The Bioscientist: Vol. 1(2):132-139, September, 2013.
Available online at http://www.bioscientistjournal.com

Full Length Research Paper

Survey of Open Larval Habitats of Mosquitoes in Four Communities in Awka South Local Government Area, Anambra State, Nigeria

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ABSTRACT
Larval survey of open habitats of mosquitoes was carried out May-July 2011 in the wet season and December 2011-February 2012 in the dry season in 3 communities in Awka South Local Government Area, Anambra State. The collection of larvae of mosquitoes was done using dipper and pipette. Five larval habitats of mosquitoes namely ground pools, drains/gutter, used tyres, discarded domestic containers and leaf axils were identified in the wet season while only ground pool was identified in the dry season. A total of 380 larvae of mosquitoes belonging to three genera and five species were collected and identified. These were *Aedes aegypti* 39.2% (149/380), *Culex quinquefasciatus* 30.3% (115/380), *Culex tigripes* 14.0% (53/380), *Anopheles gambiae* 13.7% (52/380), and *Anopheles funestus* 2.9% (11/380). In the wet season survey, *Culex quinquefasciatus* had the highest distribution in ground pools (36.7%) followed by *Anopheles gambiae* (33.7%); In drains/gutters, *Culex tigripes* had the highest distribution of 37.9% followed by *A. aegypti* and other species; In used tyres, only larvae of *A. aegypti* and *C. quinquefasciatus* were identified; Similar result was obtained for domestic discarded containers where *A. aegypti* and *C. quinquefasciatus* were collected. The larvae of mosquitoes found in tree leaf axils were only *C. tigripes*. The result also showed that *Anopheles gambiae* and *A. funestus* bred only in ground pools and drains/gutters. Only larvae of *Anopheles gambiae* and *Culex quinquefasciatus* were identified in the dry season survey. There was no statistical difference ($p>0.05$) in identified larval habitats and among species of mosquitoes in various larval habitats in the wet season. There was significant difference ($p<0.05$) in larval distribution in wet and dry seasons.

Keywords: mosquitoes, open, larval, habitats, Awka.

Introduction

Mosquitoes are known to transmit both human and animal diseases. Among the public health and veterinary important arthropods, mosquitoes rank first in the spread of such diseases as malaria, yellow fever, filariasis, dengue fever, encephalitis as well as other viral and bacterial diseases (Gillet, 1972; Service 1980). Among mosquito-transmitted diseases, malaria ranks first. Despite recent efforts at malaria control, the disease transmitted by female *Anopheles* mosquitoes still infects over 200 million people and kills up to 800,000 worldwide, with over 90% of the death still in subSaharan Africa (WHO, 2010). More than 90% of the Nigerian population is at risk of stable malaria transmission with huge economic loss (FMOH, 2010). This mosquito-borne disease is also responsible for the high rate of school absenteeism among students, loss of productive hours and adverse consequences during pregnancy.

Lymphatic filariasis is also transmitted by various species of mosquitoes including *Anopheles, Mansonia, Culex and Aedes.* The disease affects 120 million people with 40 million having overt disease and 80

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million hidden damage (Ottesen, 2006). Lymphatic filariasis is associated with both health and social consequences. Yellow fever transmitted by *Aedes* species remains one of the most debilitating diseases of global importance. The disease is endemic in most parts of Nigeria and is commonly noticed as devastating epidemics taking tolls on human lives and the economy (Monath, 1985; Tomori *et al*., 1991). Apart from disease transmission, mosquitoes are regarded as public enemies because of their biting annoyance, noise nuisance, sleeplessness and allergic reactions due to their bites (Onyido *et al*., 2009a)

Mosquitoes generally breed in various types of stagnant water bodies, both natural and artificial, at various seasons of the year. Mosquito larval stages develop in these larval habitats to emerge and become adults, ready to transmit both human and animal diseases. Adult mosquitoes show a very distinct preference for the types of water sources in which to lay their eggs. Each species has unique environmental requirements which could be determined from larval habitats (Okogun *et al*., 2003). According to The Urban Malaria Control Program of Dar es Salaam, Tanzania
(2005), mosquito habitat types can be broadly distinguished into Open Habitat and Closed Habitat. Open Habitats are defined as water bodies that are exposed to the open air and light and these constitute principal larval habitats.

