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# BUTTERFLY FAUNA (ORDER: LEPIDOPTERA) IN COLLEGE OF EDUCATION, WARRI, DELTA STATE

**[1]Chidi, O. H. and [2]Odo, P. E.**

[1]Natural Resources Conservation unit, Department of Zoology, University of Lagos.
[2]Department of Animal and Environmental Biology, Faculty of Life Sciences, University of Benin, Benin City.

**[1]Corresponding author:** hensco2020@gmail.com; +2348066474202

**Abstract -** This study was conducted to identify the Butterfly fauna in College of Education, Warri, Delta State, Nigeria. A total of 666 individuals of butterflies belonging to 53 species, 11 subfamilies and 5 families of the order Lepidoptera were recorded from April to August, 2018 in College of Education Warri. The results of the study revealed that in the sites, butterflies belonging to the family Nymphalidae were most abundant, accounting for 82.28%. The family with least number of species was found to be Papilionidae represented by 1 species which constituted 1.89% of total butterfly species sighted. The result of the study revealed that the highest number of taxa and species abundance of butterflies 30 (212) were recorded in school field area during the period of the study and least number in Secondary school area 14 (131) in the studied site. Shannon –Wiener Index value was highest in Primary school area (2.65), followed by Agric area (2.48) and least in Secondary school area (1.76) in study site. Margalef Index value was highest (5.41) in School field area followed by Primary school area (4.83), and least in Secondary school area (2.67). However, evenness value was highest in Agric area (0.60) and least in School field area (0.25). There was no significant difference in species richness across the habitat type in the studied site at 0.05 level of significance. The ecological importance of this areas demand for a greater conservation strategies like creating butterfly gardens and buffer zones.

**Keywords**: Biodiversity, Species richness, anthropogenic, mow.

## INTRODUCTION

Butterflies are important component of many ecosystems. They are typically found in areas with high concentrations of flowering plants, where plenty of nectar and food for larvae are available (Bensusan *et al*., 2014). The benefits that butterflies provide among others are pollination as well as aesthetics for human recreation. However, some flowers are designed exclusively for butterfly pollinators (Kiepiel and Johnson, 2014). Lack of butterflies can affect pollination success and seed set of some wildflowers (Bloch, *et al.*, 2006; Borges *et al*., 2003). Many butterfly caterpillars are dependent upon certain species of plants for development. For example, monarch butterflies (*Danaus plexippus*) caterpillars require milkweed and the Regal Fritillary (*Speyeria idalia*) caterpillars require violets.

Habitat loss and fragmentation can cause drastic reduction in butterfly species diversity. Moreso, changes in habitat quality might be manifested as altered host plant quality, microclimate and predation risk or soil attributes (McKinney, 2002; Rickman and Connor, 2003). Butterflies rely on host plants interactions for the completion of their life cycles which often render them highly habitat-specific and

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season-specific (Awmack and Leather, 2002; Bernays and Chapman, 2007). Additionally, their aesthetic value makes them popular among amateur naturalists and collectors. Butterflies are relatively well-studied group throughout the world, especially in temperate regions, where they are regularly used to monitor environmental changes (Thomas, 2005). However, significant data gaps exist, specifically in tropical regions (Lewis and Senior, 2011). Changes in habitat quality caused by urbanization might alter insect richness, resulting either in decrease or more rarely in increase, in the richness of specific insect groups including butterflies (McKinney, 2008). Butterfly diversity may therefore reflect overall plant diversity in the given area as a result of their dependence on the plants (Padhye *et al*., 2006). Thus, change in land use pattern may lead to landscape changes that can reflect into change in butterfly diversity and distribution. Butterflies could be used as umbrella species (the species whose protection serves to protect many co-occurring species) for conservation planning and management (Fleishman *et al*., 2000; Balakrishnan and Palot, 2004).

