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SURVEY OF NOCTURNAL INSECTS USING WHITE AND YELLOW LIGHT TRAPS IN A UNIVERSITY ENVIRONMENT IN BENUE STATE, NIGERIA

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Abstract

This study investigated the diversity and abundance of nocturnal insects trapped using white and yellow light traps on the campus of Rev. Fr. Moses Orshio Adasu University (formerly, Benue State University), Makurdi, Nigeria. Modified traps using white light and yellow lights as sources of light were attached to plastic containers containing water were placed at specific locations and checked every 30 minutes for 3 hours. Insects collected were preserved in 70% ethanol taken to the laboratory and identified morphologically. A total of 443 insects were collected, with white light traps capturing more individuals (54.4%) than yellow light traps (45.6%), although the difference was not significant (P = 0.424). *Trioza* spp. were the most abundant taxa (31.15%), and species abundance differed significantly among taxa (P < 0.001). Eight insect orders were identified, with Hemiptera exhibiting the highest species richness. Spatial variation in insect abundance showed slightly higher captures in the Eastern Wing (Second Campus) (53.27%) than in the Western Wing (First Campus) (46.72%), although the difference was not significant (P = 0.549). The Eastern Wing also recorded a higher species diversity index (H′ = 2.415), with *Anoscopus* sp., *Orius laevigatus*, and *Megalonotus hirsustus* occurring exclusively in this location. The study demonstrates that white light traps attracted a greater number of nocturnal insects than yellow light traps, although light colour did not significantly influence overall insect abundance. These findings provide baseline information on nocturnal insect diversity and highlight the utility of light traps for ecological monitoring in tropical university environments.

Keywords: Nocturnal insects; Light traps; Insect diversity; Species abundance; Ecological monitoring

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INTRODUCTION

Insects are the world's most diverse group of animals; they are diverse both in terms of taxonomy and ecology (Belamkar and Jadesh, 2014). Insects play a vital role in our environment by providing key ecosystem services such as production of fruits and seeds, improve physical soil conditions as well as fertility, devouring bodies of dead animals and plants and act as bio-indicator of the health of the environment and water bodies. Some of the insects also provide us with honey, silk and other commercial value products; they serve as food for bird and fish (Chima *et al.,* 2013). However, they are also disease vectors to many other organisms, including humans (Schowalter *et al.,* 2011).

Globally, scientific studies have reported a large and significant decline in insect populations for decades (Wagner *et al*., 2021). Terrestrial insects are more vulnerable to diverse threats and some of the most affected insect groups are bees, butterflies, moths, beetles, dragon flies and damselflies (Dar *et al*., 2021). The decline in insect biodiversity concurrently presents an immediate threat to food security and permanently affects humans' health and wealth (Akinbi *et al*., 2022). All terrestrial insects provide resources for higher trophic levels, especially for many vertebrates and the vertebrates together with other beneficiaries in the trophic groups are subject to humans.

Ground dwelling insects particularly formicidae (Ants), certain Coleoptera (Beetles) etc. are best sampled through pitfall trapping. Low flying diurnal insects are collected through Malaise trap and the robust ones by Sweep net method (Sheikh *et al*., 2016). However, there are thousands of insect species which are nocturnal and cannot be collected by the conventional methods. These insect species are best sampled though light trapping (Sheikh *et al*., 2016). Light traps capture highly diverse orders of insects like Coleoptera, Hemiptera, Lepidoptera, Diptera, Hymenoptera, *etc*. (Ramamurthy *et al.,* 2010).

Proper documentation of insects is an important component for the study of biodiversity and population dynamics (Sheikh *et al*., 2016). Assessment of diversity is central to ecology and conservation policies and action (Whittaker *et al*., 2005). Therefore, this study was set out to determine the diversity and abundance of nocturnal insects on Rev. Fr. Moses Orshio Adasu University Makurdi (MOAUM) campus using light traps.

3.0 MATERIALS AND METHODS

3.1 Description of Study Area

The study was carried out on the Rev. Fr. Moses Orshio Adasu University Makurdi campus. Makurdi is located in North central Nigeria along the Benue River between latitude 07° 44′ 28″ N and longitude 08° 32′ 44″ E. It is situated within the Benue trough, at the lower Benue valley and found in the guinea savanna region. *Based on Koppen's Scheme of Classification, Benue State and Nasarawa states are classified by Aw Climate as tropical rainy areas that experience two distinct seasons, the wet/rainy season and the dry/winter season (Mobolade and Pourvahidi, 2020).* The rainy season lasts from April to October with 5 months for dry season (November-March). Annual rainfall in Makurdi town is consistently high, with an average annual total of approximately 1173mm. Temperature in Makurdi is however, generally high through-out the year, with February and March as the hottest month. Rev. Fr. Moses Orshio Adasu University also provides several academic and non-academic facilities and services to students, the campus is segmented into three parts namely, the Western wing (First camp), Eastern wing (Second camp) and College of health sciences (COH) with students spread across these three sections. The Benue State University landscape comprises of ornamental trees, flowers, buildings and tarred road that cut across the three segments of the school.

