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Phyto-Environmental Variables, Mosquito Abundance and Malaria Prevalence in University of Uyo, Town Campus.

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Abstract: A study was carried out to investigate the influence of Phyto-environmental variables on mosquitoe abundance and malaria prevalence amongst student in University of Uyo town campus. Data on the abundance of female mosquitoes were obtained from weekly collections at 4 sampling stations within the study area between 07:00 and 09:00am hours throughout the season (June – July 2020). In order to provide information on incidence of malaria among individuals in each location, structured questionnaires were randomly administered to 80 respondents (20 in each location) on a weekly basis for four rounds. The results showed that the distribution of malaria vector in the study locations and on a temporal scale differed significantly. Conclusively, malaria seems endemic in location 3 and the highest prevalence was recorded in week 3. The location and the periods with high prevalence are believed to present ambient conditions favourable for increased ovipositioning and vectoral competence. Adequate understanding of vector ecology is needed to control mosquito particularly in deploying environmental modification around host settlements.

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1. Introduction

Mosquito species belong to the genera *Culex*, *Aedes* and *Anopheles* and right from time have received great research attention since they serve as significant vectors of several deadly diseases (Weaver and Reisen, 2010). Specifically, mosquitoes are known vectors responsible for the transmission and spread of malaria, lymphatic filariasis, yellow fever, encephalitis and rift valley fever (okogun *et al*., 2014). Consequently, up to one million people die due to mosquito-borne diseases and a relative figure of about 247 million human beings become ill in tropical and subtropical areas of the world as reported by the World Health Organization (WHO, 2016). Hence, mosquitoes are insects of great public health relevance especially when they occur in high densities to cause a nuisance. In the very recent past, more and more humans have come in contact with mosquitoes especially in this wake of a persistent rise in human population and increased urbanization which has led to the expansion of town and cities into previously undisturbed fallow areas thus providing for a greater number and variety of mosquito breeding sites outside the urban layout areas (Petric, *et. al.*, 2014).

The prevalence of malaria in any given area is mostly determined by several factors including: relative abundance of anopheline mosquitoes, feeding habit, vegetation density, the human host availability, sanitary conditions of the surrounding and others (Lefèvre *et al*., 2009, Merabti *et. al.* 2017). A combination of factors determine the capacity of a vector to transmit malaria and such factors include; abundance, anthropophily, zoophily, susceptibility to infection by the malaria parasite, infection rates (Lounibos and Conne, 2000). Breeding places are important for development and abundance of mosquitoes (Piyaratne *et al*., 2005). Different characteristics of the breeding sites such as: vegetation, temperature, turbidity, pH, concentration of ammonia, nitrite and nitrate, sulphate, phosphate, chloride, calcium, and water hardness affect mosquito abundance (Mutero *et al*., 2004). Changing these factors may create conditions favorable or unfavorable for mosquito biology (Amerasinghe *et al*., 1995).

Mosquitoes bites constitute being nuisance, allergic reactions, skin Irritation, scratching, restlessness and sleepless nights (Onyia *et. al.* 2019). Some bite during the day time while others bite during the night or at both day and night periods. Through their blood sucking habit, they act as vectors of a variety of human pathogen including viruses, bacteria, protozoa and helminthic diseases. Available Literature has shown that malaria is a serious and deadly disease killing a large population of human beings especially young children and pregnant women. Several researchers have published on the abundant and distribution of different species of mosquito across the world. But within our immediate environment, limited Literature exists on the influence of changing environmental conditions and weather patterns on the malaria vector distribution.

There is no recorded information on vector abundance and infection prevalence in relation to biotic and abiotic environment within University of Uyo campuses. Therefore, this study was conducted to investigate link between phyto-environmental variables, abundance of mosquito and malaria prevalence in the University of Uyo town campus. It is believed that the results of this research will provide useful information which may assist in the formulation of holistic and effective vector control programs and policies in the study area.

2.0 Materials and Methods

2.1 Study Area

University of Uyo is located within the heart of Uyo town, it has three main campuses in Uyo; i) The University of Uyo town campus, Ikpa Road, ii) The University of Uyo annex campus, Ikpa Road/ Ikot Ekpene Road and iii) The University of Uyo Main Campus, Nwaniba Road as shown in figure 1. This research was conducted at University of Uyo town campus, mainly within the environs of Faculty of Education (Location 1), Faculty of Arts (Location 2), Faculty of Social Sciences (Point 3) and Postgraduate Hostel (Point 4) which are all situated within The University of Uyo town campus, Ikpa Road as shown in Figure 1.

