# Breeding and Biting activities of Yellow Fever Mosquitoes in two urban Communities with delapidating infrastructures.

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**Abstract**: Breeding and biting activities of yellow fever mosquitoes in Coal Camp and Iva-Valley areas of Enugu metropolis, South Eastern Nigeria, were studied between April and June 2010. The two urban communities have similar features of decaying infrastructure. House inspection was used to detect mosquito breeding containers while human bait method was used to collect man-biting adult mosquitoes. 80 houses (40 in each area) were inspected.52 houses (25 from Coal Camp and27 from Iva-Valley) had containers with water in which *Aedes* larvae were found. 453 containers were examined, 376 (83.0%) had water in them and 71 (18.88%) had *A. aegypti* larvae. The larval indices (Breteaux, House and Container), lie within or higher than the World Health Organization standard range for epidemics to occur. 89 adult mosquitoes comprising 3 genera and 6 species were collected through human bait method. *Aedes albopictus* 50(56.2%) constituted the bulk of the collection while *Culex quinquefasciatus* 1(1.1%) was the least. A plot of quarter-hourly mosquito collection revealed that the landing populations of the two most common biting mosquitoes, *A. albopictus* and *A. aegypti,* had two biting peaks with *A. albopictus* trailing closely to the overall mosquito population peak. These mosquitoes constitute heath risk in terms of biting nuisance and disease transmission. This calls for intervention programmes to avoid disease outbreak

[Onyido, A.E., Ozumba, N A., Ezike, V I., Nwosu, E O., Amadi E.S., Obiukwu, M O.,Chukwuekezie,O C. Umeanaeto P.U. **Breeding and Biting activities of Yellow Fever Mosquitoes in two urban Communities with delapidating infrastructures.** Nature and Science 2011; 9(9): 93-98] (ISSN:1545-0740). http://www.sciencepub.net.

Key words: Yellow fever mosquitoes, urban communities, decaying infrastructure

## 1. Introduction

Yellow fever and other arboviral diseases are primary infections of vertebrates other than man but are transmitted to man through the bites of blood-sucking arthropods especially the mosquitoes and ticks. Some important arboviral infections of man transmitted by mosquitoes include yellow fever (YF), Chikungunya (CHIK), Japanese Encephalitis (JE), Western Equine Encephalitis (WEE), and Eastern Equine Encephalitis (EEE). Among these, yellow fever is endemic in most parts of Africa and it is a major threat in Nigeria (WHO, 1986). In some severe epidemics, thousands of people have been affected with numerous deaths. A yellow fever outbreak in Ethiopia between 1960 and 1962 had an estimated 100,000 cases with about 30,000 deaths. In Gambia, a yellow fever outbreak between 1978 and 1979 had an estimated 8400 cases with about 1600 deaths. A similar figure of 100,000 cases with about 40 % case mortality was recorded in a yellow fever outbreak in Nigeria in 1969. These figures were regarded as underestimates as most of the cases were not reported in the hospitals (WHO, 1986). Between 1985 and the year 2000, yellow fever outbreaks have plagued various parts of Nigeria (Onyido *et al* 2009c) and a chronicle of yellow fever outbreaks from pre-independence Nigeria to 1969 has been produced (Ozumba *et al* 2000). According to Ozumba *et al* (2000), yellow fever outbreak of 1913 occurred in Lagos, Abeokuta, Forcados, Warri, Onitsha and Calabar. Also the results of serological tests between 1928 and 1966 confirmed the endemicity of yellow fever in many parts of southern and central Nigeria.

Yellow fever is transmitted mainly by the mosquitoes belonging to the *Aedes Stegomyia* subgenus. Specifically, *Aedes aegypti, A africanus , A luteuocephalus, A vittatus, A simpsoni, A taylori* and *A albopictus* have been involved in yellow fever transmission in various parts of the African continent and diaspora (Service, 1980, Gillet, 1972). Also most of these aedes mosquitoe species were involved in various yellow fever epidemics in Nigeria (Bang *et al* 1980 & 1981, Savage *et al* 1992). These mosquitoes breed in transient water collections especially in tree holes and artificial containers (Service, 1976, Onyido *et al* 2009 a & b). Although these breeding sites are naturally available in our environments, human activities and the resultant environmental degradation have continued to create more and more favourable

breeding sites around human dwellings. The Coal Camp and Iva-Valley Areas of Enugu metropolis are the residential areas of the Nigerian Coal Corporation Staff. At inception the buildings and their surroundings were very neat but today the environment has been grossly defaced, the buildings restructured and even the streets are filled with potholes. The Coal Camp Area is engulfed by motor spare parts market and mechanic workshops and the Nigerian Coal Corporation seem not interested. This study was aimed at investigating the breeding and biting activities of mosquito vectors of yellow fever in these two urban areas (Coal Camp and Iva-Valley Areas) of Enugu metropolis with a view to understanding the mosquito abundance and the possible dangers posed by their activities in the areas. Specifically, it will identify the yellow fever vector species, their breeding sites, abundance and biting activities.

