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ECOLOGY OF MAN-BITING MOSQUITOES IN IKEGHE OKPATU, ENUGU STATE NIGERIA.

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ABSTRACT

Ecology of man-biting mosquitoes in Ikeghe Okpatu, Udi L.G.A, Enugu State was studied between August and September 2014. The eggs of mosquitoes were collected using ovitraps. Mosquito larvae were sampled from diverse habitats. Pyrethroid knock-down and human bait techniques were used for collection of indoor and outdoor biting and resting adult mosquitoes respectively. One hundred and sixteen (116) mosquitoes comprising five species were collected as larvae. *Culex tigripes* 52 (44.8%) and *Aedes albopictus* 22 (18.9%) formed the bulk of the larval collection. A total of fifty-seven (57) adult mosquitoes comprising four species were collected as outdoor biting mosquitoes. *Aedes albopictus* 39 (68.4%) constituted the highest percentage of outdoor biting mosquitoes. Twenty-two (22) adult mosquitoes comprising two species: *Anopheles gambiae* 20 (91.0%) and *Culex quinquefasciatus* 2 (9.1%) were collected indoors. A total of sixty-five (65) mosquitoes comprising six species were collected using ovitraps: *Aedes albopictus* 39 (60.0%), *Aedes circumluteolus* 7 (10.7%), *Aedes bromeliad* 1 (1.5%), *Aedes aegypti* 5 (7.6%), *Culex quinquefasciatus* 12 (18.4%) and *Eretmapodite chrysogaster* 1 (1.5%) with *Aedes albopictus* being the highest. The population of mosquitoes encountered in this study is of public health concern. Therefore, extensive vector control is very important in reducing the vector population and is therefore recommended.

Key words: Ecology, indoor, outdoor, man-biting mosquito, ovitrap, pyrethrum, Ikeghe Okpatu

INTRODUCTION

Mosquitoes are important vectors of human diseases and the most common blood sucking arthropods. They are ubiquitous in distribution and are found in both tropical and temperate regions of the world (Onyido *et al.*, 2010). Nwoke and Nwoke (2006) observed that the habit of littering the environment with discarded containers

among urban dwellers provide good breeding sites for mosquitoes.

Mosquitoes breed in both permanent and man-made water collections. Permanent water collections include fresh water swamps, edges of rivers, rice fields, slow flowing streams, marshes and irrigation dishes, tree holes, plant axils and rock pool and so on. Man-made water breeding sites include water collections in vehicle tyres, tin cans, man and animal foot prints, coconuts shells, plastic container, bamboo stumps, scoops in concrete slabs used in feeding animals, water holding cisterns and tanks and cassava fermentation pots (Onyido *et al.,* 2008; Service, 1980).

Mosquitoes are strong flies with long stylet-shaped proboscis for piercing the skin of their host and sucking blood. They hunt for their hosts both indoor and outdoor (Onyido *et al.,* 2009). They are vicious biters and their bites constitute nuisance, allergic reactions, skin irritations, scratching, restlessness and sleepless nights (Amusan *et al.,* 2003; Onyido *et al.,* 2009). Some bite during the day while others bite during the night or at both night and day periods. Through their blood sucking habits, they act as vectors of a variety of human pathogens including viruses, bacteria, protozoa and helminthes diseases. They are capable of transmitting diseases such as malaria, yellow fever, dengue fever, encephalitis and hemorrhagic fever (Onyido *et al.,* 2010; Gillet, 1972). The death toll that occurs as a result of diseases spread by mosquitoes is enormous.

Currently about 584,000 deaths occur every year as a result of malaria disease which is transmitted by the infected female *Anopheles* mosquitoes; 90% of all malaria deaths occur in Africa and the vast majority are children (WHO, 2014). Yellow fever which is transmitted by *Aedes aegypti* causes about 200,000 infections and 30,000 deaths every year (WHO, 2013) with nearly 90% of these occurring in Africa. Nearly a billion people live in an area of the world where the disease is common (WHO, 2013). Mosquitoes also transmit animal diseases like the fowl pox of poultry, myxomatosis of rabbit, rift-valley fever of sheep, encephalitis of horses and birds and heart worm diseases of dogs (Service, 1980; Soulsby, 1982). The man-biting mosquito species which bite man and animals indiscriminately also play a part in transmitting certain diseases which also exist in animal reservoirs to human hosts (Onyido *et al.,* 2011a).

