



RESEARCH

# Monitoring of Butterfly Diversity in Diverse Eco-Climatic Zones of Maharajganj District, Uttar Pradesh, India

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## Abstract

Butterflies are colourful, attractive and ecologically important creatures on the earth. The present study has been carried out in the three different climatic zones of Maharajganj district of Uttar Pradesh, India, during the months of July to December 2024. The three sampling sites were selected, i.e. Vijay Park, Farinda and Paneva Panei, to investigate the diversity of butterfly species. A total of 206 butterfly samples were collected using an insect net. Among them, 13 distinct species of butterflies belonging to 04 different families, such as Nymphalidae, Pieridae, Papilionidae and Lycaenidae were monitored. The family Nymphalidae was most dominant (106), followed by the Pieridae (70), Papilionidae (17) and the Lycaenidae (13). The distribution pattern of butterflies in numbers was shown as 74, 71 and 61 at Vijay Park, Farinda and Paneva Panei, respectively. According to the Simpson Index of Diversity, the sampling site Farindahas showed the highest score (0.88), followed by Vijay Park (0.85) and Paneva Panei (0.82). The finding score revealed that the population of butterflies needs to be protected by conservation of their habitats, which are degrading continuously due to the exponential expansion of urbanisation and agricultural activities.

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**Statement of Sustainability:** The study indicates that the butterfly species has significant importance in balancing terrestrial ecosystems and plays an important role in several biological services, so it is necessary to protect them with sustainable goals by conservation of its habitats and host plants in the area near the district Maharajganj, Uttar Pradesh, India.

## 1. Introduction

Butterflies are one of the most beautiful insects that belong to the order Lepidoptera. They have been esteemed for the 21<sup>st</sup> century because of their stunning appearance and behavioural display (Jagtap and Mamtule, 2023). The systematic position and biological profiles of butterflies are fairly clear and well defined (Kunte et al., 2019). They are closely related to moths but mostly active during the daytime and very sensitive to environmental conditions (Kawahara et al., 2018). The colouration and patterns can function as indicators of the environment (Mayur et al., 2013). Butterflies are essential pollinators, food web contributors, and indicators of climate and environmental changes. About 80% pollination is done by butterflies (Bharati et al., 2024).

Butterflies are an important component of the terrestrial ecosystem and play an important role in biological services such as nutrient recycling, soil formation, food resources and pollination (Pahari et al., 2018). Over 28,000 butterfly species exist globally, with approximately 80% found in tropical regions (Khan et al., 2015). The species of butterfly mostly survives in forest areas, trees and weeds on the soil surface. They are considered valuable environmental indicators among the most essential insects in ecosystems, and abundance and variety are practical markers of the health of any particular terrestrial biotope (Clarke and Dennis, 2020). Butterflies are an integral part of the ecosystem that make a co-evolutionary relationship among plants, as well as their lives are interlinked (Ghazanfar et al., 2016). They are very sensitive to changes in the environment and anthropogenic activities (Habel et al., 2021). The continuous changes in environmental conditions, along with rapid urbanisation, are exerting significant pressure on the survival of



butterflies and causing a decline in urban biodiversity (Grimm et al., 2008). The direct effect of climate change due to fluctuation in temperature, rainfall and drought over a long time of period is responsible for reducing the biodiversity of butterflies (Kumar et al., 2016; 2017).

