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ORIGINAL RESEARCH

Distribution and diversity of insects' species in the Federal University Lokoja Zoo and Conservatory area Kogi State Nigeria

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Abstracts

Insects are a vital part of the ecosystem, they aid in the production of fruits seeds, vegetables and flowers. They also serve as food for birds and fish. However, with increasing agricultural, industrial and human activities in the modification of the environment, their population and distribution could decline hence, the study which was aimed at investigating the insects' distribution and different species available in the study area the Federal University Lokoja Zoo and Conservatory, Kogi State Nigeria (Latitude 7º 51′ 33″ N; Longitude 6º 41′ 22″ E; Altitude 145m above sea level.). Insects were collected every other week from February to May 2024. Pitfall traps were set up, Yellow-pan traps were mounted in selected locations of the study area, Knock-down techniques were adopted for some species of insects, and a sweep net was also used, all as methods to effectively collect the insects. Identification of the collected insects were done using keys in the insectary of the Department of Zoology, Federal University Lokoja. Two hundred and thirteen (213) insects were encountered in total belonging to 33 species, 22 families, and 6 orders, were sampled from the study area. Analysed results using descriptive statistics showed that the most abundant group of insects in the study area were Coleoptera (38.03%), followed by Lepidoptera (21.13%), and Orthoptera (15.50%) while the least abundant was the Diptera (5.63%). The order Diptera was the most even (E = 0.8938), followed by Odonata (E = 0.8242) and Hymenoptera (E = 0.7252). The study revealed that Coleopterans were the most dominant and Lepidopterans were the most diverse. Finally, the study indicates that the Federal University Lokoja Zoo and Conservatory is rich in insects' abundance and diversity. Each of the species exhibits differences in abundance and distribution and this is a useful information for planning of conservation measures. The richness of the insect's species in the study area also indicates a beneficial contribution to habitat quality within the Zoo and environs.

Keywords: Insects, distribution, diversity, Conservatory, Nigeria.

Introduction

Insects are a common group of animals found almost everywhere within the ecosystem. they interact with humans in an interesting way biologically. Insects play an important to humans and environment. In terms of agriculture, they help during pollination of some plants which eventually leads to improved production of such plants, the condition factor of the soil is also improved by certain group of insects leading to a healthy soil for the ecosystem, they are seen by other researchers as the environment cleaners because of their ability

to devour both death animals and plants (Shitta et al., 2025). Apart from the above roles played by insects, they are in addition a source of food to humans and other animals. Some insects are eaten directly while others provide biproducts as food, for instance honey. (Chima et al., 2013; Amorim et al., 2022; Kachi, et al., 2022). Despite their immense benefit to the ecosystem and humans, they are also disease vectors to many other organisms including human (Schowalter et al., 2011; Shitta, et al., 2025). Although insects have interesting characteristics to other humans some see them as a source of irritation, discomfort and as a hindrance to certain human activities.

In food chain, insects provide an important link between producers and all the consumers (primary, secondary, tertiary) even the decomposers are not left out. Energy is transferred, nutrients are recycled and ultimately the ecosystem is balanced in the process. This linkage created by the insects occurs in the grassland, marine as well as the forest food chain. It can effectively be deduced that in terms of number, insect provide more services that human can depend and rely upon for survival. For instance, the biological control of weeds, agricultural pests, disease vectors and others that compete with humans or challenge their existence in some cases; and the micro/macro decomposition of leaves and carrion, which contributes to recycling of nutrient, formation of soil and the purification of water (Warren et al., 2021; Drake et al., 2024; Van Klink et al., 2024).

The removal or felling of trees without replacement as a result of increase in human population and activities, poses a bigger challenge to insect population, diversity and abundance (Khan et al., 2017; Leksono et al., 2023). In the tropical areas, a lot of insects-human interactions occurs as described earlier. Nigeria is one of the tropical countries in tropical Africa within which some of these interactions take place at incredibly alarming rate due to animal biodiversity, it is therefore, an area of significant ecological importance (Anwadike, 2020: Ajayi et al.,2022;Gunawan, et al., 2016). Unfortunately, tropical Africa is implicated for having some of the world's most severely endangered forest with approximately 55.7% of its primary forest lost mainly due to anthropogenic activities (Fingesi, Tyowua, Fajobi, and Jamilu, 2019; Leisher et al.,2022).