However, the problem of vector control differs from country to country and may not be similar even in different areas of the same country (WHO, 2000). Hence, the need for separate and proper study of the ecology, breeding and biting activities of man-biting mosquitoes in different ecological zones before embarking on useful control measures. Studying the ecology of man-biting mosquito species and their breeding sites within Ikeghe Okpatu community will help to determine ways of protecting the people from mosquito bites and mosquito borne diseases.

MATERIALS AND METHODS

Study Area

This study was carried out in Ikeghe Okpatu community which is located in Okpatu, Udi Local Government Area (L.G.A.), Enugu State, Nigeria. Udi L. G. A has an area of 897 km² and a population of 234,002 (NPC/FRN, 2006); bounded by the geographical coordinates of $6^0 19^1$N $7^0 26^1$E, 6.317^0N 7.433^0E. Ikeghe Okpatu is made up of six villages namely: Amaegbu, Amagu, Umeleme, Amaukwu, Eziama and Umuchime. It is bounded in the North by

Umulumgbe, south by Awhum, west by Egede and East by Nike. Ikeghe Okpatu is within the tropical rain forest region of Nigeria. The area is characterized by two seasons, wet season from April to October and dry season from November to March, with annual rainfall of about 2000cm, mean annual temperature of 24.8^0C. Majority of the people in Ikeghe Okpatu community are farmers. They have basic amenities like electricity, pipe borne water, schools, hospital; also present are streams like Iyi Egodo, Iyi Ahsua and Iyi Okpoala.

Habitat selection

Habitats for immature mosquito (larval and pupal) sampling such as gutters, ground water pools, discarded tyres, containers, drums and clay pots were selected and sampled using simple random sampling. This was done within the hours of 8.00am and 12.00pm. The houses used for indoor mosquito collection were randomly selected. A total of 20 houses were randomly selected from the entire community (5 houses from each village) for PKC. This was done in the early hours of the day between 6.00am-8.00am. A total of four locations were randomly selected (one location was selected from each village) and used for outdoor adult mosquito collection using human bait. The outdoor adult mosquitoes were collected between 4.30pm-8.00pm local time.

Advocacy Visits

An introduction letter was obtained from the Head, Department of Parasitology and Entomology, Nnamdi Azikiwe University Awka. The letter was taken to the Igwe of Ikeghe Okpatu to seek for and obtain his permission to work in his jurisdiction. Thereafter, courtesy visits were made to the heads of the villages. House to house sensitization was done on the importance of the study as well as to obtain the consent for the use of their houses and surroundings for survey.

Collection of mosquito eggs using ovitraps

The mosquito eggs were collected and identified as described by Service (1980) and Gillet (1972). Cups half filled with water were lined inside with white cloth ribbons such that the lower edges of the ribbons were in contact with the water inside the cups. The ribbons were placed such that they form a complete ring within the cup. They were moistened and made to adhere to body of the cups. This was to ensure that all eggs deposited by the mosquitoes would stick on the ribbon rather than the body of the cups. During the survey, the cups were placed at various points such as under tree shades, banana plantation, nearby bush and coco-yam plants. Ten cups were set per location and collected after 48 hours. At collection, the ribbons were carefully removed from the containers, air-dried at room temperature and examined for mosquito eggs. The eggs on the positive ribbons were counted using dissecting microscope and were later soaked to hatch. Larvae were reared to emerge as adult for species identification.

Collection of immature stages of mosquito

The larval and pupal stages of mosquitoes were sampled using the technique described by Forattin *et al.* (1993) and Silver (2008). Tee holes, plant axils, tyres, drums and clay pots were sampled. Breeding sites seen were counted and differentiated into types of container; those containing water and those without water and those that are positive with mosquito larva. These larvae were collected with ladles and pipette placed in bowel and sieved to remove debris. The larvae were transferred into specimen bottles and labeled properly according to their breeding sites. The specimen bottles were covered slightly

to prevent asphyxiation. The larvae were fed with ground biscuits until the pupae emerged. The pupae were separated and placed in another container (with water) inside the mosquito cage for the adult to emerge.

Collection of indoor adult mosquitoes using Pyrethrum Knock-Down Method

Indoor biting and resting adult mosquitoes were collected using PKC as described by Gillet (1972). This was done in the early hours of the day between 6.00am and 8.00am from rooms slept by at least one person the previous night. One room was sampled in each house. Large white cloth sheet was spread wall to wall on the floor of the room to making sure the surface of the room was covered. The occupants were asked to stay outside. Doors and windows were shut, moveable furniture and items were taken out of the room. A pyrethroid-based insecticide aerosol (Raid), was sprayed in the room. After 20 minutes, the spreadsheets were folded carefully taken outside the room and knocked down mosquitoes picked up with a pair of forceps into a damp Petri dish.

