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ABUNDANCE AND DIVERSITY OF BUTTERFLY SPECIES (ORDER: LEPIDOPTERA) IN SOUTH WESTERN PART OF NIGERIA

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ABSTRACT
Butterflies (Order: Lepidoptera) are potential pollinators which should be conserved for the benefits of the ecosystem. Osun State has no data base on butterfly species diversity which is necessary for conservation and wildlife management in the State despite intensive agricultural activities. Survey of abundance and diversity of butterfly species as alternative pollinators within south western Nigeria was carried out. Butterfly specimens were collected from four different sites (i) Open field (ii) Cultivated plot (iii) Non-cultivated plot and (iv) Ornamental in each selected study zones using insect sweep net along transects on each site. The collected specimens were preserved and identified up to species level. Data on the abundance and diversity of the specimen were collected and analyzed to establish the relative abundance, diversity, species richness, and evenness in the study areas. A total of 182 butterflies belonging to 30 species and 3 families (Nymphalidae, Pieridae and Papilionidae) were identified. Nymphalidae was the highest in terms of abundance and species richness. This family accounted for 52.5% of the total butterfly collection with 19 species while the least family, Papilionidae had 3 species and accounted for 6.1% of the total collection. Butterfly diversity was in the following order: Ornamental site >Non-cultivated plot> Cultivated plot> Open field, in the study areas. It is recommended that butterflies which are potential pollinators should be conserved for the benefit of the ecosystem to maintain stability and support human existence.
KEY WORDS: *abundance, diversity, Nymphalidae, Pieridae, Papilionidae, South Western Nigeria.*

INTRODUCTION

Honeybees are currently undergoing colony disorder due to impact of diseases, invasion of pests, pesticides, pathogens, parasites, poor nutrition and climate change inclusive, resulting in colony losses (Wolfgang & Pongthep, 2006) The unpleasant fate of apiculture impact negatively on honey, arable crops and fruits production globally. This may likely cause food shortage in distant time if cautions are not taken. Arable crops and fruits growers, having identified the challenges related to colony losses, seek alternatives to honeybees as pollinators to pollinate

their crops. Butterflies (Order: Lepidoptera) are also recognized as crop pollinators and they hold an important position in the ecosystem. Butterflies play key ecological processes and pollination of crops (Bhuyan *et al., 2005*). Also, they are beneficial insects as potential environmental indicators and they have aesthetic and commercial values (Ahsan & Jayaid, 1975). There are more than 28,000 species of butterflies in the world and about 80% are found in tropical regions (Hassan, 1994). According to Tiple (2011), Indian sub-continent has diverse climate, terrain, and vegetation which hosts about 1,504 species of butterflies. More than 5,000 species of insects including 400 species of butterflies and moths have been reported from Pakistan (Khan *et al.,* 2007).

A six months survey of butterfly fauna in the Abiriw and Odumante sacred groves in the Akwapim North of South Districts of Eastern Region of Ghana was conducted to characterize resident butterfly species abundance and diversity. Eighty-Nine species of 10 different families were recorded (Nganso *et al*., 2012). It was reported that the Butterfly species richness and evenness in the Abiriw grove was higher than that of the Odumante grove which provides information for bio-conservation strategies for indigenous butterflies. Koneri and Maabuat (2016) identified 4 families, 44 species and 748 individual butterflies in Manembo-Nembo Wildlife Reserve, North Sulawesi, Indonesia. Nymphalidae was reported to be the predominant family (71.12%), *Ideopsis juventa tontoliensis* (10.16%) was the most found species. Butterflies abundance (76.50), diversity (2.66), richness (20.25) and species evenness (0.88) were mostly found in riverside habitats of the forest, while the lowest was found in the primary zone of the forest. Kemabonta *et al*., (2015) investigated species diversity and abundance of butterflies at three locations in south-west Nigeria (Ajebo, Ogun State; Odongunyan Farm Settlement in Ikorodu and Hortico Gardens, Ipaja, both in Lagos State). A total of 1105 butterflies belonging to 11 genera and 4 families were identified from the 3 sampled sites. The authors reported that butterflies belonging to the Family: Nymphalidae [*Acraea* (200), *Danaus* (140), *Melanargia* (129)] were the most abundant (70.6%) in the study sites. Four species *Danaus chrysippus*, *Acraea serena*, *Melanargia galathea* (Nymphalidae) and *Eurema* sp. (Pieridae) were found in the three sites while Ajebo had the least diversity of butterflies in both seasons, while Hortico Gardens, Ipaja had the highest. However, Odongunyan farmland was the most equitable (J = 1.09) of the three sampled sites (Kemabonta *et al*., 2015).

