Malaria vector bionomics in Abagana community of Anambra State, Southeastern Nigeria

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Abstract: A study on malaria vector bionomics was carried out in Abagana community, Anambra State, Southeastern Nigeria, between April and August 2012. Mosquito larvae breeding sites were determined using simple larval collection methods of ladle, sieves and bowl. Man biting adult mosquitoes were collected using pyrethrum knockdown method. A total of 177 mosquito larvae were collected from 49 sampling sites made up of ground pools 17(9.60%), used vehicle tyres 19(10.73%) and domestic containers 13(7.34%). Of the 177 larvae collected, 64(36.16%) were collected from ground pools, 73(41.24%) were collected from used vehicle tyres, and 40(22.59%) from domestic containers. A. gambiae larvae were collected from ground pools 67(32.85%) and domestic containers 4(2.26%). A total of 152 indoor resting and biting adult mosquitoes were collected and A. gambiae were 95(62.5%) with a room density of 5.3 mosquitoes per man per night. A. gambiae was observed to be breeding and biting in all the villages of the community were at risk of acquiring malaria and other mosquito-borne diseases. Self protection by the individuals and general provision of mosquito control strategies in the community were suggested.
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1.Introduction

Malaria parasites are naturally transmitted to man through the bites of infected female mosquitoes of the genus *Anopheles*. In the sub-Saharan Africa, five *Anopheles* species namely; *A. gambiae, A. funestus, A. arabiensis, A. nili* and *A. mouchetti* have been described as the major vectors of regional importance, while 8-9 other species are secondary or local vectors (Onyido et al., 2009a). These mosquitoes are very abundant in some regions of Africa with high population densities and are responsible for the transmission of malaria to millions of people.

Anopheles gambiae is the most efficient malaria vector and the most widespread among these mosquitoes (WHO, 1992). Generally these mosquitoes breed in sunlit stagnant water collections around our homes, streets, and streams or other quiescent water collections, from where they fly into the houses to bite man. *Anopheles* species have been reported to adapt themselves to the various ecological circumstances provided by all stages of rice culture including nursery, watering, planting, growing, tillering, maturation, harvesting and land fallow (Service, 1980). They are also well known to be very adaptable to increasing ecological and environmental changes because of their high level of genetic diversity and plasticity (Coluzzi et al., 1979).

In Nigeria, the major vectors of human malaria are *Anopheles gambiae* sensu strict (s.s), *A. arabiensis, A. funestus* and A. *melas*. *A. gambiae* (ss) is the most dorminant species in the forest areas. It is a widespread mosquito and its distribution depends largely on environmental factors and availability of breeding sites (Toure et al., 1994). In many areas of Africa , including Nigeria, *A. gambiae* is the main vector of malaria. It breeds in exposed, often muddy sunlit ground pools of water of various sizes, brick pits, animal footprints and vehicle tyre prints. It is occasionally found in man-made containers such as wheel barrows, mortar pans, open tanks, canoes and abandoned concrete mixers (Gillet, 1972), (Onyido et al., 2009c).

A. funestus is a complex species with uneven distribution throughout Nigeria. It breeds in cool shady fresh water swamps along rivers and streams and other water pools often associated with water lettuce, *Pistia stratiotes* and grasses at the edges of rivers. *A. melas* are essentially coastal species and a member of *A. gambiae* complex. It is a major vector of malaria especially around lagoons. *A. arabiensis* also belongs to *A. gambiae* complex. It is a major vector where malaria transmission is unstable. *A. arabiensis* has been described as a savannah vector, in isolated populations, deforested areas and predominant in the dry season (Wagbatsoma and Ogbeide, 1995). Wherever *A. arabiensis* occur in the rainforest, it is associated with a history of extensive land clearance (Hougard et al., 2002). (Githeko et al., 1994) reported that *A. arabienisis* could be anthropophagous, where there are less animal hosts in the Savannah- forest, where *A. arabiensis* is responsible for 34.1% of human blood meals. *A. arabiensis* appears to be a good vector of malaria, especially in the Savannah-forest.

Several factors like abundance, biting behaviour, host preference and longetivity have been reported to influence the vectorial role of mosquitoes in disease transmission (Noutcha and Anumudu, 2009). The increase in environmental modification as a result of urbanization is usually being accompanied by creation of more breeding sites for mosquitoes which most often lead to the increase in the incidence of mosquito-borne diseases (Amusa et al., 2005).

