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Ecological Survey of Man-Biting Mosquitoes in Nnewi Metropolis South-East Nigeria

Onyeka Chukwudalu Ekwebene, Chukwuanugo N. Ogbuagu, Benjamin Uzonna Ononye, Angela E. Orji

ABSTRACT

The survey on the ecology of man-biting mosquitoes in Nnewi was undertaken between April and June 2019. Larval stages of mosquitoes were sampled from gutters, used discarded tyres, plastic containers, water pots, clean ground water pools, plantain and banana plants axils and dirty ground water pools using ladle, sieves and bowels. Indoor biting and resting mosquitoes were collected using pyrethrum knockdown collection method (PKC) while outdoor biting mosquitoes were collected using human being volunteer as baits and collectors. Two hundred and two (202) mosquitoes comprising of four mosquito speciesnamely; Aedesaegypt 36 (17.8%), Culexquinquefasciatus 43 (21.3%), Culextrigripes 16 (7.9%) andAedesalbopictus 107 (53.0%) was the highest larva to be collected. A total of sixty-eight (68) mosquitoes collected as adult made up of two speciesCulexquinquefasciatus 64 (94.1%) and Anopheles gambiae 4 (5.9%) were collected indoors. Culexquinquefasciatus 64 (94.1%) constituted the highest percentage of indoor biting and resting mosquito species. One hundred and fifty-two (152) mosquitoes comprising of four species; Aedesaegypti 51 (33.6%), Aedesalbopictus 96 (63.2%), Aedesleuteocephalus 2 (1.3%) and Culexquinquefasciatus 3 (2.0%) were collected as outdoor biting mosquitoes. Aedesaegyptiwas the commonest outdoor biting mosquitoes in the community. One hundred and forty-three (143) mosquitoes were collected with ovitrap, Aedesalbopictus (41.9%), Eretmapoditeschyrysogaster 2(1.4%) and Aedeaegypti 81 (56,6%) been the highest collected.

Keywords: Mosquitoes, Ecology, Man-biting and Nnewi.

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I. Introduction

Mosquitoes generally belong to the family Culicidae, the insect order known as Diptera (True flies). There are 3 subfamilies of the family Culicidaeviz: Anophelinae, Culicinae and Toxohynchitinae [1]. It is only subfamilies of Anophelinae and Culicinae that contain medically important man-biting mosquito [2], [3].

Mosquitoes are worldwide in distribution, although most species are found in the tropics and subtropics. The warmer climates in the tropical areas allow mosquitoes to be active all year round, with the ideal conditions being hot and humid with moderate rain fall. In hot climates they are able to be more active, and the rainfall gives them aquatic sites for larval and pupal stages of development [4].Mosquitoes breed in a variety of habitats where there is stagnant water bodies including swamps, ground water pools, edges of rivers, slow flowing streams, tree holes, plant axils, crab holes, broken bamboo stems, tin cans, plastic containers of all sorts, coconut shell, foot prints of animal and man, excavation ditches, stone quarry sites, discarded motor vehicle tyres, shaded quiescent water pools and cassava fermentation pots [5]-[8].

Man-biting mosquitoes are capable of transmitting diseases such as malaria, yellow fever, dengue, encephalitis and hemorrhagic fever to man [9]-[12].They also transmit animal diseases like the fowl pox of poultry, myxomatosis of rabbits, rift-valley fever of sheep, encephalitis of horses and birds and heart worm disease of dogs [13], [14]. Man-biting mosquitoes causes great harm, suffering and economic loss because of their blood sucking habits and disease transmission [15]. The number of deaths that occurs due to disease spread by mosquitoes is enormous. Over 1,000,000 deaths have been estimated annually as a result of malaria disease which is transmitted by female anopheles mosquitoes [16]. Moreso, 30,000 deaths occur every year due to yellow fever disease transmitted by *Aedesaegypti* and 600 million people living in endemic areas with 200,000 estimated to be already infected [16]. The mosquito species which bite indiscriminately also play a part in transmitting zoonotic diseases from animal reservoirs to human hosts [17].

