



## Assessment of breeding dynamics of mosquito vectors in Ugwulangwu, Ebonyi State

Uhwo C A<sup>1\*</sup>, Odikamnor O O<sup>1</sup>, Onwe C S<sup>1</sup>, Okoh F N<sup>2</sup>, Imakwu C A<sup>3</sup>

<sup>1</sup> Department of Biological Sciences, Ebonyi State University, Abakaliki, Ebonyi State, Nigeria

<sup>2</sup> Department of Biological Science, Evangel University Okpoto, Ebonyi State, Nigeria

<sup>3</sup> Department of Parasitology and Entomology, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria

### Abstract

The breeding habitat is crucial for mosquito dynamics, because it is the location where many important life cycle processes take place: oviposition, larval development, emergence and probably resting, swarming, and mating. The assessment of mosquito breeding dynamics in Ugwulangwu Ebonyi State was conducted in 2013 among households using standard entomological surveillance to collect both the larvae and the adult mosquitoes observed at the different breeding habitats. The study revealed that three species of mosquito were collected and identified and data generated were analyzed using Species richness and Shannon wiener's diversity index. The analysis showed that the variation in Species richness and Shannon wiener's index were as follows: (H): 1.147 and (H/ln(S)): 0.447 for aedes, (H): 1.525 and (H/ln(S)): 0.614 for culicine and (H): 0.366 and (H/ln(S)): 0.176 for Anopheles mosquitos respectively. The analysis revealed that there were variations in the population dynamics of each species of mosquito across the larval stages by months where the month of August 331 (33.9%), 475 (45.76%) 394 (38.5%) recorded the highest number for Anopheles, Culicine and Aedes species of mosquito vector respectively. The larval stage 1 and adult stages were significantly higher in density dynamics. Broken gallons (25.2%) and earthen pots (21.1%) recorded the highest percentage abundance among all the stages collected. The changes observed in percentage abundance in breeding pattern were ecological based and influence on the environmental component observed in the different habitats. Therefore, this study will add to the database information on the control and reduction of mosquito vector and will help in disease burden reduction.

**Keywords:** breeding dynamics, mosquito vectors, Ugwulangwu, Ebonyi state

### Introduction

Mosquitoes are insects of the order Diptera and family Culicidae (Service, 2014) [16]. They are responsible for the spread of a wide range of diseases including malaria, yellow fever, dengue, West Nile virus, and Rift Valley fever (Shaan and Canyon, 2009) [15]. The mosquito borne diseases, infecting more than 700 million people around the world each year, result in as many as two million deaths annually (Fradin, 1998) [6]. One of these diseases, Malaria is transmitted between humans by adult female mosquitoes of the genus *Anopheles*. Malaria is endemic in tropical and subtropical regions where it causes over 300 million acute illnesses and at least one million deaths each year (WHO, 2004) [19].

Several strategies have been implemented such as early diagnosis and prompt treatment of malaria patients and asymptomatic parasite carriers, implementation of selective and sustainable vector control measures based on the principles of integrated vector management protocols, forecasting, early detection, prevention of outbreaks, rapid and effective containment of outbreaks, regular reassessment of the country's malaria situation, enhancement of community participation and partnership building for effective and sustainable malaria control, promotion of human resource development and capacity building, and promotion of operational research in order to achieve the stated objectives (Karunaweera *et al.*, 2014) [7]. However, improving the entomological surveillance was considered a major challenge under the malaria elimination

program, especially in the northern and eastern provinces of the country that experienced a terror war that lasted for almost three decades (Shaan and Canyon, 2009) [15].

Mosquitoes exploit almost all types of lentic aquatic habitats for breeding. The breeding habitat is crucial for mosquito dynamics, because it is the location where many important life cycle processes take place: oviposition, larval development, emergence and probably resting, swarming, and mating (Overgaard *et al.*, 2002) [12].

Observations on local anopheline mosquitoes and their breeding habitats were first studied in 1927 (Carter, 1927) [4]. It was maintained that the chief breeding places of *Anopheles* were paddy fields, where larvae were found throughout the year in varying densities. The commonest species present therein were *Anopheles subpictus*, *Anopheles barbirostris*, *Anopheles nigerrimus*, *Anopheles peditaeniatus*, and *Anopheles culicifacies* which were more abundant in running water containing aquatic vegetation. The breeding of *An. Culicifacies* and *An. Subpictus* was extensively found in wells, abandoned paddy fields, pools, and burrow pits (Carter, 1927) [4].