Ejigbo, Ipetu-Ijesha and Osogbo are major towns in Osun State, south western Nigeria, which lack database of Butterflies fauna species for future fauna conservation and wildlife management project as the state keeps developing its infrastructures. Hence, the study on the abundance and diversity of butterflies to create a base line data for future conservation and wildlife management project. The study seeks to compare

and document butterfly species abundance and diversity in Ejigbo, Ipetu-Ijesa and Osogbo and make recommendations on conservation of butterfly species diversity.

MATERIALS AND METHODS

Study area

The study was conducted between February and August 2018 in selected study areas (Ejigbo, Ipetu-Ijesa and Osogbo) based on intensive agricultural activities in those areas. Ipetu-Ijesa has coordinate of 7º28`0`` N 4º53`0``E. Ejigbo is located between 7º54`0``N and 4º18`54``E while Osogbo is located between 7º 46`0``N and 4º34`0``E. Four major sites (Open field, Ornamental site, cultivated plot, and Non-cultivated plot) were selected in each study zone.

Sampling and Preservation of butterfly specimens for taxonomic Classification

An area of 1 km^2 was selected and divided into four linear parallel transects 1000 m long and 200 m apart in each study site. The universally recommended three complementary methods (transects walk-and-counts, Insect sweep net (Hand net) and fruit-bait traps were used to survey and monitor butterfly populations and communities (Kitahara et al. 2008; Van Swaay et al. 2008; Marín et al. 2009; Vu 2009). Sampling was conducted thrice per week between 10:05 and 03:05 h each day for seven months (February – August 2018). All butterfly specimens were preserved and transferred to permanent insect box stuffed with camphor balls appropriately based on study zones. The butterfly specimens were identified at the Natural History Museum, Department of Zoology, Obafemi Awolowo University, Ile-Ife, Osun State, Nigeria, and photographs were taken.

Statistical Analysis

Data collected were used to determine species richness, species diversity, component of dominance, relative abundance of different species and species evenness in the study areas using Menhinik, Shannon-Weiner, Simpson dominance and Pielou's evenness indices (Magurran, 1988). One-way analysis of variance using excel 2016 statistics was used for data analysis.

RESULTS AND DISCUSSION

Abundance of Butterfly species

A total of 182 butterflies were collected from four selected sites in the study areas. Thirty species belonging to 3 Families: Nympalidae, Pieridae and Papilionidae were identified. Members of the Family: Nymphalidae have the highest number of species followed by Pieridae and Papilionidae, respectively across all the study areas (Fig. 1). Twelve butterfly species were common across the three study areas while 18 butterfly species were not (Table 1).

The most common butterfly species collected across the study areas was *Pieris virginensis* (31) belonging to the Family: Pieridae followed by *Junonia oenone* (21), *Danaus chrysippus* (18), *Belenois aurota* (13), and *Acraea zetes* (10) respectively. The

species that occurred with the least number (1) were *Bicyclus sebtus, Euphaedra Proserpina, Hypolimnas monoteironis, Hypolimnas anthedon, Neptis morose, Precis pelarga, Bicyclus anynana* belonging to the family Nymphalidae and *Graphium doson* and *Pieris rapae* belonging to the Families: Papilionidae and Pieridae. Generally, four genera from two families were relatively more abundant than the others in the study areas. They were *Pieris* (Pieridae) with a total of 34; *Junonia* (Nymphalidae) with a total of 30; *Belenois* (Pieridae) with a total of 24 and *Acraea* (Nymphalidae) with a total of 17 individuals respectively (Table 1).

