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SEASONAL DISTRIBUTION AND ABUNDANCE OF YELLOW FEVER MOSQUITO VECTOR, *AEDES AEGYPTI, (*DIPTERA: CULICIDAE) IN AGUATA L .G.A, ANAMBRA STATE

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ABSRACT

This paper determined the seasonal distribution and abundance of yellow fever mosquito vector, Aedes aegypti, in Aguata L.G.A, Anambra state. Larvae were collected using ladle and pipette while adults were collected using Pyrethrum Knock-down Collection (PKC) and human bait methods. Mosquitoes collected were identified at the Arbovirus Research Centre, Enugu. A total of 2742 Aedes mosquitoes were recorded including 2012 (73.38%) larvae and 730 (36.28%) adults. Aedes aegypti were most abundant in Ekwulobia town numbering 426 (15.54%) followed by Uga (371; 13.53%), Igboukwu (307; 11.20%), Ezinifite (302; 11.01%), Umuchu (10.83%), Achina (270; 9.45%), Aguluezechukwu (259; 9.45%), Nkpologwu (235; 8.57%), Isuofia (185; 6.75%) and Ora-Eri (90; 3.28%). The disparity in the abundance was not significant (P>0.05). Artificial breeding sites yielded significantly more larvae, 97.96%, than the natural breeding sites, 2.04% (P<0.05). Although Aedes aegypti breeds in all sorts of artificial habitats, domestic containers, 882 (43.84%) and Used tyres, 502 (24.95%) were the most favourable breeding sites. The abundance of vector was significantly more in rainy season than in the dry season. There is need for drastic reduction in the artificial breeding sites created by man in Aguata L.G.A.

Keywords: *Aedes, Aegpti,* Mosquito, Yellow, Fever, Vector

INTRODUCTION

The mosquito, *Aedes aegypti*, belonging to the family of culicidae and order diptera is the principal vector of yellow and dengue fever viruses. It is closely associated with humans and their dwellings. Mosquitoes require standing water to breed and occur in almost all ecological zones especially the humid tropics and subtropics where the climate is favorable for rapid larval development, adult survival and diversity (Chadee,1992).

Many African cities now have an increasing number of overcrowded, informal settlements, or shanty towns characterized by low-grade housing, poor roads, inadequate water supplies, sanitations and waste management services. Most people who live here have no access to running water and store drinking water in containers which often serve as breeding sites for the mosquito *Aedes aegypti*. In addition, the lack of public sanitation services in many large cities prevents the removal of other artificial breeding sites such as metal cans, tyres, or derelict vehicles. The last yellow fever occurred 14 years ago, but it took 10 years to control the transmission of the virus in the population (WHO, 2014). Given the low vaccine coverage of children under 14 years old, the number of children at risk in Nigeria has been estimated at 23 million, for those children in urban areas only (WHO, 2014). Recent outbreaks of yellow fever in Nigeria occurred in Jos, Ogbomosho, Ogun in the year 1987-1995 and Kano in the year 2000 (WHO, 2014).

Aedes aegypti widely breeds in both natural and artificial habitats containing clean water (Service, 1980). They are highly domesticated mosquitoes breeding principally in domestic containers containing water in and around homes, living in close association and feeding readily on man (Gordon and Lavoipierre, 1976; Service, 1980; Gilet, 1972). Nwoke and Nwoke, (2006) report that the habit of littering the environment with discarded containers among

urban dwellers provides good breeding sites for the mosquitoes and note that storage of potable water in open tanks in homes in urban centuries constitutes mosquito breeding grounds around our homes. Ecological documentation of mosquito species in most states of Nigeria is made available by scholars such as Amusan *et al.,*(2003); Adeleke *et al.,* (2008) in Abeokuta; Anosike *et al.,* (2007) in Imo State; Idowu *et al.,*(2012); Lawal *et al .,* in Sokoto, Mafiana *et al.,* (1998) in Ibadan; Mbanugo and okpalaononuju (2005) in Awka, Okorie (1978) in Ibadan; Nwoke and Eboh (1988) in Okigwe; Onyido *et al.* (2009a, 2009b, 2011a, 2011b, 2012) in Enugu and Awka.

There is no ecological record of *Aedes aegypti* mosquito in Aguata Local Government Area. Therefore, this study aims at investigating the seasonal distribution and abundance of yellow fever mosquito vector in Aguata. This study provides baseline data on *Aedes aegpti* ecology which is indispensable for their effective control.

