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ABUNDANCE AND DIVERSITY OF INSECT SPECIES IN FEDERAL UNIVERSITY LOKOJA, FELELE CAMPUS, KOGI STATE, NIGERIA

[1]Jolly Babangida Kachi[*], [2]John Paul Abah, [1]Blessing Aanuoluwapo Afolabi, [1]Blessing Adejoh and [3]Kefas Shitta

[1]Department of Biology, Federal University Lokoja, Kogi State, Nigeria.
[2] Department of Biological Sciences, KolaDaisi University Ibadan, Oyo State, Nigeria.
[3]Department of Zoology, Federal University Lokoja, Kogi State, Nigeria.
*Corresponding author email: kachijolly@gmail.com

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Abstract: Insects are generally adjudged to be the most diverse groups of animals in the world. They play vital roles in the ecosystem but could have their population affected by increasing anthropogenic activities and habitat modifications in ecosystems where their abundance and diversity have not been reported. Therefore, this study was aimed at investigating the insects' abundance and diversity of the Federal University Lokoja, Felele Campus, Kogi State (Latitude 7^0 51′ 59″ N; Longitude 6^0 49′ 08″ E), Nigeria. Bi-weekly samples of insects were collected between April-July, 2018 using Pitfall traps, Yellow-pan traps, Knock-down techniques, and Sweep net methods. Insects sampled were identified in the insect museum of the Department of Biology, Federal University Lokoja. A total of 407 insects belonging to 36 species, 26 families, and 7 orders, were collected from the study area. Data were analyzed using descriptive statistics and results obtained showed that the most abundant group of insects were Coleoptera (58.48%), Lepidoptera (11.55%), and Orthoptera (10.07%) while the least abundant were Polydesmida (3.19%) and Diptera (2.21%) respectively. The order Lepidoptera had the highest richness index [Margalef's index (D) = 2.4740] and diversity index [Shanon's index (H) = 1.9950]. The order Diptera was the most even (E = 0.9938), followed by Odonata (E = 0.9242) and Hymenoptera (E = 0.8252). The study showed that Coleopterans were the most abundant and Lepidopterans were the most diverse. In conclusion, this preliminary survey showed that the study area was rich in insects' abundance and diversity. This result, therefore, serves as a springboard for further research. It is recommended that increasing the scope, duration, and sampling techniques of further studies would also give a comprehensive understanding of the composition of insects in the study area.

Keywords: Abundance, Coleoptera, Lepidoptera, Margalef's index, Shanon's diversity index

Introduction

Insects are the world's most diverse group of animals in the world. They are diverse both in terms of taxonomy and ecology (Belamkar and Jadesh, 2014). Insects are important because of their diversity, ecological role, and influence on agriculture, human health, and natural resources. They have been used in landmark studies in biomechanics, climate change, developmental biology, ecology, evolution, genetics, paleolimnology, and physiology (Okrikata and Yusuf, 2016). Insects are found in various types of habitats and contribute to the function and stability of the ecosystem (Ojija *et al*., 2016). Plants are reported to host more than 30 million species of animals of which about 14 million have been described and among the described species, 750,000 are insects. Insects together with other invertebrates make up more than 75% of all described global species diversity (Ojija *et al*., 2016).

As a group, insects show a wide range of differences in their life history, strategy, movement, seasonality, size, trophic level, and requirements for habitats (Belamkar and Jadesh, 2014). Also, they are reported to have contributed immensely to nutrient cycling, organic matter decomposition, pollination, and soil aeration in ecosystems (Jaganmohan *et al*., 2013).

Insects are found almost everywhere yet their abundance in some terrestrial ecosystems is still undisclosed, and as stated by Membere and Nwabueze (2019), despite their vital economic functions in the ecosystem, a large number of insects are falling and becoming extinct on a global scale owing to habitat fragmentation, degradation, bush burning, and overgrazing. The increased recognition of the importance of understanding and conserving biodiversity has sparked interest in assessing insect richness and diversity in different habitats and ecosystems. However, as revealed in previous reports, the majority of studies on insect composition and abundance, focus mainly on one or two insect orders and/or families (Medler, 1980; Okrikata and Yusuf, 2016; Ombugadu *et al*., 2021).

