

Relative Abundance and Breeding Site Preferences of Mosquito Species found in Owerri West Local Government Area, Imo State Nigeria

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ABSTRACT:

In order to determine the relative abundance of mosquitoes found in Owerri West Local Government Area Imo State Nigeria as well as their breeding sites, research work was conducted to assess the relative abundance of mosquitoes found in different parts. The study was carried out in two locations; Umuguma and World Bank areas. Mosquito larvae were collected from both areas twice a week using the standard dipping technique. These larvae were raised to adulthood in laboratory conditions. A total of two thousand four hundred and sixteen (2,416) adult mosquitoes were obtained. These mosquitoes were identified into various types morpho-metrically using binocular stereomicroscopes and taxonomic identification keys. Eight species of mosquitoes were identified in this study and these include the following; *Culex quinquefasciatus* (23.96), *Aedes aegypti* (23.88), *Culex tritaeniorhynchus* (17.79), *Aedes albopictus* (13.99), *Culex vittatus* (6.49), *Eretmapodites Species* (5.87), *Anopheles species* (4.88) and *Toxorhynchites species* (3.10). It was observed that blocked gutters, empty cans and ground pools favor mosquito breeding. Higher number of mosquitoes was noted in world bank market and Umuguma market refuse dumps. The study recommends that government should improve the standard of environmental sanitation on the proper disposal of refuse and construction of good drainage which facilitates system. This will help to minimize the blockage of gutters and stagnant water (pools) that encourage the blockage of water.

Keywords: Mosquito abundance, Breeding habitats, *Aedes aegypti*, *Culex quinquefasciatus*, Refuse dumps, Nigeria, Vector ecology

INTRODUCTION:

Mosquitoes are known vectors of such diseases as malaria, dengue fever, West Nile virus, and so forth, which are transmitted by larvae that occur in a diverse range of freshwater habitats (Becker et al 2020). Identifying mosquito larval habitats, as well as understanding the species' preferences regarding breeding locations and environmental factors influencing population size, diversity, and distribution is vital for designing successful vector control programs (Amini et al 2020). Indeed, since the only truly efficient strategy for reducing mosquito population is destroying their breeding sites (Muzari et al 2017), this issue is essential in the current context. Unfortunately, despite the growing number of publications on larval mosquito ecology (Amini et al 2020, Grech et al 2019, Emidi et al 2017, Basharet al 2016), this information is still limited, especially in areas where the risk of epidemics is low.

In recent years mosquitoes were found breeding in heavily polluted water bodies with high metal concentration and populated by humans (Okorie et al 2011). The mutually beneficial relationship between a non-malaria vector (*Culex quinquefasciatus*) and malaria vector (*Anopheles gambiae*) results in higher densities of the latter in urban areas (Okorie et al, 2011). *Culex quinquefasciatus* breeds very successfully in artificial water bodies like the drainage systems. These mosquitoes once adapted in such breeding sites develop an ecosystem in which other species including *Aedes gambiae* were found in gutters filled with trash and sewage occupied by species of *Culex* mosquito. Various types of habitats in the environment harbor mosquitoes in both temperate as well as tropical climatic conditions. Different kinds of mosquitoes at different developmental stages live together in one habitat forming a guild. Inhabitation of small water bodies, different mosquito species undergo

competition among themselves, intra- and inter-specific, which is more or less based on experimental findings (WHO 2017). Rapid population increase in Owerri city is attributed to rural-urban migration. Consequently, there has been production of large amounts of solid waste from industrial plants, homes, schools and markets in the region. Unfortunately, most African cities including Owerri lack efficient waste collection and disposal services. Sources of solid wastes in Nigeria include commercial outlets, industries, residential houses, agricultural practices and educational institutions. Proper disposal measures are yet to be implemented to curb the problem. Poor disposal of solid wastes contributes to prevalence of vector-borne diseases including malaria and dengue fever in Nigeria. Improper disposal of solid wastes usually provides mosquito breeding sites due to formation of pools of rainwater in wastes such as cans, bottles and used vehicle tires. This research therefore aims at assessing the abundance and distribution of mosquito-vectors in various refuse dumps in different parts of Owerri West Local Government Area.