Butterflies belong to one of the most important taxa of insects. Understanding their significance in an ecosystem as an environmental health indicator and pollination of flowering plants is crucial to achieving sustainability and conservation of floral diversity. In a school environment, habitat destruction due to some anthropogenic activities including construction of buildings, mowing and other developmental projects could pose a big threat to the survival of butterfly species. Human activities therefore destroy the butterfly habitats. Habitats of butterflies that are destroyed affect conditions that support their survival.

This study therefore was carried out to determine the butterfly species richness and diversity in College of Education, Warri in relation to habitat variations and varying degrees of anthropogenic activities within the sampling sites. This study therefore, seeks to document the butterfly diversity in the sites to determine the status of the various sites sampled.

Butterflies are the most important and commonly seen insects of the order Lepidoptera. Lepidoptera exhibit an extensive dispersion and distribution due to their evolutionary capability to adapt themselves morphologically and physiologically to different natural conditions. Studies have suggested a range of factors that affect the pattern of distribution of butterflies. These include competition, predation,

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numerical abundance of species, food web structure, genetic factors, short and long term aspects of evolutionary rates and size of the insect (Bruno *et al*., 2011). As herbivorous insects, the distribution of larval and nectar host plants has a distinct impact on the status of butterfly diversity (Solomon *et al.*, 2004). Hence suitable measures for the conservation of larval and nectar host plants, and to deter destruction of natural biotopes, are needed to increase butterfly diversity in a given tropical ecosystem.

Species richness and habitat preferences of butterflies as documented by various researchers in different parts as well as in the same part of the world seem to be controversial. For instance in a study in Benin-City, Nigeria, overall butterfly species richness was higher in cleared than closed forest (Fermon *et al.*, 2001). In the Eagle Owl Gully Forest Reserve of Amurum, Jos East, Plateau, Nigeria, higher diversity of butterfly species was recorded in the Protected Area than in unprotected area (Akwashiki *et al*., 2007). In Madagascar, disturbed forest habitats and edges were found to be richer in butterfly species than undistributed areas (Kremen, 1994) while higher butterfly diversities were recorded in unprotected tropical forest (Hammer and Hill, 2000). In West Africa, about two thousand species of butterflies abound, with Nigeria alone harbouring greater than one thousand species (about 50%) (Hammer and Hill, 2000). However, the figure is not constant because of continuous addition and discovery of new butterfly species. Most of the African butterfly species are restricted to one or a smaller number of ecological zones and are, therefore, found in specific habitats (Larsen, 2005). For instance, there is a large difference in the total number of butterfly species found between the fauna of the forest and the derived savanna separated by the guinea savanna (Larsen and Mei, 1998). The above records show that butterfly diversity varies from one location to another and provide the rationale for locating specific analysis to inform biodiversity status or policies.

Increased urban features, including roads, buildings and mowed lawns, correspond with decrease in butterfly species richness, diversity and abundance (Stefanescu *et al.*, 2004; Clark *et al.*, 2007; Pocewicz *et al.*, 2009). Urbanization also is associated with habitat degradation including decreased plant species diversity, reduced water quality and increased air and soil pollutions (McKinney, 2002; Singh *et al.*, 2009; Garg *et al.*, 2009). The reductions in amount and quality of natural habitat associated with urban development negatively affect nature biodiversity (Malagrino *et al.*, 2008). Depletion of forests or trees

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has a direct effect on butterfly community. In the caterpillar stage, butterflies mainly feed on plants while most butterflies feed on just one or a few related plant species. This implies that absence of that plant species may contribute to the extinction of that butterfly as well. Butterfly diversity and abundance may track changes in plant diversity and forest structure resulting from different disturbance regimes such as logging, farming, deforestation and mining. Differences in intensity of disturbance may lead to differential effects on plant community diversity and structure, with significant implications for butterfly composition and abundance.

