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Abundance of Nocturnal, Endophagous and Anthropophilic *Anopheles* Species in Relation to Human Malaria Transmission in an Urban and a Rural Community of Abia State, Nigeria

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ABSTRACT

In this study, abundance of nocturnal, endophagous and anthropophagous adult *Anopheles* species in relation to human malaria transmission in an urban setting (Umuahia) and a rural community (Uturu) in Abia State, Southeastern Nigeria, were comparatively investigated for a period of 24 months (January, 2009-December, 2010) using "night indoor human-balt insecticide spray sheet catches" and abundance of human malaria parasites vectors was also investigated. Peripheral blood smears were used to determine prevalence of malaria parasitaemia among inhabitants of the study communities. The results indicated that a total of 501 adult female *Anopheles* mosquitoes were caught: 171 (34.13%) comprising *A. gambiae* and *A. funestus* in Umuahia urban and 330 (65.87%) comprising *A. gambiae*, *A. funestus* and *A. moucheti* in Uturu community. The results also showed that *A. moucheti* was not found in Umuahia urban setting. Nocturnal, endophagous and anthropophilic *Anopheles* species were significantly more abundant in the rural area (Uturu) than the urban (Umuahia) at $p<0.05$. Prevalence rates of malaria parasitaemia between the two communities did not differ statistically at $p<0.05$: n = 231 (74.52%) in Umuahia urban and n = 230 (74.19%) in Uturu. Both urban and rural areas were coendemic for *Plasmodium vivax* and *Plasmodium malariae*. There was no correlation between malaria vectors abundance and transmission at both the urban and rural setting of the study areas. Proper implementation of the use of impregnated bed net in both urban and rural areas for the control of malaria should be advocated.

Key words: Anopheles, nocturnal, endophagous, anthropophilic, malaria transmission

INTRODUCTION

The female mosquito is the principal vector of many of the vector-borne diseases affecting human and other animals in the tropical and temperate parts of the globe (Bigoga *et al*., 2007; Mohan and Ramaswamy, 2007). All female adult mosquitoes are haematophagous in their feeding habit. While some are zoophilic others are anthropophilic in their host's preference

(Mendis *et al*., 2000). They become infected and carriers of causative agents of several serious zoonotic and human diseases when they feed on blood of infected animal hosts (Coker *et al*., 2001) while the diseaseagents they carry are inoculated into the blood stream of heath animals through their bites (Wanji *et al*., 2003).

Most important anthropophilic mosquitoes belong to the genera *Aedes*, *Anopheles* and *Culex* (Torre *et al*., 2002). *Anopheles* is perhaps the best known genus and has noxious species that are carriers of human malaria causative agents, *Plasmodium* species (Abdoon and Al-Shahrani, 2003; Duchemin *et al*., 2001) and constitute a major human health problem in malaria endemic regions of the world (Mohan and Ramaswamy, 2007; Oparaocha, 2003).

Different *Anopheles* species exhibit marked preferences for resting and biting in particular habitats. There may be differences between day-time (diurnal) and night-time (nocturnal) resting as well as biting habits. Most *Anopheles* species feed in the night, rest inside animal dwellings after feeding as well as bite indoors. The *Anopheles* species that regularly bite humans (anthropophagous) inside human habitation (endophagous) and at night (nocturnal) are often important vectors of human malaria parasites (Nandi *et al*., 2000). Transmission of human malaria requires contacts between these important vectors and their human hosts (Lee *et al*., 2001). Thus, the abundance of female adult nocturnal, endophagous and anthropophilic anopheline mosquitoes in any geographical location is an important factor in determining the prevalence and transmission of human malaria (Shililu *et al*., 2003). *Anopheles* are species complexes with different species involved in transmission in different bio-geographical zones of malaria endemic regions of the world. Fontenille and Lochouarn (1999) discussed the complexity of malaria vectorial system in Africa.

In Nigeria and many other developing countries, there has been a marked increase in the number and size of towns and cities without corresponding increase in such services that inhibit the breeding of malaria vectors. As a result, there has been an increase in the abundance of human malaria vectors and the extent of urban malaria transmission. This situation is common in the southeastern zone of Nigeria. Since the national programme for malaria control under the "Roll-Back Malaria Initiative" requires information on the malaria transmission from all the bio-geographical zones of the country, this study reports on work carried out on the abundance of nocturnal, endophagous and anthropophilic *Anopheles* species in relation to malaria transmission in an urban setting and a rural community in Abia State southeastern Nigeria.