The World Health Organisation (WHO, 1975) has advised that the planning, execution and evaluation of any anti-vector measures have to be based on a perfect knowledge of the bionomics of the vector species. The organization further suggested that the knowledge of the breeding, resting, biting habits and longevity of the vector species is essential for anti-vector measures and the evaluation of the success of such measures. (WHO, 1975) further advised that successful control of mosquito larvae requires a good knowledge of the breeding ecology of mosquitoes including, types of and preferences for larval habitats, spatial and temporal distribution of breeding sites, as well as, the physical, biological and chemical characteristics of the habitats. Presently there is no recorded information on the ecology of malaria vectors in Njikoka Local Government Area of Anambra State of Nigeria, although the government has selected the community for indoor residual sprays to reduce mosquito population and malarial transmission.

This study is therefore aimed at studying the malaria vector ecology at Abagana community so as to provide baseline data for the effective control of malaria and other mosquito-borne diseases in the area. The specific objectives were to determine the mosquito vector abundance through collection of indoor biting adult mosquitoes in the area. The study also determine the breeding ecology of the mosquito vectors through the collection of the immature stages from their breeding sites.

2.Materials and Methods

2.1. Study Area

This study was carried out in Abagana in Njikoka Local Government Area of Anambra State, South-east Nigeria. The community is located between Latitudes 6^{o}'14' and 6^{0}18'North and Longitude 7^{0}50' and 7^{o}'09' East of the equator (Microft Encarta, 2009). The vegetation is of the rainforest variety supporting several species of trees, shrubs and grasses. Drinking and domestic water supplies are from the small springs and streams running across the community. The biggest stream is the Ngene Egbedani stream flowing down from Eziowelle, running through Nimo, Enugwu-Ukwu and Neni.

The town is made up of six villages viz Adagbe, Akpu, Amaenye, Orofia, Umudunu and Uruokpala and has a population of 105,000 people (NPC, 1991). The inhabitants are mainly of Igbo origin living peacefully with people from other ethnic communities such as Hausas, Fulanis, and Yorubas. The majority of the inhabitants are farmers with a few civil servants, students and other professionals. The community has a health centre that serves the neigbouring communities. It has a rural electrification and a network of laterite roads. Most houses in the community are built of concrete walls with corrugated iron roofing sheets although there are still a few mud and thatched houses around.

2.2. Collection of larvae

A ladle was used to collect mosquito larvae from gutters, vehicle tyres and pools while larvae in small containers were overturned into the collecting bowl.The collections were sieved into a bowl to remove debris. With the aid of pasteur's pipettes the larvae were picked into clean wide mouthed jam bottles with open ends covered with mosquito nettings to allow for ventilation of the larvae. Larvae from tree holes and plant axils were collected using a 10ml pipette to which a large rubber teat was attached to the mouthpiece. The larvae were sent to the National Arbovirus and Vector Research Centre Laboratory at Enugu for identification.

2.3.Collection of indoor biting and resting adult mosquitoes

Indoor biting and resting adult mosquitoes were collected from houses using pyrethrum (insecticide) knockdown collection techniques (PKC). Eighteen rooms were selected from the six different villages (3 houses/ village). Living rooms in which the people slept the previous night were rooms of choice for the study. Two white cloth sheets measuring 3.6m x 3.6m were used to cover the floor of each room. The cloths were laid from wall to wall and were made to overlap with each other at the centre of the room to avoid escape of falling mosquitoes. In houses that were ceiled with no open eaves, the windows and doors were properly shut and the whole room sprayed with Baygon aerosol commonly available in the local markets. In houses with open eaves, all the openings for the escape of the mosquitoes were sealed with rag, paper and the eaves were quickly sprayed from the outside to avoid escape of mosquitoes, before being sprayed inside. 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 to an open space outside the house where they were spread out and the knocked-down mosquitoes collected into the vials, with the aid of a pair of forceps.

2.3.Statistical analysis of data

Data collected from the study were analyzed using Social Sciences Statistical Package (SPSS) version 17.0 at 5% confidence level.

3.Results

A total of 49 sampling sites made up of 17(9.60%) ground pools, 19(10.73%) used tyres and 13(7.34%) domestic water containers were surveyed in the six villages of Abagana (Table 1). A total of 177 mosquito larvae were collected from the sampling sites, of which 64(36.16%) were from ground pools, 73(41.24%) from used tyres and 40(22.59%) from domestic water containers. Of the 177 mosquito larvae collected, 36(20.34%) were from Adagbe village, 48(27.12%) from Akpu village, 31(17.51%) from Amaenye village, 18(10.17%) from Orofia and Umudunu villages respectively, and 26(14.69%) from Uruokpala village. The highest number of mosquito larvae 48(27.12%) were collected from Akpu village, while the least 18(10.17%) were collected from Orofia and Umudunu villages respectively. There was no significant difference in the number of larvae collected from the different villages ($P > 0.05$).