## MATERIALS AND METHODS

### Study sites

The sampling sites were located at the College of Education, Warri, Delta State, Nigeria. The study-area comprised four major sites which are semi-protected areas with a lot of human disturbance: school field area ( Longitude 5º44.490"E, Latitude 5º32.541"N), having dense vegetation, patches of farmlands, large open spaces with football and basketball court; the primary school area (Latitude 5º44.535"E, Longitude 5º31.773"N) comprised of uncompleted buildings, grasses of the poaceae family and swampy ground with puddles of water; the Secondary school area ( Longitude 5º44.681"E, Latitude 5º32.649"N ) comprised of waterlogged areas, demonstration farmlands, school buildings, grasses with little or no flowers and the Agricultural Department area (Longitude 5º 44.670"E, Latitude 5º32.302" N ) comprised of agricultural land (Teaching and Research Farm), elephant grass (*Pennisetum purpureum)* many uncompleted buildings, poultry and fishery houses as well as plantain (*Musa paradisiaca)* plantation. The sampling sites were selected based on their varying degrees of anthropogenic disturbances and habitat types.

### Butterfly sampling and Identification

The study was carried out between May and August, 2018. Each study site was divided into walk-and-capture transects routes, which were sufficiently sampled using hand-held insect sweep nets. The sweep net had a circular mouth frame with a diameter of 30cm, which was fitted with a conical cotton net 75cm long from mouth to tip of the tail. Sampling of the transect routes for butterflies was carried out

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twice each week during the sunny days between 8:30am and 12:00noon. Butterflies within a distance of 2.5m on both sides of transect were collected using a sweep net and released after identification while few species were kept as specimen voucher (Hill *et al*., 1995). Unidentified butterflies were captured, put in specimen bottles containing ethyl acetate soaked in cotton wool and were identified using taxonomical keys by Larsen (2005) and a Lepidopterist, Dr (Mrs) Ojianwuna C., Animal and Environmental Biology Department, Delta State University, Abraka.

**Data analysis**

The percentage compositions of the different families at different sites calculated were presented in tables. The diversity indices (Shannon-Wiener diversity index, Shannon Evenness Index, Simpson dominance index, Margalef index and Berger-Parker index) of the butterflies from four different habitats were calculated using PAST software (Hammer *et al.*, 2001). One-way ANOVA was used to determine the significant difference in family and species richness of butterflies across habitat.

## RESULTS AND DISCUSSION

A total of 53 species and 666 individuals in 5 butterfly families were recorded from the four sampled sites in College of Education, Warri. In the sites, *butterflies* belonging to the family Nymphalidae were most abundant, accounting for 82.28% of the total butterflies collected. *Acraea serena, Acraea encedon encedon, Junonia oenone* and *Junonia Sophia sophia* (all in the family Nymphalidae) were the most abundant butterfly species found in the study sites. Figure 1 indicate the presentation of butterfly families in different sites.

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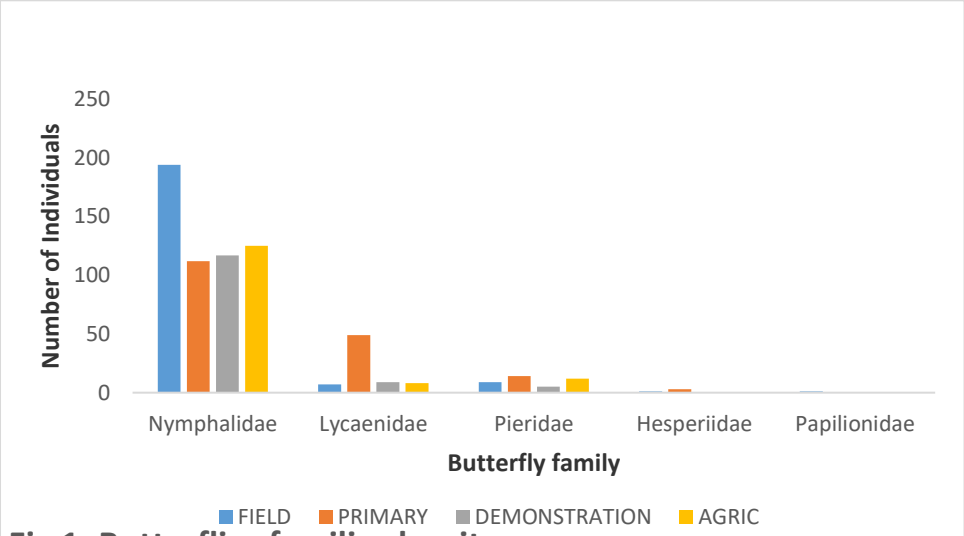


