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Effect of housing patterns on the indoor resting density of mosquitoes vector in the rural *communities* of Sagbama local government area, Bayelsa state, Nigeria

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Abstract
The housing conditions and the resting behaviour of mosquito vectors are factors that influenced vector borne diseases in community settings. This study was undertaken to determine the effect of housing conditions on the indoor-resting density of mosquitoes in the rural communities of Sagbama Local Government Areas of Bayelsa State. Data were collected from 16 houses. Indoor-resting mosquitoes were sampled using pyrethrum spray catches (PSCs) during January to March, 2016. Mosquitoes were identified morphologically using standard key. Two thousand, one hundred and thirty mosquitoes in 2 genera were identified. Species compositions in their increasing order of abundance were *Culex quinquefasciatus* (67.4%) and *Anopheles gambiae* (2.3%). The mosquito species in their increasing order of abundance in the study communities are Toru-orua (28.64%), Angalabiri (24.88%), Bolou-orua (24.41%) and Sagbama (22.07%). The differences of the mosquito species across locations were not significant ($F=0.9618$ $df=3$, $p>0.05$) The indoor resting of the mosquito species according to housing patterns were Batcher houses with zinc roof (38.03%), mud wall and thatch roofed houses (29.58%), Block wall houses with corrugated roof without ceiling (29.11%) while (3.29%) were recorded in modern block buildings with ceiling and screened windows. The differences of mosquitoes species across building types were significant ($F=11.2247$, $df=3$, $p<0.05$). This result is a demonstration on the needs to improve housing conditions as an agent for disease control.

Keywords: Mosquito, vector, housing pattern, abundance, sagbama, bayelsa state

1. Introduction

Mosquitoes are responsible for several human diseases in tropical Africa [1, 2]. Out of the 300 mosquitoes species that have been identified, over100 species are known to cause diseases in human [3-5]. *Culex quinquefasciatus, Aedes aegypti, Mansonella perstan,* culicoides species (biting midges); *Loa loa, Chrysops dimidiata* female *Anopheles* mosquito are several mosquito species that transmit different kinds of parasites in human and animal [6, 7].

Mosquito borne diseases are responsible for > 5000 death across the globe; children accounted for >20-30% of the disease burden [8]. The burdens of the diseases have translated to huge economic losses, social disgrace, low productivity and sleeplessness in many part of the world [9]. The transmission of the disease are influenced by several factors,, such as poor sanitation, mosquito feeding behavior, preferred blood meal, resting density and environmental modification are factors that can influenced the disease transmission [10].

The efforts to control mosquito have span through international and national level with different control strategy; yet, mosquito still represents a significant threat to human and animal health. Effect of housing conditions on the spatial pattern and entering behavior of mosquitoes have received attention as an important segment of the epidemiology and control of vector borne diseases in the recent time [11]. Studies elsewhere have demonstrated that relationship between housing patterns and resting behavior of mosquito vector do exist [12]. Houses with a grass roof have been associated with high malaria risk in Mozambique [13]; poorly constructed houses were also associated with high indoor vectors density in Sri Lanka [14]. In Kenya, Zhou *et al*. [15] reported that mosquito density was significantly lower in older houses, and higher in houses with mud walls and grass thatch roofs. However, information on the relationship between housing pattern and vector density does not exist in Bayelsa. This study therefore assessed the relationship between housing pattern and mosquito indoor density in the rural communities of Bayelsa State.

2. Materials and Methods

2.1 Study Area: The study was carried out in the rural communities of Sagbama Local Government Area of Bayelsa State. Sagbama (5º 09′N and 6º 14′E) is situated in the tropical rain forest areas where most houses still show features of traditional architecture with mud walls and thatched roofs [16]. Only few houses had block walls and corrugated iron sheets. The major occupations of the people are fishing, farming and petty trading.

2.2 Mosquito sampling: The study combine both field and laboratory studies. A cross sectional study design to determine the effect of housing conditions on the density of indoor-biting and indoor-resting mosquitoes in the rural communities of Sagbama Local Government Areas of Bayelsa State was conducted during January to March, 2016. Four rural communities in Sagbama Local Government Area were randomly selected. The communities are Sagbama, Angalabiri, Boru-orua and Angiama. Four houses (sixteen altogether) in the selected communities were sampled. These houses were divided into groups based on the architectural design. The groups are: A = Modern block houses with ceiling and screen; B= Block houses without ceiling and screen; C = Thatch houses with mud walls; D = Batcher houses with zinc roof.