Research Gap:

Despite several studies on mosquito ecology in Nigeria, information regarding breeding-site preference and species abundance in Owerri West remains limited.

Aim of the Study:

The aim of this study was to determine the relative abundance and breeding site preferences of mosquito species in selected areas of Owerri West Local Government Area, Imo State, Nigeria.

Objectives of the Study:

- To determine mosquito species abundance.
- To identify preferred breeding habitats.
- To evaluate seasonal variation.
- To assess correlations among mosquito genera.

MATERIALS AND METHODS:

Study Area:

The study was carried out at World Bank and Umuguma both in Owerri West Local Government Area. Owerri West is a Local Government Area in Imo State of Nigeria. The headquarter is located in Umuguma. Owerri West Local Government Area was created from the erstwhile Owerri Local Government Area in 1996. A greater part of the local government area makes up the capital city of Imo State of Nigeria. Refuse are heaped around houses, schools, roads, and market square constituting complementing poor drainage systems as a result of this, the sanitation is poor. Hence, it can encourage the transmission or dissemination of parasites. They also cause flood during rainfalls and contribute to the breeding

of mosquitoes leading to high malaria transmission rate and prevalence.

Ethical considerations:

Ethical approval for the study was gotten from the Post Graduate Board of the Department of Biology Federal University of Technology Owerri ethics committee. Consent were sought and obtained from the village heads.

Research Design:

This study employed an ecological field study and entomological survey to investigate relative abundance of mosquitoes found in different parts of Umuguma and World Bank Areas of Owerri, Imo State Nigeria. The adoption of descriptive survey design is based on the fact that it involves collecting data in order to answer research questions concerning the current status of the subject of the study.

Selection of Sampling Sites and Periods of Sample Collection:

Sampling Sites were randomly selected prior to the inundation of refuse bins and dumpster with water at the beginning of the rainy season. Eight sampling stations were randomly selected across the selected refuse dump sites in Umuguma and World Bank areas. Mosquito larvae were collected in each Sampling station in these sites between July and October 2024, while dump sites types and regions were collected in October for hatching and rearing of aestivating of mosquitoes. Field investigations were carried out in 8 selected waste dump sites with differences in ages, sizes and locations namely: World Bank market, Umuguma Market, Area L, Area H, Area A, Site and services, Federal housing estate Umuguma and Imo state housing estate Umuguma. The refuse dump sites in the study area were composed of metals, tins, plastics, organic wastes (vegetable wastes, rotten food materials etc.) and industrial wastes. The refuse dumps were always damp throughout the study period.

Mosquito Larval Collection and Rearing:

Mosquito larvae were collected by dipping (using an improvised dipper 1.5 liters capacity) at depths of no more than 5cm at the various sampling stations between 08:00-10:00 hours on each collection day. Larvae were transferred into large plastic buckets (5 liters size) to transport live larvae from the field to the laboratory. Total larvae number and larval instars were recorded within 24 hours of collection. Larvae were reared in white plastic bowls (2 liters size) in the laboratory of the Department of Biology Federal University of Technology Owerri. Each breeding site was represented with four replicate bowls covered with mosquito net to prevent emerging adult mosquitoes from escaping. Rearing was done

according to the methods described by Gillet (1972). At the end of the day, emerging adults were counted and recorded. The adults were demobilized by spraying with insecticide (Raid) for identification.