## 2. Materials and Methods

### Study Area

Enugu is a cosmopolitan and capital city of Enugu State of Nigeria and it is situate between latitudes 6° and 7° North of Equator and longitudes 7° and 8° East of Greenwich Meridian. It is surrounded by the Udi Hills and has an undulating topography. Enugu lies within the rainforest zone of Nigeria and has two marked seasons –the dry and wet seasons. The wet season is between April and November (8 months) while the dry season is between November and March (4 months). The mean annual rainfall varies between 2000mm and 3000mm while the mean monthly temperatures vary from 22°C to 28°C in the wet season and between 28° and 32°C in the dry season. It has a derived savannah vegetation with tall grasses and few trees.

Enugu metropolis has many tertiary institutions which include the Institute of Management and Technology (IMT), Enugu State University of Science and Technology (ESUTECH), University of Nigeria Enugu Campus (UNEC), Biggard Memorial Seminary, Federal School of Dental Technology and Therapy (FSDT&T), Federal School of Statistics, Federal Training School, Our Saviours Institute of Technology and the Nigerian Law School Campus. It also has many secondary and primary schools. In addition to many primary health centres and private clinics, Enugu has some tertiary and specialist hospitals like University of Nigeria Teaching Hospital (UNTH), National Orthopaedic Hospital (NOH), National Neuropsychiatric Hospital and Parklane General Hospital.

Enugu metropolis also serves as the commercial centre of Enugu State and the administrative headquarters of many national and state institutions. It has a zonal branch of the Central Bank of Nigeria, many commercial banks and departmental stores, the famous Ogbete and Aria markets with many lock-up and open stalls. It is the administrative headquarters of the civil service in Enugu State, and the zonal headquaters of Nigerian Telecommunications, Nigerian Postal Services, Power Holding Company of Nigeria (PHCN), Project Development Agency (PRODA), Industrial Training Fund and a Federal Secretariat.

Iva Valley and Coal Camp are two residential areas where the most junior staff of the Nigeria Coal Corporation were first quartered. The buildings are one-bedroom houses completely detached from each other. The buildings at Coal Camp are mostly rectangular mud houses while those in Iva-Valley are made of bricks and cement walls. In the sixties, the buildings as well as their locations were neat. Today the buildings have been extensively reconstructed to provide more rooms for the teeming relations of the occupants. The Nigerian Railway Corporation seems not to be interested any longer in the aesthetics of the quarters. The streets have many potholes; the houses and the environment are pest ridden. Spillage of water from broken water pipes is a common site and electricity supply is epileptic.

**House inspection:** House inspection was conducted in the two urban communities of Enugu, in the months of April and June to establish the breeding activities of yellow fever mosquito vectors in them and to educate the inhabitants on the control measures to reduce the population of mosquitoes thereby reducing the possibility of any arboviral outbreak.

All the water containers in the houses were inspected. Containers with water and *Aedes aegypti* larvae and those with water but without *Aedes aegypti* larvae were recorded separately. Also containers without water but have the potential of holding water were recorded. Twenty houses were inspected in each occasion at each location. The mosquito larvae found in the water containers were collected with long pipettes, transferred into white plastic bowls and finally identified with the aid of hand lens.

### Calculation of larval indices

From the house inspection data, the following larval indices were calculated based on WHO (1986)

a) Breteau index which is the total number of containers with *Aedes aegypti* larvae per hundred houses visited was calculated thus

$$\frac{\text{Number of containers with } A.\ aegypti\ larvae}{\text{Number of houses visited}} \times \frac{100}{1}$$

b) Container index which is the number of containers in which larvae of *A aegypti* were found per hundred containers with water was calculated thus

$$\frac{\text{The number of containers positive with } A \text{ aegypti larvae}}{\text{Number of containers with water}} \times \frac{100}{1}$$

c) House index which is the number of houses containing breeding places for *Aedes aegypti* larvae per hundred houses visited was calculated thus

$$\frac{\text{Number of houses with containers positive for } Aedes \text{ aegypti larvae}}{\text{Number of houses visited}} \times \frac{100}{1}$$

**Collection of Man-biting adult mosquitoes**

The biting activities of the mosquitoes were determined through human bait collections of adult mosquitoes. Three volunteer workers immunized at least 10 days prior to the beginning of collections were used to collect adult mosquitoes. For security and other logistics, collections were carried out at Coal Camp only in three consecutive days. Each collection lasted for 3 hours from 17:00 – 20:00 (5:00 – 8:00pm) local time. On each occasion each volunteer worker sat on a low stool sufficiently comfortable to monitor mosquitoes alighting to bite. With the aid of a torchlight held on one hand and test tube vial on the other, any mosquito alighting to bite was collected by covering it with a test tube while the torchlight was held steadily over the landing spot. With a gentle jerking, the mosquito was caused to fly into the test tube, quickly covered with the thumb, removed from the biting site and covered with a ball of cotton wool. One mosquito was collected per test tube. The time of collection was written on a piece of paper and kept inside the tube. Collections were collated at quarter–hourly intervals into a cellophane bag. At the end of the collections, the mosquitoes were sent to the laboratory of the National Arbovirus and Vector Research Centre at No 33 Park Avenue GRA, Enugu for proper identification.