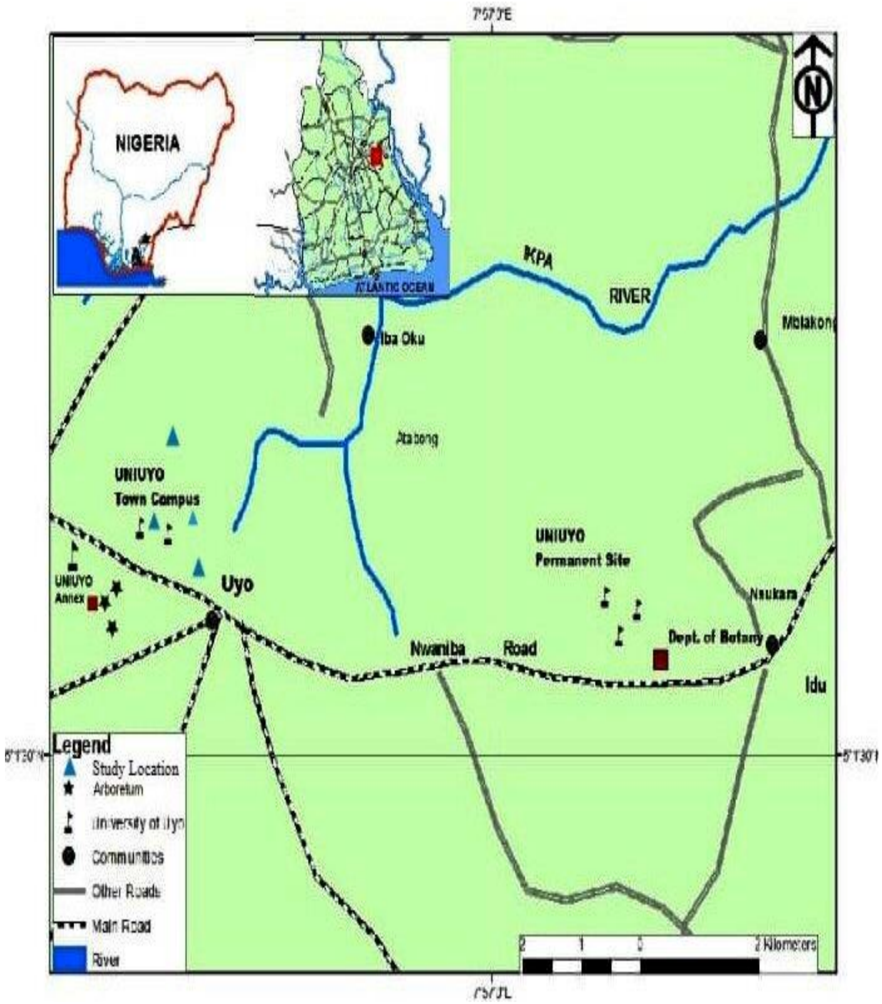

Fig 1: Map of the Study Area showing Sampling Locations

2.2 Study Population

The participants in the study were students of the University of Uyo who frequent visit, study or reside in these four locations. Three hundred and twenty individuals (Eighty in each of the four locations) in total volunteered to be included in the study.

2.3 Mosquito Abundance

Data on the abundance of female mosquitoes were obtained from weekly collections at 4 sampling stations within the study area. Sampling stations were spread evenly (200-m distant) along three 2.4-km transects which intersected at a central station. Non-attractive methods were used (resting shelters) in order to avoid disrupting the natural distribution by attracting mosquitoes from outside of the immediate vicinities of sampling stations. Mosquitoes were aspirated from resting shelters (trash cans) using a hand-held vacuum between 07:00 and 09:00 hours throughout the season (June – July 2020) of peak adult activity (Burkett-Cadena *et. al*. 2008). Samples were returned to the laboratory for species-level identification using morphological characters of adult females. The analysis was focused on unfed females because this group (composed mostly of host seeking females) is the section of the population that is most important from the disease perspective, as potentially infectious vectors. In addition, since unfed females are physiologically geared towards finding a host, it is most plausible that this cohort in particular is influenced by host distribution. Blood-engorged and egg-laden (gravid) females, more concerned with locating sites for resting and/or oviposition than encountering a suitable host, respond differently to environmental cues than do un-fed females and were therefore excluded from the analysis (Darsie and Ward, 2005).