Invariably, vector control problems differ from country to country and may also vary even in different areas of the same country [18]. Therefore, there is need for separate and proper study of the breeding and biting activities of man-biting mosquitoes in various ecological zones before embarking on proper control measures. With increasing

human population and urbanization at Nnewi due to industrialization, the main aim of this study is to investigate the ecology of man-biting mosquitoes in the community so as to determine right strategies of protecting the people from mosquito bites and mosquito-borne diseases.

II. Materials And Methods

A. Study Area

Nnewi is a commercial city in Nnewi North Local Government Area, Anambra State, Nigeria. It has geographical co-ordinates of approximately latitude 6°, 1^1 North and longitude 6°, 55^1 East of Greenwich Meridian. It is made up of four villages namely:Otolo, Uruagu, Umudim and Nnewichi in the order of seniority. It is an urban area bounded in the North by Umuoji, West by Ojoto, Oba and Oraifite, East by Nnobi and Awka-Etiti and South by Amichi town, Ozu river, Ukpor and Osumenyi. Nnewi is located East of the River Niger and about 22km from the commercial city of Onitsha in Anambra State [19].

Nnewi is within the tropical rain forest region of Nigeria, though it suffers from soil leaching and erosion which has reduced the soil in some areas to a porous sandy terrain. The vegetation is partly rainforest type and mosaic savanna type as a result of human activities [19].

Nnewi has an estimated population of 391,227 inhabitants according to the Nigeria census. The city spans over 1,076.9 square km in Anambra. Nnewi is both a commercial and industrial area as a result of the development of the local market into an international market where different commodities are sold in both retail and wholesale. Also, the large market has attracted development of different types in the community. Palm oil, Cosmetics, Motor and Motor cycle spare parts, Books, Textile, Electric cables are produced in commercial quantities in the Area. Its main trading centres include NkwoNnewi market (the largest spare parts market in West Africa), Nwafor market, Eke-Amaobi market, Eke-ochie, Eke-ichi market and OrieOtube market [19].

B. Ethical Consideration

An introductory letter was obtained from the Department of Parasitology and Entomology, Nnamdi Azikiwe University, Awka. Permission to work in the jurisdiction was obtained from igwe nnewi.The aim and objective of the research was also explained to him and also advocacy visit was paid to the heads of the four community in nnewi and their permission was also sought. Dwellers whose houses were used during the indoor spray were properly informed and their consent obtained. Volunteer staff used for collection of the outdoor man-biting adult mosquitoes and larval sampling were given adequate training on how best to collect the mosquitoes.

C. Study Design

The surveillance of man-biting mosquitoes was carried out in four communities in Nnewi (Umudim, Nnewichi, Otolo and Uruagu) which involved egg collection, larval and pupal collection and adult collection was done. Mosquito eggs were collected with ovitrap while immature stages (Larvae and pupae) were collected with ladle and sampled according to their breeding sites. Indoor mosquitoes were collected using pyrethrum knock-down collection method while outdoor adult mosquitoes were collected using human bait.

The locations where the ovitraps were set include around homes, cocoyam, banana/plantain and cassava plantations for collection of mosquito eggs was randomly selected. The traps were collected after 48hours from the time it was set at the locations. Random selection type was used in sampling the habitats for larval and pupal sampling such as gutters, ground water pools, discarded tyres, containers, drums, clay pots. This was done within the period of 8:00 am-12:00 pm. Houses where mosquitoes were sampled were selected randomly. 40 houses were selected from the entire community (ten houses from each community) for PKC and this was done in early hours of the day between 6:00 am-7.30 am. Four locations were used for collection of outdoor adult mosquito using human as baits and were done between 4:30 pm-7.30 pm, where one location was selected from each community with a random type.

D. Sampling of The Man-Biting Mosquitoes at Nnewi

Two methods were used to determine possible mosquito breeding sites in the study area, namely: ovitrap setting and larval sampling.

