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Biting Dipterous Insects Associated with Household in a Bali Community Taraba State, Nigeria

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Abstract: Insects are groups of arthropods found almost everywhere, including human dwellings. The aim of this study was to investigate species of dipterous biting insects associated with household in Aungwan Adamu community Bali, Taraba state. The insects were collected using CDC light trap placed indoor and outdoor during wet season of the year 2021. Morphological identification of collected insects was done under dissecting microscope. A total number of 254 insects were collected, 125 (49.2%) indoor and 129 (50.8%) outdoor with two major families: Culicidae (mosquitoes) 116 (45.7%), Ceratopogonidae (biting midges) 96 (37.8%) and unidentified dipterous insects 42 (16.5%.). 56 (48.3%) of the mosquito species were caught indoor, while 60 (51.7%) were caught outdoor. Mosquito species identified were: *Anopheles gambiae* 40 (34.5%), *Culex pipiens* 14 (12.1%), *Culex quiquefasciatus* 57 (49.1%), *Culex tarsalis* 2 (1.7%) and *Mansonia uniformis* 3 (2.6%). Among the *Anopheles gambiae* 16 (40.0%) were caught indoor, 24 (60.0%) outdoor. 6 (42.8%) of *Culex pipiens* were indoor, 8 (57.2%) outdoor. 33 (57.9%) of *Culex quiquefasciatus* were indoor, 24 (42.2%) outdoor. 1 (33.3%) of *Mansonia uniformis* were indoor, 2 (66.7%) outdoor. Among the biting midges 61 (63.5%) were caught indoor while 35 (36.5%) caught outdoor. *Culicoides* species identified were: *Culicoides vagus* 19 (19.8) and *Culicoides nigripenis* 77 (80.2%). Among the *Culicoide vagus* 19 (100%) were indoor while none (0%) were outdoor. 42 (54.5) of *Culicoides nigripenis* were caught indoor while 35 (45.5) were outdoor and were statistically significant ($P < 0.01$). 208 (81.9%) of the insects were female while 46 (18.1%) were male and are statistically different ($P < 0.01$). Out of the 208 female insects, 178 (85.6%), 0 (0%), 15 (7.2%) and 15 (7.2%) were unfed, fed, half-gravid and gravid respectively and are statistically significant ($P < 0.05$). The study shows that there are species of biting insects in the study area which can be endophilic or exophilic capable of causing nuisance and transmit diseases.

Keywords: Biting Insects, Resting Behavior, Prevalence, Household, Bali

1. Introduction

Phylum Arthropoda comprising predominantly the insect fauna has more species and individuals on Earth than any other metazoan phylum. Insects, in particular, who are represented by over two million animal species with many more still awaiting documentation are most important in view of their remarkable structural and behavioural diversities [1, 2].

Insects playing a vectorial role for any disease pathogen are of two types: The first group includes blood sucking micro-predators which take a little blood from many hosts. The second group comprises ecto-parasites which live on the surface of the host, feeding by prolonged stay on that one host [1]. Commonest among the insect-vector and that constitute nuisance are mosquitoes (culicidae) and biting midges (ceratopogonidae).

Mosquitoes are divided into three sub-families: Toxorhynchitinae, Anophelinae and culicinae. The most important pest and vector species belong to the genera *Anopheles, Culex, Aedes, Psorophora, Mansonia, Haemagogus and Sabethes* [3]. Medically, the most important two genera of biting midges are Leptocomorps and

Culicoides which have wide distribution worldwide and constitute serious biting problems [3].

Vectors serve as motor for the transmission of devastating human diseases, hence critical study and analysis of these vectors could be the first step in the management of these diseases. Vector control remains the most generally effective measure for preventing transmission and is essential for the control of malaria, yellow fever, filariasis, Trypanosomiasis, dengue and zika outbreaks in the absence of safe and effective vaccines [4, 5].

A lot of studies have been conducted on insects ecology especially those of medical importance in Nigeria, Taraba state inclusive [6-10].

The present study, thus is aimed at identifying the species of dipterous insects especially mosquito and biting midges, their resting behaviours and gonotrophic status in wet season of the year 2021 in a household near a small stream and banana planation at Angwan Adamu community Bali, Taraba state using CDC light trap.