Larval surveys for mosquitoes are designed to assess the distribution of the aquatic stages of various disease transmitting mosquitoes of man and animals in a given community. A collection of baseline data on mosquito larval habitats over a period helps inform larval and vector control operations, thus improving health and comfort of man.

Part of the challenges militating against effective and sustained control of mosquitoes is their ability to breed in diverse aquatic habitats that are naturally occurring and the creation of human activities (Service, 1993). Several studies have looked at mosquito larval habitats and species within Nigeria (Adebote *et al* , 2008., Okogun *et al*, 2003., Onyido *et al*., 2009a., Onyido *et al*, 2009b) but none is known to have considered survey of urban and rural communities in wet and dry seasons. This study conducted in Awka South Local Government Area, Anambra State, Nigeria, was aimed at identifying larval habitats and species of mosquitoes breeding in the rural communities of Isiagu and Umuawulu and urban community of Nibo in wet and dry seasons.

Materials and Methods

Study Area

The study was carried out in three communities, namely, Isiagu, Nibo,and Umuawulu in Awka South Local Government Area (LGA) of Anambra State, southeast Nigeria. Awka South LGA is made up of eight (8) communities, namely: Isiagu, Umuawulu, Mbaukwu, Nibo, Nise, Amawbia, Awka, and Okpuno. These communities are within the capital territory of Anambra State. Awka South LGA is considered an urban LGA though its features are largely rural. It is located between latitude $6^0$6`N and $6^0$25`N and longitude 7.0^0 E and $7^0$15`E. The study area is within the tropical rainforest biome of Nigeria. Two seasons, dry and wet season, operate within the study area. The dry season usually runs from November to March while the wet season is from April to October. The maximum temperature in the dry season is 36.6^0C while the minimum is 26.1^0C. During the wet period, the maximum temperature is 30.9^0C while the minimum is

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22.1^{0}C. The average daily humidity is 79.4%, annual rainfall ranges from 2000 to 30000mm. These climatic characteristics are favourable for the breeding of mosquitoes.

Awka South LGA has a population of 301, 657 inhabitants (National Population Commission, 2006). The area was famous for metal works before the 20th century and its blacksmiths were prized throughout the region for making farming implements, guns and tools. Presently, majority of the indigenes are peasant farmers, traders, artisans and public servants.

Selection of study communities and sampling sites

The three 3 communities were purposively selected to cover both the more rural communities represented by Isiagu and Umuawulu, and the peri-urban represented by Nibo. The sampling sites were areas of high human activities. These include densely populated nucleated settlements where people store water in all sorts of containers around their homes, drains/gutters, ground pools (rain water collections along community roads), discarded materials including pots and sachet water polythene and leaf axils. The study was carried out in six months, three months in the wet season and three months in dry season.

Collection, processing, rearing and identification of Mosquito Larvae

Mosquito larvae were collected using dipper and pipettes as described by Adeleke *et al.*, (2008). The larvae in ground pools, gutters and large containers were collected with the aid of a dipper. The dipping technique was used in which the dipper was lowered gently at the angle of 45^o just below the surface so that water flows in together with any larvae that were present. All larvae collected were transported in small containers to the insectary and reared in mosquito cages. The bowl containing larvae was placed inside the cage. The larvae were fed with a mixture of yeast and biscuits (10% yeast and 90% low fat biscuits). Water traps were placed in the cage near the larvae bowl to prevent ants from destroying the mosquito that emerge from the larvae. Emerged adults mosquitoes were left in the cage and fed with 10% glucose solution.

Emerged adult mosquitoes later were killed with the insecticide propuxur, preserved with silica gel in eppendorf tubes and taken to National Arbovirus and Vectors Research Centre in Enugu, Enugu State, for identification to species level, using external morphology keys as described by Gillets (1972). Taxonomic features used include mouthparts, terminal abdominal segments, colour, striations and palp bands. The distribution of larvae of mosquitoes in different habitats was calculated in percentages. Statistical analyses were done using Analysis of variance (ANOVA) with multiple comparison tests and Post Hoc Tests.

RESULTS

The wet season open larval habitats of mosquitoes identified were ground pools, drains and gutters, discarded vehicle tyres, discarded domestic containers, and leaf axils. Only man-made ground pools for vegetable farming along river banks was identified in the dry season. Mosquito larvae identified from the collections were species of *Aedes aegypti*, *Anopheles funestus*, *Anopheles gambiae*, *Culex quinquefasciatus*, and *Culex tigripes*.

