the selected locations varied significantly and are typical of the species breeding habitats, which explain the abundance and composition of mosquito species in the study area and shows potential threat to public health in case of disease outbreak.

The author will like to recommend that public enlightenment on the dangers of mere throwing refuges into drainages systems should discouraged by people.

REFERENCES

Adebote, D. A., Oniye, S. J., Ndams I. S. and Nache, K. M. (2006). The breeding of mosquitoes (dipteral: Culicidae) in peridomestic containers and implication in yellow fever transmission in village around Zaria, Northern Nigeria. Jounrnal of Entomology 3(2): 180-188.

Adeleke, M. A., Mafianan, C. B., Idown, A. B., Adekunle, M. F. and Samwobo, S.O. (2010). Mosquito larval habitats and public health implication in Ogun State Abeokuta, Nigeria Tanzania Journal Health Reports 10(2); 38-45.

Adnan RA, Ramli MF, Othman HF, Asha'ri ZH, Ismail SNS, Samsudin S. The Impact of Sociological and Environmental Factors for Dengue Infection in Kuala Lumpur, Malaysia. *Acta Trop* (2021) 216:105834. doi: 10.1016/j.actatropica.2021.105834[i]

Afolabi O.J, Ndams IS, Mbah C.E, kogi E (2010). The effects of alteration of PH on the breeding characteristics of mosquitoes in phytotelmata in Ahmadu Bello Zaria, Nigeria. *International journal of bioscience. 5(1):32-36.*

Afolabi O.J, Ndams IS, Mbah C.E, kogi E (2013).The effects of alteration of PH on the breeding characteristics of mosquitoes in phytotelmata in Ahmadu Bello Zaria, Nigeria. *International journal of bioscience. 5(1):32-36.*

Amini M, Hanafi-Bojd AA, Aghapour AA, Chavshin AR. Larval Habitats and Species Diversity of Mosquitoes (Diptera: Culicidae) in West Azerbaijan Province, Northwestern Iran. *BMC Ecol* (2020) 20:60. doi: 10.1186/s12898-020-00328-0.

Chinery,W.A. (1969). A survey of mosquito breeding in Accra during a two year period of larval mosquito control. The mosquito collected and their breeding places. *Ghana Medical Journal,* 8, 266-274.

David MR, Dantas ES, Maciel-de-Freitas R, Codeço CT, Prast AE, Lourenço-de-Oliveira R. Influence of Larval Habitat Environmental Characteristics on Culicidae Immature Abundance and Body Size of Adult Aedes Aegypti. *Front Ecol Evol* (2021) 9:626757. doi: 10.3389/fevo.2021.626757.

Egbuche, C.M., Ezihe, C.K., Aribodor, D.N., & Ukonze, C.B. (2016). Survey of mosquitoes in open and closed larval habitats in Aguleri, Anambra East Local Government Area of Anambra State, South-eastern Nigeria. *Journal of Mosquito Research,* 6(17): 1-5.

Grech, M, Sartor, P., Estallo E., Luduena- Almeida, F., & Almiron, W. (2019). Characterization of *Culex quinquefasciatus* (*Diptera*: *Culicidae*) larval habitats at ground level and temporal fluctuations of larval abundance in Cordoba, Argentina. Memurias do instituto Oswaldo Cruz, 108 (6), 772-777.

Hidayah N, Rahmawati D. Bio-Physicochemical Markers of the Aedes Aegypti Breeding Water in Endemic and Non-Endemic Area. *Int J Public Health Sci (IJPHS)* (2019) 8:151. doi: 10.11591/ijphs.v8i2.18883

Hopkins GHE (1952). Mosquitoes of Ethopian region, larval bionomics of mosquitoes and taxonomy of culcline larvae. 2nd edition. Adlard and sons Ltd. London. 78:307-318.

Jeffrey Gutiérrez EH, Walker KR, Ernst KC, Riehle MA, Davidowitz G. Size as a Proxy for Survival in Aedes Aegypti (Diptera: Culicidae) Mosquitoes. *J Med Entomol* (2020) 57:1228–38. doi: 10.1093/jme/tjaa055.

Li Z, Wang J, Cheng X, Hu H, Guo C, Huang J, et al. The Worldwide Sero prevalence of DENV, CHIKV and ZIKV Infection: A Systematic Review and Meta-Analysis. *PLoS Negl Trop Dis* (2021) 15:e0009337. doi: 10.1371/journal.pntd.0009337.

Luza AL, Gualdi CB, Diefenbach LML, de AG, Schüler-Faccini L, Ferraz G. Dynamic Mapping of the Probability of Infestation by Urban Arbovirus Vectors in the Municipalities of Rio Grande do Sul State, Brazil 2016-2017. *Epidemiol Serv Saúde* (2021) 30:e2020154. doi: 10.1590/s1679-49742021000200006.

Mbanzulu KM, Mboera LEG, Luzolo FK, Wumba R, Misinzo G, Kimera SI. Mosquito-Borne Viral Diseases in the Democratic Republic of the Congo: A Review. *Parasit Vectors* (2020) 13:103. doi: 10.1186/s13071-020-3985.

