ANOPHELES SPECIES ABUNDANCE AND VECTORAL COMPETENCE IN FOUR LOCAL GOVERNMENT AREAS OF GOMBE STATE NORTHEAST NIGERIA.

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Abstract

Malaria is a great public health problem in Nigeria contributing greatly to poverty stabilization in the country. Anopheles mosquitoes have been identified as the major vectors of the disease. Competency of each vectoral species differs from one species to another and from one place to the other. This study reports one year species abundance, their composition and vectoral competence of Anopheles species in four Local Government Areas of Gombe State Nigeria. Pyrethrum Spray Collection (PSC) method of indoor resting mosquitoes was used according to method of (WHO, 2009) Species identification was done morphologically and by Polymerase Chain Reaction (PCR) .Enzymes linked immune-arsobent assay (ELISA) was used to examine sporozoites infected Anopheles and their blood meal origin. Out of the 4,912 mosquitoes collected indoors, 65.1% were Culex 34.7% Anopheles and 0.2% Aedes. The result also showed that 65.7% of the Anopheles collected was engorged; the highest number of engorged Anopheles was recorded in Balanga and the least in Gombe LGA. Anopheles spp composition identified molecularly revealed the presences of three spp viz: Anopheles gambiae ss (3%) Anopheles arabiensis (84%) and Anopheles funestus ss (12%). Anopheles gambiae ss had 100% Human Blood Index (HBI) Anopheles funestus ss, 93% (HBI) whereas; Anopheles arabiensis had 71% (HBI). Anopheles gambiae ss and Anopheles funestus ss where the most competent species in terms of human blood index. The infectivity rate revealed that the highest sporozoites rate was recorded in Anopheles funestus ss 3.4% followed by Anopheles arabiensis 1.6% , Anopheles gambiae ss recorded 0% infectivity rate hence the least competent vector in terms of sporozoites rate. The present study has provided baseline data for formulating malaria control program in Gombe State Nigeria.

Keywords: *Anopheles spp Vectoral Competence, Malaria, Human blood index, Sporozoites rate Gombe-Nigeria.*

Background to the Study

Mosquitoes are the most important insects that affect human health in Nigeria, contributing greatly to poverty stabilization in the country by spreading malaria, lymphatic filariasis and other viral infections. Malaria is a problem in Africa and Nigeria in particular contributing greatly to absenteeism from office, school, farms and market places. Accurate estimation of the extent of the morbidity and mortality is difficult in view of the weakness of the reporting systems for infectious diseases in Africa (WHO,2009) an estimated figure of 60% African population have malaria each year (Awolola, et al; 2005) In Nigeria the risk exist

throughout the country more than 200million die from it alone in Nigeria. It also account for 25% infants mortality and over 30% childhood mortality (Annon, 2003; FMOH, 2010;Lamogo and Yoriyo in press). Anopheles mosquitoes have been incriminated as the major vectors (Gilles & Coetzee 1987;Okwa, et al; 2007) different Anopheles species vectors have been reported in different parts of the country depending on the ecological zones ranging from the Southern to the Northern part of Nigeria(Awolola, et al; 2002, 2003, 2005) from the south and Gadzama,(1983), Samdi, et al; (2005) from the Northeastern part)

Malaria transmission is variable depending on the ecological zone; this has an impact on its epidemiology and control (CDC2004). Malaria transmission is holo endemic in the southern part (Awolola, et al; 2005) and hyper endemic in the Northern part (Samdi, et al; 2005). Scanty information on the infectivity rate of Anopheles mosquitoes and its vectoral competence is lacking in Nigeria as reported by Awolola, et al (2002; 2003; 2005) and Samdi, et al (2005). Vectoral competence is a component of vectoral capacity governs by genetic factors that influence the ability of a vector to transmit a pathogen. Host feeding preference or susceptibility to sporozoite stage of plasmodium species are important components of vectoral competence. This study aimed to identify and compare the Anopheles species, the sporozoites rate and human blood indexes of Anophelines mosquitoes found in the four Local Government areas of Gombe State; with the objectives of: Identifying the Anopheles species found in the study area and ascertaining the infectivity rate and human blood indexes in each species. The result of this study has provided a baseline data for the control of malaria in the state.