The principal vector of malaria, *An. culicifacies*, and secondary vectors such as *An. subpictus*, are as prevalent in the country as previously (Premaratne *et al.*, 2014) [13]. Furthermore, *An. Culicifacies* has reportedly diversified its breeding habitats from previously clear, unpolluted slow flowing waters to more polluted and still sources of water (Premaratne *et al.*, 2014) [13].

Therefore, mosquito larval habitat ecology is important in

determining larval densities, relative importance of breeding habitats, and species assemblage as well as designing mosquito control programs (Simsek, 2004) [17]. To assess the mosquito breeding dynamics among household in Ugwulangwu area of Ebonyi State.

## Materials and Methods

### Study Area

Ugwulangwu is located geographically in Ohazara Local Government Area of Ebonyi State, South-East Nigeria. The entomological survey was carried out for 4 consecutive months (May to August, 2013) from different households in the District of Ugwulangwu. Factors such as environmental conditions, availability of breeding sites, an established agricultural community, and feasibility of field operations to collect relevant data were considered in selecting study areas.

### Description of the Breeding Habitats

Breeding sites (Earthen Pot Empty Tins Plastic Bottles Broken Bottles Used Tyres Aluminum Pots Broken Gallons) were categorized and classified where water movement was expressed as running, moderate, and stagnant water. All potential breeding habitats were identified through a preliminary survey conducted for a period of one week prior to the research study and certain fixed and temporary breeding places were identified for the larval survey.

### Mosquito Sampling

Collection of immature mosquitoes was made by dipping methods as per World Health Organization (WHO) guidelines. A minimum of 50 dips were taken from each breeding habitat depending on the size of the breeding place using standard dippers (250 mL capacity). Large plastic pipettes and small white enamel pans were used for small and shallow water bodies. The Anopheles larvae were separated from the Culicine larvae and classified as early instar stage (I and II) or late instar stage (III and IV). The pupae were also collected at the laboratory.

### Sample Identification

Collected stages III and IV larvae were placed individually in a depression microscopic slide with a minimum amount of water and identified under a light microscope with an objective ( $\times 10$ ) using standard morphological keys. Stages I and II instar larvae were reared to reach III and IV instar larvae and identified in species level.

Collected pupae were temporary mounted on microscopic slide and viewed at magnification  $\times 100$  under a light microscope (Olympus Optical Co. Ltd., Tokyo). Mounted pupae were identified using a standard key developed for Anopheles pupae. Much emphasis was given to the characters such as pupal trumpet, puddle, and more prominent abdominal seta. Apparently, the mosquito habitats were rain water collected by the unused containers, tins and tyres. From the collection preexistence of the either mosquito adult flies or other insects were checked and considered.

### Anthropogenic activities

Human and other animal activities were seen as it could be predisposing factors and some households were observed cohabiting domestic animals (goat, sheep and cattle) whose ranches were not exclusively separated from human domain.

Because of the period of this studied, most homes had huge grassy vegetation coupled with pear pollens. It was also observed that construction sites have created waves for the mosquito breeding due to huge presence of scattered pools within the households.

The proximal location of stagnant pools behaved by each household to enhance their contact and availability of water may have also influenced their dynamics. As such, flight range is not considered burden for the mosquito species in contact with human host.

## Results

**Table 1:** Monthly variation of Anopheles mosquito sample at Ugwulangwu

Month	L1	L2	L3	Pupa	Adult	Total
May	18	36	210	0	0	264(27.07%)
June	70	26	96	0	0	192(19.6%)
July	96	56	22	0	0	174(17.8%)
August	207	78	42	0	2	331(33.9%)
Total	391	196	370	0	2	975

**Key:** L1, L2, L3 stages of larva

**Table 1:** The monthly variation of anopheles mosquito's larvae population dynamics shows that May and August recorded the highest larvae population, while June and July recorded an intermittent fluctuation in larvae population to be low as seen in the above table. It was observed that their population grows in a geometric process.

**Table 2:** Monthly variation of Culicine mosquito sampled at Ugwulangwu

Month	L1	L2	L3	Pupa	Adult	Total
May	0	0	30	6	18	54(5.20%)
June	22	0	18	0	12	352(33.90%)
July	110	121	116	50	60	457(44.02%)
August	138	119	138	30	50	475(45.76%)
Total	270	240	302	86	140	1038

Table 2: Shows the monthly variation of Culicine mosquito species. The result shows that August recorded the highest of population larvae than others.