Changes in habitat all over the country, particularly the not so properly secured ecosystems that can easily be damaged and forests areas has negatively affected the insect diversity. they are very sensitive to any transformation in climatic factors such as rainfall, temperature, wind humidity and altitude. (Uhler, et al., 2021;Khaliq et al.,2014 and Alarape et al., 2015). The global change in climate leading global warming in some areas and inundation in other areas has impacted negatively the insect's population. The world-wide climate has changed significantly during the 20th century the typical global air temperature close to the earth surface and ocean rose by 0.74^{oC} between 1900s and 2000s (Parry et al., 2007). At a world-wide level, climate change is assumed to be a key factor affecting future developments in the area of biodiversity (Huurdeman et al., 2024)(Beck et al., 2010) with wide ranging effects on forest structure and native spatial distribution patterns (Sang and Bai 2009). Vanishing of these insects in certain areas of the world, could lead to extermination of earth's animals because of the removal of so much plant life. Today, insects are by far the most diverse, abundant and successful species in the animal kingdom. The role (positive or negative) insects play in nature require a better understanding of how these insects interact with living and non-living environment and their diversity (Franzén, et al., 2023; Naman & Abdullah, 2019).

The Federal University Lokoja main campus is a developing institution experiencing significant anthropogenic activities such as tree removal for construction purposes, this has the potential to adversely affect the insect fauna. Habitat loss possesses a significant threat to the long-term survival of species worldwide (Saunders et al.,1991; Shitta, et al., 2025). Identified potential consequences of habitat loss and fragmentation, including decreased species richness and diversity, altered abundance, and disrupted interspecific interactions. These factors are recognized as major contributors to the current biodiversity crisis.

The Federal University Lokoja Zoo and Conservatory has just been established precisely in August 2023 and commissioned for public use on 13th June 2024 there is, therefore, no reliable information on the insect diversity especially the macro - species which serves as indicator species to environmental conditions. This study is a checklist that will serve as baseline information for future research and further investigations. It

will also document the findings in a manner that will be very useful to researchers in other areas of sciences located in and around the study area.

Materials and methods

Study Area

The Federal University Lokoja Zoo and Conservatory is situated within the Federal University Lokoja Felele Campus, along Lokoja-Lagos highway, in Lokoja, Kogi State Nigeria having the coordinates of Latitude 7^{o} 51' 33'' N and Longitude 6^{o} 41' 22''E, with an altitude 145m a.s.l). The entire Zoo and Conservatory is seating on an area of 11hectres of land. It is a Zoo and conservatory; therefore, part of the undeveloped areas is allowed for conservation purposes where plants and animals can thrive and flourish together. The vegetation cover in the Zoo area is composed of trees. In terms of the vegetational composition of the study area, shrubs and herbs like *Hyptis suaveolens*, *Acanthospermum hispidum,* and *Ageratum conizoids* are very common.