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2.4 Host Abundance

Assessment of the abundance of potential human hosts at the same 4 stations where mosquitoes were collected using visual and auditory surveys. Standard herpetological survey methods were used, including visual searches (Weir and Mossman, 2005). Each of the 4 stations was surveyed daily from mid-June through mid-July, 2020.

2.5 **Administration of Questionnaires**

In order to provide information on incidence of malaria among individuals in these locations, structured questionnaires were randomly administered to 80 respondents weekly (20 in each location) for four rounds. In all, 320 respondents were covered. Respondents comprised of volunteer staff (night watchmen) and students who study or reside in these locations (especially at night) in the lecture rooms adjourning the study locations.

2.6 Data Analysis

The data were analyzed using: tabulations and percentages using Excel Spread sheet of Microsoft 2016 Office Suite. The statistical software used was the Paleontological software (PAST version 6) for computing all diversity indices.

Shannon and Weinner index of diversity was calculated using the formular;

The formula for calculating the Shannon diversity index is

$$H' = -\sum p_i \ln p_i$$

Where;

H= Shannon index of diversity

pi= the proportion of important value of the ith species (pi=ni/N),

ni is the important value index of ith species

N is the important value index of all the species.

Simpson index of Dominance was calculated using the equation;

$$D = \sum (p_i)^2$$

Where;

D= Simpson index of dominance as D increases, diversity decreases and Simpson's index was therefore usually expressed as 1-D.

3.0 Results

3.1 Abundance of Anopheles Mosquitoe in the study Area.

The results reveal that the abundance of Anopheles mosquitoe varied markedly between locations and on a weekly basis. The highest abundance was typical in location 3 (101) while location 1 had the least (17) for week 1. A similar trend was noted in week two with 101 and 40 for locations 3 and 1 respectively. For week three, there were 212 and 102 for locations 3 and 4 and a similar trend was recorded for week four with locations 3 and 4 recording 160 and 52 respectively (Table 1).

3.2 Prevalence of Malaria amongst students within the Study area

From the questionnaires administered, in terms of the locations prevalence of malaria was highest (38.8%) in Location 3 but was least in location 1 (16.55%). On a weekly basis, malaria prevalence was highest (33.9%) in week 3 but least (17.5%) in week 1(Table 2). Figures 2 and 3 describe the prevalence of malaria infection amongst the students in relation to mosquitoe abundance per location and on a weekly basis respectively.

3.3 Malaria Prevalence in relation to Phyto-diversity status of Study Location

Table three reflects that location 1 and 2 were similar in terms of the number of taxa (3) while locations 3 and 4 recorded 6 and 8 taxa respectively. Generally, species diversity (Shannon-Weinner and Simpsons) indices as expected were higher for locations 3 and 4. Based on the dendrogram which explain site similarities, site 1 and 2 were quite similar while Site 3 and 4 seemed more dissimilar (Fig. 4). The influence of phyto-environmental variables on malaria prevalence amongst students is described in Figure 5.

Table 1: Abundance of Mosquitoes within University of Uyo Town Campus

	Traps	Point 1		Point 2		Point 3		Point 4	
		5^0 2′ 40.85″ N		5^0 2′ 18.57″ N		5^0 2′ 18.36″ N		5^0 2′ 10.68″ N	
		7^0 55′ 27.26″ E		7^0 55′ 32.15″ E		7^0 55′ 25.97″ E		7^0 55′ 27.40″ E	
		Anopheles sp	*Culicines* sp	*Anopheles* sp	*Culicines* sp	*Anopheles* sp	*Culicines* sp	*Anopheles* sp	*Culicines* sp
Week 1	1	0	0	8	4	5	1	15	2
	2	7	3	8	0	57	4	13	1
	3	9	1	14	4	10	2	6	3
	4	1	0	13	2	29	6	5	0
Total		**17**	**4**	**43**	**10**	**101**	**13**	**39**	**6**
Week 2	1	2	0	11	1	32	8	6	1
	2	9	0	17	3	21	2	13	2
	3	10	2	8	0	15	4	16	4
	4	19	3	15	3	33	2	18	1
Total		**40**	**5**	**51**	**7**	**101**	**16**	**53**	**8**
Week 3	1	26	2	51	5	41	7	19	2
	2	35	5	27	3	33	1	17	1
	3	83	12	58	10	117	11	53	5
	4	13	3	12	0	21	2	13	2
Total		**157**	**22**	**148**	**18**	**212**	**21**	**102**	**10**
Week 4	1	36	2	17	3	62	4	14	2
	2	15	1	23	2	24	2	11	0
	3	11	1	21	1	39	3	16	2
	4	9	1	13	1	35	3	11	1
Total		**71**	**5**	**74**	**7**	**160**	**12**	**52**	**5**