Materials and method

Study area.

Nigeria is 923,768km2 wide (Mabogunje, 1993), with a population of 140.3 million (2006 census). Gombe State has 11 Local Government Areas located between latitude 9o 3011 to 12o 3011 North and longitude 8o 4511 to 11o 4511 East. It has a surface area of 20, 265sq.km. The projected population of the state from the 2006 Census is 2,657,246 people National population commission (NPC) 2009. The vegetation of the area is savannah type. The major occupation of the people is farming and to some extent fishing.

Sampling

Before commencement of the study, communities of the four affected Local Governments areas were informed through advocacy team. The cooperation of the communities was sort through their village heads, religious leaders and community leaders on the teams that will visit their houses to collect adult mosquitoes.

Adult Mosquito Sampling Using Pyrethrum Spray Collection (PSC)

The method, usually applied in the morning, between 06.00am to 9.00am was conducted on monthly bases from January to December 2011. In each of the four Local Government areas selected, five communities one from each of the four cardinal points: North, South, East, West and the Centre were identified and marked. In each of the five communities identified, ten houses were randomly selected and labeled as Entomology (ENT) 1-10. In each of the ten houses one room was marked for the exercise. The inhabitants of the marked rooms who do not normally used aerosol were selected. They were also instructed not to live their doors and windows open the following morning. The collection team was composed of five trained entomology technicians.

Application of the method

The windows and doors were first closed on arrival if found opened, all eaves (openings) were blocked where feasible, then all floor surfaces, beds and furniture were completely covered with white sheets. The spraying of the aerosol was first started from outside the rooms by the eaves, before spraying the inside of the room for about 30 seconds. With the door closed; it was allowed to stay for 10 minutes. At the end of the time, the room was then opened, and carefully the white sheets were retrieved, starting from the door and moving to the interior of the room (a more practical method was to remove the white sheets carefully, lifting them by the four corners and moving them gently so that the mosquitoes were gathered in the middle of each sheet).

The sheets was taken outside, examine with hand lens and all the mosquitoes on the white sheet were collected with forceps into labeled Petri-dish (es), lined with filter paper. The mosquitoes were sorted out in to Anophelines and Culicines and were preserved individually into Eppendorf tubes containing silica gel (desiccant) one mosquito per tube, for laboratory processing which was done at the National Institute of Medical Research (NIMR) Lagos.

Preservation of mosquitoes in Eppendorf tubes.

Silica gel was added to an Eppendorf tube up to half of the tube, a small piece of tissue paper was then placed on the silica gel and compress tightly on the silica gel. A Mosquito was then placed on the tissue paper and the mouth closed tightly. Each tube was labeled appropriately it was then Placed on a labeled storage box for PCR molecular work which was done on all the blood fed female Anopheline mosquitoes.

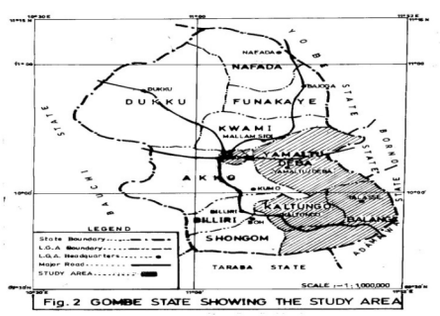

Fig I map of Nigeria showing Gombe State.

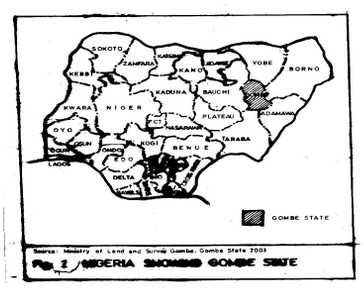

Fig II map of Gombe State showing the study area.

Results

A total of 4,912 mosquitoes were collected out of which 65.1% were Culicines, 34.7% Anophelines and 0.2% Aedes. The highest collection of mosquitoes was recorded in Balanga LGA(31.5%) followed by Kaltungo(24.5%), Y/Deba (22.3%) and the least in Gombe(21.6%).

Balanga recorded the highest no of Anopheles spp (53.3%) with the least of Culicines 46.3%. Gombe on the other hand recorded the highest occurrence of Culicines 82.6% with the least number of Anopheles 17.3% as shown in Table 1.

