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SPECIES COMPOSITION, RELATIVE ABUNDANCE AND SEASONAL VARIATIONS OF MOSQUITOES BREEDING IN DIFFERENT SITES IN IKEDURU L.G.A., IMO STATE, NIGERIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The study aimed at identifying mosquito species associated with human activities, determined species composition, relative abundance and the seasonal variations of the mosquito species in Ikeduru L.G.A., Imo State, Nigeria. Mosquitoes were randomly sampled in the area using standard methods. Results on species composition and abundance of mosquitoes confirmed eight species. They were *Aedes africanus* (18.84%), *A. aegypti* (20.16%), *A. taylori* (4.14%), *A. albopictus* (17.53%), *A. luteocephalus* (5.88%), *Anopheles gambiae* (7.79%), *Culex quinquefasciatus* (22.88%) and *C. vittatus* (2.78%) belonging to three genera (*Anopheles*, *Aedes* and *Culex*). *Culex quinquefasciatus, Aedes aegypti, Aedes africanus and Aedes albopictus* were the most abundant species encountered in this study whereas, *Anopheles spp.* recorded a significantly lower number. The results indicated that *Aedes aegypti* and *A. albopictus* bred well in cassava/maize processing sites; *A. albopictus* bred in indiscriminately dumped tires; *A. africanus* and *C. quinquefasciatus* bred well in exposed stored water while *A. aegypti, A. taylori, A. luteocephalus, Anopheles gambiae* and *Culex vittatus* bred lowly in exposed septic tank and exposed stored water. Specific analysis revealed that fermenting/ cassava processing site had a relative high abundance of mosquitoes while exposed decorated pots and vessels had the least. Three mosquito genera implicated in this study were recorded monthly throughout the year and their populations were high from April to August with peaks between June and July followed by a decline that persisted to March of the following year. *Culex* mosquitoes were consistently more abundant on monthly basis compared to *Aedes* and *Anopheles*. The peak population period of the mosquito genera coincided with high rainfall experienced between June and August annually in Nigeria. This has implications for effective control and therefore, time-specific interventions are necessary.

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Keywords: Mosquito species; human activities; species composition; peak population; time-specific interventions.

1. INTRODUCTION

Mosquitoes breed and multiply in tropical areas because of the abundance of rain and vegetation which provide a comfortable environment for it to thrive. They have different breeding sites with collection of water, which may include tree holes, floor containers, street gutters, abandoned fish pounds, old tiers, forest canopy as well as swamps [1,2,3]. Mosquitoes superficially resemble crane flies (family: Tipulidea) and Chironomid flies (family: Chironomidae). Casual observers seldom realize that there are important differences between their habits. Mosquitoes are generally slender, fragile and small sized insects with two pairs of wings, a pair of membranous wings covered with scales and reticulate venation and a pair of halters or vestigial wing otherwise called balancer. Adult mosquitoes are differentiated into male and female species. The males are nectriphagous, sucking only water, sap and nectar from flowering plants while the female mosquito species are haematophagous, sucking blood from man and other vertebrates; thus this makes it easy for this dangerous vector (female mosquito) to convey disease parasites as well as cause nuisance to man and livestock [4,5,6], whereas members of similar-looking Chironomida, Tipulidae are not. There are 41 genera of mosquitoes, containing approximately 3,500 species worldwide and over 150 species are documented in the United States alone. Some important arbovival infections of man transmitted by mosquitoes include: malaria for species in the genus *Anopheles*; yellow fever, Chikungunya and dengue, for species in the genus *Aedes*; Lymphatic Filariasis (nematode worm) for species in the genus *Culex*, *Anopheles* and *Aedes* species; Japanese Encephelitis and Eastern Equine Encephelitis for species in the genus *Culex*; and western Equine Encephalitis for species in the genus *Culex* and *Aedes* [7]. Species identification is important for controlled programme since breeding and biting habit differs between species of mosquitoes.

2. MATERIALS AND METHODS

2.1 Study Location

The study was carried out in Ikeduru, Imo State, Nigeria. Figs. 1 and 2 present details of sites/locations.