Identification of Mosquito Species:

The adult mosquitoes were carefully removed from the rearing bowls with a pair of forceps and identified under microscope, using standard morphological and Taxonomic keys (Gilles and Coetzee 1987 and Gillies and De-Mellion, 1968 and Service, 2013). The mosquitoes collected were examined one after the other using a binocular stereomicroscope with x 40 objective and x10 eye piece. They were identified using their characteristic features such as size and length of antenna, size of maxillary palps, color of the maxillary palps, length of proboscis, shape of abdomen, color of abdomen, color of wings and legs etc.

Collection and Fixing of Water Samples:

Weekly surveys were carried out to determine the presence of stagnant water habitats, their characteristics and larval densities. Mosquito larvae were collected from their breeding microhabitats in the refuse dump sites between 7am and 11 am, twice a week. They were collected using a standard mosquito dipper (Clark USA) as described by (Service, 2013). Number of dips taken from each habitat was dependent on the perimeter of the larval habitat. The larval habitats were categorized depending on their perimeter and grouped into 3 classes; $\leq 10\text{m}$, $10\text{-}100\text{m}$ and $>100\text{m}$. A maximum of 10, 50 and 100 dips were taken from these habitats respectively. They were kept at room temperature and fed with ground fish powder diet in aquarium. Adults that emerged were harvested by anesthetizing using pyrethrum base aerosol -Killit®.

Statistical Analysis:

Data obtained were entered into Microsoft Excel and analyzed using SPSS version 26. Descriptive statistics were expressed as frequencies and percentages. Pearson correlation analysis was used to determine relationships among mosquito genera. Statistical significance was set at $p < 0.05$.

RESULTS:

Table 1 shows mosquitoes' preference to the different microhabitats in the study sites *Aedes albopictus* and *Aedes aegypti* occurred mostly in containers and tires. Anopheles species and Culex species were mostly

collected in ground pools and blocked drainage (gutters), mostly plant parts such as leaf petioles and tree holes recorded a high occurrence of Aedes species. Of all the microhabitats, blocked drainages (gutters) recorded the highest collection of mosquitoes (30.71%). Table 2 summarizes the abundance of mosquito species in different refuse dump sites. A total of 2,416 mosquitoes were collected from the study sites. The highest number of collections (47.18%) was made in the month of July, followed by August (25.04%) while the least abundance of mosquitoes was in October (13.24%). Site 1 (World Bank market) recorded the highest number of mosquitoes (16.51%) followed by site 2 (Umuguma Market) with a total number of (13.74%) mosquitoes. The least collection (8.89%) was recorded in Imo State Housing Estate Umuguma. Table 3 shows the monthly distribution/occurrence of mosquitoes that breed in different microhabitat. It was observed that ground and pools was highest during the month of July (22.19%) followed by August (21.15%) and least in September (13.10%). Plastic containers had the highest occurrence during the month of August (23.63%). The month of July (25.70%) recorded the highest occurrence of mosquito in tires. In blocked gutter microhabitats, mosquitoes were highest in July (32.54%). Table 4 summarizes the monthly-related prevalence of mosquito species identified. As shown, a total of eight mosquito species were identified, including *Aedes albopictus*, *Aedes aegypti*, *Anopheles* species, *Culex tritaeniorhynchus*, *Culex quinquefasciatus*, *Culex vittatus*, *Eretmapodites* species and *Toxorhynchites* species. *Culex quinquefasciatus* has the highest collection of (23.96%). This was followed by *Aedes aegypti* (23.88%) while the least in abundance was *Toxorhynchites* species with a total number of (3.10%) individuals were recorded. Table 5 showed the correlation analysis of the relationship between Correlation between Mosquito Species Abundance in Refuse Dump Sites during the Rainy and Dry Seasons during the rainy and dry seasons. During the rainy season, *Anopheles* mosquitoes correlated negatively with *Aedes* and *Culex*, while *Aedes* correlated positively with *Culex*. All such correlations were however, strong. But for dry season aestivating mosquitoes, *Aedes* correlated positively strong with *Anopheles* and *Culex*, and a weak positive correlation also exist between *Anopheles* and *Culex*.