E. Ovitrap Setting

Mosquitoes were collected using ovitrap setting technique as described by WHO and Onyido [9]. It is safe, economical, and environment-friendly [20]. The trap consists of a plastic cup of a litre volume, half-filled with water and lined internally with a strip of white calico cloth measuring 2 cm in width and a length equal to the internal perimeter of the cup [15]. The cloth serves as an oviposition substrate for the mosquitoes.

In the survey, traps were placed strategically at various locations which include under tall trees, banana plantation, close bushes and cocoa yam plantations. Ten traps were kept per location and left for two days (48 hours) before collection. At collection, the strips of white cloth were carefully removed from the containers examined for mosquito eggs and air-dried at room temperature. The eggs on the strips were counted using dissection microscope and hand lens and sent to the laboratory for hatching and rearing to adult stage for easy identification.

F. Larval and Pupal Sampling

The larval and pupal mosquito populations in this study area were obtained using larval and pupal sampling techniques [21], [22].

Collection was done between 10:00 am-12:00 noon. The samples were collected into plastic bowl using ladles then sieved into another plastic bowl to remove debris. With the aid of micropipette, the larvae were picked into specimen bottles and labelled properly. All the collections were taken to theArbo Virus Vector and Research Center laboratory where they were reared to adults and identified.

G. Hatching of the Eggs

All the egg-positive cloth paddles were air-dried for three days and soaked in white enamel basins (measuring 30 cm

in diameter and 12 cm deep) containing water to hatch. Each basin (containing larvae) was protected from contamination with free flying mosquitoes or the escape of emerging mosquitoes with mosquito-net held tightly over the open surface with rubber bands. The clothes were removed after two days, air-dried again for three days before soaking again to ensure that all the eggs hatched out. This was repeated three times for each paddle before being discarded.

H. Rearing of Larvae to Adult

Within three days of soaking the paddles for the hatching of the eggs, tiny wrigglers were seen filling the water. They were first fed with powdered biscuits and later with Quaker oats, lightly sprinkled over the water surface. The larvae reached fourth instar in 5-7 days, and then pupated in 4-5 days with subsequent emergence of adults. The collected larval samples were also reared to the adult stage in 4-6 days before identification.

I. Method of Collection of The Man-Biting Mosquitoes in The Study Area

i. Human Bait Collection Method

Man-biting outdoor adult mosquitoes were collected using human baits [23], [24]. In this method of collection, human volunteers were used as baits. Collection was done between the intervals of 4:30 pm and 7:30 pm for easy attraction of the adult mosquitoes. Torchlight's, cotton wool, test tube vials, wrist watches for keeping time, pens and papers for recording the time of collections, cellophane bags for collection and collation of catches and low stools or benches were the materials that was used. All catches were recorded at quarter-hourly intervals.

On each occasion, the six human volunteers sat in twos at different locations which were about a pole apart. They rolled up the sleeves of their shirts and pair of trousers to their elbows and knees respectively to expose their extremities for mosquito bites. They put off their shoes and sandals, sat on the low stool, each team about a pole away from the other teams. With the aid of torchlight and test tube, mosquitoes alighting to bite them were collected and covered with a ball of cotton wool. The time of collections was recorded and placed in the test tube.

At the end of the collection period, the samples were sorted into quarter-hourly collection and placed in separate cellophane bags and sent to National Arbovirus and Vector Research Centre for identification.

ii. Pyrethrum Knock-Down Method

Indoor biting and resting adult mosquitoes were collected using pyrethriod-based insecticide knock-down method (PKC) [23], [24]. The adult mosquitoes were collected from rooms where at least one person slept the previous night. Collections were made in 16 houses (4 houses/Community). One room was used in each house. Before the spraying exercise, the doors and windows were shut, and white spread sheets were laid from wall to wall covering furniture and other immovable items in the room. Food items and cooking utensils were carried outside to avoid contamination. A pyrethroid-based insecticide aerosol (Raid) was sprayed in the room and allowed to remain for 20 minutes before collection.

At the end of the 20 minutes interval, the spread sheets were folded carefully starting from the edges, taken outside the room and a pair of entomological forceps was used to pick up the knock down mosquitoes into a petri-dish that is damped. The mosquito samples collected were then conveyed to National Arbovirus and Vectors Research Centre, Enugu, for identification.