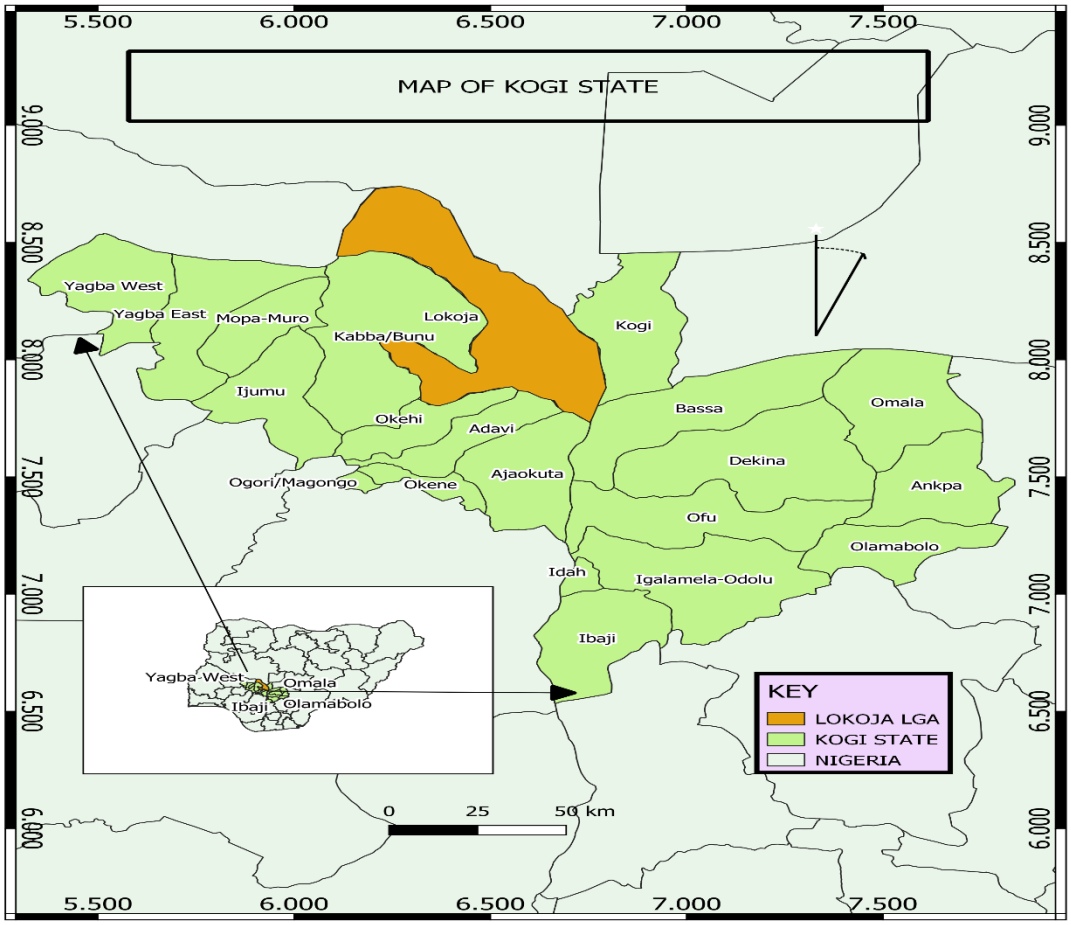

Figure 1: Map of Nigeria showing Kogi State and Lokoja area.

Sampling Points at the Conservatory

The study area was purposively demarcated into three (3) sampling points (also called plots) with the aid of a quadrat, each measuring 25m by 25m. The sampling points were carefully marked for the purpose of this study into A, B, and C. Plot A: was beside the main Zoo compound where animals are kept. Plot B was almost next to A, near a small stream, on the lowland side of the study area. The sampling point C was the woody plants' area behind the Zoo compound.

Sampling techniques

Insects were sampled every other week between the periods of February – May 2024. To avoid bias towards certain insects four sampling methods were used for insect sampling. Pitfall traps were used for capturing insects especially the ground dwelling species of insects like the ants and beetles. In this study, four (4)

pitfall traps were provided on each of the sampling points. The diameter of the trap was set at 8cm, and the height was 10cm), this was done to avoid stressing the insects unnecessarily when they fall into the trap. The trap was submerged in the soil same level with the soil surface. The traps were filled with 100ml of 75% alcohol as described by (Tmimi et al., 2018) Khadijah et al. (2013), (Gunawan et al., 2016) Greenslade (2014), and Ojija et al. (2016). Flying insects were captured using the yellow pan trap according to Saunders and Luck (2013) and Kyerematen et al. (2014). Four yellow pan traps each filled with 2-3ml of liquid soap and placed 10cm above the ground level were positioned across the sampling points. During the monitoring all insects collected on the pan and those that fall off from the pan were assembled into a sample bottle using forceps. Sweep nets captured flying insects that perch on vegetation within the samplng area as described by Belamkar and Jadesh (2014). The collection of insects using sweep net was conducted between the hours of 6 am to 9 am and 4 pm to 6 pm as described by Okrikata and Yusuf (2016) and Shitta, et al., (2025).