A total of 2,416 adult mosquitoes belonging to eight species and five genera were identified from the study sites.

Table 1. Preference of Mosquitoes species in Refuse dump sites

Mosquito species	Micro-habitats in Refuse dump sites (%)					Total (%)
	Ground Poll	Plastic Containers	Metal containers	Living Parts	Blocked Gutters	
<i>Aedes albopictus</i>	16 (3.32)	102 (20.73)	124 (25.05)	66 (34.37)	30 (4.04)	338 (13.99)
<i>Aedes aegypti</i>	23 (4.64)	194 (39.43)	193 (38.98)	101 (52.60)	66 (8.89)	577 (23.88)
<i>Anopheles species</i>	87 (17.57)	-	-	-	31 (4.17)	118 (4.88)
<i>Culex trigrupes</i>	208 (42.02)	43 (8.73)	83 (16.76)	1 (0.53)	95 (12.80)	430 (17.79)
<i>Culex quinquefasciatus</i>	146 (29.49)	62 (12.60)	65 (13.13)	-	306 (41.23)	579 (23.96)
<i>Culex vittatus</i>	15 (3.03)	59 (11.99)	27 (5.45)	11 (5.72)	45 (6.06)	157 (6.49)
<i>Eretmapodites Species</i>	-	32 (6.50)	3 (0.60)	-	107 (14.42)	142 (5.87)
<i>Toxorhynchites species</i>	-	-	-	13 (6.77)	62 (8.35)	75 (3.10)
Total	495 (20.48%)	492 (20.36)	495 (20.48)	192 (7.94)	742 (30.71)	2416 (100.00)

Table 2. Abundance of different species of mosquitoes in refuse dump sites in the study Areas

Sites	Refuse Dump site	Monthly mosquito occurrence (%)				
		July	August	September	October	Total (%)
1	World Bank market	201 (17.63)	97 (16.03)	51 (14.52)	52 (16.25)	401 (16.51)
2	Umuguma Market	178(15.61)	60 (9.91)	51 (14.52)	43 (13.43)	332 (13.74)
3	Area L	101 (8.85)	73 (12.06)	59 (16.80)	49 (15.31)	282 (11.67)
4	Area H	144 (12.63)	72 (11.90)	48 (13.67)	39 (12.18)	303 (12.54)
5	Area A	136 (11.92)	94 (15.53)	36 (10.25)	32 (10.0)	298 (12.33)
6	Site and services	130 (11.40)	88 (14.54)	40 (11.39)	40 (12.50)	298 (12.33)
7	Federal housing estate Umuguma	131 (11.49)	83 (13.71)	31 (8.83)	42 (13.12)	287 (11.87)
8	Imo state housing estate Umuguma	119 (10.43)	38 (6.20)	35 (9.97)	23 (7.18)	215 (8.89)
	Total	1140 (47.18)	605 (25.04)	351 (14.52)	320 (13.24)	2416 (100.00)

Table 3. Occurrence of Mosquitoes in the Different Micro-habitats

Micro- habitats	Monthly Occurrence of Mosquitoes (%)				Total (%)
	July	August	September	October	
Ground Pools	253 (22.19)	128 (21.15)	43 (13.10)	71 (22.18)	495 (20.48)
Plastic Containers	71 (6.22)	143 (23.63)	76 (21.65)	23 (7.18)	313 (12.95)
Metal Containers	63 (5.52)	96 (15.86)	71 (20.22)	26 (8.12)	256 (10.59)
Tires	293 (25.70)	121 (20.0)	66 (18.80)	71 (22.18)	551 (22.80)
Living parts of plants	89 (7.80)	50 (8.26)	23 (6.55)	30 (9.37)	192 (7.94)
Blocked gutters	371 (32.54)	67 (11.07)	72 (20.51)	99 (30.93)	609 (25.50)
Total	1140 (47.18)	605 (25.04)	351 (14.52)	320 (13.24)	2416 (100.00)