From this study, it was observed that Ornamental sites had the highest abundance of butterflies (35.2%) than Non-cultivated plot, Open field, and Cultivated plot (22.5%, 21.4% and 20.9%, respectively). The Family: Nymphalidae had the highest number of butterfly species which accounted for 19 species while the least number of species was recorded in the Family: Papilionidae which had just 3 species (Fig. 2).

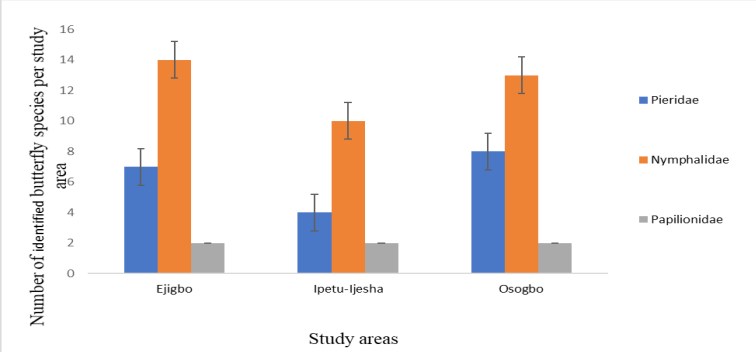

Fig. 1: ABUNDANCE OF BUTTERFLIES SPECIES IN ORDER OF FAMILIES IN THE THREE SYUDY AREAS.

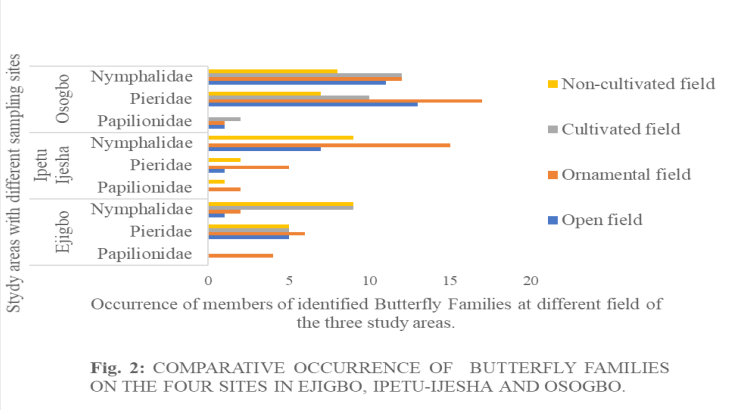

Fig. 2: COMPARATIVE OCCURRENCE OF BUTTERFLY FAMILIES ON THE FOUR SITES IN EJIGBO, IPETU-IJESHA AND OSOGBO.

TABLE 1: Commonality of families and species distribution of butterfly species in the study areas.