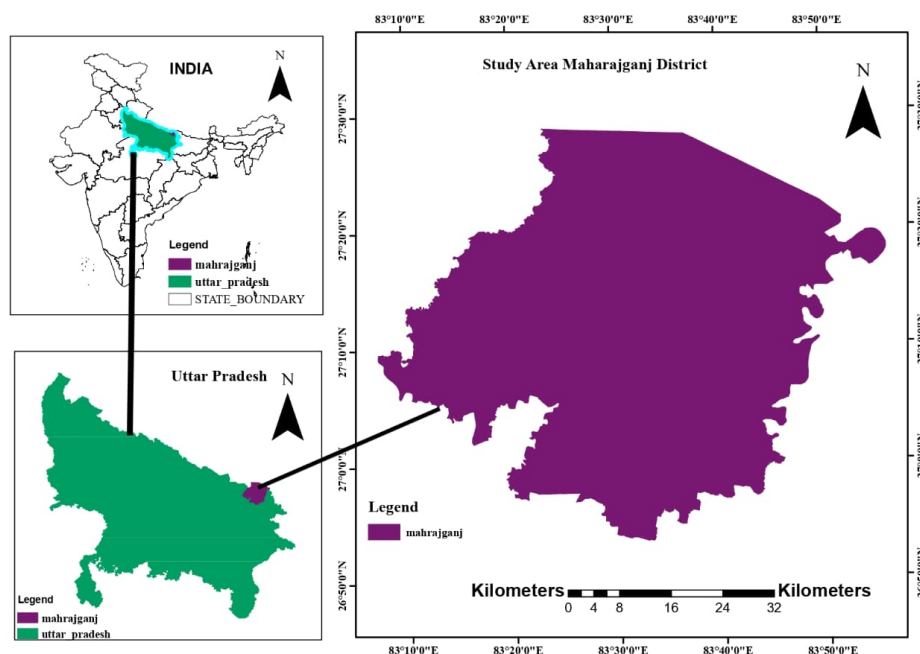
The rapid urbanisation, industrialisation, and agricultural activities like the use of pesticides and chemical fertilisers cause the destruction of their habitat, due to which some species of butterfly have either reached on verge of extinction or become extinct. It was observed that deforestation, loss of nectar resources, hunting and forest fires are also responsible for the decline of butterfly population (Kunte et al. 2012; Cardoso et al., 2020). Several studies have been conducted on the diversity of butterflies in some regions of northern, northeastern, eastern and central parts of India (Dey et al., 2017; Paul and Sultana, 2020).

The present study has been conducted to monitor the biodiversity of butterfly species in the Maharajganj district, Uttar Pradesh, India. This district is located in a different climatic zone of the Indo-Nepal border. The boundaries of the district Maharajganj touch Nepal in the north, Gorakhpur district in the south, Paderana district in the east, and Siddharth Nagar and Sant Kabir Nagar districts in the west, where, a huge population of butterflies are found. This study would support the diversity, ecology and habitat suitability, which are extremely necessary for effective and proper conservation of butterflies.

## 2. Materials and Methods

### 2.1. Study Area

The study area covered between latitude  $27^{\circ}15'N$  and longitude  $83^{\circ}58'E$  with an altitude of 66m. Three sampling sites were selected at a distance of about 10 Km in the study area, i.e. Vijay Park, Farinda and Paneva Panei. Maharajganj district was chosen for the butterfly diversity study because it has diverse habitats like forests, fields, and wetlands, which support many butterfly species. The terai climate of district with high humidity and rich vegetation creates ideal conditions for butterflies. This region is also poorly studied, so documenting its butterfly diversity provides important new ecological information. The map of the study area is shown in **Figure 1**.



**Figure 1.** Showing a map of the study area of Maharajganj district, Uttar Pradesh, India.

### 2.2. Sample Collection

Butterfly samples were collected by the "Sweep Net sampling Method" as described by Gadagkar et al. (2017). The sampling was done during the morning (8 to 11 am) and evening (3 to 6 pm) times of the month July to December 2024.



The triplicate random sampling was done in a week of each month from the selected sampling sites. This sampling method of butterflies was quite representative and can provide information about the diversity of butterflies. During sampling, photographs of each specimen were taken by a Nikon D850 camera.