Table 2: Prevalence rate of Malaria amongst students found within Study Locations

	Location 1	Location 2	Location 3	Location 4	
	5^0 2′ 40.85″ N	5^0 2′ 18.57″ N	5^0 2′ 18.36″ N	5^0 2′ 10.68″ N	
	7^0 55′ 27.26″ E	7^0 55′ 32.15″ E	7^0 55′ 25.97″ E	7^0 55′ 27.40″ E	
Week 1	4	3	7	4	18 (17.5)
Week 2	3	7	9	7	26 (25.2)
Week 3	6	11	15	3	35 (33.9)
Week 4	4	6	9	5	24 (23.3)
Total (Prevalence%)	17 (16.5)	27 (26.2)	40 (38.8)	19 (18.4)	103

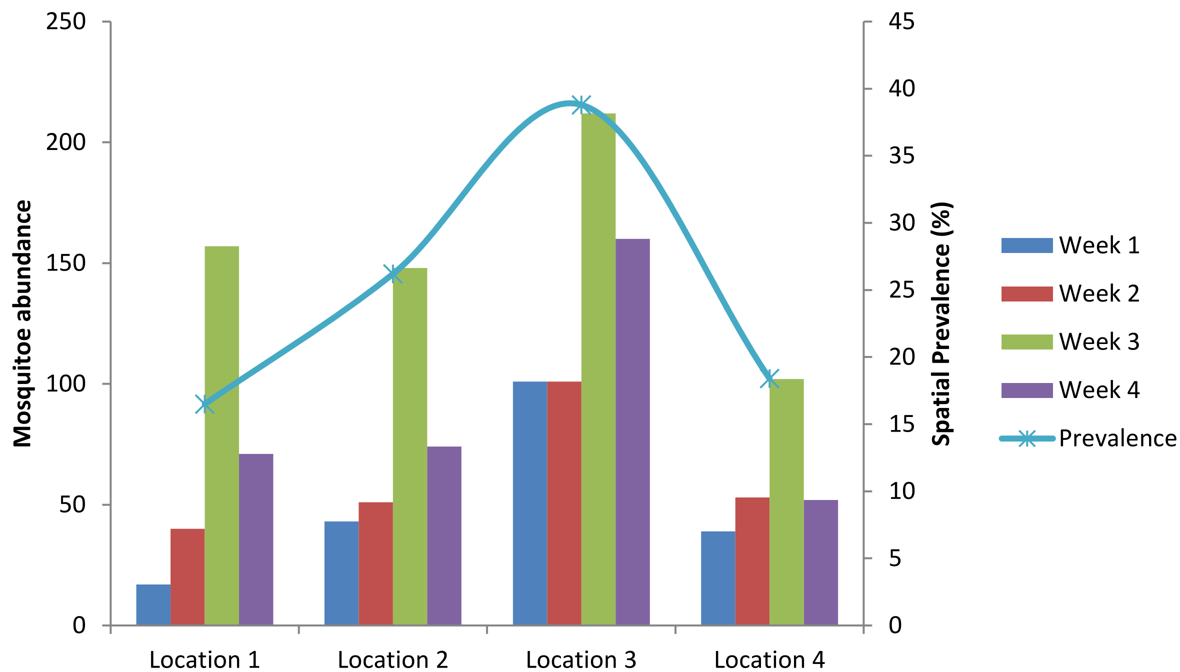

Figure 2: Mosquitoe abundance (Spatial) and Malaria Prevalence in Study locations.