The monthly variation of Culicine mosquito shows that L1 has the highest population dynamics of 138 in August and least population dynamics of 0 in May. L2 has the highest population dynamics of 121 in July and least population dynamics of 0 in May and June respectively. L3 has the highest population dynamics of 138 in August and least population dynamics of 18 in June. Pupa has the highest population dynamics of 50 in July and least population dynamics of 0 in June. While adult mosquito showed that highest population dynamics of 60 in July and least population dynamics of 12 in June.

**Table 3:** Monthly variation of Aedes Mosquito at Ugwulangwu

Month	L1	L2	L3	Pupa	Adult	Total
May	11	13	112	10	127	273(26.7%)
June	66	19	18	10	16	79(7.7%)
July	124	111	12	16	12	275(26.9%)
August	132	119	119	14	10	394(38.5%)
Total	283	262	261	50	165	1021

Table 3: Shows that the monthly variation of aedes mosquito larvae shows that August recorded the highest of population dynamics of larvae. While low in pupa and adult.

The monthly variation of *Aedes* mosquito shows that L1 has the highest population dynamics of 132 in August and least population dynamics of 11 in May. L2 has the highest population dynamics of 119 in August and least population dynamics of 13 in May. L3 has the highest population

dynamics of 119 August and least population dynamics of 10 in May and June respectively. Adult mosquito has the highest population dynamics of 127 in May and least population dynamics of 12 in July.

**Table 4:** Population Dynamics of Mosquito Larvae in Respect to Breeding Sites

S/N	Mosquito larvae stage	Earthen Pot	Empty Tins	Plastic Bottles	Broken Bottles	Used Tyres	Aluminum Pots	Broken Gallons
1	L1	217	210	131	10	142	10	221
		34.1	39.4	46.1	7.1	27.8	7.1	29.2
2	L2	121	137	61	10	72	10	140
		19.0	25.7	21.4	7.1	14.1	7.1	28.5
3	L3	114	165	82	10	181	10	256
		17.9	31.0	28.8	7.1	35.5	7.1	33.8
4	Pupa	10	10	10	10	110	10	10
		1.5	1.8	3.5	7.1	21.5	7.1	1.3
5	Adult	100	10	10	100	50	100	100
		15.7	1.8	3.5	71.4	10.0	71.4	13.2
6	Total	635	532	284	140	510	140	756
		21.1	17.7	9.4	4.6	17.0	4.6	25.2

The table 4 above shows that L1 occurred most in aluminum pot with population dynamics of 217, while broken bottles and earthen pots harbors the least of L1 with population dynamics of 10 respectively. L2 occurred most in Broken Gallons with population dynamics of 140, while broken bottles harbors the least of L1 with population dynamics of

10. L3 occurred most in Broke Gallons with population dynamics of 256, while bottles harbors the least of L3 with population dynamics of 10. Pupa occurred most in Used Tyre with population dynamics of 110, while aluminum pot, empty tins, plastic bottles, broken bottles, earthen pts and broken gallons harbor

**Tables 5:** Mosquito Species Population Dynamics for the Period of Sampling

S/N	Mosquito larvae Stage	Anopheles Spices	Culiciline species	Aedes species
1	L1	391(40.6)	270(26.0)	283(27.7)
2	L2	196(20.3)	240(23.1)	262(25.6)
3	L3	370(38.5)	302(29.0)	261(25.5)
4	Pupa	0(0.0)	86(8.2)	165(16.1)
5	Adult	4(0.4)	140(13.4)	50(4.8)

The above table shows that the mosquito species population dynamics for the period of sampling. The result shows that third instar larvae were likely higher and first instar larvae following anopheles mosquito species have the highest fluctuating population dynamics within the period of sampling. *Aedes* mosquito species were higher in adult and pupa stage of mosquito population.

Also, L1 highest population dynamics for the sampling of anopheles species of 391 and has Culiciline species of 270. L2 has highest population dynamics for the period of sampling of aedes species of 262 and has least anopheles' species of 196. L3 highest population dynamics for the period of sampling of anopheles species of 370 and has least aedes species of 261.

