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Diversity and Abundance of Butterfly Fauna (Lepidoptera) at Sa'adu Zungur University, Bauchi Main Campus, Nigeria

Abdullahi Kamal[1*] Aliyu Abdulhamid Omar[1] Abdullahi Shamsudden[2] Ladan Muhammad Auwal[3] Umar Aminu Mohammed[1] Zainab Rabiu Gamawa[1] Aishatu Abubakar[1] and Shamsiya Isa Abdullahi[1]

[1]Department of Biological Sciences,
Sa'adu Zungur University,
Bauchi State.

[2]Department of Ecology and Environment Studies,
Nalanda University,
Bihar,
India.

[3] Department of Biological Sciences,
Abubakar Tafawa Balewa University Bauchi,
Bauchi State.

Email: Kamalabdullahi@basug.edu.ng

Abstract

The study was conducted to assess the diversity and abundance of butterfly species at Sa'adu Zungur University, Main Campus, Bauchi State. A total of three hundred and fifty-seven (357) individual butterflies were recorded across two different sites within the campus, and the study was conducted between July and August, 2024. These individuals were distributed among eleven (11) species belonging to three (3) families. The recorded species included Limenitis archippus, Danaus plexippus, Anthocharis sara, Colias harfordii, Pieris rapae, Nathalis iole, Heliopetes ericetorum, Hypolimnas misippus, Lerodea eufala, Mylothris agathina, and Eurema nicippe. The New Site exhibited the highest abundance of individuals with 236 (66.11%), while the Old Site accounted for 121 (33.89%). At the Old Site, Danaus plexippus had the highest abundance, representing 35 individuals (28.93%), followed by Limenitis archippus with 21 individuals (17.36%) and Pieris rapae with 19 individuals (15.70%). The species with the lowest abundance at the Old Site was Mylothris agathina with 6 individuals (4.96%). At the New Site, Pieris rapae was the most abundant species with 43 individuals (18.22%), followed by Colias harfordii with 40 individuals (16.94%), while Heliopetes ericetorum had the lowest abundance with 17 individuals (7.20%). No significant difference in species composition was observed between the two sites (P-value > 0.05). However, a comparison of abundance, diversity, species richness, evenness, and similarity revealed that the New Site had higher abundance (236 individuals), diversity (H = 2.02), species richness (J = 41.17), and evenness (H_{max} = 0.84) compared to the Old Site, which had an abundance of 121 individuals, diversity (H = 1.88), species richness (J = 22.93), and evenness (H_{max} = 0.78). Among the families, Pieridae was the most abundant, accounting for 185 individuals (52%), followed by Nymphalidae with 147 individuals (41%), and Hesperiidae with the lowest count of 25 individuals (7%). The findings of this study highlight the diversity and composition

Author for Correspondence

of butterfly species in Sa'adu Zungur University, Bauchi State. The study also underscores the species distribution across sites with varying ecological features. Based on these findings, it is recommended that further studies on butterfly diversity and abundance be conducted to monitor changes in the ecosystem over time.

Keywords; Diversity, Abundance, Butterflies, Fauna.

INTRODUCTION

Butterflies of the order Lepidoptera are known for their greatest contribution to the ecosystem as part of the existing form of biodiversity ecologically. They play several critical roles in pollinating plants (Kemabonta *et al.,* 2015; Elanchezhyan *et al.,* 2017; Thangjam, 2018; Koneri *et al.,* 2022), as good indicators of the ecological quality of the ecosystem (Cleary, 2004; Kemabonta *et al.,* 2015), as well as in the food chain components of other forms of biodiversity including; birds, reptiles, spiders and predatory insects (Elanchezhyan *et al.,* 2017). Scientifically, butterflies were reported among the species with higher richness worldwide (Koneri *et al.,* 2022). Among the orders of arthropods, butterflies of the order Lepidoptera were revealed as the second-largest order after Coleoptera (Suhaimi *et al., et al.,* 2018; Koneri *et al.,* 2022). This indicated the level of their diversity and abundance within our natural environments. Furthermore, Dentas *et al.,* (2021) revealed that approximately there are 18, 000 butterflies species globally. This has given a special opportunity for conservationists on various investigations particularly on their roles (Koneri *et al.,* 2022), other contributions to the ecosystem (Ghazanfar *et al.,* 2016; Elanchezhyan *et al.,* 2017) as well as determining and predicting possible factors influencing the survival, diversity and abundance of butterflies species in our ecosystems.