Table 4. Monthly related Prevalence of the Relative Abundance of Mosquito species in Refuse dump sites

Mosquito species	Relative Abundance of Mosquito species (%)				Total (%)
	July	Aug	Sept.	Oct.	
<i>Aedes albopictus</i>	170 (14.91)	61 (10.08)	56 (15.95)	51 (15.93)	338 (13.99)
<i>Aedes aegypti</i>	296 (25.96)	114 (18.84)	71 (20.22)	96 (30.00)	577 (23.88)
<i>Anopheles species</i>	51 (4.47)	36 (5.95)	31 (8.83)	-	118 (4.88)
<i>Culex trigrupes</i>	253 (22.19)	116 (19.17)	26 (7.40)	53 (15.50)	430 (17.79)

<i>Culex quinquefasciatus</i>	291 (25.52)	136 (22.47)	80 (22.79)	72 (22.50)	579 (23.96)
<i>Culex vittatus</i>	37 (3.24)	51 (8.42)	49 (13.96)	20 (6.52)	157 (6.49)
<i>Eretmapodites Species</i>	45 (3.94)	64 (10.57)	20 (5.69)	13 (4.06)	142 (5.87)
<i>Toxorhynchites species</i>	15 (1.31)	27 (4.46)	18 (5.12)	15 (4.68)	75 (3.10)
Total	1140 (47.18)	605 (25.04)	351 (14.52)	320 (13.24)	2416 (100.00)

Table 5: Correlation between Mosquito Species Abundance in Dumpsites during the Rainy and Dry Seasons.

Correlations		
Variables Combination	Rainy season	Dry Season
Aedes Vs Anopheles	-0.866*	0.694
Aedes Vs Culex	0.738	0.819*
Anopheles Vs Culex	-0.612	0.355

*Indicates Strong Correlation

DISCUSSION:

The high number of mosquito species in various parts of Umuguma and World Bank Areas of Owerri, Imo State, Nigeria may be attributed to human actions such as bad sanitary practices, presence of pools, household run-off, indiscriminate dumping of waste materials, which offer various breeding grounds for the mosquitoes. The study identified species belonging to different genera, including Aedes, Culex, Anopheles, Eretmapodites and Toxorhynchites. *Culex quinquefasciatus* (23.96), *Aedes aegypti* (23.88), *Culex trigrupes* (17.79), *Aedes albopictus* (13.99), *Culex vittatus* (6.49), *Eretmapodites Species* (5.87), *Anopheles species* (4.88) and *Toxorhynchites species* (3.10) with *Aedes aegypti* showing the highest preponderance over other species followed by *Culex quinquefasciatus* while *Toxorhynchites species* was the lowest in population. The presence of all species of mosquitoes identified in this study has also been reported by various researchers in other parts of Nigeria (Okogun et al., 2005, Adeleke, 2010, Adebote et al., 2008, Bunza et al., 2010; Afolabi et al., 2013, Yayock et al., 2014). In site 1 consisting of World Bank market and the immediate surroundings, the waste disposal has not been done on regular basis and wastes generation takes place in very large quantities owing to the nature of the business conducted there. This is a mammy market and due to that reason, the generated wastes need to be disposed of immediately. The waste disposals in this study site have not taken place on regular basis. It can be concluded from the above results that high levels of mosquito presence are found in the waste dumps of the study area. This could be attributed to the environmental conditions which favour the survival of the mosquito larvae in the various microhabitats. The above findings were also reported by earlier investigators (Anosike, et al, 2007) in various regions of Nigeria. There is an interrelationship between