MATERIALS AND METHODS

Study Area

Aguata, with co-ordinates $7^0$10'0E and $5^0$10'0E, is the largest Local Government Area in Anambra State and located in the Anambra South Senatorial Zone. It lies within the tropical rainforest belt of Nigeria and in the agricultural belt of Anambra State. Aguata covers approximately an area of 19,906.25km with a total population of 369,972 people constituting 187, 262 males and 182,710 females according to 2006 population census (FRNOG, 2009).

Meteorological data were obtained from the Nigerian Meteorological Agency (NIMET) in 2010. There are two distinct seasons in Southeastern Nigeria – a dry harsh harmattan season with low relative humidity, high environmental temperatures between 28^{o}C and 36^0C with scanty rainfall (December – March) followed by a wet rainy season with abundant rainfall and flooding (April – October) and a high relative humidity (80%) and lower environmental temperatures of 21^{o}C and 28^0C.

The Local Government Area is made up of 14 towns: Ekwulobia, Aguluezechukwu, Ezinifite, Igboukwu, Ikenga, Isuofia, Umuona, Ora-eri constituting Aguata II State Constituency; and Uga, Nkpologwu, Amesi, Akpo, Achina and Umuchu constituting Aguata I State Constituency. These towns are mainly rural with the exception of Ekwulobia urban, Uga, Isuofia and Igboukwu suburbans.

SAMPLES AND SAMPLING TECHNIQUES

After a preliminary survey of the study area, ten (10) towns were randomly selected: six (6) from Aguata II and four (4) from Aguata I constituencies. These include Ekwulobia, Igboukwu, Isuofia, Ora-eri, Aguluezechukwu, Ezinifite; and Uga, Umuchu, Nkpologwu and Achina towns respectively. Twenty-seven villages were randomly selected out of a total of 55 villages in the selected towns using stratified random sampling technique according to Asika (1991). Households in the selected villages were selected using systematic random sampling technique where one out of every ten (10) houses was selected in Ezinifite, Uga, Umuchu, Ora-eri, Achina and Nkpologwu; while one (1) out of every fifteen (15) houses was selected in Ekwulobia, Igboukwu, Isuofia, and Aguluezechukwu due to household density.

SAMPLE COLLECTION

Collection of Adult Mosquitoes

Rainy season collection and identification were carried out between the months of April – October, 2010 and dry season collection and identifications were done between November, 2010 – March, 2011. Samples were collected twice a week and about at dusk and night

between 17.00 and 20.00 hours, local time (5.00 – 8.00 pm). Methods according to Youdeowei and Service (1995), were adopted for collection of out-door biting mosquitoes. A total of ten (10) human volunteers (two from each community) to serve as baits were involved in the study. Each volunteer put off his shoes, sat on a low stool at least at about a pole away from each other, outside the house in an open space. They rolled up their shirt sleeves and pairs of trousers to expose their extremities for the arrival and alighting of any mosquito on their bodies. Mosquitoes alighting on the body to suck blood were collected into test tube vials, and stoppered with a ball of cotton wool. All collections were taken to the National Arbovirus and Vector Research Centre Laboratory at Enugu for proper identification.

Indoor biting and resting adult mosquitoes were collected from the residents' rooms using pyrethriod (insecticide) Knockdown Collection Technique (PKC) according to Youdeowei and Service (1995). Rooms were selected based on residents' co-operation. A large sheet of white cloth was used to cover the floor of each room. The windows and doors were properly shut and the whole room sprayed with Baygon aerosol commonly available in the local markets. After 20 minutes of fleeting each room, the doors and windows were opened and the cloths were folded starting from the edges to ensure that all fallen mosquitoes concentrated at the centre. They were then taken outside the rooms where they were opened and all mosquitoes collected into were sorted out.

COLLECTION OF IMMATURE STAGES OF MOSQUITOES

The various natural and artificial habitats were grouped into five:

1. Plastics, drums and tin containers, automobile tyres and tubes, bottles, pure water sacks.
2. Metal cans, metal containers and abandoned automobile roof tops.
3. Clay pots/earthenware containers, reservoirs
4. Pools – ground pools, rock pools, ditches and swamps.
5. Plant axils and animal shells, leaves stalk, leaf husks (maize), tree holes and bamboo stumps.