Three species of mosquitoes namely; *Aedes albopictus*, *Culex quinquefasciatus*, and *Anopheles gambiae,* were collected as larvae from different mosquito breeding sites in the six villages of Abagana community (Table 2). Of the 177 larvae collected, 78(44.07%) were *A. albopictus*, collected largely from old tyres 63(35.59%). This was followed by *A. gambiae* 67(37.85%) and *C. quinquefasciatus* 32(18.08%). *A. gambiae* larvae were collected mainly from ground pools 54(80.60%), and a few from domestic water containers 4(2.26%). *A. albopictus* and *C. quinquefasciatus* were collected in the three categories of the breeding sites. There was a significant difference in mosquito species collected as larvae from the different breeding grounds ($P < 0.05$).

A total of 152 indoor-biting and resting adult mosquitoes were collected from 18 houses in the six villages of Abagana community (Table 3). Of the 152 adult mosquitoes collected, 129(84.86%) were from houses with ceilings while 23(15.13%) were from houses without ceilings. The number of mosquitoes collected from the houses without ceilings were significantly lower than those from the houses with ceilings ($P<0.05$). The highest number of adult mosquitoes 30(76.92%) were collected from Akpu village while the least 15(83.33%) were from Orofia village. There was no significant difference in the numbers of indoor-biting adult mosquitoes collected with PKC from the six villages of Abagana community ($P > 0.05$).

The mosquito species identified from the adult collections were shown in (Table 4). Three mosquito species, *A. gambiae* 95(62.5%), *C. quinquefasciatus* 33(21.71%) and *A. aegypti* 24(15.79%), were collected from the six villages of Abagana. *A. gambiae* which is an efficient vector of malaria accounted for 95(62.5%) of the indoor collections with a room density of 5.3 mosquitoes per room per night. The number of *A. gambiae* was significantly higher than those of *C. quinquefasciatus* and *A. aegypti*. *A. gambiae* was the only anopheles mosquito species collected from the study area.

Table 1 Mosquito larvae collected from the various breeding sites in the six villages of Abagana community.

S/N	Study village	Breeding sites: Ground pool		Used tyres		Domestic container		Total larvae collected	% Larvae collected
		No. of breeding sites	No. of larvae collected	No. of breeding sites	No. of larvae collected	No. of breeding sites	No. larvae collected		
1.	Adagbe	4	13	3	17	2	6	36	20.34
2.	Akpu	5	17	5	23	3	8	48	27.12
3.	Amaenye	3	11	4	15	1	5	31	17.51
4.	Orofia	2	8	2	9	2	1	18	10.17
5.	Umudunu	2	8	3	8	3	2	18	10.17
6.	Uruokpala	1	7	2	10	2	9	26	14.69
	Total	17	64	19	82	13	31	177	100

Table 2 Mosquito species collected as larvae from the six villages of Abagana community.

Mosquito species	Breeding sites			Total	%
	Ground pool	Used tyres	Domestic containers		
Aedes albopictus	8	63	7	78	44.07
Culex quinquefasciatus	2	10	20	32	18.08
Anopheles gambiae	54	0	13	67	37.85
Total	64	73	40	177	100
%	36.16	41.24	22.59	100	

Table 3. Numbers of Indoor-biting and resting mosquitoes collected with pyrethrum knockdown method (PKC) from the six villages of Abagana community.

Study village	No. of houses involved	Total number of mosquitoes collected (%)	No. of mosquitoes collected from houses with ceiling (%)	No. of mosquitoes collected from houses without ceiling (%)
Adagbe	3	30 (19.74%)	24 (80%)	6 (20%)
Akpu	3	39 (25.66%)	30 (76.92%)	9 (23.08%)
Amaenye	3	24 (15.79%)	23 (95.83%)	1 (4.17%)
Orofia	3	18 (11.84%)	15 (83.33%)	3 (16.67%)
Umudunu	3	21 (13.82%)	18 (85.71%)	3 (14.29%)
Uruokpala	3	20 (13.16%)	19 (95%)	1 (5%)
Total	18	152	129 (84.87%)	23 (15.13%)

Table 4 Mosquito species collected with pyrethrum knockdown collection (PKC) from the six villages of Abagana community.