As shown in Table 1, the most abundant of all the larval mosquitoes collected was *Aedes aegypti* 43.4% (149/343), followed by *Culex quinquefasciatus* 25.4% (87/343), *Culex tigripes* 15.5% (53/343), *Anopheles gambiae* 12.5% (43/343). The least

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abundant was *Anopheles funestus* 3.2% (11/343). The habitat type with the highest distribution of larval mosquitoes was ground pool 28.6% (98/343), followed by drains/gutters 25.4% (87/343), domestic containers 24.0% (82/343) and used tyres 16.3% (56/343). The habitat type with the least larval distribution was leaf axils 5.8% (20/343).

Result also showed that larvae of *Culex quinquefasciatus* were most abundant in ground pools with a distribution of 36.7% (36/98). Larvae of *Anopheles gambiae* and *Anopheles funestus* were collected in ground pools and drains only. *Aedes aegypti* and *Culex quinquefasciatus* were found in all the identified larval habitats with the exception of leaf axils. Statistical analysis showed no significant difference in larval yields of different habitats and among different species of mosquitoes in various larval habitats (P>0.05).

Table 1: Species abundance of mosquito larvae in different habitats in wet season in Awka South LGA, Anambra State

Habitats	**Mosquito Larvae (%)**						
	Anopheles gambiae (%)	***Anopheles funestus (%)***	***Culex quinquefasciatus (%)***	***Aedes aegypti (%)***	***Culex tigripes (%)***	***Total***	***%***
Ground pool N=98	33 (33.7)	9 (9.2)	36 (36.7)	20 (20.4)	0 (0.0)	98	28.57
Drains/gutters N=87	10 (11.5)	2 (2.3)	17 (19.5)	25 (28.7)	33 (37.9)	87	25.36
Used Tyres N=56	0 (0.0)	0 (0.0)	19 (33.9)	37 (66.1)	0 (0.0)	56	16.33
Domestic containers N=82	0 (0.0)	0 (0.0)	15 (18.3)	67 (81.7)	0 (0.0)	82	23.91
Tree holes/leaf axils N=20	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	20 (100)	20	5.83
Total N=343	**43 (12.5)**	**11 (3.2)**	**87 (25.4)**	**149 (43.4)**	**53 (15.5)**		

The result also showed that a total of 343 larvae were collected in the wet season and 37 in the dry season as shown in Table 2. The wet season collections were the five species shown in Table 1. The dry season collections were *Anopheles gambiae* 9 (24.3%) and *Culex quinquefasciatus* 28 (75.3%). There was a significant difference in wet and dry season surveys (p<0.05).

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Table 2: Seasonal abundance of mosquito larvae in Awka South LGA

Species	**Wet season (%)**	**Dry season (%)**	**Total**	**%**
Anopheles gambiae	43 (12.5)	9 (24.3)	52	13.68
Anopheles funestus	11 (3.2)	0 (0.0)	11	2.89
Culex quinquefasciatus	87 (25.4)	28 (75.3)	115	30.26
Aedes aegypti	149 (43.4)	0 (0.0)	149	39.21
Culex tigripes	53 (15.5)	0 (0.00	53	13.95
Total N=380	**343 (90.3)**	**37 (9.7)**	**380**	**100**

The result also showed that ground pools had the highest abundance of mosquito larvae 135/380 representing 35.5% of the total collection as shown in Table 3. This was followed by drains/gutters 87/380 representing 22.9% and discarded domestic containers 82/380 representing 21.6%. Used tyres and leaf axils had 14.7% (56/380) and 5.3% (20/380), respectively, as presented in Table 3.

Table 3: Seasonal abundance of larvae of mosquitoes in different habitats in Awka South LGA Anambra State

Species	**Larval habitats**											
	Ground pool		Drains/gutters		Used tyres		Domestic containers		Tree/leaf		**Total**	
	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry
A. gambiae	33	9	10	0	0	0	0	0	0	0	43	9
A. funestus	9	0	2	0	0	0	0	0	0	0	11	0
C. quinquefasciatus	36	28	17	0	19	0	15	0	0	0	87	28
A. aegypti	20	0	25	0	37	0	67	0	0	0	149	0
C. tigripes	0	0	33	0	0	0	0	0	20	0	53	0
Total	**98**	**37**	**87**	**0**	**56**	**0**	**82**	**0**	**20**	**0**	**343**	**37**