Despite their beneficial role in the ecosystems, butterflies continue to experience a remarkable decline in diversity, abundance and distribution across our ecosystems (Konvicka *et al.,* 2006; Kemabonta *et al.,* 2015) and this is largely associated with anthropogenic activities carried outday in-day out across our immediate environment (Pennisi, 2004; Kemabonta *et al.,* 2015). However, if the situation persists without any proper intervention and special concern, thecondition would greatly affect the balance of our ecosystem which directly leads to the loss of biodiversity. In addition, due to the important roles of butterflies in the ecosystem which have positively impacted the survival of human beings and other forms of biodiversity in the ecosystems, it therefore set in place a concern for the diversity and abundance status of butterflies need to be in focus.

Recently, more concerns about the diversity, abundance and distributions of butterflies have taken a serious dimension, this is seen in some evaluations carried out in Nigeria by Kemabonta *et al.,* (2015); Ojianwuna, (2015); Alarape *et al.,* (2015); Yager *et al.,* (2016); Efenakpo *et al.,* (2021) and other countries as in work of Koch *et al.,* (2015); Ghazanfar *et al.,* (2016); Elanchezhyan *et al.,* (2017); Pignataro *et al.,* (2020); Delabye *et al.,* (2020); Kurylo *et al.,* (2020); Koneri *et al.,* (2022) have conducted a study to investigate the diversity, abundance, distribution as well as factors influencing butterflies status and composition in a given environment. From the same vein, activities associated with urbanization have greatly caused more damage to the diversity, abundance and distribution of butterflies' species especially to urban settlements. These affect not only butterflies but also the general form of biodiversity declination (Faeth *et al.,* 2011; Deguines *et al.,* 2016; Pignataro *et al.,* 2020).

More so, noticeable changes in land use in the name of urban expansion have caused destruction of habitats to various forms of biodiversity in an environment, hence affecting the richness, diversity and distribution of these species due to reduced vegetation cover, increasing temperature and accumulation of pollutants (McDonnell and Hahs, 2015; New, 2015; Iserhard *et al.,* 2018; Pignataro *et al.,* 2020). The measurement of fauna diversity in a given ecosystem remains an important approach to understanding the distribution and diversity of species in a particular environment. This enables conservationists to make informed policies and decisions on how to protect important biodiversity from extinction. Many species are becoming increasingly rare, with many on the verge of extinction due to various factors, such as urban expansion activities (Elanchezhyan *et al.,* 2017; Piganataro *et al.,* 2020).

In this regard, there are no previous studies on the diversity and abundance of butterfly species in Sa'adu Zungur University, Bauchi State. This research represents the first systematic effort to assess and document the butterfly species present on the university's main campus. By conducting this study, we aim to establish a foundational understanding of butterfly diversity and abundance in this area, contributing valuable ecological insights to the region.

Materials and Methods

Study Area

This study was conducted at Sa'adu Zungur University, Main Campus, Bauchi State. Sa'adu Zungur University (SAZU), formerly known as Bauchi State University Gadau (BASUG), is a state-owned institution in Bauchi State, Nigeria. The university's main campus is located in Gadau, Gadau town, geographically positioned at 11.30000°N and 9.88330°E. The main campus hosts the School of Basic and Remedial Studies, as well as the Faculties of Arts, Education, Agriculture, Basic Medical Sciences, Pharmaceutical Sciences, and Sciences. The vegetation of the Gadau main campus is characterized by a mix of natural and cultivated flora, suited to the semi-arid climate of the region. The vegetation is dominated by drought-resistant grasses interspersed with shrubs and scattered trees, typical of savannah regions. Common tree species include *Azadirachta indica*, *Acacia sp*., *Adansonia digitata*, *Senna siamea*, *Tamarindus indica*, *Parkia biglobosa*, and *Vitellaria paradoxa*.

The vegetation is greener and denser during the rainy season (June to September) but becomes sparse and dry during the harmattan and dry seasons (OpenAI, 2025).

