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Ekedo Chukwuebuka Mathias
Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture Umudike, Abia State, Nigeria

Okore Oghale O'woma
Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture Umudike, Abia State, Nigeria

Uzoma Victor Chidiebere
Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture Umudike, Abia State, Nigeria

Okoro Peter Igwe
Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture Umudike, Abia State, Nigeria

Corresponding Author:
Ekedo Chukwuebuka Mathias
Department of Zoology and Environmental Biology, Michael Okpara University of Agriculture Umudike, Abia State, Nigeria

Habitat preference of mosquito larvae in Michael Okpara University of agriculture, Umudike, Nigeria

Ekedo Chukwuebuka Mathias, Okore Oghale O'woma, Uzoma Victor Chidiebere and Okoro Peter Igwe

Abstract
This study was carried out to identify and characterize the various larval breeding habitats utilized by mosquitoes in Michael Okpara University of Agriculture, Umudike Abia state, Nigeria. Mosquito larvae were collected from different points within the study area from June to December. Different habitats were examined randomly in the area and information on habitat characterization was recorded. Mosquito mean larval density was expressed as larvae per habitat for all the habitat types. All larvae specimens were identified morphologically and about 61.2% (41) out of (67) breeding sites were found positive for different mosquito species larvae. A total of five (5) different habitat types were mapped out for the study which were grouped into open ground pool (36.6%), containers and tyres (26.8%), tyre tracks (24.4%), gutters (12.2%), and swampy/marshy pool (0%). A total of one thousand, three hundred and eight (1308) mosquito larvae and one hundred and sixty nine pupae were collected comprising of three genera of which n= 828(63.3%), n= 185(14.1%), n=295(22.6%) were *Anopheles, Aedes and Culex* mosquito species, respectively. Habitat type H1 (open ground pool) had the highest number of habitats containing larvae n=15 (36.6%) while Anopheles had the highest number of species present of all the larvae sampled. Breeding pattern in the different habitats varied, some bred alone while some bred in sympathry with other species. Those that bred alone in H1 were over 50% of all the larvae that were collected in H1 habitat type. Habitat type H3 had the highest number of species that bred in sympathry. Habitats that did not contain any larvae made up (38.8%) of all the habitats examined. From the results of this study there is great need for concerted efforts in the destruction of the different mosquito larval habitats as this will greatly control their breeding in Michael Okpara University of Agriculture, Umudike, as failure to do this leaves Umudike at risk of high malaria burden, considering the fact that *Anopeheles* was the most Abundant genus.

Keywords: Abia state, habitat preference, mosquito larvae, Nigeria, Umudike

1. Introduction
Mosquitoes are found almost in every part of the world and they make use of different water bodies for their breeding (Adeleke *et al.*, 2008) [1]. A vast majority of species make use of both artificial and natural containers like holes of trees, shells of coconut, leaf axils, septic tanks, bamboo stumps, pools, gutters, septic tanks e.t.c. for breeding (Aigbodion & Anyiwe, 2005) [4].
Mosquito distribution is influenced both directly and indirectly by some climate as well as environmental related factors (Adeleke *et al.*, 2008) [1]. Mosquitoes show preference for environments with certain resources such as food, shelter, breeding sites, favourable temperature and suitable humidity in amounts sufficient for their survival (Adeleke *et al.*, 2008) [1].
Mosquito-borne diseases are increasingly becoming a very serious challenge globally, with majority of its burden in developing and underdeveloped countries of the world. Climate change have greatly contributed to the increase in incidences of mosquito-borne diseases even in regions where they were previously not in existence (Campbell *et al.*, 2015; Medeiros-Sousa *et al.*, 2015) [6, 13].
Malaria is an important mosquito-borne disease in Nigeria. In 2019, Nigeria accounted for 25% of the global malaria burden (WHO, 2019) [18] of which Abia State contributes some measurable share.

The state has also witnessed incidences of other mosquito-borne diseases like yellow fever (WHO, 2017) [17].
Studies to identify local mosquito species have been carried out in several parts of Nigeria including Ibadan, Lagos, Zaria and Benin (Mafiana, 1989; Anyanwu *et al*., 1999; Aigbodion and Odiachi, 2003) [10, 5, 3], but there is very scanty information on mosquito larvae habitat characterisation in Abia State, South Eastern region of Nigeria. This necessitates the need for this study, considering that larval source management has gained a wide attention as it is thought to be the most useful target. It deals with a developmental stage that cannot move outside the targeted site. Hence, thought to be useful if well planned.
The aim of this current study was to assess mosquito larval species and characterise larval habitats in Michael Okpara University of Agriculture Umudike, Abia State Nigeria.