2.3 Mosquito Collection: The pyrethrum spray catch (PSC) method for mosquito collection was adopted [17]. A pyrethroid spray catches was used to collect mosquito thrice quarterly from the randomly selected houses in each town/villages. Verbal consent was obtained from the household heads. In each house, at least one person must have slept in the selected room the night prior to the morning of collection. Selected rooms were used throughout the studies. Detail on the preparation for PSC houses has been described [2]. Prior to spraying, the floors of the selected rooms were covered with clean white sheets; all pet animal, food stuff and water were evacuated. Spraying of commercial pyrethroid (Mortein) was undertaken (5-6 am). The rooms were kept air tight for 15minutes after spraying. The white sheets were inspected for adults, which were picked up with fine forceps into labeled Petri dishes and preserved in refrigerator for identification.

2.4 Morphological Identification: Mosquitoes collected were identified morphologically according to standard keys [3, 18]. When Palps was shorter than the proboscis the mosquito was considered a *Culicine*. When palp and proboscis were of equal length, legs speckled, with banded veins at the costa and subcoastal of the wings and white band at segments 2 – 5 of the tarsus of the hind legs were used to confirm members of *Anophels gambiae s.l.* The patterns of wings and numbers of white bands on the palps were used to separate *Anopheles gambiae* from *A. funestus* and *A. nili* [3] Properly separated mosquitoes were individually placed in 1.5ml eppendorf tubes and preserved in silica gel for further studies.

2.5 Method of data analyses: Simple percentage was used to show the distribution of mosquito in different houses across communities. The effect of housing patterns on the mosquito abundance were determined by chi-square at P= 0.05.

3. Results

Two thousand, one hundred and thirty mosquitoes were collected from 16 houses. The mosquitoes were in two genera; Culicine and Anopheline. The species are *Culex quinquefasciatus* 2040 (95.77) and *Anopheles gambiae* 90(4.23). The mosquito compositions by study locations in their increasing order of abundance are Toru-orua (28.64%), Angalabiri (24.88%), Bolou-orua (24.41%) and Sagbama (22.07%). The differences of the mosquito species across locations were not significant ($F=0.9618$ $df=3$, $p>0.05$) Table 1. The species composition showed similar trend across the study location (fig 1). When species were pooled into housing patterns, more mosquitoes (38.03%) were collected from batcher houses with zinc roof, followed by mud wall houses with thatch roofed (29.58%). Block wall houses with corrugated roof without ceiling and screen had (29.11%) while fewer mosquitoes (3.29%) were recorded in modern block houses with ceiling and protected windows. The differences of mosquitoes species across building types were significant ($F=11.2247$, $df=3$, $p<0.05$) Table 2. The same trend was observed with all the mosquito species (fig 2)

Table 1: Species composition by study location during January, 2016 to March, 2016

Location	species		
	C. quinquefasciatus	***Anopheles gambiae***	**Total**
Sagbama	440 (21.57)	30 (33.33)	470 (22.07)
Boru-Orua	500 (24.51)	20 (22.22)	520 (24.41)
Toru -Orua	580 (28.43)	30 (33.33)	610 (28.64)
Angalabiri	520 (25.49)	10 (11.11)	530 (24.88)
Total	2040 (95.77)	90 (4.23)	2130

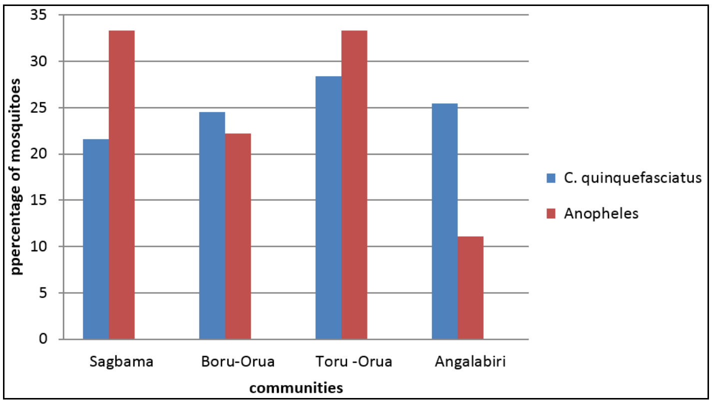

Fig 1: Trend in species composition of mosquito across locations

Table 2: Species Composition by Housing Pattern during January, 2016 to March, 2016.