Sampling of butterfly

The study area was stratified into two habitats based on vegetation and land composition. Butterfly species were assessed quantitatively across different habitats using handheld sweep nets and trapping methods, as adopted by Yager *et al.,* (2016). A 500-metre line transect was established at each site, and efforts were made to catch every butterfly observed, following the transect walking techniques of Alarape and Yager (Alarape *et al.,* 2015; Yager *et al.,* 2016). In total, four transect walks were established (two transects from each selected site). Random sweep netting formed the basis for species lists and rapid biodiversity assessments. Sampling was conducted in different habitats from July to August 2024. Line transect counts were used to determine butterfly abundance and richness. Each transect was traversed slowly at a uniform pace for 30 minutes in each habitat, with observations made during two periods: 8:00 am–10:00 am and 4:00 pm–5:00 pm, under favorable weather conditions (no heavy rain or strong wind). Photographs of butterflies observed at each site were taken with a camera. Each site was visited multiple times over the course of a month to allow sufficient time for a comprehensive survey of the environment. Surveys were conducted during the early hours

(8:00 am–10:00 am) and evening hours (4:00 pm–5:00 pm). Pictures of butterflies were taken, species were counted, and observations were recorded (Kehinde *et al.,* 2023).

Identification of specimens

Butterfly species collected were identified using Butterflies of West Africa (Larsen, 2005), identification guides of Bernard, (1982), and James, (2002) and with the help of a butterfly taxonomist at the Bauchi State University, Bauchi State.

Data analysis

Butterfly species, individual diversity and abundance were calculated by using descriptive statistics. Chi-Square test was used to determine the difference in species composition across two sites. Data was analyzed using SPSS 19. Butterfly species composition in various habitat types was expressed using diversity indices such as species richness, diversity and evenness.

RESULTS

Composition and distribution of butterflies across two different sites of Sa'adu Zungur University's main campus, Bauchi State.

A total of three hundred fifty-seven (357) individual butterflies were recorded across two different sites at Sa'adu Zungur University, Main Campus, Bauchi State. These individuals were distributed among eleven (11) species belonging to three (3) families. The recorded species included *Limenitis archippus*, *Danaus plexippus*, *Anthocharis sara*, *Colias harfordii*, *Pieris rapae*, *Nathalis iole*, *Heliopetes ericetorum*, *Hypolimnas misippus*, *Lerodea eufala*, *Mylothris agathina*, and *Eurema nicippe*. The New Site had the highest abundance of individuals, with 236 (66.11%), while the Old Site had 121 individuals (33.89%). At the Old Site, *Danaus plexippus* had the highest abundance, with 35 individuals (28.93%), followed by *Limenitis archippus* with 21 (17.36%) and *Pieris rapae* with 19 (15.70%). The species with the lowest abundance at the Old Site was *Mylothris agathina*, with 6 individuals (4.96%). At the New Site, *Pieris rapae* had the highest abundance, with 43 individuals (18.22%), followed by *Colias harfordii* with 40 (16.94%), and the lowest abundance was recorded for *Heliopetes ericetorum*, with 17 individuals (7.20%). There is a significant difference in species composition across the sites (P-value <0.05) (Table 1)

Table 1; Composition and distribution of butterfly across two different sites of Sa'adu Zungur University main campus, Bauchi State.

			Abundance across sites			
Common names	**Scientific names**	**Family**	**Old site**	**%**	**New site**	**%**
Viceroy	*Limenitis archippus*	Nymphalidae	21	17.36	31	13.14
Monarch	*Danaus plexippus*	Nymphalidae	35	28.93	39	16.53
Sara orangetip	*Anthocharis sara*	Pieridae	3	2.48	18	7.63
Harford's sulphur	*Colias harfordii*	Pieridae	13	10.74	40	16.94
Cabbage white	*Pieris rapae*	Pieridae	19	15.70	43	18.22
Dainty sulphur	*Nathalis iole*	Pieridae	0	0.00	27	11.44
Northern white skipper	*Heliopetes ericetorum*	Hesperiidae	0	0.00	17	7.20
Danaid eggfly	*Hypolimnas misippus*	Nymphalidae	0	0.00	21	8.90
Eufala skipper	*Lerodea Eufala*	Hesperiidae	8	6.61	0	0.00
Dotted border	*Mylothris agathina*	Pieridae	6	4.96	0	0.00
Sleepy orange	*Eurema nicippe*	Pieridae	16	13.22	0	0.00
Total			**121**	**100**	**236**	**100**

χ^2 =104.720, ***P-value***= <0.05

Occurrence of different species of butterfly across two different sites of Sa'adu Zungur University main campus, Bauchi State.

A total of eleven (11) species were recorded across two main sites of Sa'adu Zungur University, Bauchi State. In each site, a total of eight (8) species were recorded. The two main sites shared a total of five (5) similar species of butterfly which include; *Limenitis archippus, Danaus plexippus, Anthocharis sara, Colias harfordii, Pieris rapae, and Nathalis iole*. The Old site is composed of three (3) unique species; *Lerodea eufala, Mylothris agathina* and *Eurema nicippe* while the New site is composed; *Nathalis iole, Heliopetes ericetorum* and *Hypolimnas misippus* as unique species (Table 2).