Sampling and monitoring of insects have been reported to be fundamental components of an Insects and Pest Management (IPM) program which increases awareness of insect activity in a studied field or location (Marjorie, 2013). Generally, there are relatively few studies on the insect community composition in different Campuses within the Guinea Savanna zone of Nigeria. Notable among them include insects species abundance and diversity studies in the Federal University of Agriculture, Makurdi (Yager *et al*., 2018); Nasarawa State University, Shabu-Lafia Campus (Ajayi *et al*., 2018); Kaduna State University-Main Campus (Naman *et al*., 2019) and Federal University Lafia, Nasarawa State (Ombugadu *et al*., 2021). At the moment, no literature has reported on the diversity, abundance, and species richness of insects at the Federal University Lokoja, Felele Campus. Therefore, this study was carried out to provide a preliminary inventory of the composition and abundance of insects at the Federal University Lokoja, Felele Campus which will provide baseline data for further studies on the ecology of insects at the study site.

Materials and Methods

Study Area

The Felele Campus of the Federal University Lokoja is situated along the Lokoja-Okene express road, Lokoja, Kogi State with coordinates of Latitude 7^0 51′ 59″ N and Longitude 6^0 49′ 08″ E. The entire Campus has an area of more than 500 hectares of land but only a very small portion of this area has been developed for use. Part of the undeveloped areas is used for agricultural activities such as the cultivation of Cassava, Groundnuts, Maize, etc. The vegetation comprises a few farm trees such as *Khaya senegalensis*, *Azadirachta indica*, *Parkia biglobosa*, *Anacardium occidentale*, *Tectona grandis*, *Gmelina aborea*, *Mangifera indica*, *Vitellaria paradoxa* etc., The other vegetational composition include shrubs and predominant herbs (grasses) such as *Hyptis suaveolens*,

Acanthospermum hispidum, Ageratum conizoids, Tridax procumbens, etc.

Selection of Sampling Points

The study area was divided into four (4) sampling plots with the aid of a quadrat, each measuring 30m by 30m. **Plot A**: was behind the Vice Chancellor's office building (Latitude 7^0 52′ 4.464″ N; 6^0 41′ 3.672″ E) which was predominately occupied by grasses like *Hyptis suaveolens*, *Ageratum conyzoids* and *Tridax procumbens*. **Plot B**: was a swampy area directly in front of the Vice Chancellor's office building (Latitude 7^0 51′ 59.193″ N; 6^0 41′ 7.234″ E) which had a small stream. **Plot C**: was the woody plants' area along the main road leading into the University (7^0 51′ 56.421″ N; 6^0 40′ 55.039″ E) not too far from the Vice Chancellor's office building. **Plot D**: was the open space in front of the female hostel (7^0 52′ 6.028″ N; 6^0 40′ 47.570″ E) with marked farming activities.

Fig 1: Google Earth Map of Federal University Lokoja, Felele Campus showing the sampling sites.

Insects Sampling Methods

Insects were sampled bi-weekly between the periods of April-July, 2018 using 4 different sampling methods which include:

Pitfall Traps: A total of four (4) pitfall traps were permanently dug, one at each plot site, each of the pitfall was set at the middle of each plot. Pitfall traps (diameter = 8cm and height = 10cm), were buried in the ground in a way that the top of the trap was at the same level as the soil surface. The traps were not baited but were filled with 150ml of 70% diluted alcohol as described by Khadijah *et al.* (2013), Greenslade (2014), and Ojija *et al.* (2016).