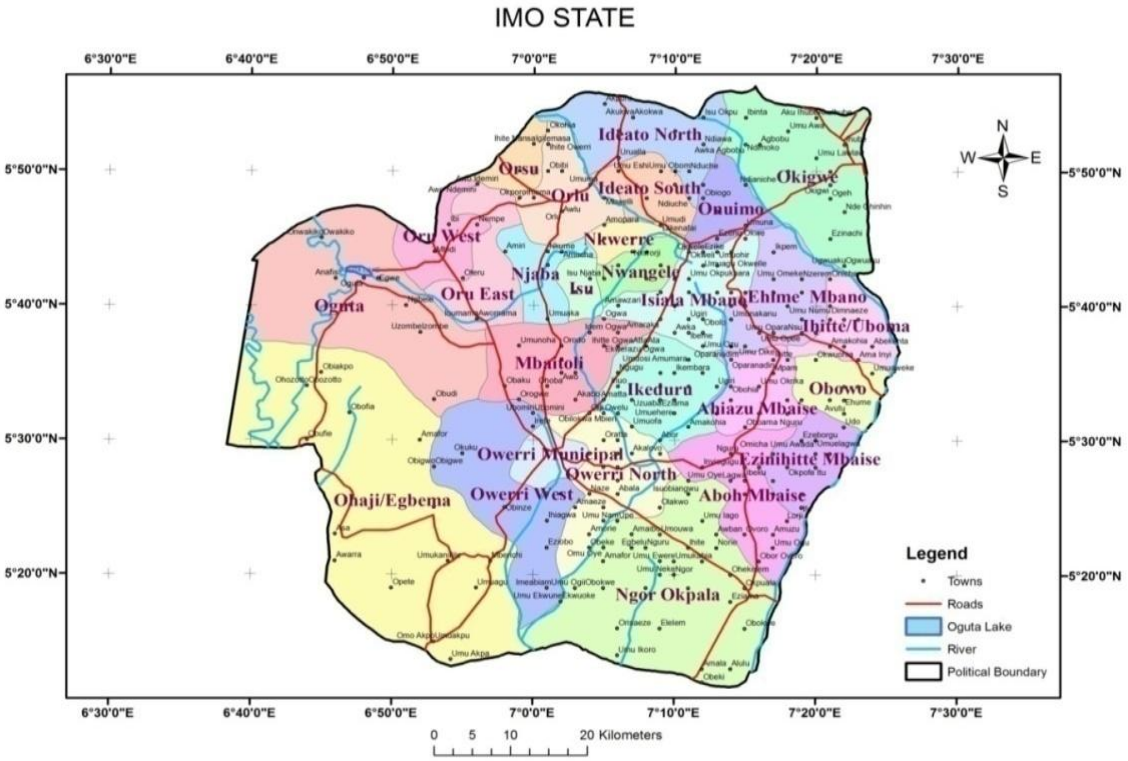

Fig. 1. Map representing Imo State and the neighbor towns
Source: Nzewuihe et al. [3]