Collection of outdoor adult mosquitoes using Human Bait Collection (HBC) method

This was done between 4.30pm and 8.00pm to attract the adult mosquitoes using the method described by Gillet (1972). Two human volunteers had the sleeves of their shirts and pairs of trousers rolled to their elbows and knees respectively to expose the hands and legs to mosquito bites. Shoes and sandals were also removed. They baits sat on the low stools at a little distance away from each other and searched for mosquitoes all over their bodies (with torchlight) especially their lower extremities. Mosquitoes alighting on their bodies to suck blood were collected into a test tube vial and covered with a ball of cotton wool. At the end of the collection, the mosquitoes were sorted into quarter-hourly collections and placed in separate cellophane bags. All collections were taken to the laboratory for identification.

Mosquito identification

All the mosquitoes collected were identified at the National Arbovirus and Vector Research Centre Laboratory, Enugu.

DATA ANALYSIS

The data obtained in the study were analyzed statistically using chi-square (χ^2) test.

RESULTS

The total of 65 mosquito eggs were collected, of which 39 (60.0%) were *Aedes albopictus*, 7 (10.7%) were *Aedes circumluteolus*, 1 (1.5%) were *Aedes bromeliad*, 5 (7.6%) were *Aedes aegypti*, 12 (18.4%) were *Culex quinquefasciatus* and 1 (1.5l%) were *Eretmapodite schrysogaster* (Table 1). The highest number of eggs 28 (43.0%) were collected from Umuchime village and the least from 5 (7.6%) in Umeleme village. Distribution of mosquito eggs in different villages of Ikeghe Okpatu was statistically significant ($P<0.05$).

A total of 116 mosquitoes comprising five species were collected as larvae from four different breeding places (Table 2). *Culex tigripes* 52 (44.8%) was the most abundant while *A. aegypti* 10 (8.6%) was the least. The highest number of mosquito larvae 68 (58.6%) was collected from gutters, while the least 12 (10.3%) was from ground pools. The highest larvae collected from discarded and used tyres were *A. albopictus* 10 (76.9%). *A. albopictus* 10 (43.5%) were mostly collected from plastic containers, drums, clay pots and discarded cans. *C. tigripes* 52 (76.5%) was recorded most from gutter collection while

Anopheles gambiae 12 (100.0%) was the only species collected from the ground pools (Table 2). The distribution of mosquito larvae in different breeding places was significant ($p<0.05$).

A total of 22 indoor biting and resting adult mosquitoes comprising two species were collected. *A. gambiae* 20 (91.0%) was the most abundant while *C. quinquefasciatus* 2 (9.1%) was the least and was collected only from Umuchime village. The highest number 9 (40.9%) of indoor biting adult mosquitoes was from Amaegbu village while the least 2 (9.1%) was from Umuchime village (Table 3). The distribution of indoor biting and resting adult mosquitoes in different villages of the community was statistically significant ($P<0.05$).

A total of 57 outdoor biting adult mosquitoes made up of 4 species were collected (Table 4). *Ae.albopictus* 39 (68.4%) was the highest while *A. aegypti* 4 (7.0%) was the least. For every 1.28 number of mosquitoes biting man per hour in the village *A. albopictus* (1 mosquitoes/man/hour) was the commonest biting mosquito outdoors. The highest number of mosquitoes was encountered between the hours of 4.45pm to 5.00pm and between 6.00pm to 6.15pm (Figure 1).

Table 1: Mosquito eggs collected using ovitrap in Ikeghe Okpatu, Enugu State.

	Mosquito species identified						
Villages	***Aedes albopictus***	***Aedes circumluteolus***	***Aedes bromelia***	***Aedes aegypti***	***Culex quinquefasciatus***	***Eretmapodite chrysogaster***	**Total**
Amagu	12(30.76)	3(42.8%)	0	2(40.0%)	0	0	17(26.1%)
Amaegbu	4 (10.2%)	3 (42.8%)	0	3(60.0%)	4(33.3%)	1(100.0%)	15(23.0%)
Umeleme	4(10.2%)	1(14.2%)	0	0	0	0	5(7.6%)
Umuchime	19(48.7%)	0(0.0%)	1(100.0%)	0	8(66.6%)	0	28(43.0%)
Total	39(60.0%)	7(10.7%)	1(1.5%)	5(7.6%)	12(18.4%)	1(1.5%)	**65**

χ^2 Cal value = 26.4>χ^2 table = 25.0 df = 15

Table 2: Mosquito species collected as larvae from the different breeding sites in Ikeghe Okpatu, Enugu State.

