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ABUNDANCE AND HABITAT PREFERENCE OF MOSQUITOES IN SOUTHERN NIGERIA

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ABSTRACT: The abundance and habitat preference of mosquitoes in 8 Local Government Areas of Akwa Ibom State was investigated between April 2009 and March 2011, to determine the type of mosquitoes found, their prevalence and habitat. Indoor collections of adult mosquitoes with spray sheet was adopted in line with World Health Organization's standard. Sampling for the immatures stages of the mosquitoes was undertaken in different habitats Monthly collections were undertaken in eight Local Government Areas, four of which were rural areas namely Abat, Odot, Nung Udoe and Oko-Ita while the other four Ikot Ebok, Iba-oku, Edisong, and Ibiakpan were in the urban areas across the 4 major eco-vegetational zones, (Mangrove swamp, fresh water swamp, lowland rainforest and moist woodland savanna). A total of 25 species of mosquitoes belonging to 7 genera namely *Anopheles, Culex, Aedes, Mansonia, Coquilettidia, Eretmapodite* and *Toxorynchite*. Out of a total of 42,547 mosquitoes collected, the dominant genus was *Culex* (20,873, 49%) followed by *Mansonia* (6,018, 14%) and *Anopheles* (4,959; 12%). The least was *Toxorynchite* (181, 0.4%). There was no variation in genera diversity between the 2 years, April 2009 – March 2010 and April 2010 - March 2011, but there were seasonal variations in species diversity. The habitat preference of the mosquitoes species cut across the 4 eco-vegetational zones. The highest numbers were located in the mangrove swamp and the least in the freshwater swamp although differences were also not statistically significant ($F = 5.799$; $P > 0.05$). Species richness was highest in the moist woodland savanna. The abundance of mosquito poses a major treat to human due to mosquito ability to carry disease causing pathogens.

INTRODUCTION

Mosquitoes are slender and relatively small insects belonging to the Phylum Arthropoda, class insecta, order Diptera and Family Culicidae. There are about 34 genera and over 3100 species of mosquitoes worldwide; about 600 species have been described in Afro Tropical regions. Pape (1991) listed about 14 genera and established that about 30% are capable of transmitting diseases to humans. The order Diptera is very large with over 85,000 species of insects. The most important genus are *Anopheles, Culex, Aedes* and *Mansonia*. Female mosquitoes are blood-feeders and various forms of water bodies serve as their breeding sites (WHO 1991). Mosquitoes have a world-wide distribution occurring throughout the tropical and temperate regions where they nevertheless cause considerable annoyance due to their bites, apart from being important disease vectors of malaria, lymphatic filariasis, yellow fever, dengue and encephalitis (Onyido *et. al.*, 2010, Badesi and Akogun 2001).

Female mosquitoes are blood feeders undergoing an autogenous development. They are unable to lay eggs unless they have taken at least one full blood meal (Pape 1991). The more reason they are greedy for human blood and in the process infect their hosts or are themselves infected with malaria, and filarial parasites, including pathogens like viruses. It is compulsory for their eggs to be laid on the surface of water for their survival and continuity. The sites for their egg laying varies from small amount of residual water in discarded containers, coconut husks, hoof-prints, to a large areas of water as in streams, ponds, lakes and rivers. They breed in almost all types of water habitats: mangrove swamp, lowland and woodland savanna, swampy pools, residential environments, gutters and septic tanks. Other factors which influence the abundance of mosquitoes include vegetation cover, climate, resting and breeding sites (Gilliet, 1972, Mbanugo and Okpalononuju 2003).