3.1 Construction of a light trap for insects sampling.

The collection of the nocturnal insects was done using the method described by Okrikata and Yusuf (2019) with little modifications. The light trap was constructed from a plastic container with a suspended LED bulb powered by a lithium battery. The bulbs used were of two light sources; the white and yellow light source (Plate 1). The constructed light traps were placed at a distance of 200metres away within the specified location and beneath the light source was placed a bowl containing water such that insects attracted towards the light source fell into the container and were trapped (Kato *et al*., 2000). Sampling was carried out for four weeks (1 month), the traps were set in the evenings 18:00hrs (6 pm) and insect samples were recovered after every 30 minutes for 3 hours.

3.3 Preservation and identification of Insects

The insects recovered were placed in well labelled airtight jars containing 70% ethanol to preserve them. Samples were taken to the Zoology Laboratory of Rev. Fr. Moses Orshio Adasu University, Makurdi. Species were identified based on their morphological characteristics through the use of microscope and hand lens and comparison were made with an identification key by Youdeowei (1977) as well as online documentations such as google lens and iNaturalist.

3.5 Data Analysis

Data collected from the study was subjected to descriptive statistics of tables, percentages, and charts. Chi square analysis was used to show relationship in abundance of insects in the different locations. The Shannon diversity index and Simpson dominance level were used for diversity indices and was calculated using the formula below as reported by Adelusi *et al*, (2018)

Shannon diversity index

Shannon Diversity Index $H' = \sum \rho i \, In \, \rho i$

Where ρi is the proportion of individuals found in the species

In Is the natural log

The Shannon Weiner index (H') is a quantitative measure that reflects how many different types (such as species) there are in a dataset, and simultaneously takes into account how evenly the basic entities (such as individuals) are distributed among those types

Plate 1: Constructed white light trap for nocturnal insects

4.0 RESULTS

A total of 443 insects were recorded distributed among 8 orders and 9 species with *Trioza* sp had the highest relative abundance of (138)31.15% followed by *Trypoxylon* sp. 63 (14.22%) and the least were 5(1.13%) observed in *Anoscopus sp.* and *Megalonotus hirsustus* respectively. The Shannon-Wiener diversity index (H′) was 2.418. The Chi-square analysis also showed a highly significant abundance in relation to the occurrence of insect species (χ^2= 171.414; df = 18; P= 0.0001), Table 1.

Based on the distribution of orders, Hemiptera had the highest species richness followed by the Orders Coleoptera and Hymenoptera, Hemiptera, Diptera, Orthoptera, Lepidoptera and Siphonaptera respectively however the differences were not significant (χ^2= 8.2368; df = 7; P=0.301), Figure 1.

The distribution of insects on the campuses based on location showed that the Eastern wing (2nd Camp) had slightly higher insect abundance 236(53.27%) than the Western wing (1st camp) 207(46.72%). *Anoscopus* sp., *Orus laevigatus* and *Megalonotus hirsutus* were recorded only at the

Eastern wing (2nd Camp). There diversity index was a slightly higher at the Eastern wing (H′=2.415) than the Western wing (H′=2.287). The species abundance was however not significantly different between sampling locations (χ^2 =0.369; df = 1; P = 0.549), Table 2.

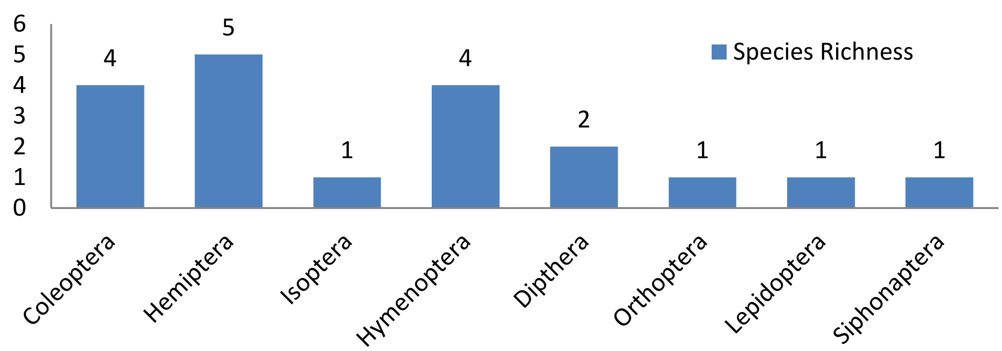
The abundance and distribution of insects according to light preference showed that insects preferred White light 241(54.40%) to yellow light 202(45.60%) however, the difference was not significant (χ^2 = 0.640; df = 1; P = 0.424), Table 2.