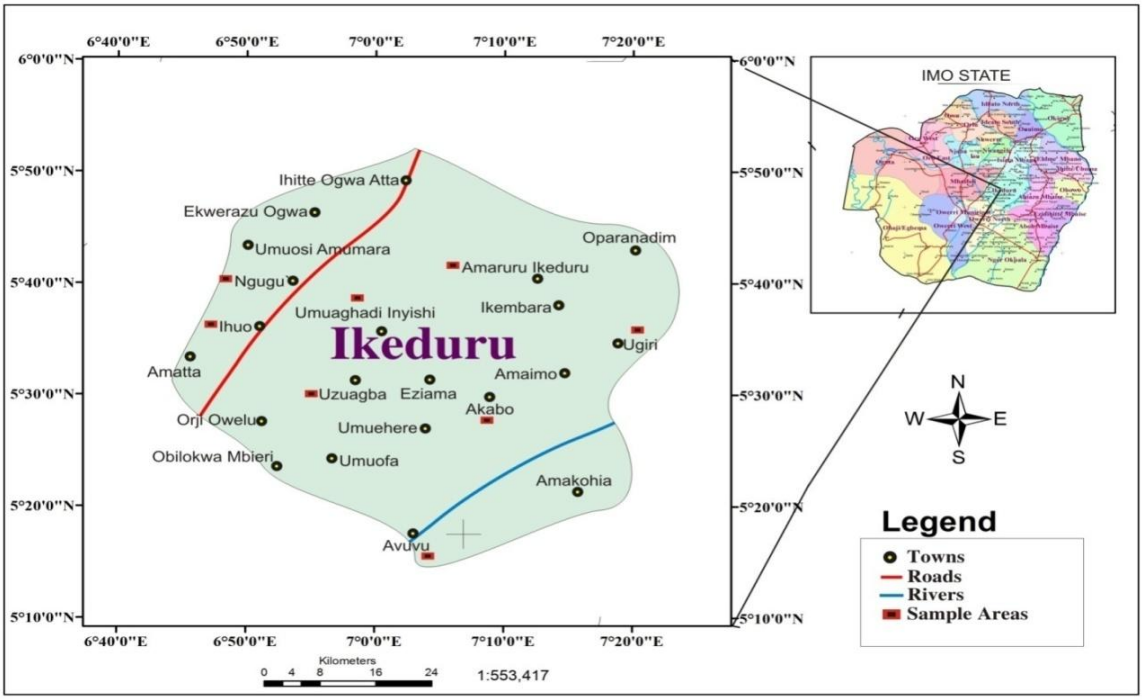

Fig. 2. Map representing Ikeduru L.G.A. and the sampled locations
Source: Nzewuihe et al. [3]

2.2 Preliminary Survey and Informed Consent

Preliminary survey carried out helped to achieve informed consent of Community Participants. Briefly, visits around the communities were made in the company of Field Assistants with an introductory/consent letter. The villages engaged in human activities that aid breeding of mosquito vectors were visited and interactions were effected- informing them of the researcher's interest in conducting the research in their area. The researcher also explained the purpose of the study to the potential respondents and got their consent to participate in the research by way of voluntarily responding to the questions posed on them via questionnaire items.

2.3 Research Design and Sample Size

This research design permitted the investigation and description of existing conditions/ specific factors among large populations [3]. The design considered exclusion and inclusion criteria. The questionnaire was distributed to the respondents in the various sampled communities and collected after completion of the answers to the questions. Trained Field Assistants helped in the administration of the questionnaire to ensure adequate coverage. Data collected were recorded and analysed using standard statistical tools. Calculation of sample size was based on standard protocol as follows:

$$\boldsymbol{n = \frac{N}{1 + N(e)^2}}$$

n = sample size; N= population; e= 0.05.

2.4 Validation of the Research Instrument and Reliability Test

The questionnaires prepared to address the different specific objectives of this study were validated by experts before they were administered to the respondents. Cronbach [8] reliability test technique was applied.

2.5 Mosquito Sampling in Different Communities

Houses and breeding sites in different communities of the study area were randomly selected and sampled from December 2017 to November 2019 to identify the mosquito species associated with human activities in Ikeduru L.G.A., determine the species composition and relative abundance of mosquitoes in their breeding sites and determine the seasonal variations of mosquito species in the area. Therefore, season was considered. Standard mosquito sampling procedures were employed [2]. Captured mosquitoes were morphologically identified using published keys [9,4] and assistance from Expert Entomologists. Rearing

larvae to adulthood to enhance accurate identification was done when the need arose.

2.6 Statistical Analysis

The software used to run data analysis in the study were SPSS (Statistical Package for the Social Sciences) version 21 and Excel Package. Data obtained were analyzed using analysis of variance and graphs. Upon the significance of F-test, significantly different means were separated using least significant difference (LSD). A probability level of 0.05 was considered for all statistical inference.