Yellow Pan Traps: Yellow pan trap methods as described by Saunders and Luck (2013) and Kyerematen *et al*. (2014) were used to attract insects to the trap. The brightness of the color attracts both ground and flying insects to the trap. A total of 4 yellow pan traps containing a combination of water with 3% mild detergent to break the surface tension placed 15cm above the ground level, were used. The traps were set for 12 hours (6 am to 6 pm). Flying insects landing on the surface of the water were also trapped and then transferred into the collecting jar with the aid of the forceps.

Sweep Net Method: The sweep net was used for capturing above ground and flying insects by sweeping on grass surfaces and above ground level (Belamkar and Jadesh, 2014). Captured insects were immediately transferred into the killing jar which contained cotton wool soaked with ethyl acetate covered by a thin paper layer serving as a membrane, to kill the insects before being transferred to the collecting jar. The sweeps were done between the hours of 6am to 10am and 3pm to 6pm as described by Okrikata and Yusuf (2016).

Knockdown Method: The knockdown method was used to collect insects hanging on walls/trees above the reach of the hand or sweep net and also, fast-flying small insects like house flies and camouflaged insects sticking to leaves or feeding on fruits as described by Kagali *et al.* (2013). The insects were knocked down by spraying an insecticide (Bagon) to demobilize them. Plain sheets of paper were used to collect the knocked down insects which were subsequently picked by forceps into the killing jar.

Identification and Preservation of Insects Collected

The collected insects were further processed for identification in the insect Museum unit of the Laboratory at the Department of Biology, Federal University Lokoja. Identification of insects was done with a standard identification guide for insects (Youdeowei, 1977). Preservation was done by direct pinning and pickling. Dead insects were placed on a setting board and mounted by the use of entomological pins which were symmetrically positioned through the thorax, in a way that a major part of the pin passes through the insects. The fore and hind wings of the insects were then neatly spread out at an angle of 90 degrees. This method was most suitable basically for large insects. In setting the insects, wings and legs were spread in a horizontal position on a standard-setting board and held in position by a setting tape. The pinned insects were allowed to dry for 48 hours before mounting on the insect box. All of these were done as described by Okrikata and Yusuf (2016). Insect specimens that could not be pinned were pickled in bottles containing fluid preservatives. 70% alcohol (ethanol) was used as the preservative for all pickled insect specimens.

Data Analyses

Data collected in this study were analyzed using descriptive statistics (frequencies and percentages). Insect species were grouped into species, families, and orders. Diversity indices such as Shannon-Wiener Index (H), Margalef Index (d), Evenness Index (E), and Equitability Index (J) were computed using the Past3 software to analyze insect species diversity, richness, and evenness respectively (Okrikata and Yusuf, 2016).

Results and Discussion

In the course of this study, a total of 407 species, belonging to 26 families and 7 orders of insects were sampled throughout the sampling period at the study site. A checklist of insect species sampled is provided (Table 1). *Diphucephala colaspidoides* had the highest relative abundance (27.5%) of insect species captured, followed by *Catharsius spp* (24.6%) *and Zoncerus veriegatus* (7.1%) respectively. Insects' species with the least relative abundance included *Danaus chrysippus*, *Junonia hierta*, *Palomen prasina*, *Cephonodes hylas*, and *Pyrgus malvae* all of which had 0.2%. The family Scarabaeidae had the most abundant species of insects sampled which belongs to the order Coleoptera.

The order Lepidoptera was the most diverse group of insects followed by the order Hymenoptera as indicated by the Shannon-Wiener (H) indices of 1.9950 and 1.7540 respectively, while the order Diptera was the least diverse (H= 0.6870) as presented in Table 3. Also, the order Diptera was the evenest species (E=0.9938), followed by Odonata (E=0.9242) and Coleoptera was the least (E=0.3544). The species richness indices computed showed that the order Lepidoptera had the highest with a Margalef index (D= 2.4740) followed by Hymenoptera (D= 1.7640) and the least was the order Diptera (D=0.4551). The Lepidopterans and the Orthopterans were the only insect orders that had species sampled across all the sampling plots.