MATERIALS AND METHODS

Study area: ABIA is an acronym formed from the initial letters of four groups of people, namely, Aba, Bende, Isuikwuato and Afikpo. Located in the southeastern region of Nigeria, Abia State lies within latitudes 4°40' 6°14' north and longitudes 7°10' and 8°0' east. The ecological characteristics of Abia State were described by Ijioma (1993).

Umuahia (5°32'20"N, 7°28'52"E) is the state capital and is located in the central part of the state. It has a good drainage system and less polluted environments. However, bushy undeveloped plots of land abound in the city and its environs. Stagnant water bodies creased by household activities are available in all the nooks and crannies of the town.

Uturu (5°51'22"N, 7°30'54"E) is a rural community. The community has streams that provide water all year round to the inhabitants. The streams overflow their banks during the rainy season and are likely to provide all year round breeding places for vectors of malaria parasites in the community.

Mosquito collections and identification: Mosquito sampling was realized using indoor human-bait nocturnal insecticide spray sheet method. Four residential buildings and a bed room per house were selected randomly from each study community, as collection sites. Mosquito collections were carried out by 8 insect collectors (4 collectors per community). Collectors used themselves as baits inside empty bedrooms having mosquito inlets and white sheet covered floor from 7.00 pm (19.00 h) Nigerian time, covered the inlets and applied insecticide spray contained in aerosol cans inside the rooms between 11.00 pm (23.00 h) and 3.00 am (03.00 h) local time.

Knocked down anophelines were picked and transported to entomology laboratory of Animal and Environmental Biology Department of Abia State University, Uturu, Nigeria, for identification. The anophelines were identified into species using morphological keys given by Gillett (1972). Collection at each site was made once in a week and for 24 months (2009-2010). All collectors received prophylactic treatment for malaria.

Blood sample collections and microscopy: Peripheral blood samples were collected from consented individuals resident in the study communities. Venous blood (5 mL) was collected from each participating individual aged above 10 years using disposable syringe in line with the method by Fleck and Moody, (1998), while thumb blood was collected from children of 0-10 years cohort by finger-prick method using disposable sterile lancets.

Thin and thick smears were prepared with the collected blood samples and examined under the microscope for the presence of malaria parasites. The parasites were further identified into species as guided by Fleck and Moody (1998).

Data analysis: Statistical analyses were performed using chi-square test, analysis of variance (ANOVA) and student's t-test. p-values <0.05 were considered significant.

RESULTS

Anopheles abundance: Between 1st January, 2009 and 31st December, 2010, a total of 501 human malaria vectors, comprising of 272 (54.29%) *Anopheles gambiae*, 156 (31.14%) *A. funestus*, and 73 (14.57%) *A. moucheti*, were caught in both urban (Umuahia) and rural (Uturu) setting in Abia state of Nigeria (Table 1). The abundance of these *Anopheles* species differed significantly in each study location (t-test, $p<0.05$). Greater species richness was recorded in the rural area, where all the three species were found, than in the urban setting, where only two species were prevalent. Human malaria vectors were significantly more abundant in the rural than the urban areas of Abia state at $p<0.05$.

Table 1: Composition and abundance of nocturnal, endophagous and anthropophagous *Anopheles* species in Umuahia and Uturu from January, 2009 to December, 2010

	No. of caught species		
Prevalent *Anopheles* species	A	B	Total species (relative abundance %)
Anopheles gambiae	101 (37.13)	171 (62.87)	272 (54.29)
Anopheles funestus	70 (44.87)	86 (55.13)	156 (31.14)
Anopheles moucheti	0 (0.00)	73 (100.00)	73 (14.57)
Anopheline total	171 (34.13)	330 (65.87)	501 (100.00)

A: Umuahia urban, B: Uturu rural

Table 2: Gender related prevalence of malaria parasitaemia in Umuahia and Uturu during the study period (January, 2009 to December, 2010)

	No. of individuals examined		No. of individuals infected	
Gender	A	B	A	B
Males	155	155	106 (68.39)	116 (74.84)
Females	155	155	125 (80.65)	114 (73.55)
Overall	310	310	231 (74.52)	230 (74.19)

A: Umuahia urban, B: Uturu rural, values in parenthesis are percentages equivalent

Table 3: Comparison of *Anopheles* abundance and prevalent of malaria parasitaemia in Umuahia and Uturu during study period (January, 2009-December, 2010)

Study area	*Anopheles* population and relative abundance	Malaria parasitemia prevalence rate	Prevalent *Plasmodium* species	Species infection rate
A	171 (34.13)	231 (74.52)	*P. falciparum*	205 (88.74)
			P. vivax	24 (10.39)
			P. malariae	2 (0.87)
B	330 (65.87)	230 (74.19)	*P. falciparum*	203 (88.26)
			P. vivax	17 (7.39)
			P. malariae	10 (4.35)