Sampling of both natural and artificial habitats was done according to the method of Nwoke *et al*. (2005); Youdeowei and Service (1995). The larvae from smaller containers were collected with (1) ladle and (2) pipette depending on the type of containers. Bigger and more elaborate pipettes were used for large containers and pools. Pipettes made of glass cylinder about an inch in diameter had a rubber bulb from motor hum attached to its top, the other end narrowed by means of cork. A six-inch rubber tubing was attached to the tiny end of the glass tube as described by Youdeowei and Service (1995). This dipping method is highly recommended because of its relative ease (Service, 1980). In each large container, such as drums, 10 dips in different parts of the water were made and taken to constitute a sample. The contents of smaller containers or the same grouped in a compound or area were carefully pooled together into a plastic dish and sampled with a pond net. The larvae collected were carefully put in the plastic bucket containers. Samples collected were labeled according to the type of containers, the macro habitat, and ecological foci, and taken to the research laboratory of the National Arbovirus and Victors Research Centre at No. 33 Park Avenue, GRA, Enugu, for proper identification.

MORPHOLOGICAL IDENTIFICATION OF COLLECTED SAMPLES (LARVAE, AND ADULTS)

Dissecting microscope was used for morphological identification. Adult mosquitoes collected were separated based on their morphological characteristics: presence of dark and white silvery patterns on the abdomen and the thorax (two straight lines surrounded by curved lyre-shaped lines on the side) as

described by Service (1980) and Gillet (1972). Identification of mosquito larvae was done with the aid of published keys of Gillet, (1972). Larvae was identified using the shape of the comb scales on the eight segment of the abdomen and shape of the pecten teeth on the siphon. In *Aedes aegypti*, larvae, the teeth have well developed lateral denticles but the pecten teeth have less defined denticles. Larvae that could not be identified were bred to adults and then identified.

ETHICAL CONSIDERATION

A letter of introduction was obtained from the Department of Biological Sciences, Chukwuemeka Odumegwu Ojukwu University and presented to the community heads/opinion leaders and the landlords. All the volunteer staff used were first educated on the nature of the work to be done and their implications, and how best to collect the mosquitoes.

Verbal consent was sought from compound/household heads before indoor resting mosquitoes were collected from people's homes. All health matters of the volunteer staff were taken care of properly during the study period.

STATISTICAL ANALYSIS OF RESULTS

Mosquito species abundance was shown in histograms, percentages and pie charts. Analysis of Variance (ANOVA), students t-tests and chi-square tests were used to compare the mosquito species abundance (population) composition, and seasonal variation in the study communities.

A total of 2742 *Aedes aegypti* mosquitoes were collected. This included 2012 (73.38%) larvae and 730 (26.62%) adults. The highest abundance was recorded in Ekwulobia numbering 426 (15.54%), followed by Uga with 311 (13.53%); Igboukwu 307 (11.20%), Ezinifite 302 (11.01%), Umuchu 297(10.83%), Achina 270(9.85%), Aguluezechukwu 259(9.45%), Nkpologwu 235(8.57%), Isuofia 185(6.75%) and Ora-eri 90(3.28%) (Table 1). The difference in mosquito abundance among the towns was not significantly higher than the adult abundance ($P<0.05$). *Aedes aegypti* larvae breed well in artificial habitats representing 2.04% abundance ($P>0.05$). This mosquito species prefers breeding in water contained in domestic containers, 822 (40.85%) and used tyres, 502 (24.95%) to other artificial breeding sites (Table 2). Ground pools and Tree holes yielded no larvae.

The abundance of *Aedes aegypti* as influenced by infrastructural development (Figure 2) revealed that rural areas in the study area yielded high mosquito abundance followed by the semi-rural areas. The mosquito abundance in the urban 426 (15.54%), semi-urban 1122 (43.54%) and rural areas did not differ significantly ($P>0.05$). The dry season mosquito abundance 359 (13.09%) differs significantly from the rainy season mosquito abundance 2583 (86.91%) (Figure 3).

Aedes aegypti breed in the months of the year with varying abundances. The highest mosquito abundance was recorded in the months of July, 539 (19.66%), whereas the least was recorded in February, 14 (0.51%). (Table 3).

Table 1: Larval and adult *Aedes aegypti* mosquito species in Aguata L.G.A.