3. RESULTS AND DISCUSSION

Results on species composition and abundance of mosquitoes confirmed the presence of eight species (Fig. 3). Briefly, they were *Aedes africanus* (18.84%), *A. aegypti* (20.16%), *A. taylori* (4.14%), *A. albopictus* (17.53%), *A. luteocephalus* (5.88%), *Anopheles gambiae* (7.79%), *Culex quinquefasciatus* (22.88%) and *C. vittatus* (2.78%) belonging to three genera (*Anopheles* = 1 species; *Aedes* = 5 species and *Culex* = 2 species). *Culex quinquefasciatus, Aedes aegypti, Aedes africanus and Aedes albopictus* were the most abundant species encountered (Table 1). The overall abundance of mosquito genera varied significantly ($p < 0.05$), with *Culex* and *Aedes* having high abundance compared to *Anopheles spp.* which recorded a significantly lower number (Table 1). The results further showed that *Aedes aegypti* and *A. albopictus* bred well in cassava/maize processing sites; *A. albopictus* bred in indiscriminately dumped tires; *A. africanus* and *C. quinquefasciatus* bred well in exposed stored water while *A. aegypti, A. taylori, A. luteocephalus, Anopheles gambiae* and *Culex vittatus* bred lowly in exposed septic tank and exposed stored water. Fig. 4 emphasized on the relative abundance of mosquito species in their breeding sites and showed that *C. quinquefasciatus* and *Aedes africanus* bred well in exposed stored-water and septic tank. *Aedes aegypti* and *A. albopictus* bred well in abandoned tires and fermented cassava and maize sites, whereas *A. aegypti, A. taylori, A. luteocephalus* bred lowly in exposed septic tank and stored water. Fig. 5 shows the seasonal variations of mosquitoes of the area. There were significant differences in mosquito abundance in relation to season. The three mosquito genera (*Anopheles*, *Aedes*, and *Culex*) were recorded monthly throughout the year and their populations were high from April to August with peaks between June and July followed by a decline that persisted to March of the following year. *Culex* mosquitoes were consistently more abundant on monthly basis compared to *Aedes* and *Anopheles*. The peak population period of all the mosquito genera coincided with high rainfall that is usually experienced between June and August annually in Nigeria.

The eradication of malaria and allied diseases transmitted by mosquitoes could not be easy, because some human activities that encourage their breeding, is more or less sources of livelihood for man. In this study, the most frequently recorded mosquito vectors globally (*Culex*, *Aedes* and *Anopheles*), were observed. These species are known for transmission of pathogens of debilitating diseases such as *Wuchereria bancrofti* known for elephantiasis during heavy infection [7] and *Aedes aegypti* and *Aedes albopictus* known for yellow fever [10]. *Aedes albopictus* and *Anopheles spp*. have been reported to be the most efficient malaria vector worldwide whereas *Culex spp*. are notorious for lymphatic filariasis [10,11]. Judging from the results of relative abundance of mosquito species, it can be inferred that individuals in Ikeduru L.G.A. are susceptible to the diseases transmitted by *Culex quinquefasciatus* and *Aedes aegypti*. Their abundance in Ikeduru localities can be strongly attributed to high rate of human activities in the area which inadvertently encouraged rapid breeding of the mosquitoes. This is supported by literature [2]. In fact, the role of fermented cassava

Table 1. Composition and abundance of mosquito species captured in Ikeduru L.G.A., Imo State, Nigeria during 2017 and 2018

Serial No.	Mosquito species	Abundance (%)*
1	*Aedes africanus*	18.84 ± 2.45^{a}
2	*Aedes aegypti*	20.16 ± 5.78^{a}
3	*Aedes taylori*	4.14 ± 1.15^{b}
4	*Aedes albopictus*	17.53 ± 2.50^{a}
5	*Aedes luteocephalu*	5.88 ± 1.71^{b}
6	*Anopheles gambiae*	7.79 ± 2.52^{b}
7	*Culex quinquefasciatus*	22.88 ± 10.34^{a}
8	*Culex vittatus*	2.78 ± 0.50^{c}