In all the sampling points, plot 3 had the highest abundance (255 individuals) of insect species followed by plots 1, 2, and 4 respectively. The Shanon-Weiner (H) species diversity indices revealed that plot 1 was the most diverse followed by plots 2, 4, and 3 in descending order respectively (Table 4). The Margalef species richness indices showed that plot 2 was the richest followed by plots 1, 4, and 3 respectively. The

species evenness indices showed that plot 4 was the most even while plots 1, 2, and 3 followed in descending order respectively.

Table 1: Checklist of insect species sampled in selected locations of the Federal University Lokoja, Felele Campus

Order	Family	Species	Plot 1	Plot 2	Plot 3	Plot 4	Total (%)
Lepidoptera	Papilionidae	*Papilio demoleus*	3	-	-	-	3(0.7)
		Craphillum pylatas	4	-	-	-	4(1.0)
	Nymphalidae	*Danaus chrysippus*	-	-	-	1	1(0.2)
		Junonia hierta	-	1	-	-	1(0.2)
	Acraidae	*Acraea eponina*	3	5	2	-	10(2.5)
	Pieridae	*Eurema brigitta*	4	3	-	-	7(1.7)
	Sphingidae	*Cephonodes hylas*	1	-	-	-	1(0.2)
	Zygaenidae	*Zygaena sp*	3	-	-	-	3(0.7)
	Hesperiidae	*Pyrgus malvae*	1	-	-	-	1(0.2)
	Lycaenidae	*Iolana Alfieri*	7	3	4	2	16(3.9)
Orthoptera	Acrididae	*Acrida ungarica*	-	-	7	1	8(2.0)
		Phaulacridium vittakim	-	-	-	4	4(1.0)
	Pyrgomorphoidea	*Zoncerus veriegatus*	5	4	16	4	29(7.1)
Hymenoptera	Apidae	*Bombus argillaceus*	3	-	1	1	5(1.2)
		Amegilla sp	-	-	3	-	3(0.7)
		Apis mellifera	5	-	4	-	9(2.2)
	Pompilidae	*Belmogester juncea*	3	2	2	-	7(1.7)
	Crabronidae	*Bembix sp*	2	-	-	-	2(0.5)
	Tenthredinidae	*Pristiphora erichsonii*	3	-	-	-	3(0.7)
	Pentatomidae	*Palomen prasina*	1	-	-	-	1(0.2)
Diptera	Syrphinae	*Asarkina africana*	2	3	-	-	5(1.2)
	Muscidae	*Musca domestica*	-	-	4	-	4(1.0)
Odonata	Libellulidae	*Palpopleura sp*	-	4	-	-	4(1.0)
		Brachythermis Lacustris	-	6	-	-	6(1.5)
		Pachydiplax longipennis	-	12	-	-	12(2.9)
	Coenagrionidae	*Ischnura haterosticta*	7	-	-	-	7(1.7)
Coleoptera	Scarabaeidae	*Catharsius sp*	-	-	100	-	100(24.6)
		Diphucephala colaspidoides	-	-	112	-	112(27.5)
	Lampyridae	*Oculogryphus bicolor*	2	-	-	-	2(0.5)
	Chrysomelidae	*Clytrini sp*	3	-	-	-	3(0.7)
	Curculionidae	*Sitophilus zeamais*	3	-	-	-	3(0.7)
	Tenebrionidae	*Zophobas morio*	2	-	-	-	2(0.5)
	Cantharidae	*Ditemnus bidentatus*	8	-	-	-	8(2.0)
		Cantharis nigricans	5	-	-	-	5(1.2)
		Silis percomis	3	-	-	-	3(0.7)
Polydesmida	Eurymerodesmidae	*Eurymerodesmus* spp.	-	5	-	8	13(3.2)
		Total	83	48	255	21	407(100)

Table 2: Frequency distribution of insect species sampled in selected locations within Federal University Lokoja, Felele Campus