J. Identification of Species of Man-Biting Mosquitoes Collected During the Study

The mosquitoes were separated into Anopheline and Culicine groups using the length of the palps, antennae, spotted wings and speckled legs. The culicine group was separated into Aedes, Culex, Mansonia, using gross morphological features. Some of which are presence of dark and white silvery patterns on the thorax and abdomen for Aedes, and pale brown coloration without any visible ornamentation for Culex. Individual species were then identified using the keys of Service [6], Gillet [4] and Hopkins [8].

K. Statistical analysis

The biting rate of mosquitoes was computed using the formula below:

$$Bitingrate = \frac{\text{No .of mosquitoes}}{Noofbaits} xtime$$

The result was analysed statistically using Chi-square ($\chi 2$) test. The level of significance was set at $P<0.05$.

III. Results

A. Abundance of Mosquitoes Results Obtained from Ovitrap Setting Technique

The container breeding mosquitoes collected with ovitraps in Nnewi were 143, of which 81 (56.64%) were *Aedes aegypti*, 60 (41.96%) were *Aedes albopictus* and 2 (1.40%) were *Eretmapodites chrysogaster* (Table 1). the mean egg per trap for the various mosquitoes varied from 0.2 eggs/traps for *Eretmapodites chrysogaster* and 8.1 egg/trap for *Aedes aegypti*. Umudim village has the highest number of eggs 95 (66.43%) and the least 4 (2.80%) in Nnewi-ichi village. The egg collection from other village were 34 (23.78%) for Uruagu and 10 (6.99%) fom Otolo village. There was no significance difference in the abudance of mosquitoes among the locations ($P>0.05$).

B. Results Obtained from Larval Sampling Technique

Two hundred and two (202) mosquitoes comprising of four species were collected in larval stage from six different grounds identified in the four communities in Nnewi (Table 2). Of the four mosquito species, Aedes *albopictus* 107 (52.97%) was the most abundant while *Culex tigripes* 16 (7.92%) was the least. Other mosquito species collected were *Aedes aegypti* 36 (17.83%) and *Culex quinquifasciatus* 43 (21.29%). Among the breeding site, clean ground water pools has the highest number of mosquito larva 82

(40.59%), while the least 5 (2.48%) was from plantain and banana plant axils. The larval yield from other breeding grounds were discarded used tyres 38 (18.82%), domestic containers comprising of clay pots, plastic drums and metal tanks 18 (8.91%), dirty ground water pools 25 (12.38%) and gutter 34 (16.38%). Clean ground water pools and discarded used tyres were the major breeding grounds for mosquitoes at Nnewi. There was no significance difference in the number of mosquitoes collected among the different breeding tests.

TABLE 1: MOSQUITO EGGS COLLECTED WITH OVITRAP FROM THE FOUR VILLAGES

Villages	Mosquito species identified			Total
	Aedes aegypti	*Aedes albopictus*	*Eretmapoditeschry-sogaster*	
Umudim	60(74.10%)	35(58.3%)	0(0.00%)	95(66.4%)
Uruagu	15(18.50%)	18(30.0%)	1(50.0%)	34(23.8%)
Otolo	4(4.90%)	5(8.3%)	1(50.0%)	10(6.9%)
Nnewichi	2(2.50%)	2(3.3%)	0(0.00%)	4(2.80%)
Total	81(56.64%)	60(41.96%)	2(1.40%)	143(100%)

$\chi 2 = 11.213$, df = 6, P =0.082.

C. Result Obtained from Human Bait Collection Technique

One hundred and fifty-two (152) outdoor biting adult mosquitoes comprising of 4 specieswere gotten from the four villages in Nnewi (Table 3). *Aedes albopictus* 96 (63.16%) was the common outdoor biting adult mosquito and the least were *Aedesluteocephalus* 2 (1.32%). Other outdoor biting adult mosquitoes collected were *Aedes aegypti* 51 (33.55%) and *Culex quinquefascitus* 3 (1.97%). *Aedes albopictus* (1 mosquitoes/man/hour) was the commonest outdoor biting mosquito for every 1.58 number of biting mosquito in the vicinity per hour.

