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# Diversity and Abundance of Butterfly Species Complex in Two Diverse Habitats of Jawaharlal Nehru Krishi Vishwavidyalaya, India

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

Butterflies are important bio-indicators that should be protected to conserve the biodiversity and environment. They play an important role in the food chain and are valuable pollinators in the local environment. The present study investigated and compared the butterfly abundance and diversity within two different habitats (i) Undisturbed and (ii) Disturbed, in Jawaharlal Nehru Krishi Vishwavidyalaya Campus, Jabalpur Madhya Pradesh. A total of 24 butterfly species were recorded during the study from June 2022 to July 2023 using transects with the aid of sweep nets. An overall total of 2537 butterflies were recorded, which spread across 05 families 17 genera and 23 species. The most abundant family of butterflies caught in undisturbed ecosystems was Pieridae 38% followed by Nymphalidae 27%, Lycaenidae 14%, Papilionidae and Hesperiidae 7%. In disturbed ecosystems butterflies were distributed as Pieridae being dominated with 52% followed by Lycaenidae at 22%, Nymphalidae at 16%, Hesperiidae at 7% and Papilionidae at 3%. The undisturbed habitat was more diversified (H'-1.59) in butterfly diversity than the disturbed habitat (H'- 1.20).


*Keywords: Lepidoptera; diversity; abundance; shannon index.*

## 1. INTRODUCTION

Habitat diversity is an important concept in ecology that represents the health of ecological systems [24]. Insects play an important role in the success of an agro-ecosystem. Insects are found in a wide range of environments and perform a diversity of crucial ecological services [68]. Insects comprise 53% of the world's 1.4 million species with butterflies accounting for 15 to 16 thousand [23,25-28]. Butterflies belong to the order Lepidoptera the second largest group of class Insect which includes Butterflies and Moths. About 17,820 Butterflies are reported [70,72-76]. Since the early 18$^{th}$ century 28,000 butterfly species have been identified globally [2] Scaled wings are found in a range of habitats worldwide [77]. of biological and ecological settings [14-21,22]. The Papilionidae, Pieridae, Lycaenidae, Riodinidae, Nymphalidae, and Hesperiidae are the six families that together make up the Lepidoptera [46]. They play a vital role in ecosystem function by pollinating wild plants and crops [63]. These are usually found in flower-rich areas with an abundance of nectar as well as food for the larvae [83]. Butterflies are crucial indicator of diversity, ecology, and numerous functions in an ecosystem, as well as for investigating the effects of disturbance and changes in land use [1,4,5,7].

Artificial ecosystems, similar to agricultural land systems are used to attract distinct types of insects for nesting, resting, investigating accessible foods, or biological action. Agriculture provides a very reliable source of food of various types, such as grain, seeds, fruits, and green foliage of crop plants, grasses, insects [8,12,24]. Butterflies are very sensitive to habitat patterns sand are severely affected by slight changes in environmental conditions such as increasing temperature, humidity, and rainfall [65]. Changes in the global climate [64]. have an impact on butterfly habitats as well. They are also excellent markers of activity and environmental disruption [45,79-82]. Sensitivity to temperature and climatic variations, butterflies may be valuable ecological markers of urbanization [78,84-88]. The present study two year investigates insect biodiversity in two different micro agro ecosystem.

## 2. MATERIALS AND METHODS

Two study sites inside the JNKVV campus were chosen for this study, as described below.

**M1:** This undisturbed site, has thick trees in the field of agroforestry, with an area of 4 acre (approx.) located at latitude 23.211504°N and longitude 79.966421°E. Kharif season was fallow. Weeds heavily overrun across the plantation's interspace. Safedmurg (*Celosia argentea*), Bhangraj (*Eclipta alba*), Makraghas (*Dactylocenium aegyptium*), Dhoobghas (*Cynodon dactylon*), and Canney (*Commelina benghalensis*) were the weeds. Mustard and coriander were cultivated during the Rabi season.

**M2:** The seed production area, located at latitude 23.215062 °N and longitude 79.969995°E chosen as a disturbed site. Its primary field measured one acre with mung, soybeans, and gram serving as the cropping sequence during summer, Kharif, and Rabi seasons, respectively. The intense rainfall during the Kharif season prevented soybeans from germination. As a result, the field was overrun with the following weeds: Safed murg (*Celosia argentea*), Lhesua (*Digera arvensis*), Marwari (*Medicago denticulata*), Motha (*Cyprus rotundus*), and Sanwa (*Echinochloa colona*).

The technique of random surveys employed to sample butterflies and to gather butterflies using a sweep net was used to collect butterflies from the two experimental sites. Following the collecting and killing of the butterflies in the various bottles with 70% alcohol, the butterflies got to use the pin and spread their wings on a spreading board before being moved to wooden boxes sized 15 x 45 $cm^2$ fitted with four corners of naphthalene.