S/N	Order	Number of species (%)	Individuals (%)
1	Lepidoptera	10 (27.78)	47 (11.55)
2	Orthoptera	3 (8.33)	41 (10.07)
3	Hymenoptera	7 (19.44)	30 (7.37)
4	Diptera	2 (5.56)	9 (2.21)
5	Odonata	4 (11.11)	29 (7.13)
6	Coleoptera	9 (25.00)	238 (58.48)
7	Polydesmida	1 (2.78)	13 (3.19)
	Total	36 (100.00)	407 (100.00)

Table 3: Diversity Indices of Insect Species sampled from different locations of Federal University Lokoja, Felele Campus

S/N	Order	Species Evenness (E)	Equitability (J)	Simpson Index (1-D)	Shannon-Weiner Index (H)	Margalef Index (D)
1	Lepidoptera	0.7355	0.8666	0.8366	1.9950	2.4740
2	Orthoptera	0.7351	0.7198	0.4521	0.7908	0.5386
3	Hymenoptera	0.8252	0.9013	0.8022	1.7540	1.7640
4	Diptera	0.9938	0.9911	0.4938	0.6870	0.4551
5	Odonata	0.9242	0.9431	0.7087	1.3070	0.8909
6	Coleoptera	0.3544	0.5279	0.5998	1.1600	1.4620
7	Polydesmida	1	0	0	0	0

Table 4: Diversity indices of Insect species sampled from the different sampling points within the Federal University Lokoja, Felele Campus

S/N	Indices	Plot 1	Plot 2	Plot 3	Plot 4
1	No of species	6	6	5	4
2	Individuals present	83	48	255	21
3	Dominance_(D)	0.2495	0.2960	0.7017	0.3515
4	Shannon-Weiner (H)	1.5500	1.4530	0.6509	1.1540
5	Speies Evenness_e^H/S	0.7617	0.7123	0.3835	0.7925
6	Margalef (D)	1.1320	1.2920	0.7219	0.9854
7	Equitability (J)	0.8481	0.8107	0.4044	0.8322

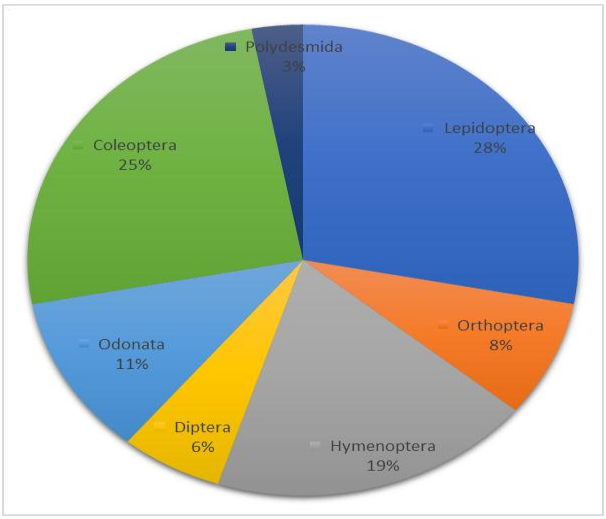

Fig 2: Insects species distribution by orders in the study area

The result of this study which showed a total number of 407 insect individuals is an indication that the Felele Campus of the Federal University Lokoja is high in insect abundance. The rich number of insects in this study could be a result of the availability of different plants or vegetation cover which were mostly herbs like *Hyptis suaveolens* and *Ageratum conyzoides* which have been reported to attract pollinators like stingless bees and butterflies (Brodmann *et al*., 2008); shrubs and a few trees, with specific microhabitats which are relatively undisturbed. The number of insect individuals recorded in this study was higher than that recorded by Ajayi *et al*. (2018) who reported a total of 243 insect individuals in a study of insect abundance and diversity in and around the faculty of agriculture at Nasarawa State University, and Ombugadu *et al*. (2021) who reported a total of 301 butterfly individuals within the different habitats of the Federal University of Lafia Campus. The study however agrees with the findings of Yager *et al*. (2018) and Naman *et al*. (2019) who reported a high number of insects in their studies of insect diversity and abundance in the Forestry Nursery of Federal University of Agriculture, Makurdi, Benue State, and Main Campus of the Kaduna State University respectively.