TABLE 3: ADULT MOSQUITOES COLLECTED THROUGHHUMAN BAIT METHOD AT NNEWI

Mosquito species	No collected	Biting rate
Aedes aegypti	51(33.6%)	0.53
Aedes albopictus	96(63%)	1
Aedes leuteocephalus	2(1.3%)	0.02
Culex quinquefasciatus	3(2.0%)	0.03
Total	**152**	**1.58**

TABLE 2: MOSQUITO SPECIES COLLECTED AS LARVAE FROM THE DIFFERENT BREEDING SITES FROM THE FOUR COMMUNITIES

Breeding sites	Mosquito species				Total
	A.albopictus	*A. aegypti*	*C.quinquefasciatus*	*C. tigripes*	
Discarded used tyres	34(89.5%)	4(10.5%)	0(0.00%)	0(0.00%)	38(18.8%)
Plastic container, clay pots, drums and metal tanks	16(88.9%)	2(11.1%)	0(0.00%)	0(0.00%)	18(8.9%)
Clean ground pools	52(63.4%)	40(36.6%)	0(0.00%)	0(0.00%)	82(40.6%)
Plantain & banana plant axils	5(100.0%)	0(0.00%)	0(0.00%)	0(0.00%)	5(2.5%)
Dirty ground pools	0(0.00%)	0(0.00%)	15(60.0%)	10(40.0%)	25(12.4%)
Gutters	0(0.00%)	0(0.00%)	28(82.4%)	6(17.7%)	34(16.8%)
Total	**107(53.0%)**	**36(17.8%)**	**43(21.3%)**	**16(7.9%)**	**202 (100)**

D. Result Obtained from Pyrethrum-Knock Down Collection

68 adult mosquitoes was collected indoor comprised of 2 mosquito species viz: Culex quinquefasciatus and Anopheles gambiae, were collected from the 16 houses selected from the four villages in Nnewi (Table 4) of these 68 mosquitoes, 64 (94.12%) were *Culex quinquefasciatus* and 4 (5.88%) were *Anopheles gambiae. Culex quinquefasciatus* was the most abundant indoor biting adult mosquitoes in Nnewi while Anopheles gambiae was in very small quantity and was from umudimvillage only. Otolo village has the highest 27 (39.71%) of indoor biting adult mosquitoes while 10 (14.71%) was from umudim village having the least amount of mosquitoes. The collections from other villages were 18 (26.47%) from nnewi-ichi village, 13 (19.12%) from Uruagu village.

TABLE 4: QUARTER-HOURLY COLLECTIONS OF DIFFERENT OUTDOOR BITING ADULT MOSQUITOES AT NNEWI

Mosquito species	*Aedes aegypti* (%)	*Aedes albopictus* (%)	*Aedes leuteocephalus* (%)	*Culex quinquefasciatus* (%)	Total
4:30-4:45pm	4(7.8%)	13(13.5%)	0(0.0%)	0(0.0%)	17(11.18)
4:45-5:00pm	0(0.0%)	2(2.1%)	0(0.0%)	0(0.0%)	2 (1.32)
5:00-5:15pm	2(3.9%)	1(1.0%)	0(0.0%)	0(0.0%)	3(1.97)
5.15-5.30pm	3(5.9%)	0(0.0%)	0(0.0%)	0(0.0%)	3(1.97)
5.30-5:45pm	3(5.9%)	3(3.1%)	0(0.0%)	0(0.0%)	6(3.95)
5.45-6:00pm	4(7.8%)	3(3.1%)	0(0.0%)	0(0.0%)	7(4.61)
6.00-6:15pm	1(2.0%)	8(8.3%)	0(0.0%)	0(0.0%)	9(5.92)
6:15-6:30pm	14(27.5%)	30(31.3%)	0(0.0%)	0(0.0%)	44(28.95)
6:30-6-45pm	12(23.5%)	21(21.9%)	0(0.0%)	0(0.0%)	33(21.71)
6:45-7:00pm	3(5.9%)	2(2.1%)	2(100.0%)	2(66.7%)	9(5.92)
7:00-7:15pm	0(0.0%)	0(0.0%)	0(0.0%)	1(33.3%)	1(0.66)
7:15-7:30pm	5(9.8%)	13(13.5%)	0(0.0%)	0(0.0%)	18(11.84)
Total	**51(33.6%)**	**96(63.2%)**	**2(1.3%)**	**3(2.0%)**	**152(100)**