## 3. RESULTS

### 3.1 Simpson Index (D)

Measure the probability that two individuals randomly selected from a sample will belong to the same species for some category other than species. There are two versions of the formula for calculating D

$$D = \sum (n/N)^2$$

where,
**n**= Total number of organisms of a particular species
**N**= Total number of organisms of all species

Simpson index of diversity ranges between 0 and 1, the greater the value, the greater the sample diversity. The index represents the probability that two individuals randomly selected from a sample will belong to different species.

### 3.2 The Shannon Diversity index

$$(H)\ H = -\sum(Pi \log 10 Pi)$$

**Pi =** Proportion of a population made up entirely of a given species, or the number of individuals of that species / (n/N)
**n** = Individual number of butterflies
**N**= Total number of butterflies ($M_1$/ $M_2$) system

The maximum value of index equals $\text{Log}N$ which works out to be 3.135 for $M_1$ AND 3.065 for $M_2$. Using Shannon's formula, the diversity of butterfly species was determined. Index of Diversity

(H) that incorporates the variety of species present in arrangement concerning each species' proportional abundance [47]. The Shannon diversity index was calculated using base 10 in this paper. Higher H values would be indicative of more varied communities. Since Pi would equal 1 and be multiplied by log Pi, which would also equal zero, a community with only one species would have an H value of 0. The H value would be the if species are evenly distributed.

### 3.3 According to Individual Number of Butterflies Depends on the Family

The present study highlighted on the biodiversity and were represents two major's habitats of Agroforestry and seed production units each with a unique indicator of ecological conditions. In the M1 Agroforestry ecosystem, JNKVV Campus, Jabalpur total of 2537 butterflies were recorded, of which 22 species was observed divided into 5 families, according to the results 519 (38%) among the two families and (subfamilies Pierinae and Coliadinae) Pieridae was determined to be the most prominent, followed by Nymphalidae with population 362 (27%), Lycaenidae (292/21%), Hesperidae and Papilionidae with population respectively 99 and 95 (7%) (Table 1, Figs.1 & 2). M2 there were 22 species in total which are divided into 5 families of Lepidoptera Order.

Pieridae family was predominant at 609 count was 52% followed by Lycaenidae at 262 or 22% Nymphalidae percentage 16%, Hesperiidae and Papilionidae 7% and 3% in population.

The butterfly families Pieridae, Nymphalidae, Lycaenidae, Papilionidae and Hesperiidae have diversity in terms of species count accordingly family which is represented by the Shannon Diversity Index (H′) of M1 habitat respectively 0.618 this was near to 1.M2 habitat Shannon Diversity Index (H′) of 0. 541.Hmax value depends on 5 families 0.699 after calculated with Log (5).

**Table 1. Butterfly diversity found in the research area (June 2022- June 2023)**

| Family | Subfamily | Common name | Scientific name | M1 | M2 |
|---|---|---|---|---|---|
| **Hesperiidae** | **Coeliadinae** | Conjoined swift | *Pelopides conjunctiva* Herrich-Schaffr, 1859 | 99 | 77 |
| | **Danainae** | Common crow | *Euploea core* Cramer, 1780 | 28 | 14 |
| | **Heliconinae** | Tawny coster | *Acraea terpsicore* Linnaeus,1758 | 8 | 30 |
| | | Chocolate pansy | *Junonia iphita* Cramer, 1782 | 77 | 3 |
| | | Egg fly | *Hypolimnas bolina* Linnaeus,1758 | 15 | 9 |
| ***Nymphalidae*** | **Nymphalinae** | Lemon pansy | *Junonia lemonias* Linnaeus,1758 | 6 | 23 |
| | | Blue pansy | *Junonia orrithya* Linnaeus. 1758 | 12 | 6 |
| | | Grey pansy | Junonia atlites (Linnaeus, 1763) | 29 | 11 |
| | | Peacock pansy | Junonia almana (Linnaeus, 1758) | 8 | 8 |
| | **Satyrinae** | Common evening brown | *Melanitis leda* (Cramer, 1775) | 76 | 43 |
| | | Long-branded bush brown | *Mycalesis visala* Moore, 1758 | 103 | 50 |
| **Lycaenidae** | **Polymmatinae** | Forget-me-not | *Catochrysops strabo* Fabricius,1793 | 152 | 108 |
| | | Orange-crowned cupid | *Everes lacturnus* Godart,1824 | 118 | 139 |
| | | Common Pierrot | *Castalius rosimon* Fabricius,1775 | 22 | 9 |
| | | Swallowtail butterfly | *Papilio demoleus* Linnaeus,1758 | 48 | 9 |
| **Papilionidae** | **Papilioninae** | Common rose | *Pachilopla aristolochiae* Fabricius, 1775 | 25 | 13 |
| | | Common Mormon | *Papilio polytes* Linnaeus, 1758 | 22 | 9 |
| | | Psyche | *Leptosia nina* Fabricius, 1793 | 70 | 98 |
| | **Coliadinae** | Common gull | *Cepora nerissa* Fabricius,1775 | 19 | 19 |
| **Pieridae** | | Common Jezebel | *Delias eucharis* Drury, 1773 | 10 | 0 |
| | | Common grass yellow | *Everes hecabe* Linnaeus, 1758 | 211 | 219 |
| | **Pierinae** | Mottled emigrant | *Catopsilia pyranthe* Linnaeus,1758 | 58 | 55 |
| | | Lemon emigrant | *Catopsilia pomona* Fabricius,1775 | 151 | 218 |
| | | | **Total** | **1367** | **1160** |