Knockdown Method was also used to collect insects hanging on walls/trees above the reach of hand or sweep net and, fast-flying small insects like house fly and camouflaged insects sticking to leaves or feeding on fruits as described by Kagali et al. (2013). The insects were knocked down through a gentle, non-lethal insecticidal spray or fog applied to the vegetation or area where the insects are found.

All insects captured were immediately transferred into pre-labelled sampling bottles and transferred to the laboratory for identification and documentation.

Insect identification and processing

All the collected insects were further processed for identification in the insectary of the Department of Zoology, Federal University Lokoja, Felele Campus. Identification of insects was done using standard identification guide and keys for insects (Mendoza, et al., 2008). Preservation of the insect was done by pinning directly with entomological pins. Insects that were found dead were also processed. The fore and hind wings of the insects are very delicate, it must be handled with care to avoid damage. It was carefully spread out and pinned. This method was more effective and better for larger insects. The pinned insects were allowed to dry for 24 to 48 hours before it was mounted in the entomological box. All of these were modified and processed according to the description by Okrikata and Yusuf (2016). Other insect's specimens that were too large or too small for pinning, were placed in bottles containing 75% alcohol and properly labelled with the identity of the insect in detail.

Data Analysis

Data collected in this study were entered in a Microsoft excel sheet and transferred into a statistical package for social science (SPSS version 28). Descriptive statistics was used for the analysis. For a better description and understanding of the results, insect's species were grouped into species, families, and orders. Diversity indices such as Shannon-Wiener Index (H), Margalef Index (d), and Evenness Index (E) were also analysed. (Okrikata and Yusuf, 2016).

Results

A total of two hundred and thirteen (213) individual insects were collected from three (3) selected plots at the Conservatory. These 33 species of insects belong to 23 families and 6 orders (Table 1). *Catharsius sp* (19.25%) had the highest relative abundance of the captured insect species, followed by *Zoncerus veriegatus* (9.85%) *and Diphucephala colaspidoides* (8.45%) respectively. Results obtained in these studies showed that, Insect's species with the least relative abundance were *Danaus chrysippus, Junonia hierta, Palomen prasina, Cephonodes hylas and Pyrgus malvae* all of which had 0.2% abundance. The family Scarabaeidae had the most dominant species of insects encountered which belongs to the order Coleoptera (Table 1).

In terms of diversity, the order Lepidoptera occurred as the most diverse group of insects, this was followed by the order Hymenoptera having 1.8950 and 1.6540 respectively in Shannon-Wiener indices. The order Diptera was the least diversity (H = 0.5870) as shown in Table 3. Additionally, the order Diptera was the most evenly distributed species (E = 0.8938), followed by Odonata (E = 0.8242) and Coleoptera was the least evenly distributed species (E = 0.3322). How rich an individual species is in the study area was revealed by species richness indices. The species richness indices analysis revealed that the order Lepidoptera had the highest with (D = 2.4640) according to Margalef index, it was followed by Hymenoptera (D = 1.7540) and the least was the order Diptera (D = 0.4451). All the orders recorded in this study area were encountered in all the sampling points.

In all the sampling points, plot A showed the highest abundance (93 individuals) of insect species followed by plots B, and C. The Shannon-Weiner (H) species diversity indices revealed that plot A was the most

diverse followed by plots B, and C in descending order (Table 4). The Margalef species richness indices showed that plot B was the richest followed by plots A, and C. Regarding the species evenness indices data obtained indicates that all the 3 plots (A, B, and C**)** are evenly distributed.