Location	Larvae (%)	Adult (%)	Total (%)
Ekwulobi	264(13.12)	162(22.19)	426(15.54)
Uga	319(15.86)	52(7.12)	371(13.53)
Igboukwu	121(10.54)	95(13.03)	307(11.20)
Isuofia	135(6.71)	50(6.85)	185(6.75)
Aguluezechukwu	136(6.76)	123(16.85)	259(9.45)
Umuchu	213(10.59)	84(11.51)	297(10.83)
Achina	211(10.49)	59(8.08)	270(9.85)
Nkpologwu	215(10.69)	20(2.74)	235(8.57)
Ezinifite	247(12.28)	55(7.53)	302(11.01)
Ora-Eri	60(2.98)	30(4.11)	90(3.28)
Total	**2012(73.38)**	**730(26.62)**	**2742**

Table 2: Relative abundance and distribution of Aedes *aegypti* larvae among the breeding sites sampled

Breeding sites	Larval abundance	Percentage
NATURAL HABITATS		
Tree holes	0	0.00
Bamboo stumps	36	1.79
Ground pools/ditches	0	0.00
Plant axils (banana, pineapple)	5	0.25
ARTIFICIAL HABITATS		
Used tyres	502	24.95
Domestic containers including those containing fermented cassava water	822	40.85
Abandoned car roofs	41	2.04
Discarded containers in gardens around homes/refuse dumps	173	8.60
Discarded polytene bags and pure water sacks	32	1.59
Gutters/drainage	22	1.09
Drums and concrete moulds used to separate kernels from covering	216	10.74
Underground reservoir	163	8.10
Total	**2012**	**100**

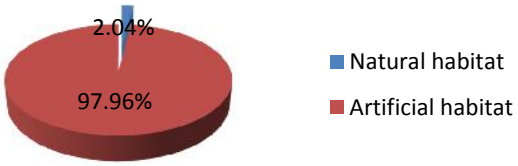

Figure 1: Pie chart showing the abundance of *Aedes aegypti* in natural and artificial habitats

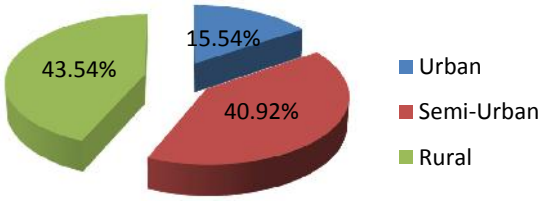

Figure 2: Pie chart showing the relative abundance of *Aedes aegypti* in relation to infrastructural development

Table 3: Relative abundance and distribution of *Aedes aegypti* among the months of the year

Months	Larval abundance	Percentage
January	16	0.58
February	14	0.51
March	26	0.95
April	279	10.18
May	313	11.42
June	571	20.82
July	539	19.66
August	472	17.21
September	209	7.62
October	160	5.84
November	122	4.45
December	21	0.77
Total	**2742**	**100**

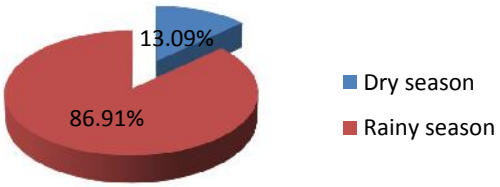

Figure 3: Pie chart showing the seasonal abundance of *Aedes aegypti*

DISCUSSION

Understanding mosquito larval habitat ecology is important in designing targeted mosquito-borne disease control programs. This helps in knowing when a larval habitat is most productive and clearly shows when it should be

targeted for maximum reduction in adult population. This study revealed that the principal yellow fever mosquito vector is present in Aguata Local Government Area. This is an indication that the climatic and environmental conditions of Aguata L.G.A. are conducive to support the survival and development of *Aedes aegypti*.

The disparity in the abundance and distribution of the mosquito vector in the different locations appears to be due to different environmental conditions or microclimatic variations as well as availability of suitable preferred breeding sites. The occurrence of this mosquito species which is a known vector of diseases is of great public health importance. *Aedes aegypti* transmits yellow fever virus, dengue fever, encephalitis virus, haemorrhagic fever virus, chikungunja viruses (Gillett, 1972 service, 1980). Yellow; fever epidermis was first recorded in 1913 in most rural communities including Lagos, Abeokuta, Warri, Onitsha and Calabar (service, 1980) and recently occurred in Delta State in 1991 (Anosike *et al.,* 2007).