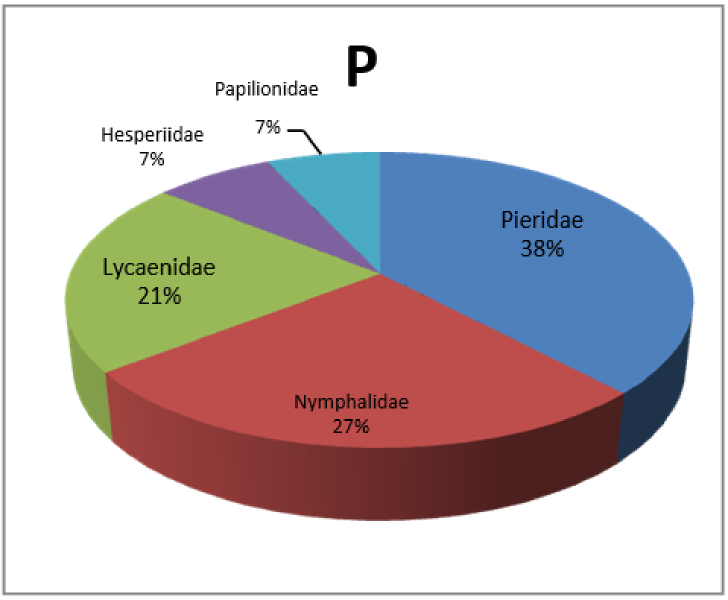


**Fig. 1. Agroforestry Micro Agroecosystem**

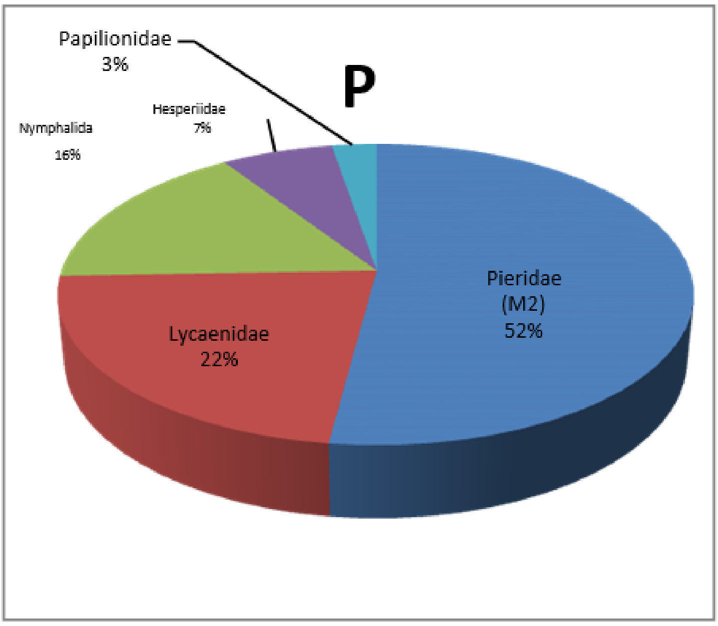


**Fig. 2. Seed production ecosystem**

## 3.4 According to Subfamilies Individual Number of the Population

There were two different systems, which divided into 5 families and nine subfamilies at M1 habitat family Pieridae subfamily Pierinae 430 (32 %) and Coliadinae 111 (8%) were found to be the most prominent, followed by Lycaenidae Polymmatinae 373(27%), Papilioninae 95(7%), Nymphalidae subfamilies Nymphalinae 139 (10%), Satyrinae 84(7%), Danainae 28(2%) and Heliconinae 8(1%) and Hesperidae coeliadinae 99(7%) population with percentages. Shannon- Weiner Diversity Index (H′) of 0.1.