Table 1. Abundance and diversity of night insects on campuses of Fr. Moses Oshio Adasu University Makurdi.

Order	**Representative species**	**Species Abundance**	**Relative abundance (%)**
Coleoptera	*Tachys Puchellus*	10	2.26
	Agathidium nigrium	15	3.39
	Amara bifrons	9	2.03
	Hydrocanths Oblongus	10	2.26
Hemiptera	*Microporus nigrita*	20	4.51
	Trioza sp	138	31.15
	Anoscopus spp	5	1.13
	Orius laevigatus	10	2.26
	Megalonotus hirsutus	5	1.13
Isoptera	*Macrotermes bellicosus*	35	7.90
Hymenoptera	*Trypoxylon sp*	63	14.22
	Sceliphron spirifex	10	2.26
	Trichogramma spp	13	2.93
	Odontomachus spp	15	3.39
Diptera	Anopheles spp	41	9.26
	Drosophila spp	8	1.82
Orthoptera	*Acheta domesticus*	12	2.71
Lepidoptera	*Heliozola hammonella*	7	1.58
Siphonaptera	*Pulex irritans*	17	3.84
Total		**443**	**100**
Shannon-Wiener Index (H′)		2.418	

χ^2 = 171.414; df = 18; P= 0.000

Shannon Weiner index (H′); Species abundance: 2.418



χ^2 = 8.368; df = 7; P = 0.301

Figure 1. Species richness of nocturnal insects on Rev. Fr. Moses Orshio Adasu University Makurdi Campus according to Orders

Table 2. Distribution of insect species based on light preference and sampling sites
Location: $\chi^2 = 0.360$; df = 1; P = 0.549; Light preference: $\chi^2 = 0.640$; df = 1; P = 0.424

	Western wing		Eastern wing		
Species	**White Light**	**Yellow Light**	**White Light**	**Yellow Light**	**Total**
Tachys Puchellus	1	4	2	3	**10**
Agathidium nigrium	4	4	1	6	**15**
Amara bifrons	1	3	1	4	**9**
Hydrocanthus oblongus	3	0	1	6	**10**
Microporus nigrita	4	7	3	6	**20**
Trioza sp	42	18	38	40	**138**
Anoscopus spp	0	0	5	0	**5**
Orius laevigatus	0	0	2	8	**10**
Megalonotus hirsutus	0	0	5	0	**5**
Macrotermes bellicosus	22	4	4	5	**35**
Trypoxylon spp	18	7	21	17	**63**
Sceliphron spirifex	3	3	4	0	**10**
Trichogramma spp	4	0	0	9	**13**
Odontomachus spp	6	4	3	2	**15**
Anopheles spp	19	8	4	10	**41**
Drosophillia spp	2	0	4	2	**8**
Acheta domesticus	3	1	4	4	**12**
Heliozela hammonella	1	1	1	4	**7**
Pulex irritans	6	4	4	3	**17**
Total	**139**	**68**	**107**	**129**	**443**
Shannon-Weiner index (H′)	2.287		2.415		**2.418**

Pictures of insect species viewed under the dissecting microscope is shown in Plate 2-11

Plate 2. ***Tachys puchellus***
Order: Coleoptera

Plate 3. ***Amara bifrons***
Order: Coleoptera

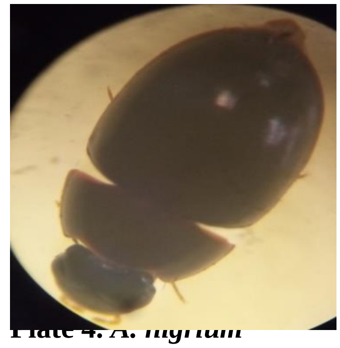


Plate 4. ***A. nigrum***
Order: Coleoptera

Plate 5. ***Orius laevigatus***
Order: Hemiptera

Plate 6. ***Trioza*** **spp**
Order: Hemiptera

Plate 7. ***Anoscopus*** **sp**
Order: Hemiptera

Plate 8. ***Heliozella hammonella*** **Plate 9.** ***Acheta domesticus*** **Plate 10.** ***Trichogramma spp*** ***Order: Orthoptera*** **Order: Lepidoptera** **Order: Hemiptera**