**Fig 1: Butterflies families by sites**

The butterfly survey recorded 666 individuals and 53 species belonging to 5 families. The highest number of individual butterflies was recorded in the family Nymphalidae (548), followed by Lycaenidae (73), Pieridae (40), Hesperiidae (4), and Papilionidae (1) (Table 1).

Nymphalidae was the most dominant family in the study site comprising 28 species and constituted 52.83% of the total butterfly species sighted. This was followed by Pieridae in study site 1 with 11 species which constituted 20.75% of total butterfly species in the study sites. The family Papilionidae have the least value of 1.89% of total butterfly species sighted at the study sites. Thus, the population of these families are in the order: Nymphalidae> Pieridae >Lycaenidae >Hesperiidae> Papilionidae (Table 1)

**Table 1: Relative number of individuals and species of different butterfly families.**

| S/N | Family | Subfamily | No. of Species (%) | Individual (%) |
|---|---|---|---|---|
| 1 | Nymphalidae | Heliconiinae | 18 (33.96) | 435 (65.32) |
| | | Nymphalinae | 6 (11.32) | 92 (13.81) |
| | | Satyrinae | 3 (5.66) | 20 (3.00) |
| | | Danainae | 1 (1.89) | 1 (0.15) |
| 2 | Lycaenidae | Polyommatinae | 9 (16.98) | 31 (4.65) |
| | | Theclinae | 1 (1.89) | 42 (6.31) |
| 3 | Pieridae | Pierinae | 6 (11.32) | 31 (4.65) |
| | | Coliadinae | 5 (9.43) | 9 (1.35) |
| 4 | Hesperiidae | Hesperiinae | 2 (3.77) | 3 (0.45) |
| | | Pyriginae | 1 (1.89) | 1 (0.15) |
| 5 | Papilionidae | Papilioninae | 1 (1.89) | 1 (0.15) |
| | **Total** | | **53 (100)** | **666(100)** |

**Source**: Field survey, 2018

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The result of the study as presented in Table 2 revealed that the highest number of taxa and species abundance of butterflies was recorded in school field during the period of the study with 30 and 212 respectively while the least was in Secondary school area with 14 and 131 respectively in the study sites. Shannon –Wiener index value was highest in Primary school area (2.65), followed by Agric area (2.48) and least in Secondary school area (1.74) in study site. Margalef index value was highest (5.41) in School field area, followed by Primary school area (4.83) and least in Secondary school area (2.67). However, evenness value was highest in Agric area (0.60), and least in School field area (0.25). Berger-Parker index recorded maximum in school field area (0.53) and minimum in Primary school area (0.22) in the study sites.

**Table 2: Diversity indices of Butterflies from selected habitats**

| **Indices** | **SCHOOL FIELD AREA** | **PRIMARY SCHOOL AREA** | **SECONDARY SCHOOL AREA** | **AGRIC** |
|---|---|---|---|---|
| Taxa | 30 | 26 | 14 | 20 |
| Individuals | 212 | 178 | 131 | 145 |
| Shannon-Wiener | 2.02 | 2.65 | 1.76 | 2.48 |
| Evenness Index | 0.25 | 0.54 | 0.41 | 0.60 |
| Simpson's Index | 0.70 | 0.90 | 0.72 | 0.87 |
| Margalef Index | 5.41 | 4.83 | 2.67 | 3.82 |
| Berger-Parker Index | 0.53 | 0.22 | 0.49 | 0.28 |

**Source**: Field survey, 2018

**Species richness across habitat type.**

Table 3 indicated the one-way ANOVA of the species richness across the habitat type in College of Education, Warri study sites. The result indicated that there was no significant difference in species composition across habitat at 0.05 level of significance.