A: Umuahia urban, B: Uturu rural, values in parenthesis are percentages equivalent

Malaria transmission: Blood samples were collected from 310 subjects comprising equal numbers of male and female residents in the study communities between 1st August, 1999 and 30th September, 2010 to ascertain prevalence of malaria of malaria parasitaemia in relation to vector abundance. 231 (74.52%) blood samples in Umuahia urban, made up of 106 (68.39%) males and 125 (80.65%) females, showed positive blood smears, while in the rural area 230 (74.19%) subjects: 116 (74.84%) males and 114(73.55%) females, had malaria (Table 2). Levels of malaria transmission in the two study communities did not differ statistically (χ^2, $p>0.05$). Both urban and rural areas were coendemic for *P. falciparum*, *P. vivax* and *P. malariae* malaria during study period (Table 3). Though malaria prevalence rates were significant, there was no significant difference in malaria prevalence between urban and rural areas of the state during the present study period at $p<0.05$.

Vector abundance in relation to malaria transmission: The data presented are indicative of high levels of malaria transmission by nocturnal, endophagous and anthropophilic *Anopheles* in rural and urban areas of Abia state, southeastern Nigeria and would be of value for developing future intervention strategies. Results of this study have revealed that level of human malaria transmission in any locality depends upon the prevalence of the important malaria vectors and independent upon abundance of the vectors.

DISCUSSION

The present study was carried out to update our knowledge of the prevalent nocturnal, endophagous and anthropophilic *Anopheles* species and their abundance in relation to human malaria transmission in urban and rural setting of Abia state, southeastern Nigeria. Nigeria is part of the afrotropical malaria zone (Onyabe and Conn, 2001) and Abia state is one of the malaria endemic areas of Nigeria (Ukpai and Ajoku, 2001).

Anopheles gambiae and *A. funestus*, recorded in the present study, are the main human malaria and filariasis vectors in Nigeria (Anosike *et al*., 2003) as well as efficient vectors of human malaria in other areas of Africa (Manga *et al*., 1997). Relative abundance of the important human malaria vectors differed between the study localities, with fewer vectors and *Anopheles* species collected in Umuahia than Uturu. This result is in agreement with the fact that less availability of suitable habitats and increased water pollution generally inhibit the development of anopheline larvae in urban centres, resulting in fewer anopheline mosquitoes (Keating *et al*., 2004). The lower *Anopheles* species abundance recorded in Umuahia in the present study supports reports that urban areas typically have low anopheline mosquito populations and that city centres are significantly less likely to harbor mosquitoes as a result of decreased open space, increased pollution and different economic activities (Robert *et al*., 2003). It is also generally thought that the abundance of clean, sunlit, and shallow water bodies, as were observed in Uturu community, make rural populations vulnerable to increased contact with anopheline mosquitoes (Shililu *et al*., 2003). The difference in the vector abundance between the urban and rural localities in the present study conforms with the finding of Bruce-Chwatt (1993) that the density of anophelines increase as the distance to the city centre increases, with rural areas being more likely to harbour *Anopheles* mosquitoes as compared to urban areas.

The high prevalence rates of malaria in Umuahia as well as Uturu show that malaria infection is endemic in both urban and rural areas of Abia state, southeastern Nigeria. These findings agree with those of Ukpai and Ajoku (2001) that malaria is holoendemic in Nigeria and that it is one of the reasons of high mortality rate in children. The high prevalence rates of malaria in both the urban and rural study communities could be due to the prevalence in the two localities, of the important vectors of human malaria. Prevalence of more than one Anopheles species in both the urban and rural areas could have enhanced malaria transmission in the two communities. This is because each sympatric *Anopheles* population varies in their capacity to transmit malaria parasites (Cohuet *et al*., 2004).

The implication of the findings of this study include: that prevalent Anopheles species in Umuahia and Uturu are efficient transmitters of human malaria parasites in Africa high population densities of prevalent *Anopheles* species in the study locations expose the inhabitants to incessant contact with the malaria parasites carriers; vectors were more abundant in the rural area (Uturu) than the urban (Umuahia); irrespective of the difference in abundance of the vectors, high rates of malaria prevalence were recorded indicating high levels of malaria transmission in both communities.

The findings of this study reveal that the major and efficient human malaria vectors in sub-Saharan Africa are prevalent in Umuahia and Uturu making the communities malaria endemic. Also, there is high level of human malaria transmission in both locations as indicated by the high malaria prevalence rates recorded in the areas. These results indicate that both urban and rural areas in Abia state of Nigeria may be malaria endemic and expose the need for public health concern in both urban and rural settings in the state, especially in both study localities.

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