**3. Results**

Out of the 80 houses visited in the present study (40 from each area), 52 houses (65%) had water containers in which *Aedes* larvae were found. Of the 52 houses with *A. aegypti* larvae, 25 (48.00%) were from Coal Camp area while 27(51.92) were from Iva valley (Table 1). The difference in the number of houses in which *A. aegypti* bred in the two areas was not statistically significant (P>0.05). Also from the 80 houses visited, a total of 453 containers were examined. 77 containers (17.0%) had no water in them, while 376 containers (83.0%) had, of which, 71 containers (18.88%) had *A. aegypti* larvae. Of the 71 containers with *A. aegypti* larvae, 32(45.08%) were from Coal Camp Area while 39(54.92%) were from Iva-Valley. Again the difference in the number of mosquito breeding containers was not statistically significant (P>0.05). The larval indices calculations based on WHO (1986), were Breteau index 65 in April and 95 in June, Container index 52 in April and 13.01 in June and House index 55 in April and 70 in June for Coal Camp. The larval indices for Iva-Valley in both months were Breteau index, 115 in April and 80 in June; House index, 70 in April and 65 in June and Container index, 28.75 in April and 12.8 in June.

The mosquito species collected by human bait method at Coal Camp area were shown in table 2. A total of 89 mosquitoes belonging to three mosquito genera and comprised of six mosquito species were collected. *Aedes albopictus* were 50 (56.2%), and constituted the bulk of the mosquitoes biting in the area while *A. simpsoni* and *Eretmapodites chrysogaster* were the least with one mosquito each (1.1%). Others were *A. aegypti* 25 (28.1%), *A. luteocephalus* 8(9.0%) and *Culex quinquefasciatus* 4 (4.5%). From the calculated biting rates, for every 3.3 mosquitoes biting man per hour in the area, 1.9 mosquitoes per man per hour were *A. albopictus*, 0.9 mosquitoes were *A. aegypti* while 0.4 mosquitoes could be any of the rest.

Figure 1 shows the graph of quarter-hourly mosquito collections at Coal Camp. The landing populations of the two most common biting mosquitoes (*A. albopictus* and *A. aegypti)* were plotted with the total quarter-hourly collections of all the mosquitoes. Both mosquitoes were found to have bitten the collectors throughout the periods of collection but *A. albopictus* graph trailed more closely to the overall mosquito population peak than that of *A aegypti*. Also most of the mosquitoes bit between 17.30 and 18.45 hours (5.30pm and 6.45pm) with a major biting peak between 18.00 and 18.15 hours (6.00-6.15pm) local time.

Table 1:Vector breeding indices at Coal Camp and IvaValley Areas of Enugu metropolis, Southeastern Nigeria.

| Location | Month | No of houses inspected | Total No of container examined | No of containers without water | No of containers with water | No of containers with *Aedes* larvae | No of houses with *Aedes* | Breteau index | Container index | House index |
|---|---|---|---|---|---|---|---|---|---|---|
| Coal camp | April | 20 | 32 | 7 | 25 | 13 | 11 | 65 | 52 | 55 |
| | June | 20 | 188 | 42 | 146 | 19 | 14 | 95 | 13.01 | 70 |
| Iva Valley | April | 20 | 100 | 20 | 80 | 23 | 14 | 115 | 28.75 | 70 |
| | June | 20 | 133 | 8 | 125 | 16 | 13 | 80 | 12.8 | 65 |
| Total | 2 Months | 80 | 453 | 77(17.00) | 376(83%) | 71(15.67%) | 52(65%) | | | |

Note: The ranges of larval indices associated with yellow fever outbreak are

a) House index = 4 – 35 or above
b) Container index = 3 – 20 or above
c) Breteau index = 5 – 50 or above

(WHO, 1986)