This study serves as post epidermis entomological investigation. *Aedes aegypti* breeds well in all the breeding sites sampled except tree holes and underground pools. This could be attributed to the indiscriminate breeding of *Aedes aegypti* as reported by Mgbemena *et al.* (2012) in a study where it was recorded in all microhabitat. The result of this study supports the findings of Adeleke *et al.,*(2008), Mafiana *et al.*(1998), Okorie, (1978) where *Aedes aegypti* was recorded in all microhabitats. However, the ubiquity of *Ae. aegypti* could be explained by considering the structure of the eggs. The eggs possess hardened endochorion which enables them to resist desiccation. Hence the environmental conditions of the microhabitat do not have adverse effects on these species with no resistant endochorion (Clement, 2000).

The preference of artificial habitats to natural habitats by *Aedes aegypti* can be attributed to the more abundance of artificial habitats than natural habitats as a result of activities of man in modifying the environment, by storing water in domestic containers around homes, indiscriminate litter of tin containers in and around homes/farms, lands, poor disposal of refuse including used tyres. The preference of domestic containers and used tyres for breeding as revealed in this study is supported by the result of Mafiana *et al.* (1998) who reported that tyres and domestic containers provided the highest number of breeding sites in both wet and dry seasons in Abeokuta.

Seasonal abundance of this mosquito species showed that most of them were collected during the wet season because of the availability of more breeding sites created by rainfall. This invariably suggests that incidence of the disease it transmits will be high during the wet season than the dry season. This pattern of seasonal abundance reported in this study agrees with reports of Adeleke *et al.* (2010); Olayemi and Ande (2008), Okogun *et al.* (2005).

CONCLUSION

This study has provided information on larval habitats, seasonal distribution and abundances of larvae and adults yellow fever mosquito vector in Aguata L.G.A. This mosquito species is of epidemiological and public health importance as the inhabitants of are prone to diseases vectored by it. This study also provided information and baseline data on the activities of man that encourage the breeding of this mosquitoes species which are epidemiologically important in mosquito control. This calls for an accelerated campaign of mosquito control in Aguata L.G.A. especially during the rainy

season encompassing the integrated vector management approaches.

REFERENCES

Adeleke, M.A., Mafiana, C.F., Idowu, A.B., Adekunle, M.F. and Sam-Wobo, S.O. (2008): "Mosquitoes larval habitats and public health implication in Ogun State, Nigeria". *Tanzania Journal of Health Research, **10**(2):* 103−107.

Adeleke, M.A., Mafiana, C.F., Idowu, A.B., Sam-Wobo, S.O. and Idowu, O.A. (2010). "Population dynamics of indoor sampled mosquitoes and their implication in disease transmission in Abeokuta, South-western Nigeria". *Journal of Vector Borne Disease, **47**:* 33−38.

Amusan, A.A.S., Mafiana, C.F., Idowu, A.B and Oke, O.A. (2003). "A survey of adult mosquitoes in the hostels of the University of Agriculture Abeokuta, Ogun State, Nigeria". *The Nigerian Journal of Parasitology*, ***24**:*167 – 178.

Anosike, J.C., Nwoke, B.E.B., Okore, A.N., Aku, E.E., Asor, J.E., Emmy-Egbe, I.O. and Adimike, D.A. (2007). "Epidemiology of Tree-hole breeding mosquitoes in the tropical rainforest of Imo State, South-East Nigeria". *Annals of Agricultural and Environmental Medicine, **14**:* 31−38.

Asika, N. (1991). *Research Methodology in Behavioural Sciences.* Longmam Nigeria Plc. Ikeja, Lagos state. p.39-49.

Chadee, D.D. (1992). "Indoor and outdoor host seeking rhythms of *Anopheles albitarsis* (Diptera: culicidae) in Trinidad, West indies". *Journal of Medical Entomology, **29**(3):* 568−569.

Clement, A.N. (2000). *The biology of mosquitoes.* Volume 1 Development, Nutrition and Reproduction. Wallingford, UK CABI publishing, p.265−280.

Federal Republic of Nigeria, (2009). Government Notice *Federal Government of Nigeria Official Gazette.* No 2. ***96***:20-43.

Gillet, J.D. (1972). *Common African Mosquitoes and their Medical Importance.* William Heinemann Medical Books Limited, London. Volume 1, Pp.106.

Gordon, R.M. and Lavoipiere, M.M. J. (1976). *Entomology for students of medicine,* 4th

Lawal, M.D., Fabiyik, J.P., Mohammed, A.A., Alayande, M.O., Mohamuda, A., Usman, M. and Mohammed, I.S. (2012). "Preferred breeding sites of different mosquito species in Sokoto Township and Environs". *Continental Journal of Biological Sciences*, ***5**(1):* 1−3.