2. Materials and methods

2.1 Study Area

The study was carried out in Michael Okpara University of Agriculture Umudike which is located in Ikwuano L.G.A. of Abia State, South-Eastern Nigeria. Michael Okpara University of Agriculture Umudike is one of the three specialized Universities of Agriculture established by the Federal Government of Nigeria in 1992. The university is located in the well-known agricultural training and research community of Umudike. Ikwuano, is located in the tropical rain forest zone of Nigeria on Latitude 05°26'-5°29'N and Longitude 07°34'-7°36'E. It has a mean annual rainfall of 2238 mm, minimum and maximum temperatures of 23 and 32°C, respectively, with a relative humidity range of 63-80% (NRCRI, 2003) [14].

2.2 Larval Sampling

Larval sampling in the study area was done randomly and every identified open water body in the study area was considered a potential breeding site. The positive sites included those having at least one larva in the habitat. Materials used for mosquito larvae sampling included plastic bowls, labelled containers, sieve (fine mesh-net), dropping pipette.

2.3 Classification of Breeding Sites

Breeding habitats that were found in the sampling locations were categorized into one of the following based on: Size, Nature of substance (plastic, rubber, metal, concrete and soil) and Habitat origin (natural or artificial). These included;

i. Open ground pool (pools of water on the ground)
ii. Containers (Milo tin, interlock mould, tomato tins, take away packs, buckets)
iii. Gutters (pools of water in gutter)
iv. Tyre (pools of water in disposed tyre)
v. Tyre tracks (pools of water in tracks created by tyre of moving vehicles)
vi. Marshy pool (ground pools of water with grasses)
vii. v. Swamps (Naturally occurring swamps)

2.4. Sampling Procedure

Sampling was done by using a hand fine mesh net. This was used to collect as much larvae as possible at every sampling site. Scooping of larvae was done in places likely to harbour mosquito larvae such as around tufts of submerged vegetation or substrate, edges of water bodies and around floating debris. While dropping pipette was used to collect in areas inaccessible to the hand nets and scooping bowls. Mosquito larvae collected were concentrated in a sieve and introduced into a labelled container according to the habitat from which it was collected. Predacious larvae were noted and removed, the breeding pattern of the habitats were also noted. The collected larvae were taken to the laboratory and was introduced into a bowl containing some water were the larvae were identified and sorted out according to species and breeding pattern as labelled in the containing vessel. The larvae were then counted using a dropping pipette, and properly identified morphologically according to the morphological keys of Gillies and Coetzee (1987) [8].

2.5 Statistical Analysis

Simple percentages were calculated to show the abundance of the various mosquito species in the different habitats.

3. Results and Discussion

The mosquito larval habitats and mosquito abundance in the study area are presented in Table 1 below.

Table 1: Mosquito Breeding Habitats and larval Abundance in Michael Okpara University of Agriculture

	Habitat Types					
	H1 Open Ground Pool	**H2 Containers/Tyres**	**H3 Tyre Tracks**	**H4 Gutters**	**H5 Swarmpy Pool/Marshy Pool**	**Total**
Total Number of Sites Examined	21	16	18	8	4	67
Number of Sites With Larvae	15	11	10	5	0	41
Number of Larvae	609	247	288	164	0	1308
Number of Pupa Present	61	46	39	23	0	169

Results in Table 1 above shows that a total of sixty seven (67) potential breeding sites were identified in the study area and only forty one (41) were positive. These positive sites had in them one thousand three hundred and eight (1308) larvae and one hundred and sixty nine (169) pupae. This selectivity of mosquitoes for specific water receptacle spots for breeding within a particular locality supports the assertion that mosquitoes prefer habitats with certain resources like food, shelter, suitable relative humidity and temperature (Agwu, 2005) [2].
Table 2 below shows the larval productivity and the mean larval densities of different habitats

Table 2: Mean Larval Densities in the Different Habitat Types

Habitat Type	Number of sites Containing Larvae	No of Larvae Collected	Average (Larvae/Habitat)
H1	15(36.6%)	609(46.6%)	40.6
H2	11(26.8%)	247(18.9%)	22.6
H3	10(24.4%)	288(22.0%)	28.8
H4	5(12.2%)	164(12.5%)	32.8
H5	0(0%)	0(0%)	0
Total	41	1308	31.9

Open ground pool (Habitat Type H1) was the most productive habitat with a total number of fifteen (15) and 36.6% of all the habitats containing larvae, and also contained (46.6%) of all larvae collected. This shows that this University environment is made up a large number of manmade open ground pools serving as water receptacles that favour mosquito breeding. Mosquito love for ground pools noted in this study is in tandem with reports from Adeleke *et al.* (2008) [1]. This was followed by Type H3 habitat (tyre tracks) with ten (10) habitats containing larvae which is (24.4%) of all the positive habitats. This goes a long way to show that most of the un-tarred floors within the University environment have now turned to breeding receptacles for mosquito larvae. Tyre tracks habitat (H3) also contained (22.0%) of all the larvae samples, which could have been averted if the roads where well built. Gutters (habitat type H4) was the least productive habitat with 12.5% larval collection. This is in variance with reports of Adeleke *et al.* (2008) [1], and goes to prove that most of the gutters within the University are to some extent clean and free flowing, hence not providing much suitable habitats for mosquito larval breeding. Swamps (habitat type H5) had no larva and also had the least number of habitats. The null occurrence of larvae in swamps (H5) could be attributed to the fact that the swamps were many kilometres away from human dwellings within the University. The overall mean larval density was (31.9) larvae per unit of habitat. The most productive habitat, Type H1 had (40.6) larvae/habitat while the least productive habitat, Type H4 had (32.8) larvae/habitat.