DISCUSSION

Mosquito larval habitats were significantly more and diverse during the wet season than the dry season. This may not be unrelated to the fact that virtually all the larval habitats identified during the wet season had dried up following the stoppage of rains. The wet season is known to be associated with abundant rainfall and flooding, supporting the growth and development of aquatic larval stages and abundant recruitment of young adults. A similar finding was reported by Okogun *et al* (2003) working in Midwestern Nigeria and Onyido *et al* (2008) in Jos, Nigeria. The implication of this finding is that efforts at larval control of mosquitoes are more beneficial during the wet. The result produced no significant difference among identified larval habitats and species of mosquitoes breeding in them. This finding agrees with the study by Onyido *et al* (2010) in Calabar, Nigeria where no significant difference was reported among species diversity between mosquitoes sampled in three locations.

Four of the five species of mosquitoes that emerged from collected larvae are known to

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be efficient vectors of some parasitic diseases. *Aedes aegypti* is an important yellow fever vector, *Anopheles funestus and Anopheles gambiae* transmit malaria, *Culex quinquefasciatus* transmit filarial nematode parasites including loiasis and elephantiasis. Of all the mosquito species identified, *Aedes aegypti* had the highest abundance followed by *Culex quinquefasciatus*. Onyido *et al* (2008) obtained similar result in a study in Jos Plateau State where out of 168 mosquitoes collected as larvae 119 representing 70.8% were larvae of *A. aegypti*. *A. aegypti* is of apparent health danger being a principal vector of viral infections such as yellow fever, dengue fever virus, encephalitis virus, haemorrhagic fever virus, Chikungunya, and Rift Valley virus (Gillet 1972, Service 1974). Awka South LGA is known to habour monkeys which are reservoir hosts of yellow fever virus. There is therefore the need for routine surveillance to monitor outbreaks of mosquito-borne infections. *Culex tigripes*, though not known to transmit any infection may in future be an effective vector of diseases; close monitoring is recommended. Only a species of *Culex tigripes* larvae were identified in tree holes and leaf axils. According to Mafiana *et al.*, (1998), tree holes and leaf axils can only retain water for short period of time and dry at the time of no rain. This may be the reason for low species distribution in tree holes and leaf axils in this larval survey.

From the result, different species appear to prefer one habitat to the other. *Anopheles species* were more in ground pools than drains/gutters while absent in others; whereas *Culex quinquefasciatus* and *Aedes aegypti* appear less selective in larval habitats (Table 1). The capacity of *Culex* and *Aedes* species to breed in nearly all habitats in the wet season is attributable more to the availability of nutrients and competition for food according to Akoh *et al* .(1992). Nearer homes, plastic containers discarded in surrounding bushes, in gardens and farms, discarded automobile tyres have an organic content that largely support the growth of these species. These species were less selective in their requirement for breeding habitats. The large occurrence of *C. quinquefasciatus* was observed in gutters and is not surprising because of its preference to breed in polluted water. The presence of *Anopheles spp* in drains/gutters may elicit some questions but Awolola *et al* (2007) reported the breeding of *Anopheles gambiae sensu stricto* in polluted water bodies in urban Lagos, Nigeria, collaborating this particular finding. It may appear that the ecology of mosquitoes may be changing but more investigations on this and factors responsible are needed. The larval habitat with the highest number of larvae of mosquitoes was identified as the ground pool 28.6% (98/343), followed by drains/gutters 25.4% (87/343). Larval control of mosquitoes at these locations may improve public health and make more economic sense.

Conclusions

The outcome of this survey indicates that there is a high vector breeding potential for four main vector borne diseases transmitted by mosquitoes belonging to the three genera; *Anopheles, Culex* and *Aedes* species. Vector control remains the most plausible management method for vector borne diseases. This requires proper environmental planning and environmental audit. It will also make a better sense to study larval control alternatives in the wet season when there will be abundant and diverse larval habitats as seen in this open habitat survey.

In conclusion, this study has added to vital information on larval habitats of mosquitoes within Awka South L.G.A. Potential vectors

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of mosquito- borne diseases including malaria, yellow fever virus and lymphatic filariasis breed in various open habitats. Adequate public enlightenment about these mosquito larval habitats will help inform better environmental management in the control of mosquito borne diseases in the community. Good construction practices especially of roads and drainages may help reduce the breeding sites of mosquitoes and limit diseases transmission.

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