The result showed that a total of 65.7% of the Anopheles collected were blood fed (engorged) and more than 50% in all the four areas were blood fed. The highest number of engorged Anopheles was recorded in Balanga (73.2%) with the least at Gombe (53.4%) as in

Table 2.

Anopheles species composition identified molecularly revealed that, An. arabiensis recorded the highest occurrence of 84%, this percentage was almost found in all the four areas. An.funestus ss recorded a prevalence of 12%; the least occurring specie was An.gambiae ss 3%. The distribution of An.gambiae ss

showed the highest occurrence in Yamaltudeba (5%) followed by Balanga (4%) and none was recorded in Gombe, as shown in Table 3. The human blood index (HBI) of Anopheles gambiae ss was 100% in all the areas recorded. This means that they were more anthropogenic than the rest. An.funestus ss recorded 93% HBI whereas, An.arabiensis the most cosmopolitan in the study area had the least HBI of 71% meaning that An. funsetus ss are more competent than An.arabiensis in terms of human blood meal and second to An.gambiae ss, as shown in Table 4.

The infectivity rate also revealed that, An.funestus ss had the highest infectivity rate (3.4) followed by An.arabiensis (1.6). But An. gambiae ss had zero infectivity rates, Balanga LGA had the highest sporozoite rate of (5.2) followed by Yamaltudeba (3.8), Kaltungo (1.7) and Gombe having the least infectivity rate of 1.4 as shown in Table 5.

Table 1 Morphological distribution of indoor resting mosquitos' species in the four LGAs

Areas /spp	Anopheles spp.		Culex spp.		Aedes spp.		Total (%)
Balanga	827	53.3%	718	46.3%	3	0.2%	1549(31.5)
Gombe	184	17.3	879	82.6	0	0	1063(21.6)
Kaltungo	465	38.5	740	61.3	2	0.2	1207(24.5)
Yamaltudeba	229	20.9	861	78.7	3	0.3	1093(22.3)
Total	1705	34.7	3198	65.1	8	0.2	4912

Table 2 Anopheles with blood meal (engorged) and without (un engorged) in the four areas.

Areas	Engorged	% engorged	Un engorged	%un engorged	Total
Balanga	539	73.2	197	26.7	736
Gombe	70	53.4	61	46.6	131
Kaltungo	230	58.1	166	41.9	396
Y/Deba	106	60.2	70	39.8	176
Total	945	65.7	494	34.3	1439

Table3 Species composition of blood fed female Anopheles (identified molecularly) in the four areas, with percentages in parenthesis (%).

Areas/species	An.gambie ss		An. arabiensis		An.funestus ss		Total
Balanga	20	(4)	454	(84)	65	(12)	539
Gombe	0	(0)	62	(88)	8	(11)	70
Kaltungo	8	(3)	188	(81)	34	(14)	230
Y/Deba	6	(5)	89	(84)	11	(10)	106
Total	34	(3)	793	(84)	118	(12)	**945**

Table 4 Human blood index (HBI) of Anopheline species encountered.(% from total blood fed of each spp)

Areas /spp.	An.gambie ss		An.arabiensis		An.funestus ss		Total
Balanga	20	(100)	318	(70)	60	(92)	398
Gombe	0	(0)	30	(48)	8	(100)	38
Kaltungo	8	(100)	153	(81)	32	(94)	193
Y/deba	6	(100)	64	(72)	10	(91)	80
Total	34	(100)	565	(71)	110	(93)	709

Table5 Infectivity/sporozoites rate, with its percentage from Human blood index of each spp

Areas/spp.	An.gambie ss		An.arabiensis		An.funestus ss		Total (%)	
Balanga	20	(0)	6	(1.3)	2	(3.1)	28	(5.2)
Gombe	0	(0)	1	(1.6)	0	(0)	1	(1.4)
Kaltungo	8	(0)	3	(1.6)	1	(2.9)	4	(1.7)
Y/Deba	6	(0)	3	(3.3)	1	(9.1)	4	(3.8)
Total	34	(0)	13	(1.6)	4	(3.4)	17	(1.8)

Discussion

The high occurrence of culicines in this report may be due to increased human activities which favors the breeding site of culicines. This was evident as observed in Gombe LGA the state capital. The low occurrence of culicines observed in Balanga agrees with the finding of Awolola et al(2007) who reported that, Anopheles mosquitoes breeding sites decreases from rural to urban areas, while that of culicines increases in that direction.