Table 1: Insect species encountered at the study site

Order	**Family**	**Species**	**PlotA**	**Plot B**	**Plot C**	**Total (%)**
Lepidoptera	Papilionidae	*Papilio demoleus*	5	2	1	8(0.7)
		Craphillum pylatas	2	1	1	4(1.0)
	Acraidae	*Acraea eponina*	2	3	4	9(2.5)
	Pieridae	*Eurema brigitta*	2	1	3	6(1.7)
	Sphingidae	*Cephonodes hylas*	1	1	1	3(0.2)
	Zygaenidae	*Zygaena sp*	4	1	1	6(0.7)
	Lycaenidae	*Iolana Alfieri*	5	2	2	9(3.9)
Orthoptera	Acrididae	*Acrida ungarica*	1	-	7	8(2.0)
		Phaulacridium vittakim	1	2	1	4(1.0)
	Pyrgomorphoidea	*Zoncerus veriegatus*	8	4	9	21(9.85)
Hymenoptera	Apidae	*Bombus argillaceus*	2	-	1	3(1.2)
		Amegilla sp	-	-	3	3(0.7)
		Apis mellifera	3	-	2	5(2.2)
	Pompilidae	*Belmogester juncea*	2	1	1	4(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	2	2	6(1.2)
	Muscidae	*Musca domestica*	1	1	4	6(1.0)
Odonata	Libellulidae	*Palpopleura sp*	1	1	1	3(1.0)
		Brachythermis Lacustris	2	2	1	5(1.5)
		Pachydiplax longipennis	3	3	1	7(2.9)
	Coenagrionidae	*Ischnura haterosticta*	2	2	2	6(1.7)
Coleoptera	Scarabaeidae	*Catharsius sp*	15	10	16	41(19.25)
		Diphucephala colaspidoides	8	6	4	18(8.45)
	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*	2	2	2	6(2.0)
		Cantharis nigricans	2	1	1	4(1.2)
		Silis percomis	1	1	-	2(0.7)
		Total	**93**	**49**	**71**	**213(100)**

Table 2: Insect distribution at the study site

Order	**Number of species (%)**	**Individuals (%)**
Lepidoptera	6 (18.18)	45 (21.13)
Orthoptera	4 (12.12)	33 (15.50)
Hymenoptera	7 (21.21)	21 (9.86)
Diptera	3 (3.03)	12 (5.63)
Odonata	4 (12.12)	21 (9.86)
Coleoptera	9 (27.27)	81 (38.03)
Total	**33 (100.00)**	**213 (100.00)**

Table 3: Insect species diversity at the study site

Order	Species Evenness (E)	Equitability (J)	Simpson Index (1-D)	Shannon-Weiner Index (H)	Margalef Index (D)
Lepidoptera	0.6355	0.7666	0.7366	1.8950	2.4640
Orthoptera	0.6351	0.6198	0.3521	0.6908	0.5286
Hymenoptera	0.7252	0.8013	0.7022	1.6540	1.7540
Diptera	0.8938	0.8911	0.3938	0.5870	0.4451
Odonata	0.8242	0.8431	0.6087	1.2070	0.8809
Coleoptera	0.3322	0.4279	0.4998	1.1600	1.4610

Table Error! No text of specified style in document.**: Diversity indices of insect species with respect to sampling plots**

Indices	Plot A	Plot B	Plot C
No of species	3	3	3
Individuals present	93	49	71
Dominance_(D)	0.2495	0.2960	0.7017
Shannon-Weiner (H)	1.5500	1.4530	0.6509
Species Evenness_e^H/S	0.7617	0.7123	0.3835
Margalef (D)	1.1320	1.2920	0.7219
Equitability (J)	0.8481	0.8107	0.4044

Discussion

The diversity and species richness of the study area, the Federal University Lokoja Zoo and Conservatory, could be attributed to the abundance of plants species providing food and shelter for the insects (Kachi, et al., 2022). Furthermore, the study site is relatively free from so much human activity and an undisturbed area can be a good shelter for a lot of animals including insects. The number of individual insects recovered in the study area is high, this is also similar to studies conducted elsewhere reporting a significantly high number of insects in a given area Kachi, et al., 2022 and Ombugadu, et al., 2021). This study is in keeping with the results of studies by Yager, et al., (2018), Shitta, et al., (2025) and Naman, et al., (2019). They reported a high numerical value of insects in their studies of insect diversity and population in the seedling growing area of the Federal University of Agriculture, Makurdi, Benue State, parts of Federal University Lokoja Zoo and Conservatory, and the Main Campus of its sister institution the Kaduna State University respectively.