Table 2: Mosquito species collected by human bait method at Coal Camp

| Mosquito species | Number collected | Percentage | Biting Rate |
|---|---|---|---|
| *Aedes aegypti* | 25 | 28.1 | 0.9 |
| *Aedes albopictus* | 50 | 56.2 | 1.9 |
| *Aedes luteocephalus* | 8 | 9.0 | 0.3 |
| *Aedes simpsoni* | 1 | 1.1 | 0.04 |
| *Eretmapodites chrysogaster* | 1 | 1.1 | 0.04 |
| *Culex quinquefasciatus* | 4 | 4.5 | 0.1 |
| Total | 89 | 100 | 3.3 |

**4. Discussion**

From the house inspection results, 52(65%) of the 80 houses visited in the two areas of study, had containers with water in which *A. aegypti* larvae were collected. This is an indicative that a large proportion of the houses in the two areas of study had transient water collections that encouraged the breeding of aedes mosquitoes. This observation corroborates with the existing knowledge that the larvae of aedes group of mosquitoes are found typically in transient water collections such as water in treeholes, plant axils, rock pools and artificial containers like tin can litters, earthen wares and broken household utensils (Service 1976 & 1980, Gordon and Lavoipierre 1976 Onyido *et al* 2006 a & b, Onyido *et al* 2009 a, b & d).

Of the 453 water - holding containers examined, 376 (83.0%) had water in them, of which, 71(18.9%) had aedes larvae. Although some of these containers were litters, most of them were purposeful water storage containers owned by different households. The result portends poor or inadequate water supply to the areas from the public water works, and the people have resorted to storage of water for their domestic chores. The preponderance of water storage containers in a community in addition to litter containers encourage vectors and mosquito breeding in an area. This observation is in keeping with the findings of Nwoke and Nwoke (2006) who observed that indiscriminate littering of our environment with tin cans and other water – holding containers encourage mosquito breeding and dissemination of mosquito – borne diseases.

According to the World Health Organisation (WHO, 1986) 'the larval indices associated with yellow fever outbreaks include a) House index of 4 – 35 houses or above, b) Container index of 3 – 20 containers or above, c) Breteaux index of 5 – 50 containers with *A. aegypti* larvae or above'. These indices, as calculated from the present studies, either lie within the range or are higher than the WHO observed standard indices. The result shows that all the conditions favourable for arboviral disease outbreak, especially yellow fever, abound in the areas studied.

The mosquito species collected from the area through human bait catches are not only indicative of the preponderance of disease – transmitting mosquitoes but also a pointer to poor environmental conditions overwhelmed with stagnant pools of water and litters. For instance, of the six species of mosquitoes collected in the area, four species were *Aedes* namely *A. aegypti,*

*A. albopictus, A. luteocephalus and A. Simpsoni*. The other two species were *Eretmapodites chrysogaster andCulex quinquefasciatus.* All the four species of *aedes* mosquitoes belong to the subgenus *Stegomyia,* with well – recognized medically important species that transmit many viral and helminthic diseases. *A. aegypti* which is a pre – eminently important vector of yellow fever is a highly domesticated mosquito, breeds in stagnant water around homes, lives in close association and feeds readily on man (Gordon & Lavoipierre 1976, Service 1980, Onyido *et al* 2010a). *A. albopictus* which utilizes both artificial and natural containers, especially vehicle tyres, for oviposition, is an avid biter, highly anthropophilic and efficient vector of a number of viral diseases in African continent including yellow fever, Chikungunya virus, Rift Valley virus and West Nile virus (Tesh *et al* 1976, Shroyer 1986, Mitchel 1991, Savage *et al* 1992, Onyido *et al* 2009c).

*A. luteocephaus and A. simpsoni* are treehole and leaf axil breeders respectively and are proven vectors of yellow fever in rural areas of Africa (Gillet 1972 Service 1980). *Eretmapodites chrysogaster,* a related species to the *aedes* group of mosquitoes, is widely distributed in equatorial region, breeds in fallen leaves, fallen banana bracts and snail shells and transmits yellow fever and Rift Valley viruses (Gillet 1972). *Culex quinquefasciatus*, the commonest nuisance mosquito in most urban and semi – urban parts of Africa, feed on man in great numbers both inside and outside the houses by night, transmits the filarial worm *Wuchereria bancrofti*, the heavy infection of which leads to elephantiasis. It breeds in drains and polluted water collection including cess pits, around homes (Service 1980, Gillet 1972). These mosquitoes therefore constitute health risks in terms of biting nuisance and disease transmission to the inhabitants of the study areas. This calls for immediate intervention programmes to avoid disease outbreak.

A graph of quarter – hourly mosquito collections at the Coal Camp Area shows that the major biting peak period of the mosquitoes is from 5:30 – 6:45 pm (local time). The inhabitants are advised to avoid staying outdoors during the risk hours especially between 5:00 – 7:00 pm to reduce the chances of contracting diseases through mosquito bites. It is also suggested that the inhabitants maintain a clean environment to reduce mosquito breeding as well as man- vector contact in the area.

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8/7/2011