### 2.3. Survey Method

The study area is covered with different vegetation, such as food plants, nectar plants, and breeding habitats, which provides a strong base for butterfly diversity. The data obtained on butterflies was based on observation of the individual species of butterfly. The collected individuals were transferred into insect collection paper packs and were brought to the laboratory, where they were properly stretched, pinned and preserved in collection boxes.

### 2.4. Identification of Butterfly Species

During the month of the sampling period, most of the nectar-rich plants of the selected area began to flower. Thus, it was an excellent source of nutrition that supported the life and breeding of butterflies. Colour patterns, sizes and shapes, as well as their designs, were considered in the identification of the species of butterfly with the help of an entomologist expert and relevant available literature.

### 2.5. Statistical analysis

The observed data of butterflies from the three sampling sites were analysed by using the Simpson index of diversity formula. The Simpson index of diversity formula is given below:

$$D_{\text{Simpson}} = 1 - \frac{\sum n(n-1)}{N(N-1)} \quad (1)$$

Where, D = Simpson Index Diversity;  $\Sigma$  = Sum of total; n = The number of individuals of each different species; N = The total number of individuals of all the species.

## 3. Results and Discussion

### 3.1. Different Species of Butterfly in the Study Area

During the present study total of 206 individuals from 13 species of butterfly, which belonged to four families, were recorded from different study sites. The maximum number (106) and percentage (51.45%) of butterflies belonged to family Nymphalidae, followed by Pieridae (70, 33.98), Papilionidae (17, 8.25 %) and Lycaenidae (13, 6.31 %) (**Table 1** and **Figure 2**). However, Rai and Chaudhary (2023) found that Nymphalidae had found maximum number and percentage (13, 48%) of species, followed by Pieridae (6, 22%), Papilionidae (3, 11%), and Lycaenidae (2, 8%) species of the family. Similarly, Arya et al. (2018) reported that family Nymphalidae was dominant, 45.29% of total individuals, followed by Pieridae (31.04%), Lycaenidae (11.20%), Papilionidae (8.33%). Furthermore, Sethy et al. (2014) obtained that the Nymphalidae family characterises the dominant in the study site with 42.5%, followed by Papilionidae of 21.2%, Lycaenidae 15.1%, and Pieridae 14.1%. Nymphalidae was the most dominant family, with the maximum number of individuals, 43.07%, followed by Pieridae 35.24%, Lycaenidae 9.61%, Papilionidae 8.07% (Arya et al., 2020). They also reported that such domination of Nymphalidae butterflies might be due to the polyphagous nature of their larval forms and a similar pattern with the predominance of the family Nymphalidae. Due to differences in habitat and sampling time and effort, it would be inappropriate to make quantitative comparisons in the diversity of butterflies from other protected areas of the Maharajganj district, Uttar Pradesh. Additionally, the highest number was recorded from family Nymphalidae (43%), followed by Pieridae (20%), Papilionidae (11%); however, Lycaenidae recorded 6% of relative abundance (Bhowate and Kumar, 2020).

A total of 42 species were observed around the reservoir, dominated by Nymphalidae (38%) over Pieridae (31%), Lycaenidae (21%) and Papilionidae (10%). In addition to, the most dominant species was *Danaus chrysippus* (Plain tiger, 55 individuals) showed highest number of individuals followed by *Pieris brassicae* (Cabbage White butterfly, 46 individuals), *Danaus genutia cramer* (Stripped tiger, 21 individuals), *Eurema andersoni* (One spot yellow, 13 individuals), *Eurema hecabe* (Common grass yellow, 11 individuals), *Hypolimnas bolina* (Great egg fly, 10 individuals), *Euploea core cramer* and *Papilio demodeus* (Common crow and Lime butterfly, 9 individuals), *Atrophaneura varuna* (Batwing, 08



individuals), *Zizeeria karsandra* (Dark grass yellow, 7 individuals), *Junonia almana* and *Zizina otis* (Peacock pansy and Lime blue, 6 individuals), and *Melanitis leda* (egg fly, 5 individuals) (Gandhi et al., 2018)