**Values are means ± standard error of the means. Values in the column with same letter are not significantly different by LSD ($\alpha = 0.05$)*

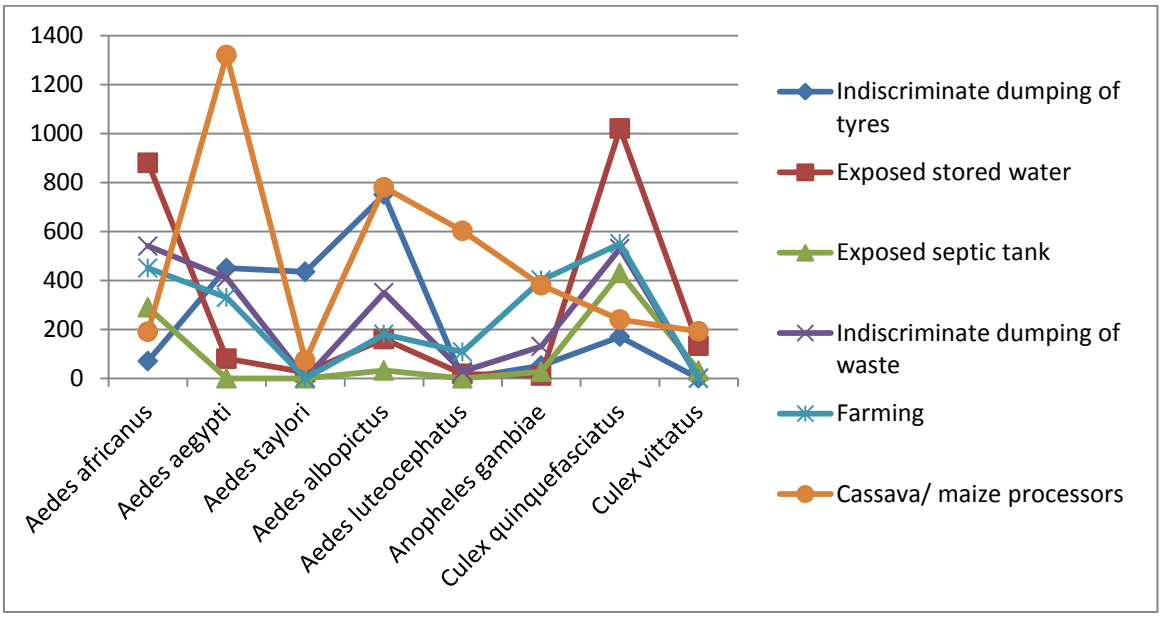

Fig. 3. Mosquitoes species populations associated with human activities in Ikeduru L.G.A., Imo State, Nigeria