Mafiana, C.F., Anaeme, L. and Olatunde, G.O. (1998). "Breeding sites of larval mosquitoes in Abeokuta, Nigeria". *Nigerian Journal of Entomology, **15**:*136−143.

Mbanugo, J.I. and Okpalaononuju, C.N. (2005). "Surveillance of mosquito vectors in some habitats of Awka metropolis, Anambra". *Nigerian Journal of Parasitology*, ***24**:* 184 – 191.

Mgbemena, C.I., Adjeroh, L.A., Opara, F.N., Ezeagwuna, D. and Ebe, T. (2012). "Seasonal variation and relative abundance of drainage breeding mosquito species in Imo State, Nigeria". *International Journal of Biosciences*, ***2**(8):* 23−35.

NIMET (2010). *Nigeria Meteorological Agency: Seasonal Rainfall prediction and socio-economic implication for Nigeria*. p.6−21.

Nwoke, B.E.B. and Eboh, J. (1988). "A study of larval binomics for culicine mosquitoes breeding in artificial containers in Okigwe and Environs". *Nigerian Journal of Environment, **3**:* 67−73.

Nwoke, B.E.B. and Nwoke, E.A. (2006). Contributions of occupational hazards and environmental degradation on emergence and reemergence of diseases. Book of proceedings, 3rd Annual National Conference of Occupational Safety and Environmental Health Management in Nigeria, November 8 – 11th, 2006 Nnamdi Azikiwe University, Awka, Anambra State Nigeria P.p 7−16.

Okogun, G.R.A., Anosike, J.C., Okere, A.N. and Nwoke, B.E.B. (2005). "Ecology of mosquitoes of Midwestern Nigeria". *Journal of Vector- Borne Diseases, **42**:* 1–8.

Okorie, T.G. (1978). "The breeding site preference of mosquito in Ibadan, Nigerian". *Nigerian Journal of Entomology, **3**:* 1–80.

Olayemi, I.K. and Ande, A.T. (2008). "Species composition and larval habitats of mosquitoes (Diptera: Culicidae) in Ilorin, Nigeria". *The Zoologist*, ***6**:* 7–15.

Onyido, A.E., Ezike, V.I., Ozumba, N.A., Nwosu, E.O., Ikpeze, O.O. and Obiukwu, M. O. (2009a). "Crepuscular man–biting mosquitoes of a tropical zoological garden in Enugu South-Eastern Nigeria". *The Internet Journal of Parasitic Diseases*, ***4**(1):* 1- 16.

Onyido, A.E., Deezia, N.P.L., Obiukwu, M.O. and Amadi, E.S. (2009b). "Ecology of man-biting mosquitoes in the development site of Nnamdi Azikiwe Unviersity Awka, Anambra State South-eastern Nigeria". *The Internet Journal of Health, **9**(2):*8-13

Onyido, A.E., Ebenighe, V.O., Ozumba, N.A., Ikpeze, O.O., Obiukwu, M.O. and Amadi, E.S. (2011a). "An investigation of the methods of self-protection against mosquito bites in Ogbaru Local Government Area of Anambra State, Nigeria". *New York Science Journal*, ***4**(8):* 10–115.

Onyido, A.E., Ozumba, N.A., Ezike, V.I., Nwosu, E.O., Amadi, E.S., Obiukwu, M.O., Chukwuekezie, O.C. and Umeanaeto, P.U. (2011b). "Breeding and biting activities of yellow fever mosquitoes in two urban communities with dilapidating infrastructures". *Nature and Science*, ***9**(9):* 93–98.

Onyido, A.E., Ikpo, A.U., Obiukwu, M.O. and Amadi, E.S. (2012). "Vector abundance and prevalence of malaria parasites among hostel residential students of Nnamdi Azikiwe University Awka, South-Eastern Nigeria". *Nature and Science, **10**(11):* 150–155.

Service, M.W. (1980). *A guide to medical entomology*. Macmillan International College Edition. Macmillan Press Ltd. London. pp. 226.

WHO (2014). Increased risk of urban yellow fever outbreaks in Africa. Global Alert and Response (GAR) network. www.who.int./../en/

Youdeowei, A. and Service, M.W. (1995). *Pest and vector management in the tropics.* Second edition, Longman Nigeria. pp. 84–92.