	Number of mosquitoes collected in various villages.								
Mosquito species	Adagbe	Akpu	Amaenye	Orofia	Umudunu	Uruokpala	Total	%	Room density
Anopheles gambiae	26	20	16	9	12	12	95	62.5	5.3
Culex quinquefasciatus	3	12	5	2	3	8	33	21.71	1.8
Aedes aegypti	3	4	9	5	1	2	24	15.79	1.3
Total	32	36	30	16	16	22	152	100	8.4
%	21.05	23.68	19.74	10.53	10.53	14.47	100		

4.Discussions

Of a total of 329 mosquitoes from the study area, 177(53.79%) were larvae and 152(46.20%) were adults. The results corroborate with earlier study by (Onyido et al., 2009b). The difference in the numbers of adults and larvae collected could be attributed to the spatial distribution of the different stages. The larvae and other immature stages of mosquitoes live in aggregated colonies in varying volumes of stagnant water and could be collected with one scoop of the bowl in their habitats. The adults on the other hand are highly dispersed and fly scattered in the air, their entry into the houses depended solely on their physiological state of hunger and preference for human blood which attracts them inside the houses (Service, 1980).

Of the three major mosquito breeding sites at Abagana, ground water pools 64(36.16%) and discarded tyres 82(46.33%) yielded very large populations of mosquito larvae while domestic water containers yielded relatively few 31(17.51%). Similar results were obtained by various authors (Onyido et al., 2006a), (Onyido et al.,2009b). It seems that ground pools and discarded tyres were preferred breeding sites as they contained water that were relatively stable for the development of mosquitoes as opposed to the water in domestic containers which were subject to being discarded depending on the water storage needs of the owner.

Most of the *Anopheles* larvae, 54(80.60%) were collected from ground water pools as opposed to 13(19.40%) collected from domestic water containers. *Anopheles* mosquitoes, especially, *A. gambiae* is a selective breeder usually found to breed in sunlit stagnant ground pools in the street, streams and around our homes from where they fly into homes to bite (Service, 1980).

Of the the 78 *A. albopictus* larvae collected 63(35.59%) were from used tyres. *A. albopictus* belongs to *Aedes stegomyia* subgroup that breeds in temporary pools of water especially tin cans, discarded tyres and other man made water holding containers (Gordon and Lavoipirre, 1975), (Service, 1980), (Gordon and Lavoipierre, 1979). The large numbers of discarded tyres in the study area indicates indiscriminate dropping of this commodity that are good breeding sites for *Aedes* mosquitoes. The number of *Aedes albopictus* 188(89.95%) collected in the study is relatively high and could pose a potential danger of epidemic should any arboviral infection be introduced in the community (Onyido et al., 2009a), Onyido et al., 2009c).

The highest number of mosquito larvae, 48(27.12%), were collected from Akpu village while the least, 18(10.17%), were collected from Orofia and Umudunu villages respectively. Akpu village has many natural streams and freshwater swamps that encourage mosquito breeding. While there is none in Orofia village. The distribution and abundance of mosquito depends largely on a number of environmental factors

including the availability of breeding sites (Toure et al., 1994).

Of the 329 mosquitoes collected, 162(49.24%) were *A. gambiae*. This indicates that virtually a half of the mosquito population collected in the study area were malaria vectors, especially *A. gambiae*, which were collected from the temporary ground pools sustained by constant availability of water in fresh water swamps due to overflow of the streams and flooding during the rains. High incidence *Anopheles gambiae* have been reported by (Aribodor et al., 2011) and (Onyido et al., 2011) in different parts of Anambra State, Nigeria (WHO, 1995), noted that in places like Nigeria, there are higher breeding rates of malaria vectors due to rainfall patterns of the area and that the amount of rainfall determines the abundance of mosquito breeding sites.

Anopheles gambiae which is an efficient malaria vector accounted for 62.5% of the indoor biting and resting adult mosquito collections with a room density of 5.3 mosquitoes/room/night. This figure is very high when compared with the critical density of 0.02 bites per man per night required for maintaining transmission. This probably accounts for high malaria prevalence in the area (Onyido et al., 2010). Earlier, (WHO, 1975) observed that *Anopheles gambiae* has high human blood index, high sporozoite index and are typically longlived mosquitoes connected with stable malaria in equatorial Africa.

The findings of this study indicate that almost every person in Abagana community is at risk of malaria attack. The study revealed that *Anopheles gambiae* was not only abundant but breed in all the villages. This calls for mass education of the people on malaria infection, prevention, and control through environmental management. The government of the day should assist communities in adequate environmental sanitation including provision and opening of existing drainages to reduce water accumulation in depressions which will in turn reduce vector breeding sites and malaria transmission through reduced man-vector contacts.

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