	Mosquito species identified					
Breeding sites	***Aedes albopictus***	***Aedes aegypti***	***Culex quinquefasciatus***	***Culex tigripes***	***Anopheles gambiae***	**Total**
Discarded or used tyres	10(76.9%)	3(23.0%)	0	0	0	13 (11.2%)
Plastic containers drums, clay pots discarded cans	10 (43.5%)	7(30.4%)	6(26.1%)	0	0	23(19.8%)
Gutters	2(2.9%)	0	14(20.6%)	52(76.5%)	0	68(58.6%)
Ground pools	0	0	0	0	12(100.0%)	12(10.3%)
Total	22(18.9%)	10(8.6%)	20(17.2%)	52(44.8%)	12(10.3%)	**116**

χ^2cal = 244.2> χ^2 table = 26.03 df = 12

Table 3: Indoor-biting ad resting adult mosquito collected from different villages of Ikeghe Okpatu using PKC

Villages	Number of houses sprayed	Mosquito species: *Anopheles Gambiae*	*Culex quinquefasciatus*	Total number of mosquito per village
Amagu	5	6 (100.0%)	0	6 (27.3%)
Amaegbu	5	9 (100.0%)	0	9 (40.9%)
Umeleme	5	5 (100.0%)	0	5 (22.7%)
Umuchime	5	02(100.0%)		2 (9.1%)
Total	20	20 (91.0%)	2 (9.1%)	22

χ^2cal = 19.9 > χ^2 table = 7.82 df = 3

Table 4: Adult mosquitoes collected through human bait method at IkegheOkpatu

Mosquito species	**Number of mosquitoes collected**	**Biting rate**
Aedes albopictus	39 (68.4%)	0.9
Aedes aegypti	4 (7.0%)	0.08
Aedes africanus	5 (8.8%)	0.1
Eretmapodite chrysogaster	9 (15.8%)	0.2
Total	57	1.28

Biting Rate = $\frac{\text{Number of mosquitoes}}{\text{Number of bait x time}}$

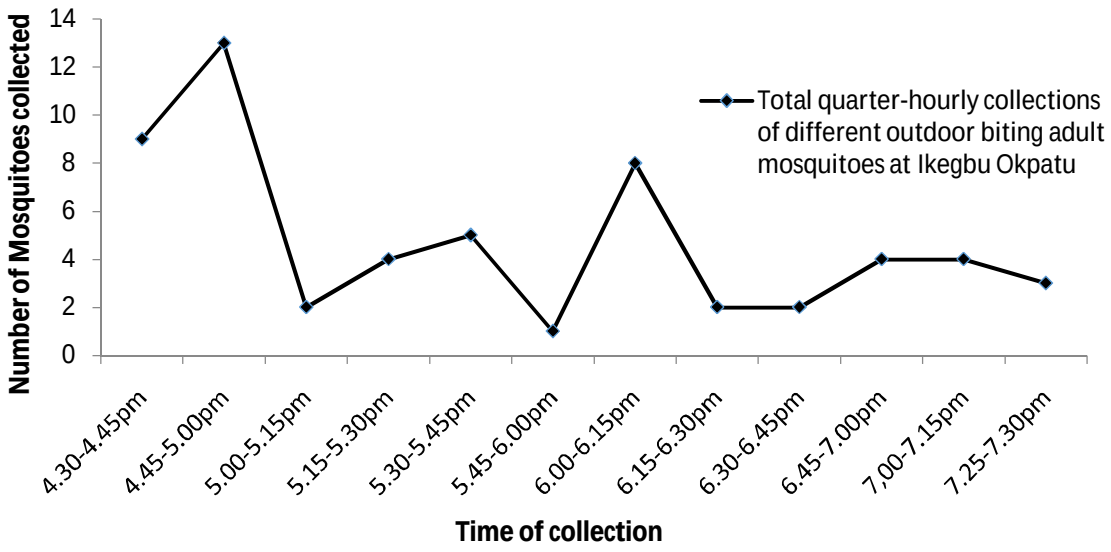

Figure 1: Total quarter-hourly collections of different outdoor biting adult mosquitoes at Ikegbu Okpatu

DISCUSSION

The ecology of man-biting mosquitoes in Ikeghe Okpatu community showed various species of mosquito in relation to their breeding sites. One hundred and sixteen (116) mosquitoes which were collected as larvae from discarded used tyres, domestic containers, clay pots, drums, water in gutters and clean water on the ground around the villages was an indication of intensive breeding of mosquitoes in the community. The findings agreed with the observation of Mbanugo and Okpalanonuju (2003) and Onyido *et al.*, (2011a) who noted the abundance of mosquitoes due to prevailing habitats in Awka metropolis and Uli, Anambra State, respectively. The intensive breeding of mosquitoes could be as a result of human activities, which has led to the littering of the environment with all sorts of containers serving as mosquito breeding habitats. These mosquitoes are widely distributed throughout the world and they utilize different water bodies for their breeding (WHO, 1982). Also according to Ridl *et al*. (2008), the tropical all year round humid climate provides ideal breeding conditions for different mosquitoes.