**Table 1.** The taxonomic composition of butterfly species in different sites of the Maharajganj district.

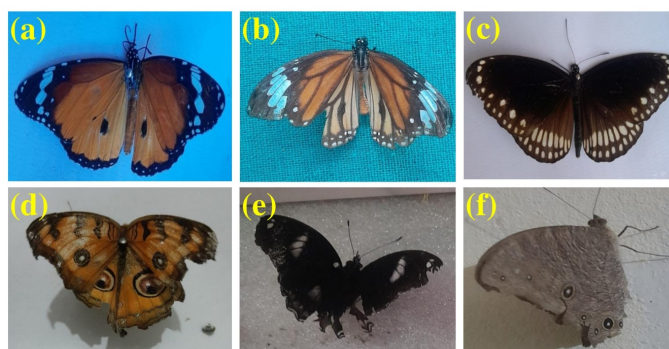
Families of Butterfly	Scientific Name	Common Name	Number of individuals in different study sites			Total
			Vijay Park	Farinda	Paneva Panei	
Nymphalidae	<i>Danaus chrysippus</i>	Plain tiger	15	17	23	55
	<i>Danaus genutia cramer</i>	Stripped tiger	10	8	3	21
	<i>Euploea core cramer</i>	Common crow	3	4	2	9
	<i>Junonia almana</i>	Peacock pansy	2	1	3	6
	<i>Hypolimnas bolina</i>	Great egg fly	2	5	3	10
	<i>Melanitis leda</i>	Evening brown	1	1	3	5
Pieridae	<i>Eurema hecabe</i>	Common grass yellow	6	3	2	11
	<i>Pieris rapae</i>	Cabbage butterfly	21	15	10	46
	<i>Eurema andersoni</i>	One spot grass yellow	5	4	4	13
Papilionidae	<i>Papilio demoleus</i>	Lime butterfly	3	2	4	9
	<i>Atrophaneura varuna</i>	Batwing	3	4	1	8
Lycaenidae	<i>Zizina Otis</i>	Lime blue	1	3	2	6
	<i>Zizeeria karsandra</i>	Dark grass blue	2	4	1	7
<b>Total</b>			74	71	61	206

### 3.2. Observation of Butterfly Diversity by Simpson Diversity Index

The diversity of butterfly species observed in the different sites is presented in **Figures 2, 3, 4, 5, 6, and 7**. The results showed that the highest number of butterflies was observed in site Vijay park (74) and the lowest number in the site of Paneva panei (61). Simpson index diversity was found to be the highest in the site of Farinda (0.88), and lowest in the site Paneva paeai (0.82). Pardhi and Havale (2024) reported that the site Dhakale shows the maximum number of butterflies (126), followed by Thakarwadi (Kolwadi/kotamdara) (113), and the Sal site shows the minimum (97) number of individuals in the Ghodegaon region of Maharashtra, India. Rai and Chaudhary (2023) found that the Simpson Index of Diversity was found highest in Shanti Upvan zone (0.9) followed by Draupadi Temple zone (0.8) and Abhimanuzone (0.7) in the Meerut region of Hastinapur Wildlife Sanctuary is rich in terms of diversity of butterfly species and further studies might be conducted to figure out the variation in butterfly species diversity in different habitats. Subsequently, several studies have been conducted by various workers to explore the butterfly diversity at different locations in the Kumaun Himalaya (Smetacek, 2004).

## 4. Conclusion

A total of 206 species of butterflies belonging to four families were collected during this study. The family Nymphalidae was found to be the most dominant in terms of the number of species, followed by Pieridae, Lycaenidae, and Papilionidae. The study area is covered with different vegetation, such as food plants, nectar plants, and breeding habitats, which provides a strong base for butterfly diversity. The maximum number of butterfly species and Simpson Index was reported from the sampling site Vijay Park than from other sites. Therefore, it is concluded that this study area is rich in butterfly diversity and further research should be conducted for the conservation of butterflies in these parks. Butterflies are very sensitive to their host plant availability; if the diversity of host plants could be increased, the diversity of butterflies may also be affected. Therefore, it is concluded that the study area is rich in butterfly diversity and further research could be conducted to obtain details and documentation on butterfly diversity for the conservation and butterfly parks.