location	species		
	C. quinquefasciatus	*Anopheles gambiae*	Total
A	60 (2.94)	10 (11.11)	70 (3.29)
B	570 (27.94)	50 (55.56)	620 (29.11
C	620 (30.39)	10 (11.11)	630 (29.58)
D	690 (33.82)	20 (22.22)	810 (38.03)
Total	2040 (95.77)	9 (4.23)	2130

ŧ Numbers in parentheses is the percentages of mosquito species caught in different housing pattern. A= Modern building+ ceiling and screen; B= Block wall without ceiling and screen
C= Mud wall +thatched roof; D= wooden wall+ Zinc roof

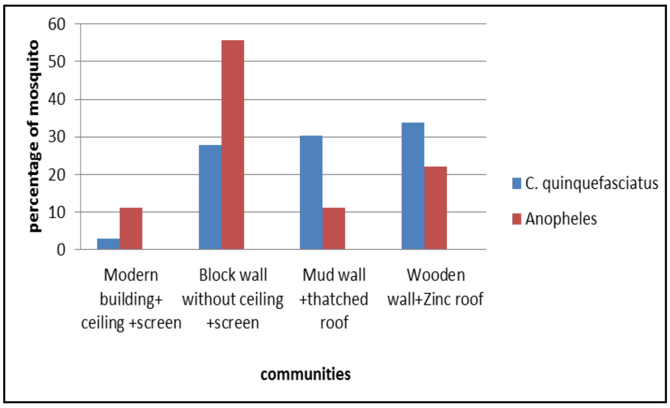

Fig 2: Trend of Species Composition by Housing Pattern

4. Discussion

The two mosquito species (*Culex quinquefasciatus* and *Anopheles gambiae*) encountered at the study location is an indication that they are anthropogenic. This observation is consistent with Ebenezer *et al.* [19]. *An. gambiae* encountered during this study highlighted their efficiency of the two mosquito as malaria vector [20]. The indoor abundance of the mosquito species does not vary significantly with locations. This is possibly because the factors that influenced the house entering behavior of these mosquitos may be similar in all the study locations [21, 22]. The study location is a typical low deltaic plan that is mostly surrounded with water. This waterlogged environment was responsible for the increased breeding behavior and density of the mosquitoes.

Although, mosquito species were encountered in all the residential houses in the study communities, the housing characteristics had significant effect on their entry and indoor resting behavior. The percentages of mosquitoes recorded in this present study were 9-fold lower in modern building with screen door and windows than other house conditions. This highlighted the importance of incorporating mosquito screening during building plan of houses.

In this present study, the number of *Anopheles* mosquito that attempted to bite in houses that are not properly screened was 55.6% higher than other housing conditions. This is an indication that unprotected houses may increase the access for mosquito to enter and rest indoor. More so, the proportion of *Anopheles* mosquito was 11.1% lower in properly protected houses than other housing conditions. This could be attributed to the practice of always keeping screened windows and doors open in order to increase the aeration of the inside house to reduced temperature. The effect of low ambient temperature on indoor resting density and biting rates of mosquito had been reported elsewhere [12].

The lower prevalence of *Culex* mosquito in modern, screened windows and doors was not surprising. In a study in Ganbia, Nje *et al.* [23] demonstrated that Culex mosquito preferred doors and windows as route to enter houses. The variation in the mosquito abundance in relation to housing pattern in this present study agrees with the report of Animut *et al.* [12] who reported that block houses without paints or ceilings had higher number of *A. gambiae* while houses with open eaves were associated with increased risk of *Culex quinquefasciatus*. The high density of mosquito inside houses with open eaves in this present study may highlight the predominant upward-flying behavior of the mosquito when it encountered wall surfaces [24, 25]. Ye *et al.* [11] also supported that constructing houses with iron-sheet roof instead of thatched roof could reduce malaria infection risk. However, An. gambiae encountered in close eaves have the tendency of increasing malaria prevalence when the right controls strategy in not implemented.

5. Conclusion

Houses with open eaves have proven to have high density of indoor-resting mosquitoes. Better house designed in addition to the implementation of control programmes may help to reduce indoor resting and indoor-biting rates of both *Culex quinquefasciatus* and *An. gambiae*. These may increase the propensity of increasing transmission dynamics of vector borne diseases. It is recommended therefore that houses built with modern facilities should also be sprayed with pyrethroid regularly in order to reduce the mosquito indoor resting density.

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