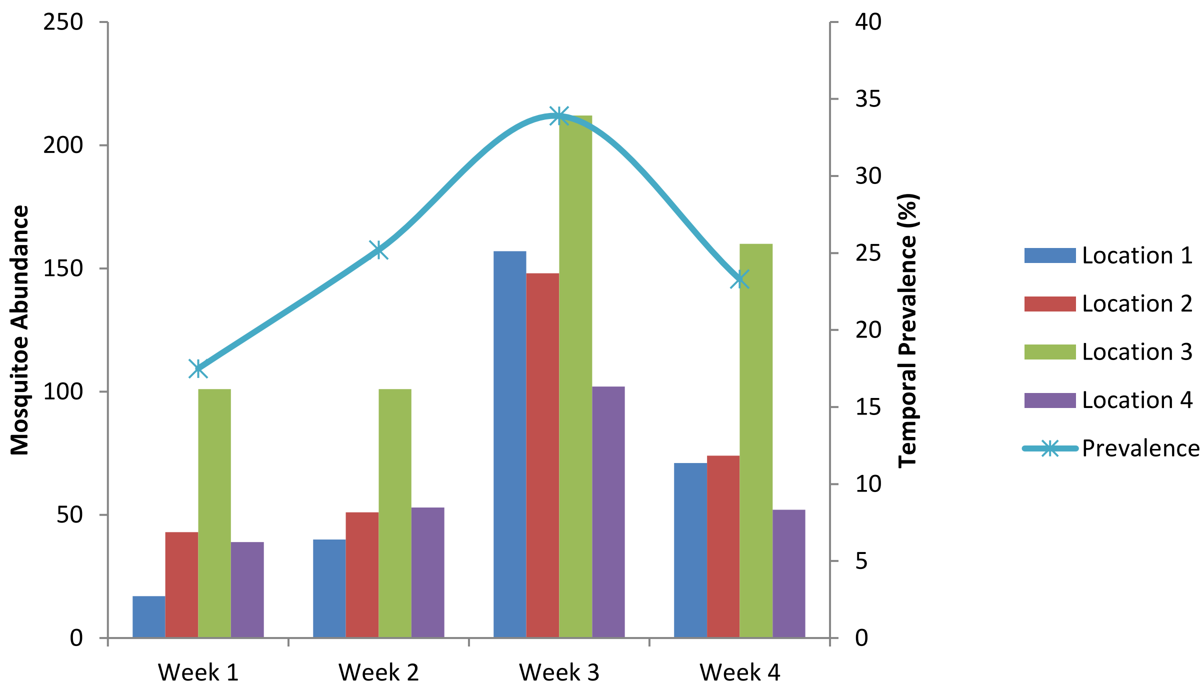

Figure 3: Mosquitoe abundance (Temporal) and Malaria Prevalence in Study locations.

Table 3: Floristic richness and phyto-diversity status of study locations

	Location 1	Location 2	Location 3	Location 4
Altenanthera sessils (L.) R.Br. ex DC.	10	-	-	-
Eleusine indica (Linn.) Gaertn	25	5	8	-
Laportea aestuans (Linn.)	5	-	-	-
Acacia auriculiformis A. Cunn. Ex Benth	-	1	-	-
Setaria verticilata (L.) P. Beauv.	-	3	-	2
Caladium bicolor Vent.	-	-	4	-
Chromolaena odorata (L.) R. M. King & H. Rob.	-	-	6	-
Commelina benghalensis L.	-	-	15	-
Lagenaria breviflora (Benth.)	-	-	4	-
Solenostemon monostachyus (P. Beauv.) Briq.	-	-	5	4
Ageratum conyzoides Linn.	-	-	-	3
Emilia sonchifolia (L.) DC. ex DC.	-	-	-	5
Khyllinga erecta Schumach.	-	-	-	13
Ludwigia erecta (L.) H. Hara	-	-	-	2
Tridax procumbens Linn	-	-	-	3
Xanthosoma sagittifolium (L). Schott	-	-	-	2
Taxa S	3	3	6	8
Individuals	40	9	42	34
Shannon H	0.9003	0.9369	1.663	1.83
Simpson 1-D	0.5313	0.5679	0.7834	0.7924