**Table 3: One Way ANOVA Difference in Species richness across habitat type**

| | **Sum of Square** | **Df** | **Mean Square** | **F** | **P-VALUE** |
|---|---|---|---|---|---|
| Between groups: | 74.0566 | 3 | 24.6855 | 0.2333 | 0.8731 |
| Within groups: | 22005.7 | 208 | 105.797 | | |
| Total: | 22079.8 | 211 | | | |
| Omega^2: | -0.01097 | | | | |

There is no significant difference at 5%

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Nymphalidae family was the most common butterfly species recorded in all the sites, totaling 28. This was expected as the family constitutes a very diverse group which occupied a wide range of habitats. Species such as *Acraea serena, Acraea encedon encedon, Acraea bonasia bonasia, Junonia oenone* and *Junonia Sophia sophia* were recorded in all the studied sites. *Acraea serena* was the most dominant species of Nymphalidae, followed by *Acraea encedon encedon*. The second highest number of individuals sighted in studied sites was from the family Lycaenidae with 73 individuals, which constituted 10.96% of total number of butterflies while family Pieridae constituted 6 % of the total number of individual observed in studied sites. *Appias epaphia epaphia* and *Mylothris chloris chloris* were the most dominant members of the family Pieridae which constituted 40% of total individuals of this family, followed by *Mylothris yulei bansoana* (15%). The result of the study also revealed that five (5) out of the 53 species were recorded in all the studied sites while six (6) out of the species number were recorded in a studied site. Nymphalidae had the highest percent of species and individuals; which is 52.83% and 82.28% respectively. Pieridae had the second highest percent of species and lower number of individuals, which is 20.75% and 6% respectively. However, Papilionidae had the least percent of species and individuals.

The high number of species recorded in the families of Nymphalidae, Pieridae, Lycaenidae, Hesperiidae and Papilionidae in the study was 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. The lower number of species recorded in the families of Hesperiidae and Papilionidae was similar with other studies of Aiswarya *et al*., (2014) and Alarape *et al*., (2015). The availability of larval host plants and adult nectar plants could attract butterflies to a particular habitats (Majumder *et al*., 2013). Fermon *et al*., (2001) indicated that Nymphalidae butterflies have a much higher diversity of phenotypes when larval food plants are more evenly distributed across all habitats. The study indicated that the School field area had highest species richness compared to other sites. Many studies have shown that insect abundances are highly correlated with the abundance of floral nectar sources. Flower rich field margins in agro-environment schemes also harbour more butterflies and other pollinators (Pywell *et al.*, 2011; Kehinde *et al.*, 2014; Westphal *et al*., 2003). Thus, there was

no significant difference in species richness across habitat type at 0.05 level of significance. This means that species richness was well represented across habitats in the study sites.

## CONCLUSION AND RECOMMENDATIONS

The presence of 666 individuals, 11 subfamilies and 53 species of butterflies in study sites indicated the ecological importance of this area. The biological diversity of this area has not been documented till date thus it cannot be concluded whether the butterfly fauna is increasing or decreasing. Therefore, this area needs continuous monitoring and effort should be made to document its unknown flora and fauna. It is equally necessary to identify the rare butterfly species and conserve them by establishing butterfly garden and buffer zones.

## REFERENCES

Aiswarya, V. N. Pradarsika, M. and Soma A. B. (2014). Studies on the diversity and abundance of butterfly (Lepidoptera: Rhopalocera) fauna in and around Sarojini Naidu college campus, Kolkata, West Bengal, India, *Journal of Entomology and Zoology Studies,* 2 (4): 129-133.