Taxonomy	Numbers of individuals species	Ejigbo	Ipetu-Ijesha	Osogbo	Remarks
PIERIDAE					
Anteos maerula	9	3	2	4	COMM
Belenois calypso	4	2	0	2	NCOM
Belenois aurota	13	4	2	7	COMM
Belenois java	7	3	0	4	NCOM
Colotis vestalis	2	0	0	2	NCOM
Nepheronia thalassina	7	3	2	2	COMM
Pieris virginensis	31	5	2	24	COMM
Pieris rapae	3	1	0	2	NCOM
Sub Total	**76**	**21**	**8**	**47**	
NYMPHALIDAE					
Amauris niavius	4	2	1	1	COMM
Amauris ochlea	3	1	2	0	NCOM
Amauris albimaculata	6	2	1	3	COMM
Acraea eponina	3	1	1	1	COMM
Acraea encedon	4	1	0	3	NCOM
Acraea zetes	10	1	3	6	COMM
Bicyclus sebtus	1	1	0	0	NCOM
Danaus chrysippus	18	3	9	6	COMM
Euphaedra proserpina	1	0	0	1	NCOM
Hypolimnas monoteironis	1	0	0	1	NCOM
Hypolimnas bolina	2	1	1	0	NCOM
Hypolimnas anthedon	1	0	0	1	NCOM
Hyalites eponina	8	1	3	4	COMM
Junonia oenone	21	3	8	10	COMM
Junonia terea	7	0	2	5	NCOM
Junonia stygia	2	2	0	0	NCOM
Neptis morose	1	1	0	0	NCOM
Precis pelarga	1	1	0	0	NCOM
Bicyclus anynana	1	0	0	1	NCOM
Sub Total	**95**	**21**	**31**	**43**	
PAPILIONIDAE					
Graphium doson	1	0	0	1	NCOM
Papilio erithonioides	6	2	1	3	COMM
Papilio grosesmithi	4	2	2	0	NCOM
Sub Total	**11**	**4**	**3**	**4**	
TOTAL	**182**				

COMM: Common species across the three study areas (12 species); NCOM: Not common across the three study areas (18 species).

Butterfly species Diversity, Richness and Evenness

However, Ejigbo study area has more species diversity (by Shannon-Wiener Diversity Index: H) (2.9242) compared to that of Osogbo (2.62) and Ipetu-Ijesha (2.4552) respectively. In a similar trend, species richness (using Menhinick's D index) of butterflies at the three study areas, Ejigbo, Ipetu-Ijesha and Osogbo were 3.3912, 2.4689 and 2.3722, respectively. However, by Margalef's D index, species richness of Ejigbo, Ipetu-Ijesha and Osogbo are 5.7461, 4.0132 and 4.8423, respectively. This showed that Species diversity and species richness are higher in Ejigbo than what was observed in Osogbo and Ipetu-Ijesha. Species evenness by Pilou evenness (J) across Ejigbo, Ipetu-Ijesha and Osogbo were 0.9326, 0.8855 and 0.8356, respectively (Table 2).

From the *J-values* (Pilou evenness), there was less variation in abundances between different taxa within the study areas because of the high *J-values* close to 1.0. There was no significant difference between the butterfly species abundance and species richness across the study areas (Table 3).

Also, there was no significant difference $_{(P < 0.05)}$ between the butterfly species diversity and species evenness across the study areas (Table 4).

TABLE 2: Species abundance, richness, and diversity of butterflies in the study areas.

	Ejigbo	Ipetu-Ijesha	Osogbo
Abundance	46	42	94
No of species	23	16	23
Species richness			
Menhinick's *D*	3.3912	2.4689	2.3722
Margalef's *D*	5.7461	4.0132	4.8423
Species diversity by Shannon-Wiener Index (H)	2.9242	2.4552	2.62
Evenness by Pilou evenness (J): (0 – 1.0). The lower the *J-values* the more the variation in abundance between taxa within the community Or Degree of Diversity (Equitability= H/H_{max}) (where H_{max} = lnD)	0.9326	0.8855	0.8356

TABLE 3: One-way ANOVA testing the significance of species abundance and diversity in the study areas.

Source of Variation	*SS*	*df*	*MS*	*F*	P_{-value}	F_{crit}
Between Groups	984.3333	2	492.1667	0.472783	0.663007	9.552094
Within Groups	3123	3	1041			
Total	4107.333	5				

TABLE 4: One-way ANOVA testing the significance of butterfly species diversity and evenness in the study areas.