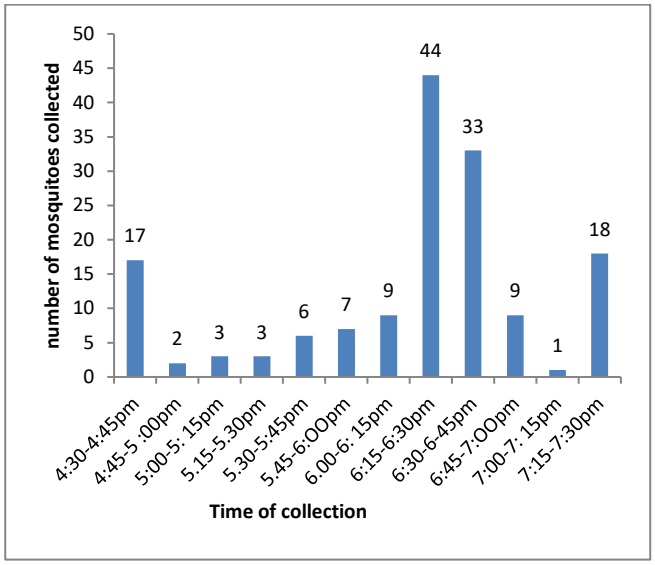

Fig. 1. Quarter-hourly collection of mosquitoes by human bait method.

TABLE 5: INDOOR BITING AND RESTING MOSQUITOES COLLECTED USING PYRETHRUM KNOCK DOWN METHOD FROM THE FOUR COMMUNITIES IN NNEWI

Study village	No of houses sprayed	Mosquito species		Total no of mosquito
		Culexquinque-fasciatus	*Anopheles-gambiae*	
Nnewichi	10			
Otolo	10			
Uruagu	10			
Umudim	10			
Nnewichi (26.47%)	10	18(100.0%)	0	18(26.5%)
Otolo (39.71%)	10	27(100.0%)	0	27(39.7%)
Uruagu (19.12%)	10	13 (100.0%)	0	13(19.1%)
Umudim (14.71%)	10	6 (60.0%)	4(40.0%)	10(14.7%)
Total	**40**	**64 (94.1%)**	**4(5.9%)**	**68(100%)**

IV. DISCUSSION

The surveillance of man-biting mosquitoes at Nnewi, showed variety of mosquito species in respect to their breeding sites. 202 mosquitoes was collected as larvae forms from water in gutter, used discarded tyres, water pots, drums, domestic plastic containers, clean ground water pools and dirty water pools, plantain and banana plant axils around the villages is an indication of intensive breeding of mosquitoes in the area as a result of many breeding sites in the community. The findings corroborates with the observations of Mbanugo and Okpalaononuju [25] who noted that the prepodence of mosquitoes in Awka metropolis was due to prevailing habitats in the area. Four mosquito species which include *Aedes albopictus* 107 (52.97%), *Aedes aegypti* 36 (17.82%), *Culex quinquefasciatus* 43 (21.29%) and *Culex tirigripes* 16 (7.92%) were collected as larvae from different breeding sites, with *Aedes Albopictus* 107 (52.97%) and *Culex quinquefasciatus* 43 (21.29%) predominating in the collections. *Aedes* groups were sampled from water in used dumped tyres, clay pots, plastic container, metal tanks and drums, plantain and banana plant axils, whereas Culex group where collected in dirty and clean ground water pools and gutters. Anopheles larvae were not collected during the collection of immature stages of mosquitoes and this was observed to be as a result of rainfall, since it has been implied that rainfall can affect the larval stages thereby flooding their habitats and invariably flushing out the larval stages [29]. Increased larval mortality have been observed by [26] in an unenclosed habitats in the western kenya highlands and this implied a damaging effects of rain on the larval stages. In similar study by Mbanugo and Okpalaononuju [25] in Awka metropolis, *Aedes albopictus, Culex quinquefasciatus, Aedes aegypti and Culex tigripes are* predominant species occuring in that area.