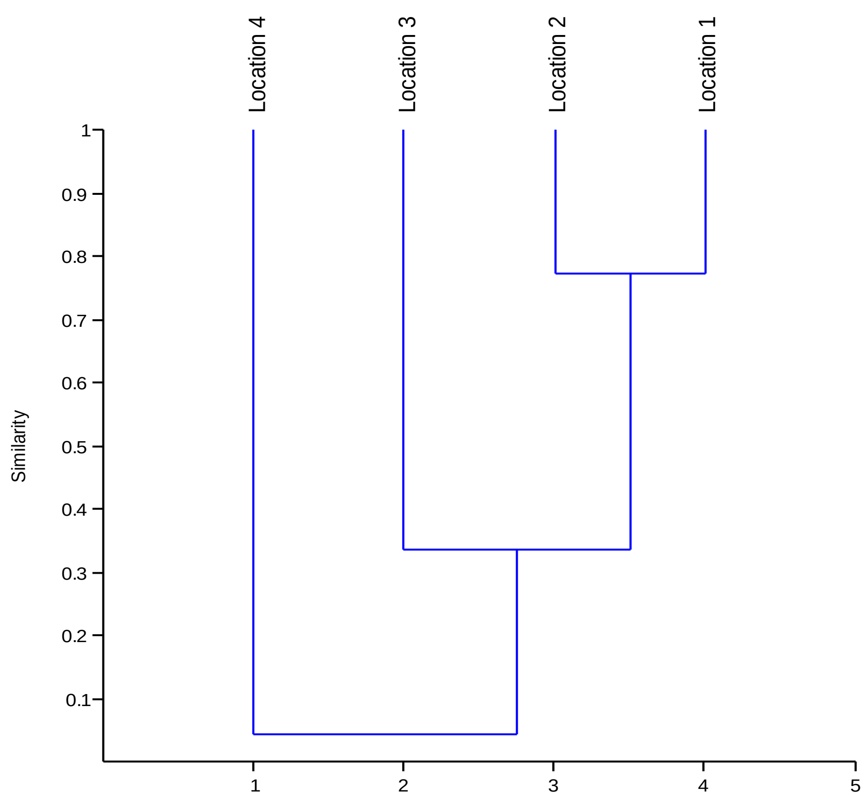

Figure 4: Dendrogram describing vegetation dissimilarities in the studied locations.

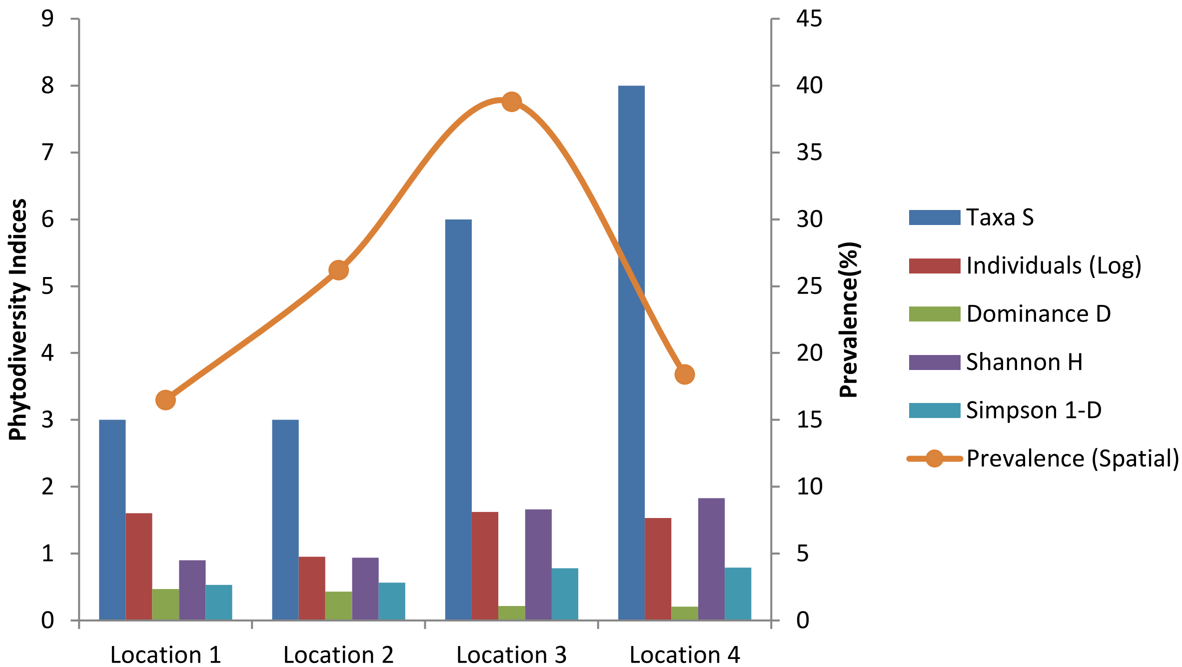

Figure 5: Phyto-environmental variables and Malaria Prevalence in Study locations.