Key: Each dot under each species represents its high or low abundance

and farm land as major breeding sites of mosquitoes has earlier been recorded. The composition of mosquitoes belonging to three genera (*Anopheles*, *Aedes* and *Culex*) recorded has been reported by several studies in Imo Sate and other parts of Nigeria [12,13]. Mosquito species occurred in all the six habitats sampled in Ikeduru L.G.A. and populations were relatively abundant throughout the season with peak population observed between June and July, probably due to high rainfall. It is a common knowledge that high rate of precipitation favors rapid breeding of mosquito vectors and therefore, it is not surprising that peak populations of the insects occurred between June and July. The month of April to October is usually the wet season in Nigeria and it is characterized by high humidity, high rainfall and average temperature of 26.5^{o}C. The impact of precipitation notwithstanding, a combination of these factors could be responsible for higher mosquito abundances recorded during the rainy season. The increases in mosquito population during the wet seasons have been previously reported in Nigeria and elsewhere [14]. Environmental factors such as temperature, relative humidity and seasonality have been found to be indices of mosquito distribution [7]. The persistence monthly occurrence of all three mosquito genera in the area may be due to the increased and varied human activities, urbanization and other related anthropogenic factors that create different natural and artificial habitats as sources of water for breeding sites for several mosquito species. Also poor economic condition, low literacy levels, poor sanitation levels, indiscriminate disposal of wastes (such as household materials, cans, plastic and metal containers) and indiscriminate disposal of tires may in part, be responsible for the proliferation of mosquito breeding sites in Ikeduru. In this study, the results revealed that *Culex* was the most abundant genus while *Anopheles* was the least. The absence of significant differences between *Culex* and *Aedes* genera showed that Ikeduru L.G.A. is a good breeding ground for both mosquito genera. This study revealed that *Culex* species ranked as the leading genus followed by *Aedes* and *Anopheles* species. Most *Culex* species have been reported to prefer pools and containers as breeding sites [10]. The occurrence of *Culex* species recorded in this study is similar to the findings of [9]. The persistent occurrence of *Aedes*, *Culex* and *Anopheles* species and human activities which culminate in breeding habitat diversification by these mosquitoes as recorded in this study, pose a serious epidemiological concern to the inhabitants of Ikeduru L.G.A. Further seasonal analysis revealed that the months of June and July recorded the highest number of *Culex quinquefasciatus* and *Aedes albopictus*. This agrees with [7] that *Aedes* larvae are more rapidly collected in July. The concerned months indicate the peak of their breeding periods and this has implications for effective control of these species. In other words, time-specific interventions would be necessary to achieve control at a time when adults and larvae are very abundant in the environment. The peak of rainy season supports pockets of dirty water with much pollution, and again, this inadvertently supports profuse breeding of *Culex* and *Aedes* [15].