Most of the ovitraps set yielded positive number of eggs. However, the hatching process was gradual especially the *Aedes*. This could be attributed to the fact that the eggs of *Aedes* mosquitoes are known to hatch out in small batches as an adaptive strategy for surviving unfavourable environmental condition (Chandler and Read, 1961).

Five mosquito species which included *Aedes albopictus, Aedes aegypti, Culex quinquefasciatus, Culex tigripes and Anopheles gambiae* were collected from different breeding sites, with *C. tigripes and A. albopictus* predominating in the collection. *A. albopictus* and *A. aegypti* were collected from water in discarded used tyres, plastic containers, drums, clay pots and discarded cans. *C. quinquefasicatus* were collected from plastic containers, drums, clay pot and gutters. *C. quinquefascitus, C. tigripes* and *A. albopictus* were collected from the gutters. *A. gambiae* larvae were collected only from the ground pools. According to Service (1990), the presence of *Anopheles* mosquitoes is of great interest in public health because they are efficient malaria transmitters and can infect many people in a place even at lower densities.

According to Onyido *et al*. (2009), malaria mosquito breeding grounds include fresh water or salt-water, vegetative or non-vegetative, shady or sunlit. Ground pools, small streams, irrigated lands, freshwater marshes, forest pools, and any other place with clean, slow-moving water are all considered prime malaria mosquito breeding grounds for egg-laying. This may be the reason why ground pools yielded only *A. gambiae*.

Anopheles is generally anthropophilic mainly endophilic and endophagic mosquitoes (Gordon and Lavonpierre, 1976), hence the collection was more indoors. *A. gambiae* being the only mosquito collected from ground pool agrees with the report of Onyido *et al*. (2011b), who recorded the highest collection of *A. gambiae* larvae in ground pools in Umudioka community, Anambra State. Aniedu (1992) reported that *A. gambiae* breeds in undisturbed pool resulted from overflow of rivers, also in fresh swamps and water pools in the nearby farmlands close to human dwelling. *Culex* and *Anopheles* mosquitoes are night biters and usually enter houses to bite their victims when asleep. Gordon and Lavoipierre (1976) observed that the more important vectors of mosquito-borne disease are those which show a close

association with man and prefer man to other animals as source of food.

In human bait collection method, the outdoor biting mosquitoes collected were *A. albopictus, A. aegypti, A. africanus, E. chrysogaster. Aedes* mosquitoes are diurnal and are crepuscular insects (Onyido *et al*., 2008). *Eretmapodite* are day biters, they attack humans but probably prefer other host. *E. chrysogaster* transmits both Rift valley virus and yellow fever virus in East Africa (Gillet, 1972). The present study is of public health concern because the mosquito species collected have been implicated with one type of mosquito-borne disease or the other. Culicine mosquitoes were mainly collected outdoors showing that they are more exophilic and exophagic mosquitoes occurring in different habitat including polluted habitat. Their presence poses danger should there be any introduction of arboviral diseases in the area. So there is need for application of mosquito control measures.

CONCLUSION AND RECOMMENDATION

In conclusion, this study has provided information on mosquito breeding sites especially larval habitats of mosquito and species diversity in Ikeghe Okpatu. Human activities, poor sanitation, indiscriminate disposal of household materials and used tyres and abundant rainfall could have contributed to high mosquito population in the community. Since most mosquito species collected from the study are potential vectors of one mosquito-borne disease or another, control strategies should be used to reduce mosquito-man contact vis-à-vis disease transmission among the people.

The need for health education of the people in control of mosquito is therefore suggested to reduce mosquito-man contact and improve the health of people. People are advised not to expose themselves to mosquito bites especially within the periods of peak of bite like 4.30 to 8.00pm and also to employ personal protective measured to prevent mosquito bite. Finally, continuous surveillance including monitoring for mosquito population to prevent risk of epidemic should be carried out by the government.

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