the habitats of the immature stages and adults (Onyiudo et al, 2017) because the female mosquitoes require the water sources to lay their eggs (Onyiduo et al, 2019). Mosquitoes were collected in high numbers in July. This may be attributed to breeding of haemophilus insects during the beginning and ending of the rainy season when the insects cannot be disturbed or flushed out of their breeding sites as a result of rains (Mbanugo and Okpalaononuju, 2013). Nevertheless, mosquitoes were present throughout the study period due to consistent rainfall that resulted in availability of water sources in refuse dumps. Refuse dumping sites usually go for long periods without evacuation despite the fact that waste removal takes place; sometimes wastes are partially evacuated and some parts of these sites are left unattended. The above has provided conditions under which microhabitats would retain water that offers plenty of chance for adult female mosquitoes to lay eggs. This means that all immature stages would complete their life cycle within these microhabitats (Service, 2013). Water from breeding sites such as container, tires and others was rain water and remained undisturbed, not thrown away or dried up. Site 3 (Imo State Housing Estate Umuguma) recorded lowest number in abundance of mosquitoes. Different species of mosquitoes found indicate that there might be a very serious health hazard associated with diseases spread by mosquitoes. Species of *Culex* complex found in the area plays a significant role in the transmission of various pathogens such as lymphatic filariasis, avian malaria, arbovirus and encephalitis (Okoye and Nwachukwu, 2014). Availability of these mosquitoes is attributed to their adaptation to altered environments by man and their widespread global movement through man-made dispositions (Okwa et al, 2016). The *Anopheles* species detected at the breeding sites cause the endemic nature of malaria. Also, the

Anopheles gambiae complex has the ability to transmit filarial worms and arboviruses but malaria is undoubtedly the greatest threat posed by these species (Anosike, et al, 2017). Breeding of *Anopheles* complex species occurred in rain water pools and ditches, abandoned automobile tires, cans and gutters. These observations are similar to the findings of (Michele et al 1938; Gillet, 1972) in Awka, Enugu and Nasarawa. However swamps and standing water sources were preferred by these species. Some dump sites (site 1,2,3,5,6) were found to be two months old which was enough time for the mosquitoes to lay eggs in the microhabitats, which complete their lifecycles (Gilles and Cotze, 1987). Most of the drainage system (gutters) at the sites were clogged with wastes. This causes poor drainage of rain water which then collects in these drainages forming favorable microhabitats for mosquitoes breeding in polluted waters such as *Culex* species (Onwughara and Nnorom, 2009). Apart from the *Culex* species in the polluted drainages, *Anopheles* mosquitoes were detected in other gutters and ground pools. The ground pools in this habitat were very persistent and covered with plants. This is just like the findings of (Okoye and Nwachukwu 2016) in Owerri, Abuja, Kaduna and Ogun states. There were *Aedes aegypti*, *albopictus* and *vittatus* belonging to the subgenus *Aedes stegomyia* in this study area. These are the vectors of yellow fever and filariasis (Savage and Kothera, 2012). They are mosquitos of tropical and sub-tropical areas whereby they bite during the day time (Nasir et al, 2015). Most of the mosquitos found on plants (tree holes) belong to the *Aedes* genus. The results from the correlation analysis of the relationship between the abundance of mosquitos in refuse dumps during the rainy season revealed that *Anopheles* correlated negatively with *Aedes* and *Culex*, whereas *Aedes* correlated positively with *Culex*. This means that when there is a rise in the abundance of *Anopheles*, there will be a decrease in the number of *Aedes* and *Culex*, thus malaria fever. On the contrary, there is the possibility of same prevalence of mosquito-borne diseases in the dry season, because the abundance of all the three mosquito types increases simultaneously during the dry season.

Public Health Implications:

The predominance of *Aedes aegypti* and *Culex quinquefasciatus* indicates a potential risk of mosquito-borne diseases in the study area. Effective waste management and environmental sanitation are therefore necessary to reduce breeding opportunities.

Strengths of the Study:

This study provides baseline data on mosquito ecology and breeding-site preferences in Owerri West.