Only few of the traps set in the four villages were negative, high numbers were positive. However, the hatching process were very poor. Cloth paddles containing the eggs were soaked more that once before complete hatching was achieved. The large number of eggs collected within the period indicated intensive breeding of mosquitoes especially *Aedes aegypti.* More so, the hatching in parts can be linked to the fact that the eggs of Aedes mosquitoes are known to hatch out in small batches as an innate and adaptive strategy for surviving unfavourable condition [27].

Anopheles gambiae and *Culexquinquefasciatus* were the three species of mosquitoes caught indoors with *Culexquinquefasciatus* 64 (94.12%) predominating in the collections. This is so because adults of Culexquinquefasciatus are anthropohilic, endophagic and endophilic. Culex and Anopheles mosquitoes which are usually night biters enter dwellings to bite their prey when asleep. The study of Gordon and Lavoipierre [28] observed that the more important vectors of mosquito-borne diseases are those which show a close relationship with man and prefer man to other animals as source of living.

In human bait collection method, the outdoor-biting mosquitoes collected were *Aedes albopictus* 96 (63.16%), *Aedesluteocephalus* 2 (1.32%), *Aedes aegypti* 51 (33.55%) and *Culex quinquefascitus* 3 (1.97%). Service [6] indicated that adults of *Culex quinquefascitus* are mainly anthropophilc, endophagic and endophilic, with *Culex quinquefascitus* which bites indoors but occassionally bite outdoor, the rest were Aedes mosquitoes which are diurnal and crepuscular insects [9]. Mosquito species observed in this study area are proven vectors of mosquito-borne diseases.

The present study is of public health concern because the mosquito species collected have been implicated in one type of mosquito-borne disease or the other. The people are therefore adviced to protect themselves from mosquito bites and organise control strategies which should be used to reduce mosquito-man contact vis-à-vis disease transmission among the people.

V. CONCLUSION AND RECOMMENDATION

This survey has provided ideas on mosquito breeding sites especially larval habitats of mosquito and the species in Nnewi. Inadequate environmental sanitation and heavy rainfall might have brought about the high mosquito

population in the community. Mosquito species collected from the study area are vectors of one mosquito-borne diseases. The high population of Culex, Aedes and Anopheles species of mosquito in the area is a danger sign of possible epidemic, if any arbo-viral disease agents is introduced.

Health education of the populace is encouraged and suggested to control of mosquitoand to reduce man mosquito contact thereby improving the health of the people. From the result of the study represented in figures, peaks of bites were recorded at periods 6.15-6.30 pm, 7.15-7.30 pm, 4.30-4.45 pm and 6.00-6.15 pm and 6.45-7.00 pm having the same number of mosquitoes. Based on this, the populace are encouraged not to fall prey to mosquito bites within these time frame. As the rate of bites recorded is sufficient enough to cause transmission of arboviral infections should any be introduced. Of utmost importance is the enlightenment of the residents of Nnewi on the environmental factors that contribute to mosquito breeding. The immediate reduction in vector population could be achieved by eliminating all possible breeding sites. The public should also be advised to use personal protective measures to avoid mosquito bites. Finally, the State Ministry of environment should continously prevent epidemic by daily surveillance and monitoring for mosquito population.

VI. Competing Interests

The authors declared that they have no competing interests and no funding for this research work.

VII. Limitations Of The Study

Part of the limitations to this study includes:

- There was no fund for this study because such study should be a prospective study which is capital intensive.

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