The result obtained showed the order Coleoptera were the most abundant in terms of individual species. This particularly agrees with the findings of Okrikata and Yusuf (2016), who recorded Coleoptera as the dominant insect order in Wukari, Taraba State, and Tscharntke and Brandl (2004) who showed the Coleopterans to be predominant in their study of tropical ecosystems. This could have been a result of the availability of favourable abiotic conditions such as light, temperature, humidity, etc., and biotic conditions such as vegetative biodiversity which serve as cover and diet as well as symbiotic interactions with other higher animals in the study site. Khaliq *et al*. (2014) support this view by reporting that both abiotic and biotic conditions could significantly affect insects' population dynamics in ecosystems. This result was however contrasted to the previous findings of Yager *et al*. (2018) who reported Hemiptera as the most dominant insect order in the Forestry Nursery of Federal University of Agriculture Makurdi, Benue State, Nigeria; Naman *et al*. (2019) who reported Odonata as the most dominant insect order in the main Campus of Kaduna State University, Kaduna State, Nigeria, and Ajayi *et al* (2018) who reported Orthoptera as the most dominant insect order in Shabu-Lafia Campus of Nasarawa State University, Nasarawa State, Nigeria. These differences could be attributed to the peculiarities of the different study locations and other environmental conditions as rightly posited by Alarape *et al*. (2015) on a temporal scale, the abundance of any given species was dependent on environmental (abiotic and biotic) factors.

The high relative abundances of *Diphucephala colaspidoides* (27.5%) *and Catharius sp* (24.6%) members of the Coleopterans in this study could be of benefit to the entire ecosystem. The high presence of the coprophagous dung beetles (*Catharius sp*), could have been a result of the presence of a Cattle ranch within the study location which provides the dungs the insects utilize to improve the quality and texture of the soil. The beetle serves as macrofauna which helps in improving soil fertility due to its incorporation of humus into the soil. The findings of Lee and Kwon (2013) support this view by reporting that beetles greatly influence the environment through their effects on green plants, their role in the breakdown of plant and animal remains as well as their predatory activities

The insect order Lepidoptera was the second dominant insect order in this study which agrees with the findings of Yager *et al*. (2018) and Ajayi *et al* (2018) who both reported Lepidoptera as the second most dominant insect order in the Forestry Nursery of Federal University of Agriculture,

Makurdi, Benue State and Nasarawa State University, Shabu-Lafia Campus, Nasarawa State respectively. Also, the Lepidopterans were the most diverse (Shanon-Weiner Index = 1.9950) and richest (Margalef Index = 2.4740) group of insects in this study. As reported by Nwosu and Iwu (2011), the Lepidopteran species captured in this study were typical of the taxa in West Africa which include the families Pieridae, Nymphalidae, and Papilionidae. These observed results could be a consequence of the plant varieties which provide cover and food for them.

Across the four sampling points, the diversity indices showed that Plot 1 had the higher value of insects' species diversity and evenness. This implies the availability of different plants which could influence the diversity and abundance of insect species. This corroborates the findings of Hougen and Rausher (1994) and Chen *et al*. (2007) who opined that insects interact by way of mutualism and phytophagy.

Conclusion and Recommendation

This present study has shown that the Federal University Lokoja, Felele Campus is rich and diverse in insect biodiversity. It has also provided for the very first time, the checklist of insects' fauna in the Federal University Lokoja, Felele Campus, which will serve as baseline information for further research in the study site, and assist all stakeholders to optimize the use of beneficial insects while managing noxious species. It is therefore recommended that increasing the scope, duration, and sampling techniques of further studies would also give a comprehensive understanding of the composition and population dynamics of insects in the study area.

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Conflict of Interest

Authors declare that there is no conflict of interest related to this work.

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