2. Materials and Methods

2.1. Site of Collection

The area is located behind Angwan Adamu Primary School, Bali close to a small stream and banana plantation. Notwithstanding the use of insect nets on the windows and doors that are always closed, the people in the community experience bites of insects of different types majorly mosquitoes.

Figure 1. *Environment of the Study site with stream and banana plants (Photo by the Researcher).*

2.2. Insect Collection

Insects were collected during wet season of the year 2021 from the household using CDC light trap both indoor and outdoor, the efficacy of which is comparable to other sampling techniques [11]. One CDC light trap was mounted inside the house and the other one outside once in the week covering rainy months. The traps were operated from dusk to dawn, according to manufacturer instructions. The trapped insects were collected for sorting, counting and identification.

Figure 2. *CDC light trap in operation (Photo by the Researcher).*

2.3. Insects Identification

The collected insects, already sorted out into families by the aid of hand lens were mounted under dissecting microscope where all diagnostic parts, wings, antennae, legs, etc were examined. Identification to species level was done by comparing the various parts with identification keys [1, 3, 12].

Figure 3. *Culicoides Species.*

Figure 4. *Female Culex Species.*

Figure 5. *Mansonia Uniformis.*

Figure 6. *Male Culex Species.*

Figure 7. *Unidentified dipterous insect.*

2.4. Statistical Analysis

The data collected on abundance of insect families, genera and species in relation to indoor and outdoor catch and gonotrophic frequencies were presented in tables. Chi-square (X^2) analysis was used to determine the significant difference in the species abundance in relation to indoor and outdoor catch at 0.01 level of signicance. And also male and female abundance. Analysis of Variance (ANOVA) was used to determine the significant difference in the gonotrophic status of the species at 0.05 level of significance.

3. Results

A total of two hundred and fifty four (254) insects were trapped and collected in the overnight trappings comprising of 2 insect families: Culicidae (mosquito) 116 (49.2%) and ceratopogonidae (biting midges) 96 (16.3%) and unidentified dipterous 42 (16.3%) (Table 1). Among these insect families, 125 (49.2%) were caught indoor and 129 (50.8%) outdoor (Table 2).

Among the insect genera, *Anopheles* constitute 40 (15.7%), *Culex* 73 (28.7%), *Mansonia* 3 (1.2%), *Culicoides* 96 (37.8%) and unidentified dipterous 42 (16.5%). More of these insects generally were collected outdoor 129 (50.8%) than indoor 125 (49.2%). However *Culex* species and *Culicoides* were specifically more indoor with 39 (53.4%) and 61 (63.5%) respectively than outdoor with 34 (46.6%) and 35 (36.5%) respectively (Table 3).

Among the five (5) mosquito species collected *Culex quiquefasciatus* was predominant with 57 (49.1%), followed by *Anopheles gambiae* 40 (34.5) and the least was *Culex tarsalis* 2 (1.7). More *Anopheles gambiae* were caught outdoor 24 (60.0%) than indoor 16 (40.0) also with *Culex pipiens*, *Culex tarsalis* and *Mansonia uniformis,* but reverse was the case with *Culex quiquefasciatus* 33 (57.9%) indoor and 24 (42.1%) outdoor. *Culicoides nigripenis* predominated the over *Culicoides vagus* with 77 (80.2%) and 19 (19.8%) respectively. More of the culicoides were indoor 61 (63.5%) than outdoor 35 (36.3%). The unidentified dipterous were more outdoor 34 (81.0) than indoor 8 (19.0) (Table 4). The difference in the indoor and outdoor preference in genera and species is statistically significant ($P < 0.01$).

Prevalence of the insect species based on sex showed that female were 208 (81.9%) and male were 46 (18.1%). All the species caught had more of the female than males except *Culex tarsalis* which was 1 (50%0 male and 1 (50%) female. No male species of the *Culicoides vagus* was caught (Table 5). The difference in the male and female abundance is statistically significant ($p < 0.01$).