4.0 Discussion

The results of this study confirmed variation in spatial and temporal abundance and composition of mosquito vectors in the study area. A similar trend was reported by Avoaja *et. al.* (2014) and Onyia *et. al.*, (2019). Awolola *et al*., (2002) noted that there are different species of mosquitoes distributed in different parts of the country which are not restricted by change in topography and local climates. This is typified by the observed presence of both species of Mosquitoes. Typically, the distribution and abundance of an insect species at each location to a large extent depends on its own biological characteristics, influence of other organisms as well as the physical environment. Hence, the marked variation in the spread and distribution of both species of mosquitoes is justified.

The numeric gap in abundances of the two species within the campus creates evidence indicating preference for prevailing variations in the physical and biotic factors by the dominant *Anopheles* sp across the studied locations. These ever-present factors in the environment responsible for this result include temperature, relative humidity, availability or absence of thick plant biomass, frequency and intensity of clipping, site sanitary conditions, continuous availability of human host etc. This aligns with the views of earlier researchers (Merabti, *et. al.* 2017; Oniya, *et. al.* 2019). Concurrently, Oguoma and Ikpeze (2008) indicated that habitat type, floating debris and emergent plants were key factors determining the presence of mosquitoes in some studied habitats. Also, it is noted that Oviposition preferences of gravid females to a large extent associates with the ability of immature stages of mosquito to survive both biotic and abiotic environmental conditions within its given habitat, this in turn shapes the abundance and distribution of mosquito larvae (Okogun *et. al.* 2014).

The observed trend of infection prevalence within the campus during the period, vary markedly between locations and periodically. Malaria infection (prevalence) amongst respondents revealed a dump-bell uni-modal distribution indicating peak values at Location 3 and Week 3 for spatial and temporal computation respectively. This can never be taken for granted. This credits that the interplay of prevailing factors in this particular location and at this specific period seemed an ecological optimum for rapid oviposition, multiplication and spread of vectors within the campus. This trend may further point towards some level of endemicity in location 3 compared to other locations within the campus (Nasir, *et. al.* 2015).

The prevalence of malaria infection between stations in this study is sensitive to phytodiversity dynamics. This corroborates the findings of erudite researchers Tadesse *et. al. (*2011). Accordingly, Mwangangia *et al.* (2007) noted that the nature and amount vegetation is a key driver of the presence and abundance of mosquitoes. This explains the phenomenal response of infection prevalence to floral dynamics of studied habitat. As observed, highest infection prevalence tallies with Location 3 which also records high taxa presence and species diversity values (Shannon-Weinner and Simpson indices). Also, the presence of broad-leaved plants such as *Caladium bicolor* and *Lagenaria breviflora* and high number of *Commelina benghalensis* (a plant commonly associated with frequently moist soils) in this location is diagnostic. From this, it is believed that these plants help in protecting the larva from local predators and provide shading effects from direct intense solar radiation. The perpetual moistness and vegetation morphology in this habitat thus create an ecological ambience for rapid oviposition, increased abundance and relative endemism of the vector population in this site. Worthy of note is the fact that despite the high taxa and species diversity indices noted for Location 4 tallied with low infection prevalence. This is so because of intense human disturbance in the form fumigation and rapid intense clipping activities in this particular location. The low mosquitoes of Anopheles in some locations species in some habitats may be explained by the presence of plants with high concentration of compounds which has repellant effects on the species and so deter females from laying eggs.

5.0 Conclusion

A study was carried out to investigate the influence of Phyto-environmental variables on mosquitoe abundance and malaria prevalence amongst students in University of Uyo. The results showed that the distribution of malaria vector in the study locations and on a temporal scale differed significantly. Conclusively, malaria seems endemic in location 3 and the highest prevalence was recorded in week 3. The location and the periods with high prevalence are believed to present ambient conditions favourable for increased ovipositioning and vectoral competence. Adequate understanding of vector ecology is needed to control mosquito particularly in deploying environmental modification around host settlements. This understanding will better serve over deployment of chemicals into such sites that may also serve other functions to non-target organisms.

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