Source of Variation	*SS*	*df*	*MS*	*F*	P_{-value}	F_{crit}
Between Groups	0.07342	2	0.03671	0.022909	0.97752	9.552094
Within Groups	4.807256	3	1.602419			
Total	4.880676	5				

Butterfly species Abundance

The study showed that Nymphalidae was the most dominant and abundant butterfly family across the three study areas followed by Pieridae and Papilionidae, respectively. Based on reports of other studies on butterfly species abundance and richness, members of Nymphalidae and Pieridae were identified to be the dominant butterflies families in almost tropical ecological communities (Kunte, 1997; Hamit and Erol, 2007; Nganso *et al*., 2012; Arya *et al*., 2014; Alarape *et al*., 2015; Fileccia *et al*., 2015; Kemabonta *et al*., 2015; Imam, 2015; Ghosh and Saha, 2016; Umapati *et al*., 2016; Dilla and Senthilkumaar, 2016) as confirmed by this study.

Butterfly species Diversity, Richness and Evenness

Thirty species of butterflies were identified across the study areas with Ejigbo having the highest species richness comparatively based on Menhinick's index D: 3.3912 and Margalef's D: 5.7461. The diversity of butterfly species depends on the botanical species composition within their ecosystem which serves as source of food for the larvae and adults. Incidentally, the anthropogenic activities such as cutting of grasses and trees for domestic uses, constructions of buildings and roads, beautification and expansion across the areas, including vehicular movement and the release of exhaust fumes probably reduced the natural habitats preferred by different species of butterflies. This study points to the fact that this area still supports a high diversity of butterfly species despite the relatively high level of disturbance and manipulation in the environment. This could be due to the proximity of natural habitats and vegetational succession on unused land mass. This confirmed the study of Kunte (2001) who reported that impacted areas may have higher butterfly species richness.

However, the two indices varies for Papilionidae and Pieridae which were (4.0132) and (4.8423) at Ipetu-Ijesha and Osogbo, respectively by Margalef's D index while Menhinick's D index present species richness of 2.4689 and 2.3722 of butterflies at Ipetu-Ijesha and Osogbo respectively. Butterfly species diversity by Shannon-Wiener index (H) was comparatively high at Ejigbo (2.9242). while Ipetu-Ijesha has the least species diversity (2.4552). Species evenness by Pilou index (*J*) across Ejigbo, Ipetu-Ijesha and Osogbo were 0.9326, 0.8855 and 0.8356, respectively of which each was relatively close to 1.0. This indicates that the specie evenness across the three study areas was exceptionally low because the lower the *J-values* (Pilou index) the more the variation in abundance between taxa within the community. From the survey, Menhinick (D) and Shannon-Weiner (H′) and Pielou's Evenness (*J*) indices revealed that the individual Butterflies species were not evenly distributed which indicates that some Butterflies species were more abundant than the others in the study areas. This showed the difference in the efficiency of different butterfly species to efficiently use their immediate habitats dependent on suitable biotic and abiotic environmental factors. This suggests that each habitat provides key services to specific species and has strong effects on species composition. Butterfly species are important members of

the Class: Insecta frequently used as important ecological indicators of disturbances to ecosystems (Erhardt, 1985; Fleishman *et al*., 2005; Bobo *et al*., 2006; Pöyry *et al*., 2006; Leidner *et al*., 2010). Habitat loss is one of the greatest problems for insect extinction most especially natural pollinators such as honeybees and butterflies (alternative pollinators), and their populations are influenced by anthropogenic forest fragmentation due to modern civilization (Hogue, 1993; Leidner *et al*., 2010). Hence, the need to protect the environment and conserve the fauna, including Butterflies as alternative pollinators.

CONCLUSION

Research on 14 studies has shown in 11 of them the negative effect of human *Papillomavirus*, especially on sperm motility, a process that could be responsible for the higher rate of infertility in infected men. Two of the studies showed that the parameters of the spermogram are not changed, even though the virus was present in the analyzed samples. One study demonstrated a possible treatment hypothesis by adding Heparinase III during positive sperm samples processing with encouraging results.

The present paper is intended to be a study of the scientific literature, the results obtained after analyzing the works advocate for the introduction in human assisted reproduction laboratories as a routine test to identify the presence of HPV in men. Although the data are still in small numbers, as practical applicability can be taken into account, the recommendation of vaccination in men as a prevention method, and in infected samples, the possibility of treating samples with Heparinase III.

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