The M2 habitat family comprised of five families and nine subfamilies. As per the collection, the most prevalent subfamilies were found to be Pierinae 492(42%) and Coliadinae 126 (11%) in the Pieridae subfamily, followed by Polymmatinae 297(25%), Pappilioninae 31(3%), Nymphalidae subfamilies Nymphalinae 52(4%), Satyrinae 51(4%), Danainae 14 (1%), Heliconinae 30(3%), and Hesperidaecoeliadinae 77(3%). The Shannon-Weiner Diversity Index (H′) 0.08.

## 4. DISCUSSION

In observed habitats (Table 2) showed that the values of the Simpson's diversity index (D) of butterflies in M1 were total population, family and subfamily respectively 0.918,0.618 and 0.839 while for M2 was 0.889,0.648 & 0.925. D is usually between 0 and 1. The closer the D value is to 1, the higher the diversity is higher.

In the M1 for population D value (0.918) was near to 1 as compared to M2. Similarly, family diversity was high (0.776) in the M1 habitat as compared to (0.648) in the M2 habitat. Both indices were analyzed to understand the level of diversity of subfamilies in M1 and M2. When diversification both indices were calculated according to subfamily, the highest diversity was found in the M2(0.925) habitat then M1 (0.839). The results are consistent on both the indices for three different levels of aggregation.

Shannon diversity index (H) for M1 was more diverse according to population, family and subfamilies respectively 1.59,0.618 and 0.917 as compared to that 1.209,0.541 and 0.737 respectively in M2. In M1 Simpsons H value was found to be maximum in the family Nymphalidae (0.9) followed by Pieridae (0.8), it was minimum (0.08) found in Hesperiidae The results revealed that there were two different systems, which were divided into 5 families and nine subfamilies Shannon Diversity Index (H′) 0.10. In M2 the Shannon Diversity Index (H′) was 0.08 while the Subfamilies $H_{max}$ value was 0.955 i.e. 95%.

Species diversity in the different MAES indicated outputs of almost similar proportions of species used as cereals, pulses, medicinal and traditional uses. Bhagwat *et al*., [6] confirmed that heterogeneous agroforestry systems, in which tall trees are maintained and planted for shade form a good refuge for tropical biodiversity. The common grass, forget me not and orange crown cupid were found to be more abundant in both M1 and M2 while the genera Papilio was more abundant in the M2 ecosystem [40-44]. The Hesperiidae family species minimally occurred in the Kharif seasons of both habitats. Most butterfly species found in the M1 have more attractive colors, and high flyers though very energetic. M1 was found to be more abundant and diverse probably due to low levels of anthropogenic activities. The site had more species of the family Nymphalidae flourishing amount in M1 [59-62]. The finding of this study is further supported by Hill *et al*. [29], Brown [13], Bonebrake *et al*. [9] and Akwashiki *et al.* [3] who reported great abundance of butterfly species in less disturbed habitats [3,9,13,11]. The higher diversity abundance in the M1 (Agroforestry site) may be because the site provides wider resources for the butterflies as compared to M2 (seed production). The letter where the both destruction of the microhabitat and depletion of necessary resources needed for the daily activities, had butterflies. Similarly, the M1 habitat has no anthropogenic disturbances in the microclimate as compared to M2 habitat. Thus, species richness was a natural outcome of the findings of [10,30-39]. Although there were various factors potentially influencing the result such as land use intensity and ecosystem modification, which was the highest in the annual cropping monoculture which was the case with the M2 habitat [48-57,66,67,69,71]. Our results on various habitat butterfly species composition show a high similarity between agroforestry systems and seed production.

**Table 2. Butterflies" species diversity index for the M1 and M2**

| Based on | M1 Agro-Forestry Ecosystem | | M2 Seed Production Ecosystem | |
|---|---|---|---|---|
| | D | H | D | H |
| Population | 0.918 | 1.59 (87%) | 0.889 | 1.209 (74%) |
| Family | 0.776 | 0.618 (89%) | 0.648 | 0.541 (77%) |
| Subfamily | 0.805 | 0.907 (95%) | 0.748 | 0.737 (77%) |

*Figures within parenthesis are percentage to maximum value of max Simpson (D) and Shannon Diversity Index*

## 5. CONCLUSION

A total of 2537 butterfly species from five lepidopteron families were recorded in the two Micro- Agro-Ecosystems. Among them, 1367 species were in M1 (agroforestry) and 1170 species in M2 (seed production Unit). Further, the Shannon diversity index was 4.49 to 4.59 with a good Fisher alpha value. The presence of butterflies is essential for pollinating different plant species within protected natural ecosystems. The variety of butterflies on the university campus may rise with thoughtful landscape planning and upkeep, creating an ideal environment for both research and butterfly conservation. Greater diversity and abundance in the undisturbed site may result from the site offering more resources for butterflies to use than in the disturbed area. where there is less vegetation and less activity from other taxa due to the destruction of microhabitats and depletion of resources required for all living things to go about their daily.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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