Plate 11. ***Auplopus carbonarius***
Order: Hymenoptera

5.0. DISCUSSION

The overall diversity of insects recorded during this study was moderate this shows that the community has a fair mix of species however the species are skewed towards a few becoming dominant over others (Baliton et al 2020). In this study, insects such as *Trioza* sp and *Trypoxylon sp.* Occurred in very high numbers, while others such as *Anoscopus sp* and *Megalonotus hirsutus* occurred in very low numbers and were only encountered at the Eastern wing of the campus with less human activities. Previous researches observed that some insects do not only cohabit with humans but also thrive in human dominated environments, often evolving to live in close association with humans. This type of association is commonly exhibited by insects from orders such as diptera, coleoptera, hemiptera, siphonaptera and blattodea and is known as **s**ynathrophy (Klegarth, 2017 and Adelusi *et al*. 2018).

Insects overtime have developed phototropic behaviours in response to light sources, including positive phototrophic behaviour towards light sources and negative phototrophic behavior away from light sources, therefore light traps have been developed and are used as a device for insect diversity assessment and monitoring (Briscoe and Chittka 2001). Some studies have reported on the various effects of light on insect species for example, Vilayanoor *et al*. (2010) reported that insect abundance varies with different sources of light traps stating that insect species exhibited specific sensitivities to light spectra, wavelengths and intensity (mercury, black and ultraviolet). Pan et al (2021) also reported that insects responded differently to wavelengths in field conditions, they noted that insects in different taxonomic groups had significantly different responses to light at various wavelengths. Carvalho *et al*. (2021) reported that some insect species tend to be light specific and were attracted to particular sources of light of LED lamp. Chukwu and Okrikata (2020) reported that two spotted crickets responded differently to different sources of light of an incandescent bulb and LED bulb.

In this study, wave length and light intensity were not measured however, more insect species were recorded at the white light than yellow light, even though the difference was not statistically significant. It was noticed that *Anoscopus sp* was found only at the white light trap while *Megalonotus hirsutus* was found only at the yellow light trap. The variations of insect attraction to different sources of light therefore agrees with the work of Pan et al (2021) who reported that insects responded differently to different sources and intensities of light.

A total of eight orders of insects were recovered in this study and these orders are consistent with nocturnal insect orders recorded in the works of Thomas and Gijo (2022) in Bayelsa State, Nigeria who reported eight orders (Diptera, Hymenoptera, Lepidoptera, Orthoptera, Odonata, Hemiptera, Coleoptera and Blattoidea). However other research findings have reported higher order of insects compared to this present study. Kimondiu *et al*. (2019) in India reported 21 orders of insect from different sources of light; Okrikata and Yusuf (2016); Okrikata and Anuoluwa (2019) in Taraba reported nine orders (Colepotera, Dictyoptera, Diptera, Hemiptera, Hymenoptera, Lepidoptera, Isoptera, Orthoptera and Mantodea) using different trapping methods of pitfall, sweep net and light trap. Vilayanoor *et al*. (2010) in India reported eleven orders of insect (Lepidoptera, Orthoptera, Hemiptera, Hymenoptera, Diptera, Coleoptera, Neuroptera, Dictyoptera, Odonata, Dermaptera and Isoptera) using different light sources.

This study was carried out on a university campus with high human activity, unlike the works of Thomas and Gijo (2022), which were conducted on the Niger Delta University campus and the surrounding Amassoma community, and Vilayanoor *et al*. (2010), who conducted their study in the experimental fields of the Indian Agricultural Research Institute, areas characterized by richer vegetation and more favourable ecological conditions that support higher insect abundance and diversity.

The order hemiptera had the highest insect composition in this study. This is in contrast to studies by Thomas and Gijo (2022) who reported the order Diptera as the most abundant; Okrikata and Yusuf (2017); Okrikata and Anuoluwa (2019) both reported order Coleoptera to be the most abundant. The abundance of order Hemiptera compared to other insect orders in this study was as a result of the high numbers of *Trioza* sp.

Previous research findings have attributed their results to the season at which the study was conducted, environmental activities, conditions and nature of the vegetation of the sampling sites. This study was conducted at the onset of the dry season and the campus is located on the bank of River Benue where individuals engage in rice farming, during this period many rice farms were still active and not yet harvested and this may have been a very favourable habitat for *Trioza* sp. compared to other insects.

The study concludes that nocturnal insects on the Rev. Fr. Moses Orshio Adasu University Makurdi campus belonged to eight orders, with Hemiptera (especially *Trioza* species) being the most abundant, the eastern wing showing slightly greater species diversity than the western wing, and although light color did not significantly affect insect abundance, white light attracted more insects than yellow light, demonstrating the value of light traps for ecological monitoring.

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