Table 2; Occurrence of different species of butterfly across two different sites of Sa'adu Zungur University's main campus, Bauchi State.

Scientific names	Family	Old site	New site
Limenitis archippus	Nymphalidae	+	+
Danaus plexippus	Nymphalidae	+	+
Anthocharis sara	Pieridae	+	+
Colias harfordii	Pieridae	+	+
Pieris rapae	Pieridae	+	+
Nathalis iole	Pieridae	-	+
Heliopetes ericetorum	Hesperiidae	-	+
Hypolimnas misippus	Nymphalidae	-	+
Lerodea Eufala	Hesperiidae	+	-
Mylothris agathina	Pieridae	+	-
Eurema nicippe	Pieridae	+	-

Keys; (**+**) = Presence of butterfly, (**-**) = Absent of butterfly.

Comparison between abundance, diversity, species richness, evenness and similarity of butterflies across two different sites of Sa'adu Zungur University's main campus, Bauchi State.

On comparison between abundance, diversity, species richness, evenness and similarity between butterfly species, the results revealed that the New site had the higher abundance (23 individuals), diversity (H=2.02), species richness (J=41.17), and evenness (H_{max}= 0.84) as compared with the Old site, abundance (121 individuals), diversity (H=1.88), species richness (J=22.93), and evenness (H_{max}= 0.78) respectively (Table 3). Pieridae family had the highest number of species 185 (52%), followed by Nymphalidae 147 (41%) with the least in Hesperiidae 25 (7%) (Figure 1).

Table 3; Comparison between abundance, diversity, species richness, evenness and similarity of butterflies across two different sites of Sa'adu Zungur University's main campus, Bauchi State.

Index parameters	Old site	New site	Sum
Individuals	121	236	357
Shannon index	1.88	2.02	3.9
Margalef index	22.93	41.17	64.1
Evenness	0.78	0.84	1.62
Sorenses index			0.38

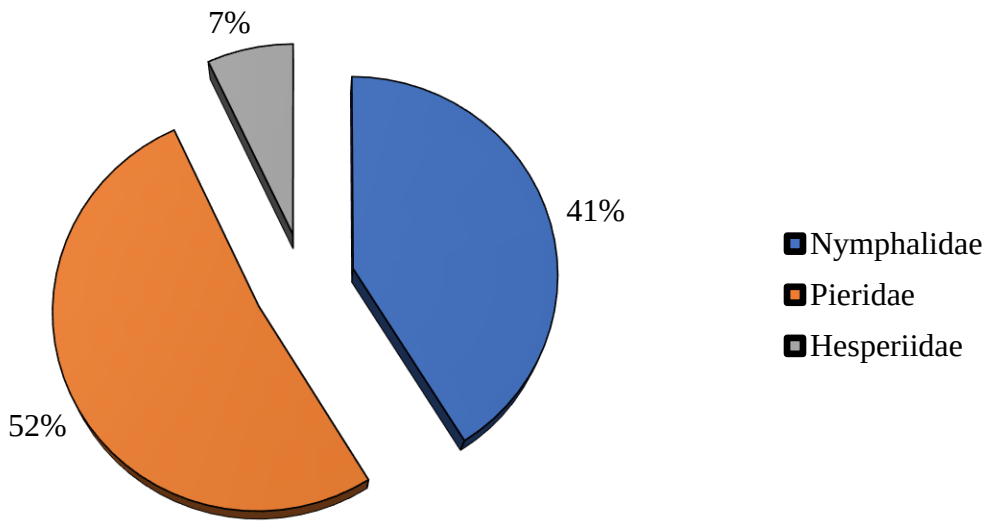

Figure 1; Percentage Composition of Butterfly Families Across Two Sites at Sa'adu Zungur University-Main Campus, Bauchi State