Study Limitations:

This study was limited to selected locations within Owerri West Local Government Area and covered only one study season. Molecular identification of mosquito species was not performed.

CONCLUSION:

A total of 2,416 mosquitoes belonging to eight species were identified in the study area. *Culex quinquefasciatus* and *Aedes aegypti* were the most abundant species, while blocked gutters constituted the most preferred breeding habitat. Human activities like industrialization, commercialization, and housework in most parts of the study area led to the rapid production of wastes which remained undischarged causing drainage blockages hence the breeding and re-breeding of mosquitoes in the study area. In addition, water in most part of the study sites stayed in the water body for an extensive time without being disturbed. There is need to develop prevention and control strategies for proper disposal of refuse by the public. Also filling the potholes, low lying area and ditches will help to remove potential breeding sites. Refuse dumps should not be allowed to stay for a long time before taken to final disposal sites.

Data Availability Statement

The datasets generated during the study are available from the corresponding author upon reasonable request.

Funding Statement:

No external funding was received for this study.

Conflict of Interest:

The authors declare no conflict of interest.

Author Contributions:

U.O.P.: Conceptualization, data collection, analysis, manuscript preparation.

REFERENCES:

1. Bunza, M.D.A. Suleiman, A. A. Yusuf, A. M., Bala, A. Y. (2010). Relative Abundance of Mosquito Species in Katsina Metropolis, Katsina State, Nigeria. *Nigerian Journal of Parasitology*, 31(2), 73-78.
2. Adebote, DA, Oniye SJ, Muhammed YA (2008). Studies on mosquitoes breeding in rock pools on inselbergs around Zaria, Northern Nigeria. *J. Vector Borne Dis.* 45: 21-28.
3. Adeleke MA (2010). Population dynamics of indoor sampled mosquitoes and their