The result in this study revealed that the order Coleoptera were the most abundant with respect to individual species. This corroborated the study of Kachi et al., (2022), who recorded Coleoptera as the prevalent insect order in Lokoja, Kogi State, and Tscharntke and Brandl (2004) who showed the Coleopterans to be predominant in their study in tropical ecosystems. This may be so because of the availability of healthy shrubs and herbs around the study area, their presence provides food and shelter for these species of insects helping them to thrive, it also helps in strengthening the association between these insects, their environment and possibly other higher animals in the study area. Other environmental factors that may have contributed to the abundance this species are favourable temperature, humidity, and light. These are factors that facilitates the hatching of eggs in organisms leading to the increase in population of the insects. In their studies, Khaliq et al. (2014) corroborated the above assertion stating that the two conditions referred to above are very vital for ecosystem and can effectively affect the population of organisms positively in most part of the world. However, a few exceptions were observe by Yager et al. (2018) in their research work. They observed that

Hemiptera was the most prevailing insect order in their study area which is in contrast to the current findings. Other studies elsewhere have reported different orders as dominant their study area, this is not surprising as the condition factors, vegetation may be different creating all the differences in results. Additionally, Naman et al. (2019) have reported Odonata as the most prevalent insect order in their study sites while Ajayi et al (2018) observed that Orthoptera was the most prevalent insect order in their study area, all within Nigeria. This also reveals the rich biodiversity of insect's orders in the country. These differences are attributable to the uniqueness of the different study areas, sample size and other environmental conditions as rightly pointed out by Alarape et al. (2015) that the availability of any given species of organism was dependent on the condition factors of the environment.

The high relative abundances of *Catharius sp* (19.25%) and *Diphucephala colaspidoides* (8.45%) members of the Coleoptera as observed in the study area, is highly beneficial to the environment, they help to balance the ecosystem by their day-to-day activities. The huge presence of the coprophagous dung beetles (*Catharius sp*) reveals a lot, one of which is that there is an indication of activities of cattle near the study area or a cattle ranch not too far from the study location. Wherever cattle are present dungs from them will not be lacking as such the insect can take advantage of it, thereby helping to improving the texture, health and quality of the soil around the study site. The findings of Lee and Kwon (2013) supports the above assertions that beetles immensely affect the environment positively through their activities, breaking down the remains of both plants and animals.

The insect order Lepidoptera was the second dominant insect order in the study area 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, Markurdi, Benue State and Nasarawa State University, Shabu-Lafiya Campus. With respect to the diversity index of the insect's species in the study area, the Lepidopterans showed more diversity index of 1.8950 as analysed by Shanon-

Weiner Index and richest with a 2.4640 Margalef Index. Nwosu and Iwu (2011), agreed with these results and asserts that this is very typical of the Lepidopteran species characteristics in West Africa.

It was observed in all the three sampling points, that the diversity indices of Plot A had the higher value of insect's species diversity and evenness. The implication of this is that the different plants species present in the study area could have influenced the diversity and abundance of the species of insects encountered. The findings of Hougen and Rausher (1994) and Chen et al. (2007) are both in agreement with the current study and they opined that insects interact symbiotically in a mutual way with plants and depends on plants for their food provision.

Conclusion

In conclusion the present study indicates that the Federal University Lokoja Zoo and Conservatory area, is abundant with variations in insects' biodiversity. It has also provided additional information that is useful and will be useful in future to researchers that may build on the current findings. The information obtained here will help in species conservation and vector management in and around the Zoo.

Recommendations

It is recommended that further studies should be conducted using other sampling techniques as well as expanding the geographical scope of the study, and the duration of the study as seasonal variations could affect the population dynamics of insects.

Conflicts of interest

The authors declare that there are no conflicts of interest.

Author's contributions: Conceptualization: KBS, JAB. Experimentation: KBS, ZOY. Data curation and analysis: KBS. Entomological field surveys: ZOY, KBS, JAB. Original draft of the manuscript: KBS, ZOY, JAB, HAO. Review and editing of manuscript draft: JAB, HOA.

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