The species abundance of mosquitoes varied between habitats. High abundance of *Culex quinquefasciatus, Aedes aegypti, Anopheles gambiae and Mansonia africana* in Uyo Akwa Ibom State were reported by Usip and Ibanga (2003) and that the number of mosquitoes entering houses is related to the distance between the house and mosquito breeding sites. Epidemiology of the disease depends on a complex of factors which include distribution of the vectors, rural and urban divide, climatic factors and density of human population (Sebastian and deMeillion 1967, Muller, 1975 and Simard *et. al*,. 2004). In West Africa, *Anopheles gambiae Anopheles funetus* and *Culex quinquefasciatus* have been recorded as main vector of filariasis. Ogunba (1971) incriminated *Culex* species in Ibadan Nigeria, Ngu and Folami (1965) in South western Nigeria, Udonsi (1988) in Igwun river basin of Abia State and Lenhart *et al* (2007) in Plateau State. In Akwa Ibom State of Nigeria limited work (Usip and Ibanga 2003 and Ekanem 2001) has been done on mosquitoes. The objective of this study was to identify the diversity of mosquito species found in Akwa Ibom State and to examine their abundance and habitat preference in the state.

MATERIALS AND METHODS

The Study Area

This work was carried out in Akwa Ibom State, located in the south southern region of Nigeria between 4.32^0 – 5.33^0N and 7.25^0 – 8.25^0E. The vegetation zones are mangrove swamp, fresh water swamp, Lowland rainforest and moist woodland savanna. The State has a mean annual rainfall of between 2000mm and 2500mm. The temperature ranges between 27^0C – 32^0C. There are 2 seasons: the rainy (April – October) and the dry (Nov – March). The population of male to female ratio is 49:51, based on 1991 National census.

Study Sites

The study sites were located in eight LGAs (Eket, Onna, Etinan, Nsit Atai, Uyo, Ibesikpo Asutan, Ikot Ekpene and Ibiono-Ibom) and from 4 vegetational zones (Mangrove swamp, Fresh water swamp, Lowland rainforest, and Moist woodland savanna). Two LGAs were selected from each zone consisting of the dominant urban centre and a rural community. The rural LGAs were randomly selected from the 4 vegetational zones and most of the study sites were near health centres.