Table 3 below shows the distribution of various mosquito species in different habitats.

Table 3: Distribution of Mosquito larval Species in Different habitats in the study area

Mosquito Species	Sources of Collection					
	H1 Open Ground Pool	H2 Containers/ Tyres	H3 Tyre Tracks	H4 Gutters	H5 Swarmpy Pool/Marshy Pool	Total
An. Gambiae sl.	495(77.8%)	0(0%)	273(98.2%)	60(38.9%)	0(0%)	828(63.3%)
Ae. Aegypti	59(9.3%)	114(47.5%)	5(1.8%)	7(4.5%)	0(0%)	185(14.1%)
C. quinquefasciatus	82(12.9%)	126(52.5%)	0(%)	87(56.5%)	0(0%)	295(22.6%)
Sub-total	636(48.6%)	240(18.3%)	278(21.3%)	154(11.8%)	0(0%)	1308

From table 3 above three mosquito genera, Culex, Aedes and Anopheles were encountered in the study. All species of mosquitoes reported in this study have also been reported by different researchers elsewhere in Nigeria (Ezike *et al*, 2001; Aigbodion and Odiachi, 2003; Mbanugo and Okpalaononuju, 2003; Onyido *et al.* 2003) [7, 3, 12, 15]. Amongst the three species *Anopheles gambiae* had the highest number of larvae and this may be owing to the fact that more of these species bred in open ground pool and tyre tracks which are the major breeding sites of mosquito in the area. *An. Gambiae* utilized tyre tracks as well as all the other habitat types for breeding except for containers and tyres (H2) and had a total of (828 larvae) which makes up (63.3%) of all the larval sample. These kinds of habitats utilized by Anopheles mosquito supports the fact that they love to breed in clear water (Robert *et al.* 1998; Mahgoub *et al.* 2017) [16, 11]. This high number of *Anopheles* species may result to a higher rate of malaria transmission in the area, since they are the vectors of the disease.

Ae .aegypti was found in all habitats except in swamps (H5) and made up (14.1%) of all the larvae sampled. This indiscriminate breeding of *Ae.aegypti* is in agreement with that of Adeleke *et al.* (2008) [1]. The high occurrence of this mosquito specie in discarded tyres/containers (H2) goes a long way to support the long history of Aedes larvae interaction with tyres/containers (Adeleke *et al.*2008; Agwu, 2005; Mahgoub *et al.* 2017) [1 2, 11].

C. quinquefasciatus larvae was found in ground pools (H1), tyres/containers (H2), as well as in gutters (H4), but was absent in tyre tracks (habitat type H3) and swamps (H5). *C. quinquefasciatus* presence in gutters (H4) and tyres and containers (H2) which are characterised to be turbid due to the fact that it houses dirty water, demonstrates the love of *C. quinquefasciatus* mosquito for dirty water as have been reported by Mahgoub *et al.* 2017 and Adeleke (2008).

Table 5 below showed two major breeding patterns. Those that breed alone, and those that breed with other species (sympathry).

Table 5: Breeding Pattern of Mosquito Species in the Various Laraval Habitat Types

Breeding pattern	Habitat Types					Total
	H1 Open Ground Pool	H2 Container/ Tyres	H3 Tyre Tracks	H4 Gutters	H5 Swarmpy Pool/Marshy Pool	
Alone	12(57.1%)	1(6.25%)	9(50%)	3(37.5%)	0(0%)	25(37.3%)
Sympathry	3(14.3%)	10(62.5%)	1(5.6%)	2(25%)	0(0%)	16(23.9%)
No Observation	6(28.6%)	5(31.25%)	8(44.4%)	3(37.5%)	4(100%)	26(38.8%)
Sub-Total	21(31.3%)	16(23.9%)	18(26.9%)	8(11.9%)	4(6.0%)	67

Among the positive habitats, (23.9%) bred in sympathry and the highest percentage was observed in the habitat type (H3), indicating that tyres containers allow for more of these mosquito larvae to breed together. This is in tandem with the work of Haruna and Abdulhamid (2019) [9]. (37.3%) all the mosquitoes bred alone and ground pools (habitat type H1) had the highest number of all the habitats that bred alone.

4. Conclusion

This study showed that that over half of the habitats encountered were positive, with *Anopheles gambiae sl.* as the predominant species followed by *C. quinquefasciatus*, while open ground pool was the most favourable habitat for mosquito breeding. This is detrimental to the wellbeing of students and all those living in this area as they would be prone to malaria or even yellow fever disease at the outbreak of such.

It is therefore recommended that areas favouring ground pools and tyre tracks be made unable to serve as water receptacles for mosquito larvae.

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