The result showed that, 65.7% of the Anopheles collected were engorged, these was close to the finding of Okwa, et al; (2007) who recorded 40.7% HBI in Lagos. This high human blood meal may be due to poor house construction and lack of protective mosquito nets in the houses thereby exposing humans to high man biting rate (Yoriyo et al in press). The molecularly identified species revealed three species, An. gambiae ss, An. arabiensis and An. funestus ss. Similar to the work of Oringanje, et al; (2011) and Okwa, et al ;(2007) who reported these species in addition to An. moucheti and also to that of Samdi, et al; (2005) in Maiduguri who reported the occurrence of these species with the exception of An.funestus ss.

The report recorded 100% HBI of An. gambiae ss as against 75.7% of OKwa et al (2007) and 71% An. arabiensis ss as against 2.1% in Lagos. The high human dependence of these species in this area could be due to the fact that they are predominantly savannah vectors. There was a 93% HBI in An .funestus ss as against 21% observed in Lagos, these showed that An. funestus ss was a more competent malaria vector in terms of human blood meal and sporozoite rate, thus posing a serious treats in this area. The occurrence of 100% HBI, but with zero infectivity rate observed in An. gambiae ss opens a new chapter on why the low infectivity since they were known to be good vectors elsewhere; could it be genetically, environmental, or combination of both? This is a question that cannot be answered by this finding.

According to Githerko, et al; (1994)species which feed on many host are less likely to be such a good malaria vector as highly anthropophagic ones ,hence An. arabiensis may be a lesser competent vector compared to the rest as up to 30% had other animal blood meal. An. arabiensis was the most prevalent malaria vector in the area, but less competent compared to An. funestus ss. An. gambiae was the most anthropophagic but least infective hence the least competent vector in the study, after An. funestus ss and An. arabiensis. This is of research interest because they were known to be good malaria vectors elsewhere as reported by OKwa et al ;(2007) and Awolola, et al; (2003) .

Although the An. gambiae omnipotency has been settled by Annon, (2003) and Gilles & Coetzee (1987); this report revealed that more work need to be done on these species in the Savannah area. Okwa et al (2006) showed that An. gambiae ss was the most prominent species in Badagry Lagos, with an infectivity rate of 4.2% and HBI of 67.3%, It appears as the least in infectivity rate but highest in HBI in this study. Oyewole et al (2006) reported more of Anopheles melas and least of An. arabiensis these was in variance with this report where An. arabiensis was the highest and no An.melas recorded. This confirms the fact that An.malas is a vector of the mangroves whereas An. arabiensis are savannah vectors. The postulation of Gilles and Coetzee (1987) that An. funestus ss are the next problematic species in Africa has been unveiled. Therefore, this species complex deserved the most needed attention especially in the study area.

A Malaria resistant mosquito has been developed in the laboratory. This suggest that the competent vectors in terms of human blood meal like Anopheles gambiae ss as observed in this study could be manipulated by locating resistant genes.

The malaria vectoral system in these four areas which are far from each other shows that an understanding of these local vectors bionomics and transmission are vital for successful malaria control. Any strategy adapted by these heterogeneities so that relevant Anopheles species in each area can be targeted. The present study has provided baseline data for formulating malaria control program in Gombe State Nigeria.

Acknowledgments
The authors are thankful to the residents of the four local governments' areas for allowing the collection of mosquitoes in their houses. We are also grateful to the State Ministry of Health and Malaria Control Booster Project Gombe (MCBP) for providing the logistics, aerosols and financing the Molecular analysis. We also appreciate the Management of National Medical Research Institute Yaba Lagos for allowing us used their facilities we also appreciate Mal Umar Galadima ,Railwanu Bukar, Ibrahim Zambuk, Martha Gawon and Markus Yusuf for the collection of mosquitoes, we are also grateful to Mrs Martha Doya for typing and typesetting the manuscript.

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