**Discussion**

This study was aimed on the mosquito breeding dynamics among household in Ugwulangwu area of Ebonyi State shows that our activities has inversely detrimental implications on us due to our general unawareness of their consequences. The environment and the time of this studies has placed us with a high risk of diseases acquisition. The environment was highly characterized with humid and arid green vegetation and scatters of pool and temporal ponds side by side left in almost each household by construction firm. Ugwulangwu being a semi urban is constructed with urban life style and careless attitude of living all their responsibilities to government. Comparison of the anopheline mosquito population compositions clearly shows

the changes taking place in mosquito breeding dynamics in the Ugwulangwu area. The present study confirms that the high mosquito abundance patterns is due to environmental changes occasioned by urbanization, resettlements, and development projects which has created patched for increased mosquito breeding activities.

The monthly variation of anopheles mosquitoes' larvae population shows that May and August recorded the highest larvae population, while June and July recorded an intermittent fluctuation in larvae population. Also, it was observed that month of May is the beginning of wet season which supports sudden maturity and metamorphosis of certain insect species even to adult stages. Therefore, such changes in weather brings changes in environmental condition which can create favorable condition for breeding. Kusumawathi *et al.*, (2006) [8], collaborates this finding stating that *Anopheles* species were encountered in a variety of breeding habitats and in addition to traditional breeding habitats. He also reported that *Anopheles* species were more in abundant than other mosquito species.

The population dynamics of mosquito larvae in respect to breeding sites revealed that mosquito larvae were not recovered from one breeding site assayed: The Open well. This is because of constant use of water from these two. The results also showed that population of L<sub>3</sub> were predominantly higher than other instar larvae stages and adult stage recovered. It has also shown that broken gallon and earthen pot harbor more mosquito larvae than other breeding sites as the habitat could be seen to contain

optimum ambient temperature that can keep them. The water content in these two sites were purer and has less debris than other habitats.

The broken gallons encountered significant abundance pattern of mosquito stages, followed by earthen pot throughout the study period. Water bodies with similar characteristics found in houses in Ugwulangwu area and other associated activities in these habitats is seen to have supported high presence of mosquito larvae. These two habitats were not frequently used for drinking and bathing purposes during the course of this study and so could maintain long standing condition suitable for breeding. But some studies reported that *Anopheles* breeding were high in wells, which were not used (Adeleke *et al*; 2008) [1], it has been evidenced that behavior of anopheline mosquitoes in selecting broken gallons as the breeding habitats for their oviposition is as result that it can only breed in clean water with high oxygen content.

This is also supported by other researchers who reported that mosquito larvae frequently found in domestic water containing drains may be due to two reasons: firstly, the preferential selection of open habitats for oviposition by anophelines (Oguoma *et al*; 2008) [11] and, secondly, larval predation may be less prevalent in temporary and man-made habitats than it is in large, permanent habitats (Sunahara *et al.*, 2002) [18].

The use of broken gallons for water storage for domestic use but creates artificial sites for breeding places of *Anopheles mosquito not only but* indicates that both of these habitats act as larval reservoirs during dry seasons. Therefore, this creates a serious threat in malaria transmissions because most of these habitats were located at close proximity to human habitations and thus can cause disease burden to people. Hence, breeding habitats such as broken gallon, earthen pots, used tyres, used thin/cans used for water storage does not drain easily or used up frequently and thus can act as important breeding places even in the dry seasons. Some studies have shown that an increasing access to water supply pipes in individual houses, the construction of ponds for fisheries, vegetable farming, road access in villages to vegetable marketing, a frequent movement of vehicles, and micro hydropower electricity gridlines in communities might have created more conducive environments for the passive and active dispersal of mosquitoes (Dhimal *et al.*, 2014) [5]. The irrigation canal system and irrigation practices may influence the breeding of anopheline vectors by creating stagnant water pools within the irrigation system's boundaries, when water is not flowing through the system (Premasiri *et al.*, 2005) [14].

The current study observed mosquito species could be factor to play a role in malaria transmission. Therefore, the prevalence of major and potential vectors with diversified breeding habitats implies a vulnerability to malaria in rural area. This, when combined with the increasing reports of malaria incidence in the country will help a measure towards vector reduction and prevent malaria burden.