DISCUSSION

In this study, a high species number was recorded across the two main sites of Sa'adu Zungur University, Bauchi State, and they are typical of West African taxa. This was reported in a similar study conducted by (Nwosu and Iwu, 2011) who reported rich butterfly fauna in protected areas and Yager *et al.,* (2016) who reported a high species number in both dry land and the swampy part of forestry nursery. This result indicated that the habitat had a considerable diversity and abundant number of butterfly species. The high number of species recorded in the families of Pieridae and Nymphalidae in the study is in line with the findings of Bora and Meitei, (2014) who reported that Nymphalidae is the most dominant group of butterflies among all families in the tropics. This result is consistent with Kemabonta *et al.,* (2015), Ojianwuna (2015), Efenakpo *et al.,* (2021), and Koneri *et al.,* (2022) where Nymphalidae has a higher family composition. Furthermore, the increased number of Nymphalidae is because of the fact that the study site contains plants that support lives as a source of food and shelter as revealed also by Koneri *et al.,* (2022). The result also is consistent with Yager *et al.,* (2016) in Federal University of Agriculture Makurdi, Forestry Nursery, but contrary to the findings of Akwashiki *et al.,* (2007) in Eagle Owl Gully of Amurum Forest Reserve Jos East L.G.A, Plateau State and Nwosu and Iwu, (2011) in Okwu Ogbaku forest reserve in Imo State.

This could be attributed to differences in study location and other environmental factors. The high abundance of the Nymphalidae is highly associated with the available nectar-producing plants in the study area, as they normally feed on it. However, Nymphalidae depends not only on the availability of flower nectar but other sources, since food sources can be obtained from rotting fruits and other animals, respectively (Sarma *et al.,* 2012; Sari *et al.,* 2013; Widhiono, 2015; Koneri *et al.,* 2022). The preference of butterflies for particular habitats is associated with the availability of larval host plants and adult nectar plants (Majumder *et al.,* 2013), thus, the dominance of Pieridae could be attributed to a varied assemblage of fruit-bearing plants and some ornamental plants present in the study area. The study area is dominated by plant species like *Magnifera indica, Terminalia mantaly, Syzygium cumini, Tamarindus indica, Calotropis procera, Guiera senegalensis, Senna siemia, Azadirachta indica* and other ornamental flowering plants which promoted the butterfly richness. This is obvious that some of the tree and shrub species in the two main sites are attractive to the butterflies.

This finding is similar to the findings of Yager *et al.,* (2016) and Alarape *et al.,* (2015) who reported some species being attractive to butterflies in the forest nursery of the Federal University of Agriculture Makurdi and botanical garden of the University of Ibadan. The lower number of species recorded in the families of Hesperiidae is similar to other studies by Yager *et al.,* (2016), Aiswarya *et al.,* (2014) and Alarape *et al.,* (2015). This is evidently linked with the hiding behavior of the species from that family as well as their preferable habitat. This result is in line with that of Koneri *et al.,* (2022) who reported that the least family was Hesperidae, which has dark brown wings. Also, Sutra *et al.,* (2012) stated that the Hesperidae is difficult to find because it hides under leaves. The variation in species composition recorded between the two main sites in the study area could be attributed to the distribution of some flora species composition, the nature of the ecosystem settings and ornamental plants. A similar statement was reported by Yager *et al.,* (2016) in a study conducted at the forest nursery of Federal University of Agriculture Makurdi. According to Imam, (2015) and Alarape *et al.,* (2015) food web structure and ornamental plants form one of the factors responsible for butterfly species diversity and richness. Even though the New site had a high value of butterfly species diversity and evenness (H′ = 2.02), (J′= 0.84) than the Old site (H′ = 1.88), (J′= 0.78). This could be attributed to the high representation of seedlings and fruit-bearing plants in the area. However**,** the two main sites shared a moderate similarity in species composition (0.38). This could be the result of similarities in terms of plant species which are common among two main sites. Thus, there was no significant difference in species composition/richness across main sites at 0.05%. This means that species composition was well represented across two main sites.

CONCLUSION

The findings of the present study revealed the diversity and composition of butterfly species at Sa'adu Zungur University, Bauchi State. It also highlighted the various species observed at each site, each with distinct features. Despite the fact that more infrastructural activities occurred at the New Site of the campus, it exhibited greater species abundance compared to the Old Site. This is likely due to the larger land size and available space at the New Site. The study provides baseline information on butterfly species in the study area.

Based on the findings of this study, we recommend that additional research be conducted to further explore the diversity and abundance of butterfly species. Ecosystems are inherently dynamic, with ongoing changes in environmental conditions, species interactions, and habitat availability. These changes can have significant impacts on biodiversity, making it essential

to continually monitor and assess butterfly populations. Further studies will not only provide valuable insights into the trends and patterns of butterfly species over time but also contribute to our understanding of how ecosystem shifts may influence species distribution and abundance. Such research will be crucial for developing informed conservation strategies and ensuring the protection of butterfly species in the face of ecological changes.

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Conflict of interest
The authors declare no conflict of interest.

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