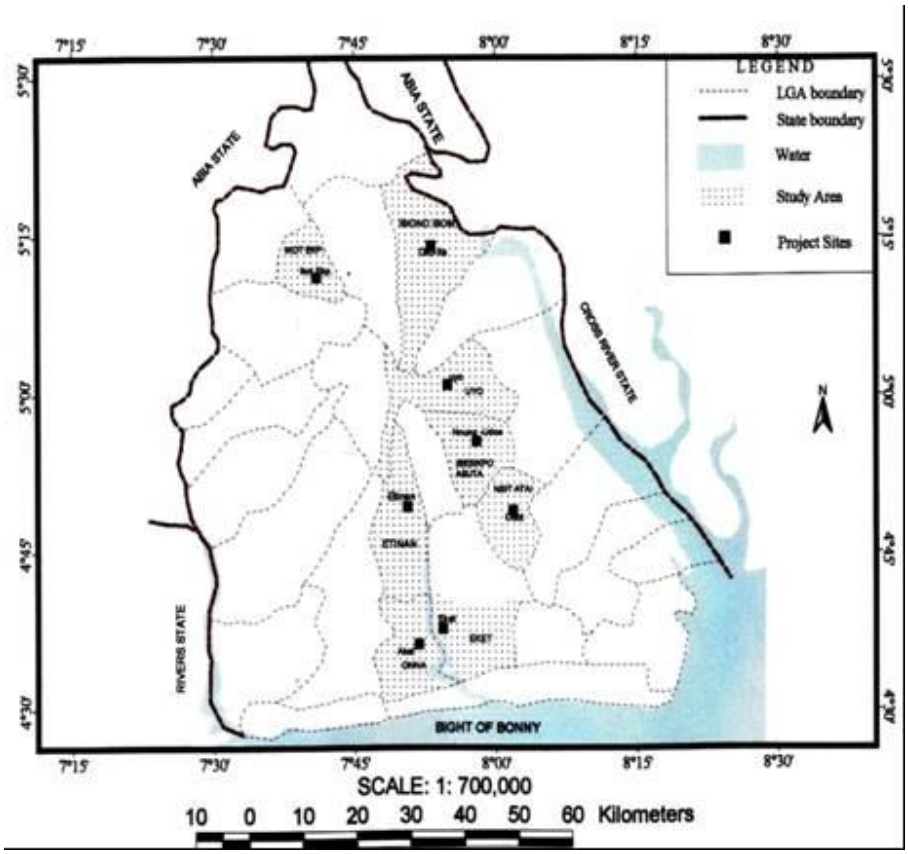

Figure I: Map of Akwa Ibom State showing the Study area

Mosquito Sampling Procedures and Identification.
The survey for adult mosquitoes was for 2 years, April 2009 – March 2011. Initial period involved sensitization of community leaders at the sites in 8 LGAs and selection of houses. Sampling sites were distributed between rural and urban areas.

Indoor collection of adult mosquitoes with spray-sheet was adopted. In each house a room occupied by residents the previous night was used and collections were made in the mornings before 10am. Food items including small furnitures and all flat surfaces were completely covered. The targeted room was sprayed from outside with pyrethrin-based sheltox B.P through openings below doors and later inside clockwise on ceilings and walls until the room was filled with the insecticidal mist. After 20 minutes the room was opened and the sheets carefully picked up at the corners by about 3 staff. Mosquitoes were collected with forceps and placed on soaked cotton wool in containers covered with filter paper. They were later put in insulated box and taken to the lab for counting. Mosquitoes were identified using hand lens and dissecting microscope. The key of Gillett (1972) and Pratt (1972) were used for identification. This was complemented with type specimens, under the supervision of an insect curator.

Data Analysis
SPSS was used for data analysis. The student t-test and analysis of variance (ANOVA) were used. All statistical test were performed at 5% (0.05) level of significance.

RESULTS

The result showed that a total of 42,547 adult mosquitoes in 7 genera were collected. 14,934 (35%) were collected in the first year while 27,613 were collected in the second year.(Table 1)

Table 1: Mosquitoes obtained from indoor collection

Genera	Counts		Mean No Collected	
	2009/2010	2010/2011	2009 – 2011 Total	Mean ± SD
Anopheles	1307	3652	4,959	2479.5
Culex	7764	13109	20,873	10436.5
Aedes	3141	4862	8,003	4001.5
Coquilettidia	474	1281	1,755	877.5
Eretmapodite	311	447	758	379
Mansonia	1874	4144	6,018	3009
Toxorynchite	63	118	181	90.5
TOTAL	14934	27613	42,547	21,273.5

The mosquitoes encountered were *Anopheles* spp (4,959), *Culex* spp (20,873), *Aedes* spp (8,003), *Coquilettidia* spp (1,755), *Eretmapodite* spp (758), *Mansonia* spp (6,018) and *Toxorynchite* spp (181). The most abundant mosquitoes were *Culex* spp (20,873) and the least *Toxorynchit*e spp (181).

Table 2 : Number of mosquitoes obtained by indoor collection in wet and dry season (April 2009 - March 2011)

Season	General	2009 - 2011 No. collected	Mean
	Anopheles	3,396	1,698
	Culex	9,311	4655.5
	Aedes	3,595	1797.5
Wet	*Coquillettidia*	1,010	505
	Eretmapodite	376	188
	Mansonia	2,903	1451.5
	Toxorynchite	173	86.5
Sub Total		20764	10,382
	Anopheles	1,563	781.5
	Culex	11,562	5781
	Aedes	4,408	2204
Dry	*Coquillettidia*	745	372.5
	Eretmapodite	382	191
	Mansonia	3,115	1557.5
	Toxorynchite	8	4
Sub Total		21,783	10,891
Grand Total		42,547	21,273.5

The result in Table 2 indicates that more mosquitoes were collected during the dry season than wet season in 2009/2010 while the reverse was the case in 2010/2011. There was a significant difference ($t = 3.24 < 0.05$) between the numbers of mosquitoes collected in wet and dry seasons.
The seasonal distribution of indoor collected mosquitoes based on genera showed that 14% of *Anopheles* species were collected in the wet season of the first year while 86% of the species were collected in the wet season of the second year. But in the second year more 68% were collected in the wet season than in the dry season (32.1%). In the first year more *Culex* species were collected during the dry season (6808) while the least was *Toxorynchite* species (8). But in the wet season *Culex* species was more in the list (958).