Akwashiki, B.A., Amuga, G.A., Nwansat G.S and Ombugadu, R.J. (2007). Assessment of Butterfly Diversity in Eagle Owl Gully of Amurum Forest Reserve, Jos East Local Government Area, Plateau State, Nigeria. *The Zoologist* 5: 33-38.

Alarape, A. A., Omifolaji, J. K. and Mwansat G. S. (2015). Butterfly Species Diversity and Abundance in University of Ibadan Botanical Garden, Nigeria. *Open Journal of Ecology,* 5, 354 – 357.

Awmack C.S. and Leather S.R. (2002). Host plant quality and fecundity in herbivorous insects. *Annual Review of Entomology*. 47:817–844.

Balakrishnan V.C. and Palot M.J. (2004). A checklist of larval food plants of butterflies in Kerala. *Proceedings of National seminar-cum Workshop on butterfly diversity of Western Ghats,* Malappuram, Kerala, 34-35.

Bensusan K.J.R, Nesbit, C.E. Perez, P. Tryjanowski, E. and Zduniak, P. (2014). Species composition and dynamics in abundance of migrant and sedentary butterflies (Lepidoptera) at Gibraltar during the spring period. *European Journal of Entomology*, 111:555-559.

Bernays E.A. and Chapman R.F. (2007). Host-plant selection by phytophagous insects: *Contemporary Topics in Entomology 2*. International Thomson Publishing Company, New York.

Bloch D., Werdenberg N., and Erhardt A. (2006). Pollination crisis in the butterfly-pollinated wild carnation *Dianthus carthusianorum*? *New Phytologists.* 169: 699–706.

Borges R., Gowda V. and Zacharias M. (2003). Butterfly pollination and high-contrast visual signals in a low-density distylous plant. *Oecologia*, 136 (4): 571-573.

Bruno B., Fulvio, C., and Giuseppe N., (2011). Pattern of species occurrence in detritus-based communities with variable connectivity. *Web Ecology*, 11: 1-9.

Clark P. J., Michael J.R. and Chew, F.S. (2007). Effects of urbanization on butterfly species richness, guild structure, and rarity. *Urban Ecosystems*, 10:321–337.

Fermon, H. Schulze, C.H and Waltert, M. (2001). The butterfly community of the Noyau Central, Lama Forest (Republic of Benin), with notes on its ecological composition and geographic distribution. *African Entomology*, 9:177-185.

Fleishman E. Murphy D.D. and Brussard P.F. (2000). A new method for selection of umbrella species for conservation planning. *Ecological Applications*, 10: 569-579.

Garg, R.K., Rao, R.J. and Saksena D.N. (2009). Water quality and conservation management of Ramsagar reservoir, Datia, Madhya Pradesh. *Journal of Environmental Biology*, 30: 909-916.

Hammer K.C. and Hill J.K. (2000). Scale-dependent effects of habitat disturbance on species richness in tropical forests. *Conservation Biology*, 14, 1435–1440.

Hammer, O., Harper, D.A.T., and P. D. Ryan, (2001). PAST: Paleontological Statistics Software Package for Education and Data Analysis. Palaeontologia Electronica 4(1): 9pp.

Hill, J. K., Kramer, K. C., Lace, L. A. & Banham, W. M. T. (1995). Effects of selective logging on tropical forest butterflies on Buru, Indonesia. *Journal of Applied Ecology* 32. 754-760.

Kehinde T., Amusan B., Ayansola A., Oyelade S., and Adu W.,(2014) Status of insect diversity conservation in Nigeria: a review, *Ife Journal of Science*, 16 (2) 319–330.

Kiepiel I. and Johnson, S.D. (2014). Shift from bird to butterfly pollination in *clivia* (Amaryllidaceae). *American Journal of Botany*, 101:190-200.