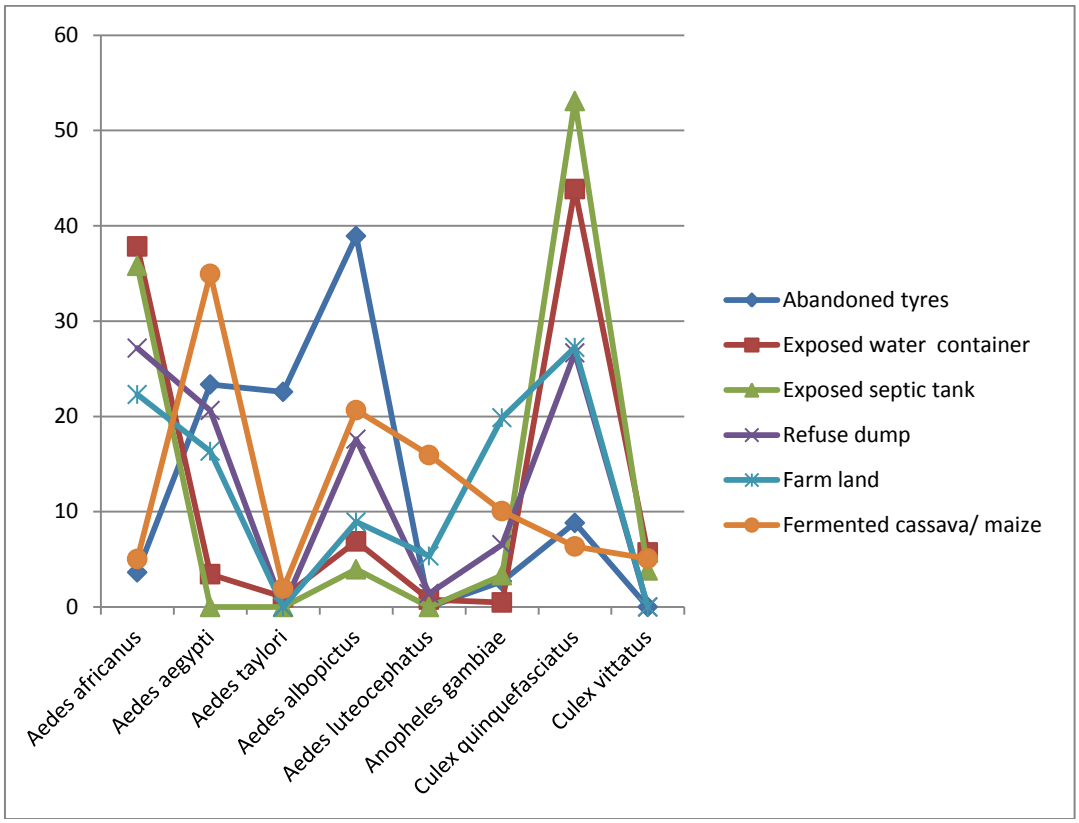

Fig. 4. Relative abundance (%) of mosquito species in their breeding sites
Key: Each dot under each species represents its high or low abundance

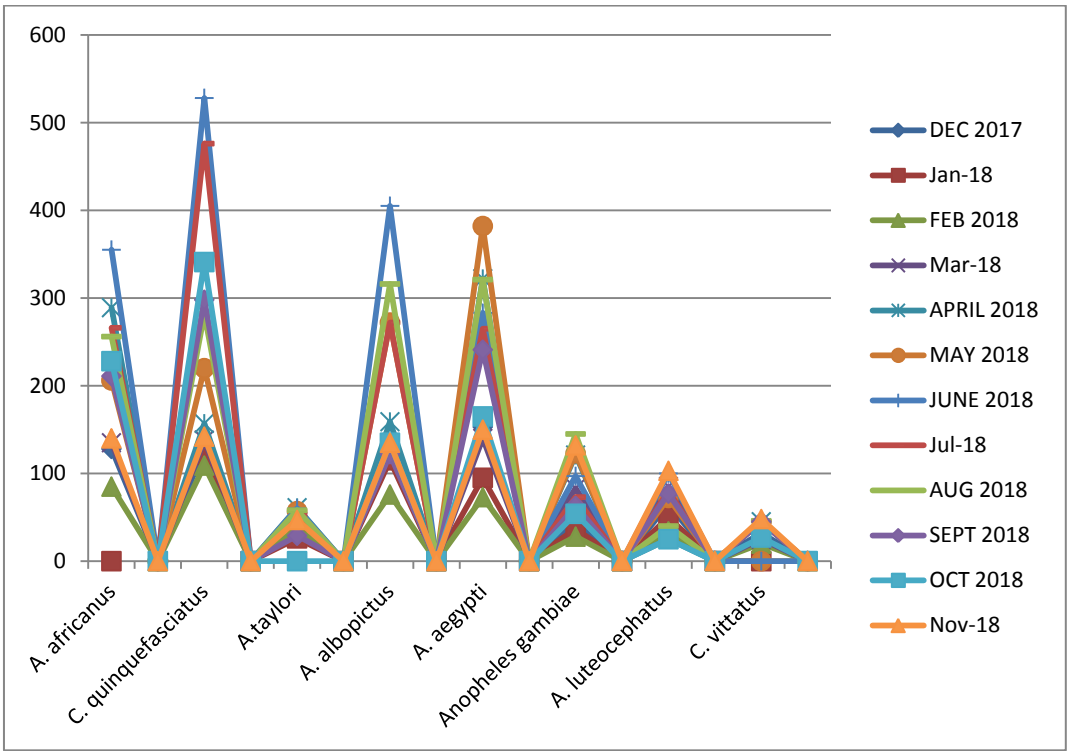

Fig. 5. Seasonal variations of mosquito species in Ikeduru L.G.A., Imo State, Nigeria
Key: Each dot under each species represents its high or low abundance

4. CONCLUSION

Aedes aegypti and *A. albopictus* bred well in cassava/maize processing sites; *A. albopictus* bred in indiscriminately dumped tires; *A. africanus* and *C. quinquefasciatus* bred well in exposed stored water while *A. aegypti*, *A. taylori*, *A. luteocephalus*, *Anopheles gambiae* and *Culex vittatus* bred lowly in exposed septic tank and exposed stored water. Fermenting/ cassava processing site had a relative high abundance of mosquitoes while exposed decorated pots and vessels had the least.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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