Table 3: Total Numbers of Indoor Collected Mosquitoes in Different Vegetational Zones

Vegetation Zones (Rural/Urban)	Numbers 2009/2010	2010/2011 X	X
Mangrove Swamp Forest (Rural/Urban)	4575	8977	4488.5
Fresh water swamp Forest (Rural/Urban)	2928	5725	2862.5
Lowland rainforest (Rural/Urban)	3288	6641	3320.5
Moist woodland savanna (Rural/Urban)	4143	6270	3135
TOTAL	14934	27613	3806.5

The result in Table 3 indicates the distribution of the mosquitoes with reference to vegetation zones. In the first year, out of a total of 14,934 species collected 30.4% was in the mangrove swamp while the least (22%) was located in the Fresh water swamp. In the second year, out of a total of 27,613 species collected the Mangrove swamp had 33% while the Fresh water swamp had the least (21%). There was a significant difference in number ($P < 0.05$) between the first and second year and the variations in mosquito number across vegetation zones. On the whole the mean abundance of the mosquitoes with respect to ecological zones were Mangrove swamp forest (6,675), Fresh water swamp forest (4,326.5), lowland rainforest (4,964.5) and moist woodland savanna (5,206.5). The species richness of the mosquito examined between 2010 and 2011 indicates that species from the seven genera of the mosquitoes were encountered.

The species richness of Anopheles revealed that six species were collected namely *Anopheles gambiae* (1735), *Anopheles ziemanni* (324), *Anopheles funestus* (95), *Anopheles nili* (66), *Anopheles implexus* (30), and *Anopheles mouchetti* (40). Thus the most dominant species was *Anopheles gambiae*. The most preferred habitat were ground/rock pools and natural waters. Four species of Culex were identified {*Culex quinquefasciatus* (6481), *Culex poicilipes* (496), *Culex tigripes* (1101), and *Culex annuliorus* (14)}. The most abundant mosquito species encounter was *Culex quinquefasciatus* which was found in many habitats mostly pit latrines, ditches and drains and discarded containers. None of the *Culex* species encountered were found in the ground/rock pools.

Eight *Aedes* species were identified with *Aedes aegypti* dominating (2898). Others were *Aedes africana* (369), *Aedes albopictus* (209), *Aedes taylori* (28), *Aedes cumminsii* (18), *Aedes vitattus* (17), *Aedes simpsoni* (77) and *Aedes circumluteolus* (36). *Aedes* most preferred habitats were discarded containers and domestic containers. None was found in natural waters. Only 2 species of *Eretmapodite* were encountered namely *Eretmapodite chrysogaster* (214) and *Eretmapodite inornatus* (71). Eretmappdites preferred discarded containers, holes in plant and domestic containers.

Only one species of *Toxorynchite* were encountered (*Toxorynchite rutilis).* For distribution between rural and urban locations, out of a total of 42,546 collected 51.3% was from urban while 49% was from rural. In the first year, out of 14,934 collected, rural locations had 7,557 (51%) while urban had 7,377 (49.4%). In the second year, out of a total of 27,613 mosquitoes, 14,429 (52.3%) was collected in the urban locations while 13,184 (48%) was collected in rural locations. However there was no significant difference ($t = 0.17$, $P > 0.05$) in the abundance of mosquitoes between rural and urban communities.