### Conclusion

Research should be geared towards controlling the breeding habitats of mosquitos on interim especially on anthropogenic and natural breeding habitats in an environmentally friendly manner as this will bring about vector reduction and malaria disease reduction. There is a need for further investigations on other breeding habitat

diversities and ecology of mosquito. Therefore, proper entomological investigations targeting the primordial stage of these disease vectors should be done in other to control the disease burden.

### References

- 1 Adeleke MA, Mafiana CF, Idowu AB, Adekunle MF, Sam-Wobo SO. Mosquito Larval Habitats and Public health Implication in Abeokuta, Ogun State, Nigeria. *Tanzanian Journal of Health Research*,2008;10(2):103-107.
- 2 Amusan AAS, Mafiana CF, Idowu AB, Oke OA. A survey of adult mosquitoes in the hostels of the University of Agriculture, Abeokuta, Ogun state Nigeria. *Nigerian Journal of Parasitology*,2003;24:167-172.
- 3 Bentley MD, Day JF. "Chemical ecology and behavioral aspects of mosquito oviposition," *Annual Review of Entomology*,1989;34:401-421.
- 4 Carter HF. "Report on malaria and anopheline mosquitoes in Ceylon," in *Ceylon Sessional Papers*, Government Press,1927:148:6-65.
- 5 Dhimal B, Ahrens M, Kuch U. "Species composition, seasonal occurrence, habitat preference and altitudinal distribution of malaria and other disease vectors in eastern Nepal," *Parasites & Vectors*,2014;7:540.
- 6 Fradin MS. "Mosquitoes and mosquito repellents: a clinician's guide," *Annals of Internal Medicine*,1998;128(11):931-940.
- 7 Karunaweera ND, Galappaththy GN, Wirth DF. "On the road to eliminate malaria in Sri Lanka: lessons from history, challenges, gaps in knowledge and research needs," *Malaria Journal*,2014;13(1)59.
- 8 Kusumawathie AR, Wickremasinghe ND, Karunaweera MJSPHD, Wijeyaratne AMGM, Yapabandara. "Anopheline breeding in river bed pools below major dams in Sri Lanka," *ActaTropica*,2006;99(1)30-33.
- 9 Mafiana CF, Anaeme L, Olatunde GO. Breeding sites of larval Mosquitoes in Abeokuta Nigeria. *Nigerian Journal of Entomology*,1998;15:136-143.
- 10 Mbanugo JI, Okpalaononuju CN. Surveillance of Mosquito Vectors in some Habitats of Awka Metropolis, Anambra, Nigeria. *Nigerian Journal of Parasitology*,2003;24:184-190.
- 11 Oguoma VM, Ikpeze OO. Species composition and abundance of mosquitoes of a tropical irrigation ecosystem. *Animal Research International*,2008;5(2):866-871.
- 12 Overgaard HJY, Tsuda W, Suwonkerd A, Takagi M. "Characteristics of *Anopheles minimus* (Diptera: Culicidae) larval habitats in northern Thailand," *Environmental Entomology*,2002;31(1)134-141.
- 13 Premaratne RL, Ortega N, Janakan S, Mendis KN. "Malaria elimination in Sri Lanka: what it would take to reach the goal," *South-East Asian Journal of Public Health*,2014;3(1):85-89.
- 14 Premasiri AR, Wickremasinghe DS, Premasiri DAR, Karunaweera N. "Malarial vectors in an irrigated rice cultivation area in southern Sri Lanka," *Transactions of the Royal Society of Tropical Medicine and Hygiene*,2005;99(2):106-114.
- 15 Shaalan EAS, Canyon DV. "Aquatic insect predators and mosquito control," *Tropical Biomedicine*,2009;26(3)223-261.

- 16 Service MW. Medical Entomology for Students, The Press Syndicate of the University of Cambridge, Cambridge, UK, 3rd edition, 2004.
- 17 Simsek "FM. Seasonal larval and adult population dynamics and breeding habitat diversity of *Culex theileri* Theobald, 1903 (Diptera: Culicidae) in the Glba. district, Ankara, Turkey," Turkish Journal of Zoology, 2004;28:337–344.
- 18 Sunahara K, Ishizaka T, Mogi M. "Habitat size: a factor determining the opportunity for encounters between mosquito larvae and aquatic predators," Journal of Vector Ecology, 2002;27(1):8–20.
- 19 World Health Organization (WHO), the Global Burden of Disease: 2004 Update, World Health Organization (WHO), Geneva, Switzerland, 2004.