Investigation into the gonotrophic status: Unfed (UF), freshly Fed (FF), Half Gravid (HG) and Gravid (GV) of the female insect species revealed that out of 208 female caught 178 (85%) were unfed, none (0%) was fed, 15 (7.2%) were Half Gravid and 15 (7.2%) were Gravid. Among the mosquito species 69 (69.7%) were unfed, 15 (15.1%) were Half-Gravid and 15 (15.1%) were Gravid. All 85 (100%) female culicoides species caught were unfed and all 24 (100%) female unidentified dipterous were also unfed (Table 6). ANOVA showed that difference in the gonotrophic status among the species is statistically signicant ($P < 0.05$).

Table 1. *Prevalence of the insects caught in the household.*

Insect families	Total trapped (%)
Culicidae	116 (49.2)
Ceratopogonidae	96 (37.8)
Other dipterous	42 (16.3)
Total	254

Table 2. *Prevalence of identified insect families based on resting/feeding behavior.*

Insect families	Total No trapped (%)		Total (%)
	Indoor	Outdoor	
Culicidae	56 (48.3)	60 (51.7)	116 (45.7)
Ceratopogonidae	61 (63.3)	35 (81.0)	96 (37.8)
Unidentified	8 (19.0)	34 (81.0)	42 (16.5)
Total (%)	125 (49.2)	129 (50, 8)	254

** Significantly different X^2 =19.48; df =2; P < 0.01

Table 3. *Prevalence of identified insect genera based on resting/feeding habit.*

Insect genera	Total No trapped (%)		Total (%)
	Indoor	Outdoor	
Anopheles	16 (40.0)	24 (60.0)	40 (15.7)
Culex	39 (53.4)	34 (46.6)	73 (28.7)
Mansonia	1 (33.3)	2 (66.7)	3 (1.2)
Culicoides	61 (63.5)	35 (36.5)	96 (37.8)
Other dipterous	8 (19.0)	34 (81.0)	42 (16.5)
Total	125 (49.2)	129 (50.8)	254

** Significantly different X^2 = 16.82; df= 4; P< 0.01

Table 4. *Prevalence of insect species based on feeding/resting habit.*

Insect species	Total No trapped (%)		Total (%)
	Indoor	Outdoor	
Mosquitoes			
Anopheles gambiae	16 (40.0)	24 (60.0)	40 (34.5)
Culex pipiens	6 (42.8)	8 (57.2)	14 (12.1)
Culex quiquefasciatus	33 (57.9)	24 (42.1)	57 (49.1)
Culex tarsalis	0 (0)	2 (1000)	2 (1.7)
Mansonia uniformis	1 (33.3)	2 (66.7)	3 (2.6)
Total (%)	56 (48.3)	60 (51.7)	116 (45.7)
Biting midges			
Culicoides vagus	19 (100)	0 (0)	19 (19.8)
Culicoides nigripenis	42 (54.5)	35 (45.5)	77 (80.2)
Total (%)	61 (63.5)	35 (36.5)	96 (37.8)
Other dipterous	8 (19.0)	34 (81.0)	42 (16.5)
Grand Total	125 (49.2)	129 (50.8)	254

** Significantly different X^2 = 41.31; df= 6; P<0.01

Table 5. *Prevalence of insect species based on sex.*

Insect species	Total No trapped (%)		Total (%)
	Male	Female	
Mosquitoes			
Anopheles gambiae	2 (5.3)	38 (94.7)	40 (34.5)
Culex pipiens	2 (16.7)	12 (83.3)	14 (12.1)
Culex quiquefasciatus	12 (21.0)	45 (79.0)	57 (49.1)
Culex tarsalis	1 (50)	1 (50)	2 (1.7)
Mansonia uniformis	0 (0)	3 (100)	3 (2.6)
Total (%)	17 (14.7)	99 (85.3)	116 (45.7)
Biting midges			
Culicoides vagus	0 (0)	19 (100)	19 (19.8)
Culicoides nigripenis	11 (14.3)	66 (85.7)	77 (80.2)
Total (%)	11 (11.5)	85 (88.5)	96 (37.8)
Other dipterous	18 (42.9)	24 (57.1)	42 (16.5)
Grand Total	46 (18.1)	208 (81.9)	254