- implication in disease transmission in Abeokuta, South-western Nigeria. *J. Vector Borne Dis.* 47: 33-38.
4. Afolabi O. J., Simon-Oke I. A. and Osomo B. O. (2013). Distribution, abundance and diversity of mosquitoes in Akure, Ondo State, Nigeria. *Journal of Parasitology and Vector Biology* 5(10):132-136
 5. Amini M, Hanafi-Bojd AA, Aghapour AA, Chavshin AR (2020). Larval habitats and species diversity of mosquitoes (Diptera: Culicidae) in West Azerbaijan Province Northwestern Iran. *BMC Ecol.*20:60.
 6. Anosike, J.C., Nwoke, B.E.B, Okere, A.N., Oku, E.E., Asor, J.E., Emmy-Egbe I.O., Adimike, D.A. (2017): Epidemiology of tree-hole breeding mosquitoes in the Tropical rain forest in Imo State, South East Nigeria. *Ann Agric, Envi med* 14,31-38.
 7. Bashar K, Rahman MdS, Nodi IJ, Howlader AJ (2016). Species composition and habitat characterization of mosquito (Diptera: Culicidae) larvae in semi-urban areas of Dhaka, Bangladesh. *Pathog Glob Health.* 110:48–61.
 8. Becker N, Petric D, Zgomba M, Boase C, Madon MB, Dahl C, et al (2020). Mosquitoes: identification, ecology and control. 3rd ed. Switzerland: Springer;
 9. Emidi B, Kisinza WN, Mmbando BP, Malima R, Mosha FW (2017). Effect of physicochemical parameters on Anopheles and Culex mosquito larvae abundance in different breeding sites in a rural setting o Muheza, Tanzania. *Parasit Vect.* 2017;10:304.
 10. Gillet, J. D. (1972). *Common African Mosquitoes and their Medical Importance*. William Heinemann Medical Books Ltd., London, UK. pp106.
 11. Gillies MT and Coetzee M. A (1987) supplement of the Anophelinae of Africa south of the Sahara. Johannesburg: *South African Institute for Medical Research*; 1987. p. 1-55.
 12. Gillies MT and De Meillon B (1968). The Anophelinae of Africa south of the Sahara (Ethiopian zoogeographical region). Johannesburg: *South African Institute for Medical Research*; 9.
 13. Grech MG, Manzo LM, Epele LB, Laurito M, Claverie AÑ, Ludueña-Almeida FF (2019). Mosquito (Diptera: Culicidae) larval ecology in natural habitats in the cold temperate Patagonia region of Argentina. *Parasit Vect.* 12:214.
 14. Mbanugo, J.I., and Okpalaononuju, C.N.(2013): Surveillance of mosquitoes vectors in some habitat of Awka metropolis, *Anambra State Nigeria Journal of Parasitology* 24:184-190.
 15. Michele, M., Cutiva, George, F.O., Mera (1938): *University of Florida Entomology Laboratory*. Evans publishers.
 16. Muzari MO, Devine G, Davis J, Crunkhorn B, van den Hurk A, Whelan P, et al (2017). Holding back the tiger: successful control program protects Australia from Aedes albopictus expansion. *PLoS Negl Trop Dis.* 11(2):1-17.
 17. Nasir, I. D., Muhammed, M.A., Emeribe, A.I., and Babayo, A. (2015): Prevalence of Malaria parasitemia among Residents Proximal to Environmental Waste Dump Sites in Abuja Nigeria. *Journal of Medicine in the Tropics.*17:91-96.
 18. Okogun GRA, Anosike JC, Okere AN, Nwoke BEB (2005). Ecology of Mosquitoes of Midwestern Nigeria. *J. Vector Borne Dis.* 42:1-8.
 19. Okorie, P. N., McKenzie, F. E., Ademowo, O. G., Bockarie, M. and Kelly-Hope, L (2011) Nigeria Anopheles Vector Database: An Overview of 100 Years' Research. *PLoS ONE* 6(12): e28347
 20. Okoye, C. and Nwachukwu, M.C.(2014): Human induce environmental vectors as mosquitoes breeding in Enugu urban, Nigeria. *America Journal of Engineering Research* 5(05)57-63.
 21. Okwa, O.O, Rasheed, A., Adeyemi, A., Omoyer, M., Oni. (2006): Anopheles species of malaria patients reporting to and management in Nigeria. *Iran Journal of Environmental Science and Engineering* 6(3) 173-180

22. Onwughara, I.N; Nnorom. I.C, Kanno, O.C. (2000): Issues of Road Side Disposal Habitat of Municipal Solid Waste, Environmental Impacts and Implementation of Sound Management practices in Developing Country Nigeria. *International Journal of Environment Science and Development*.
23. Onyiudo, A; Deeza, N; Obiukwu, M.D; Amadi, E., (2017): Ecology of man-biting mosquitoes in the developing sites of Nnamdi Azikiwe University Awka Anambra State Southern Nigeria. *Internet Journal of Health* (9)
24. Onyiudo, A; Ozumba, N; Ezike, V, Nwosu, E, Chukwuekezie, O. and Amadi, E. (2019): Surveillance study of *Aedes stegomyia* Mosquitoes in the Ecological Locations of Enugu, south eastern Nigeria. *Internet Journal of Infectious Diseases* 8(1).
25. Savage, H.M and Kothera, L. (2012): The *Culex pipiens* complex in the Mississippi River Basin. Identification, Distribution and Blood Meal Hosts. *Journal A.M Mosquitoes Control Association* 28(4)93-99.
26. Service, M.W (2013): Mosquito (culicidae) in Medical insect and Aracnidas, Lane R.P. and Crosskey R.W., Ed Chapman and Hall, London p.120-140.
27. WHO (2017) Manual on practical Entomology in malaria, World Health Organization, Geneva. Prepared by the WHO division of malaria and other parasites diseases. Part 1-2 offset publicationn.
28. 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*, 31:15-21