Mgbemena, I. C., Opara, F. N., Osuala, F. O. U., and Iwuala, M. O. E. (2009). The Physico-chemical characteristics of Drainage Breeding sites of Mosquitoes in parts of Imo Hopkins, G. H. E. (1952). Mosquitoes of Ethopian region, larval bionomics of mosquitoes and taxonomy of culcline larvae. 2 edition. Adlard and sons Ltd. London. 78:307-318.State, South Eastern Nigeria. International journal of Environmental Health and Human Development, 10(2), 1-13

Mgbemena, I.C., & Ebe, T.(2012). Distribution and Occurrence of Mosquito species in the Municipal Areas of Imo State, Nigeria. *International Journal of Biosciences*, 2(8), 23-35.

Nwosu, L.C., Iwu, C.J. & Nwosu, U.I. (2011). Assessment of mosquito diversity and evaluation of impact of house Treatment with DDT on their population in Amauro, Okigwe Local Government Area, Imo State, Nigeria. *Ethiopian Journal of Environmental Studies and Management,* 4(3), 51-55.

Oguoma, V.M., & Ikpeze, O.O. (2008). Species Composition and Abundance of Mosquitoes of a Tropical Irrigation Ecosystem. *Animal Research International Journal* 5(2), 886-871.

Oloruniyi, O.F. (2016). Abundance and Diversity of Mosquito Genera at Ilokun and Irasa Communities, Ado-Ekiti, Nigeria. *Journal of Biological Innovation* 5(3), pp: 379-385.

Okogun GRA, anosike JC, Okere AN, Nwoke BEB (2005). Ecology of mosquitoes of Midwestern Nigeria. *J. Vector borne* Dis. 42:1-8.

Olayemi, I. K., and Ande, A. T. (2008). Survivorship of Anopheles gambiae in relation to malaria transmission in Ilorin, Nigeria. Online Journal of Health and Allied Sciences, 7(3), 1.

Olayemi, I. K., Ukubuiwe, A. C., and Oyibo-Usman, K. A. (2014). Mosquito Species Occurrence and Diversity in Conventional larval breeding sites in Minna Metropolis, Nigeria .International Journal of Innovation and Scientific Research.

Olayemi, I. K., Victoria, O., Ukubuiwe, A. C. and Jibrin, A. I. (2016). Effects of Temperature Stress on Pre-Imaginal Development and Adult Ptero-fitness of the Vector Mosquito, Culex quinquefasciatus (Diptera: Culicidae). Journal of Mosquito Research, 6(15): 1-8(doi: 10.5377/jmr.2016.06.0014).

Puntasecca CJ, King CH, La Beaud AD. Measuring the Global Burden of Chikungunya and Zika Viruses: A Systematic Review. *PLoS Negl Trop Dis* (2021) 15:e0009055. doi: 10.1371/journal.pntd.0009055.

Simon-Oke, I. A., Afolabi, O. J., and Olofintoye, L. K. (2012). Species Abundance and monthly distribution of adult mosquito vector in Ekiti State, Nigeria. FUTA Journal of Research in Science, 1, 83-88.

Rim- Rukeh, A. (2013). Physcio-Chemical and Biological Characteristics of Stagnant Surface Water Bodies (Ponds & Lakes) used for Drinking and Domestic purposes in Niger Delta, Nigeria. *Journal of Environmental Protection*, 4, 920-928.
Simon-Oke, I. A., Afolabi, O. J., and Olofintoye, L. K. (2012). Species Abundance and monthly distribution of adult mosquito vector in Ekiti State, Nigeria. FUTA Journal of Research in Science, 1, 83-88.

Service MW (1993). Mosquito (Culicdae). In: Lane RP, crosskey RW (Eds), Medical insects and arachnids. Chapman and Hall, London, pp. 120-240.

Ukubuiwe, A.C., Olayemi, I.K., Omalu I.C.J., and Jibrin A.I. (2016). Genetic Variations in Bionomics of Culex quinquefasciatus Diptera (Culicidae: Diptera) Mosquito Population in Minna, North Central Nigeria. International Journal of Insect Science , 8, 1-7.

Wat'senga Tezzo F, Fasine S, Manzambi Zola E, Marquetti M, del C, Binene Mbuka G, et al. High Aedes Spp. Larval Indices in Kinshasa, Democratic Republic of Congo. *Parasit Vectors* (2021) 14:92. doi: 10.1186/s13071-021-04588-7

World Health Organization (2015). Annual Report on Lymphatic filariasis 2015. Geneva. World Health Organization (accessed 24 August, 2015).

World Health Organization (2018). Global programme to eliminate Lymphatic filariasis. http://www.who.int/lymphatic filariasis/elimination-programme. Accessed 14 Oct 2018

Yayock, H.C., Ndams. I.S., Kogi, E., Ahmed A.B. and Vagime, C.G. (2014). Distribution of mosquito species in Kaduna metropolis, Kaduna State, Northern Nigeria. Nigerian *Journal of Entomology*. Vol.31