** Significantly different X^2 = 28.3; df= 6; P < 0.01

Table 6. *Prevalence of insect species based on gonotrophic status.*

Insect species	Total No trapped (%)				Total (%)
	UF	FF	HG	GV	
Mosquitoes					
Anopheles gambiae	21 (55)	0	12 (31.6)	5 (13.1)	38 (38.4)
Culex pipiens	11 (91.7)	0	0	1 (9.3)	12 (12.1)
Culex quiquefasciatus	33 (73.3)	0	3 (6.7)	9 (20.0)	45 (49.1)
Culex tarsalis	1 (100)	0	0	0	1 (1.0)
Mansonia uniformis	3 (100)	0	0	0	3 (33.3)
Total (%)	69 (69.7)	0	15 (15.1)	15 (15.1)	99
Biting midges					
Culicoides vagus	19 (100)	0	0	0	19
Culicoides nigripenis	66 (100)	0	0	0	66
Total (%)	85 (100)	0	0	0	85
Other dipterous	24 (100)	0	0	0	24
Grand Total	178 (85)	0	15 (7.2)	15 (7.2)	208

**** Significantly different, $F = 9.43$; $df = 31$; $P < 0.05$
KEY: UF = Unfed; FF = Freshly Fed; HG = Half Gravid; GV = Gravid

4. Discussion

This study has established that apart from mosquitoes that people think as biting insects there are also other anthropophilic insect species present in this study area. This to the best of my knowledge the first time this kind of holistic study was made. Previous study in this area centred on mosquitoes only [6-10]. Studies have been carried out on culicoides in some places in Nigeria, one of this was in Markudi [13] who reported presence of one species of *Culicoides*.

The predominance of *Culex quiquefasciatus* in this study among other *Culex* species is similar to the findings of [7] using Pyrethroid Spray Catch. When considered with other mosquito species it is followed by *Anopheles gambiae* in this study using CDC light trap. This is the reverse case from the earlier study in the same area by the author using Pytrethrum Spray Catch [6, 10] but it is similar to findings of [14] who collected more of *Culex* followed by *Anopheles* mosquitoes in Thai-Myanmar border. This indicates that these mosquito species compete with each other in frequency regardless of the methods of collection. Although in a study using the same method in Ogun state, Nigeria *Mansonia africana* took the led followed by *Anopheles gambiae* and *Culex quiquefsciatus* was far behind [15].

The presence of two different species of *Culicoides* in this study area: *Culicoides vagus* and *Culicoides nigripenis* is different from those reported in Markudi with only one species [13], although virtually similar ecological conditions abound in the two places.

The predominance of female insect species over the males is in line with reports of other researchers. This is an indication that only females are blood feeders and males are not. Specifically, only *Culex tarsalis* had equal proportion of female to male ratio... This might be due to the number caught, being the least insect species caught and may be behavioural difference or just accidental.

The endophilic/exophilic and endophagic/exohagic behaviours of the insect species observed in this study revealed that generally that more insects were caught outside than inside. The mosquito species were generally outdoor because the study house was protected against entry of mosquitoes and probably some of the mosquito species caught prefer outdoor biting.

The biting midges found were predominantly caught indoor which indicates endophagic/endophilic behaviours. This might be because *Culicoides* species are reportedly to be among the world smallest blood-sucking flies and are able to pass through mosquito-screened net [13].

The gonotrophic status of the dipterous insect species were unfed, few of them were gravid and half gravid. Specifically all the *Culicoides* species were unfed. This is in line with study conducted in Ogun state where most of the mosquitoes collected were unfed and nulliparous [15].

5. Conclusion

The major mosquito species in this study area are *Anopheles gambiae* and *Culex quinquefasciatus.* Other anthropophagic insects which need more attention are biting midges and are capable of transmitting insect-borne diseases. The light trap method did not trap fed insects probably because they are usually at their resting period at that stage and are not flying around.

6. Recommendations

Further study should be conducted on the molecular identification of the *Culicoides* (biting midges) as confirmation of laborious morphological method.

Population dynamics of the *Culicoides* in the study area and beyond should be conducted for more knowledge on the biology and ecology of the biting midges.

More sampling methods should be employed to compare and contrast the efficacy of the methods.

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