Table 4: Relative Abundance of Mosquitoes species reared from breeding site collections (April 2010 – March 2011)

	MOSQUITO SPP	NW	G/RP	DIC	D/D	HP	DOC	PL	TOTAL
1	*Anopheles gambiae*	-	701	428	143	-	463	-	1735
2	*Anopheles ziemanni*	324	-	-	-	-	-	-	324
3	*Anopheles funestus*	95	-	-	-	-	-	-	95
4	*Anopheles nili*	66	-	-	-	-	-	-	66
5	*Anopheles implexus*	-	30	-	-	-	-	-	30
6	*Anopheles mouchetti*	40	-	-	-	-	-	-	40
	Sub total	525	731	428	143	-	463	-	2290
1	*Culex quinquefasciatus*	-	-	1367	1407	55	1467	2185	6481
2	*Culex poicilipes*	294	-	-	202	-	-	-	496
3	*Culex tigripes*	369	-	418	-	314	-	-	1101
4	*Culex annuliorus*	14	-	-	-	-	-	-	14
	Sub total	677	-	1785	1609	369	1467	2185	8092
1	*Aedes aegypti*	-	153	1171	-	508	1066	-	2898
2	*Aedes africanus*	-	90	131	-	44	104	-	369
3	*Aedes albopictus*	-	47	-	-	162	-	-	209
4	*Aedes taylori*	-	-	-	-	28	-	-	28
5	*Aedes cumminsii*	-	18	-	-	-	-	-	18
6	*Aedes vitattus*	-	17	-	-	-	-	-	17
7	*Aedes simpsoni*	-	-	-	-	32	45	-	77
8	*Aedes circumluteolus*	-	36	-	-	-	-	-	36
	Sub total	-	361	1302	-	774	1215	-	3652
1	*Eret chrysogaster*	-	-	75	-	75	64	-	214
2	*Eret inornatus*	-	-	29	31	11	-	-	71
	Sub total	-	-	104	31	86	64	-	285
	Total	1202	1092	3619	1783	1229	3209	2185	14319

NW	-	Natural water
G/RP	-	Ground/rock pool
DIC	-	Discarded containers
D/D	-	Ditches and drains
HP	-	Holes in plants
DOC	-	Domestic containers
PL	-	Pit latrines

DISCUSSION

The high species richness of mosquitoes suggests that the environmental conditions in these ecosystems were complex and favourable to support the continual breeding and survival of these vectors as previously observed by Adeleke (2010). Temperal variations in abundance highlighted the natural fluctuations of environmental conditions. Temperature and rainfall affects the availability of breeding sites and survival of mosquitoes. The most abundant genus was *culex* species as dominated by *Culex quinquefasciatus*. The high numbers of *Culex quinquefasciatus* was similar to result obtained by Ogunba (1971) and Usip and Ibanga (2003) who reported that *Culex quinquefasciatus* accounted for 70% and 43.5% respectively of mosquitoes in urban areas of Ibadan and Uyo respectively. The high numbers of *Culex quinquefasciatus* in rural areas is significant because the species was before considered an urban one (Bockarie *et. al.*, 2009). It is apparent that with urbanization the species is extending its range into rural areas in all ecovegetational zones. The rural advance had been observed by Chavasse *et. al* (1995) in Tanzania, East Africa. The dominance of *Culex quinquefasciatus* in indoor collections both in urban and rural locations indicates that this species is becoming increasingly endophargic and endophilic. This result has established the species richness of mosquitoes, important vectors in human helath across the 4 eco-vegetational zones. It has further confirmed that the two major vectors of bancroftian filariasis *Anopheles gambiae* and *Culex quinquefasciatus* were distributed across the zones. Finally this studies has confirmed that *Culex quinquefasciatus* once considered and urban species and a major vector of bancroftian filariasis was widely distributed in rural areas in Akwa Ibom State. The breeding distribution of the mosquitoes in the study area indicates that Akwa Ibom State is an endemic region for malaria and there are confirmed endemic foci of Onchocerciasis and lymphatic filariasis. Vector-borne diseases such as those transmitted by Mosquitoes contribute significantly to the total disease burden in developing countries. Knowing where infectious diseases are likely emerging could also aid health worker in diagnosing and treating patients promptly. This implies that both Federal and State government should pay necessary attention in the control and possible elimination of these diseases and their mosquitoes vectors in different ecological zones of the State and Nigeria as a whole.

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