Kremen, C. (1994). Biological inventory using target taxa: A case study of the butterflies of Madagascar, *Ecological Applications*, 4(3)*:* 407-422.

Larsen T.B. (2005). *Butterflies of West Africa 2 Volumes*, 125 plates, Apollo Books, Stenstrup, Denmark

Larsen T.B. and Mei, M. (1998). Butterflies from a Guinea transition area, the Parc National de Haut Niger (Republic of Guinea), with a description of a new subspecies of Platyleschesrobusta (Lepidoptera: Hesperiidae). *Bollettinodella Societ`aEntomologicaItaliana*, 130: 255–272.

Lewis O.T, and Senior M.J. (2011). Assessing conservation status and trends for the world's butterflies: The Sampled Red List Index approach. *Journal of Insect Conservation*. 15:121–128.

Majumder J, Lodh R, Agarwala B.K. (2013). Butterfly species richness and diversity in the Trishna wildlife sanctuary in South Asia. *Journal of Insect Science* 13: 79.

Malagrino, G, G., Lagunas, M.M. and Rubio, A.O. (2008). Environment impact reduction through ecological planning at Bahia Magdalena, Mexico. *Journal of Environmental Biology*, 29: 79-82.

McKinney M.L (2002). Urbanization, Biodiversity, and Conservation. *Bioscience*, 52:883–890.

McKinney M.L. (2008). Effects of urbanization on species richness: a review of plants and animals. *Urban Ecosystem*, 11:161–176.

Nwosu, L. C. and Iwu, C. J. (2011). A comparative study of diversity of species of butterflies in protected and unprotected habitats of Okwu Ogbaku forest reserve in Mbaitoli L.G.A., Imo State, Nigeria, *Journal of Environmental Issues and Agriculture in Developing Countries*, 3 (1): 129 -135.

Padhye A.D., Dahanukar N., Paingankar M., Deshpande M., and Deshpande D. (2006). Season and Landscape wise distribution of Butterflies in Tamhini, North-Western Ghats, India. *Zoos*' *Print Journal*; 21(3):2175-2181.

Pocewicz, A., Morgan P., and Eigenbrode S.D. (2009). Local and landscape effects on butterfly density in Northern Idaho grasslands and forests. *Journal of Insect Conservation*, 13: 593-601.

Pywell, R. F., Meek, W. R., Hulmes, L., Hulmes, S., James, K. L., Nowakowski, M., and Carvell, C. (2011). Management to enhance pollen and nectar resources for bumblebees and butterflies within intensively farmed landscapes. *Journal of Insect Conservation* 15(6): 853-864.

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***e* - ISSN: 2659 - 1529**

Rickman J.K, and Connor E.F. (2003). The effect of Urbanization on the quality of remnant habitats for leaf-mining Lepidoptera on *Quercusagrifolia. Ecography*, 26:777-787

Singh, S. K, Srivastava, S. P, Tandon, P. and Azad, B. S. (2009). Faunal diversity during rainy season in reclaimed sodic land of Uttar Pradesh. *India Journal of Environmental Biology*, 30:551-556.

Solomon, A., Raju, M. and Lewis, R. (2004). Nectar host plants of some butterfly species at Visakhapatnam. *Science and Culture*, 70:187-190.

Stefanescu C., Herrando S., Páramo F. (2004). Butterfly species richness in the North-west Mediterranean Basin: the role of natural and human-induced factors. *Journal of Biogeography*, 31:905–915.

Thomas, J.A. (2005). Monitoring change in the abundance and distribution of insects using butterflies and other indicator groups. *Philosophical Transactions of the Royal Society of London, Biological Sciences*. 360:339-357.

Westphal C, Steffan-Dewenter I, and Tschantke T, (2003). Mass flowering crops enhance pollinator densities at a landscape scale. *Ecological Letter*. 6: 961–965.