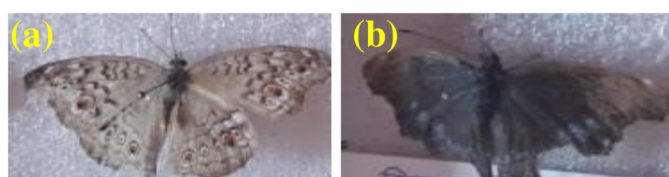
**Figure 2.** Different butterfly species of family Nymphalidae (a) *Danaus chrysippus*, (b) *Danaus genutia cramer*, (c) *Euploea core cramer*, (d) *Junonia almana*, (e) *Hypolimnas bolina*, (f) *Melanitis leda*.



**Figure 3.** Different butterfly species of the family Pieridae (a) *Eurema hecabe*, (b) *Pieris rapae*, (c) *Eurema andersoni*.



**Figure 4.** Different butterfly species of family Papilionidae (a) *Papilio demoleus*, (b) *Atrophaneura varuna*.



**Figure 5.** Different butterfly species of family Lycaenidae (a) *Zizina otis*, (b) *Zizeeria karsandra*

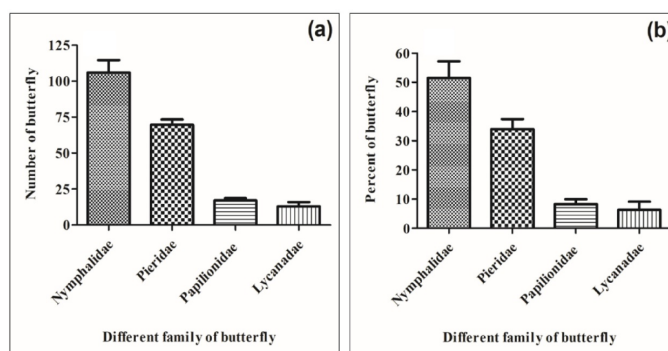
## Authors' Contributions

Suresh Kumar: Investigation, Resources, Software, Data curation, Writing original draft; Sanjay Kumar: Supervision, Conceptualisation, Methodology, Validation, review and editing. Both authors have read and agreed to the published version of the manuscript.

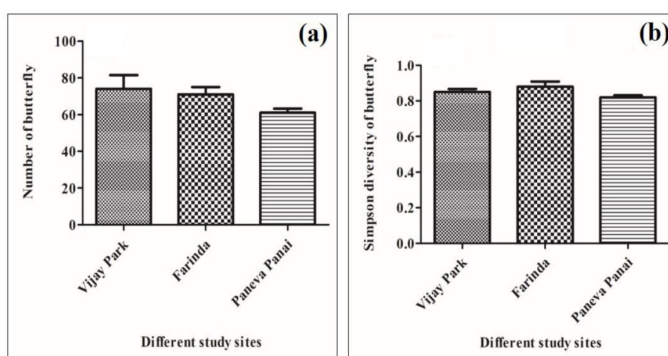
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**Figure 6.** Different families of butterfly species (a) number, (b) per cent.



**Figure 7.** Study of butterflies from different sites (a) number, (b) Simpson diversity index.

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## Declarations

**Conflict of Interests:** There is no conflict of interest in this work by the authors.

**Institutional/Ethical Approval:** Note applicable.

**Data Availability/Sharing:** The datasets used and analysed during the current study will be made available from the corresponding author upon a reasonable request.

**Supplementary Information Availability:** Not applicable.

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