



## A PRELIMINARY STUDY ON DIVERSITY AND RELATIVE ABUNDANCE OF BUTTERFLY FAUNA (ORDER: LEPIDOPTERA) IN NAWAB WAJID ALI SHAH ZOOLOGICAL GARDEN, LUCKNOW, U.P., INDIA

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### AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration among all authors. Author BS designed the study, carried out all the work, wrote protocol and first draft of manuscript. Author Sushmita designed all the graphs, performed the statistical analysis of the study and managed the literature searches. All authors read and approved the final manuscript.

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### ABSTRACT

The assessment of butterflies diversity and relative abundance were conducted in the Butterfly Park, Nawab Wajid Ali Shah Zoological Garden (Lucknow Zoo) from the month of July 2020 to December 2020. Butterflies are considered as valuable bio-indicator species for examining and detecting changes in the environment because of their diversity, broad distribution specifically to vegetation type, quick response to perturbation, statistically significant abundance, and sensitivity to environmental variations. This study revealed presence of 62 species of butterflies belonging to 45 genera which represents five families. Family Nymphalidae has been most abundant and comprising 24 species, followed by 16 species of Lycaenidae, 14 species of Pieridae, 6 species of family Papilionidae and 2 species of Hesperidae were recorded from the study area during the study period. According to the Wildlife Protection Act, 1972 four species found to be protected. Species richness and abundance of butterflies has been highest during late monsoon to early winter. The relative abundance and diversity of each butterfly species depends upon the availability of food source, habitat condition and their environmental conditions. The present study will illuminate the knowledge about the diversity and abundance of butterflies in Butterfly Park of Nawab Wajid Ali Shah Zoological Garden, (Lucknow Zoo) Lucknow.

**Keywords:** Abundance; species richness; zoological garden; diversity; habitat conditions; environmental factors.

### 1. INTRODUCTION

Butterflies are very fragile insects that belong to order "Lepidoptera" and regarded as one of the significant components of biological diversity. They are closely

associated with their feeding plants (host plants and nectar plants) and environmental conditions. Lepidoptera (Butterflies and Moths) are the second largest order of Arthropods and are well recognized; making them particularly valuable for biodiversity

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survey [1-4]. Numerous species of butterflies are seasonal and select only specific set of habitats [5]. Their occurrence and diversity are considered as positive indicators of the health of any given terrestrial biotope [6,7]. Butterflies are an important aspect of ecosystem for they interact with plants as pollinators and herbivores [8]. The connection between plants and butterflies is extremely complex and co-evolved [9]; since the butterflies that depends on plants for the food and accomplish their life cycle; opposite to this many of the economically relevant plant species are pollinated by butterflies [10]. Some butterflies are attracted on the rotten fruit; carrion; urine and animal dung [11]. Butterflies are usually regarded as one of the best taxonomically studied groups of insects [12]. The areas with undisturbed natural vegetation and excessive floral diversity support large butterfly communities [13]. The diversity and distribution of a specific species of butterfly is dependent not merely on the geographical area and the capability of the species to move around within it; but also on the ecological demands of the species [14]. Butterflies are sensitive to environmental pressures and thus extremely suitable for monitoring the health and diversity of ecosystems and detecting indications of environmental change [15,16]. In previous studies of 5 Urban forest fragments of Lucknow; total 643 butterflies belonging to 5 families of 26 genera were recorded [17]. Again in 2020; 930 individuals of collected from 4 study sites; which include 27 genera and 35 identified species belonging in six families. Nymphalidae- Brush footed butterfly family was the most dominant with (12) species followed by Pieridae- White and Yellows (8); Lycaenidae- Blues (5); Danaidae- The Tigers (5); Hesperidae- Skippers (2); Papilionidae- Swallowtails (3) [18]. In Butterfly Park of Nawab Wajid Ali Shah Zoological Garden; Lucknow (Lucknow Zoo) some studies has been undertaken on the status of butterfly. Thus; the main objective of this study is to investigate the butterfly diversity and relative abundance in Butterfly Park of Nawab Wajid Ali Shah Zoological Garden; Lucknow.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

The Butterfly park of Nawab Wajid Ali Shah Zoological Garden; Lucknow (Fig. 1) covers an area of 0.008 km<sup>2</sup> (2 Acre). It lies between 26°50'37" latitude and 80°57'6" longitude.

### 2.2 Field Methods

This study was done from July 2020 to December 2020 in the butterfly park of Nawab Wajid Ali Shah

Zoological Garden; Lucknow. Observations were done twice a day; first shift 9:00 to 11:00 AM and in second shift from 2:00 to 4:00 PM; when butterflies are more active; resting on plants and those in flight has been counted and identified. The diversity and abundance of butterflies were recorded by the direct watching and through the photographic confirmations. The collection of specimen was strictly avoided. Photographs were taken from different angles as often as possible to get sufficient photos with (Nikon D7200) DSLR Camera. On the basis of constant sighting of the butterfly species has been divided into three categories namely Very Common; Common and Rare. All scientific name followed in the present study are in accordance with Varshney [19] and common English names follow Wynter-Blyth [20].

### 2.3 Statistical Analysis

The collected all data has been calculated by following formulas:

- Simpson's Diversity (D) =  $\sum n(n-1) / N(N-1)$

Where; n = the total number of butterflies of a particular species.

N = the total number of butterflies of all species.

For the calculation of Relative Abundance using

- Shannon-Wiener Diversity Index (H) =  $-\sum p_i \ln p_i$

Where; p<sub>i</sub> is the proportion of total sample represented by species *i*.

(Divide number of individuals of species *i* by total number of samples)

- Genus(%) =  $\frac{\text{Total number of genus in a family}}{\text{Total number of genus in all families}} \times 100$

- Species(%) =  $\frac{\text{Total number of species in a family}}{\text{Total number of species in all families}} \times 100$

## 3. RESULTS AND DISCUSSION

The diversity and relative abundance of butterflies was conducted in Butterfly park of Nawab Wajid Ali Shah Zoological Garden; Lucknow during July 2020 to December 2020. The total 40;810 number of individuals represented to 62 species belonging to 5 families of 45 genera recorded from the study area Table 1. The diversity and abundance of butterflies are declining through the fragmentation of their natural habitat; extending of modern cities. Among them 24 species belonged to family Nymphalidae; 14

species belonged to Pieridae; 16 species belonged to Lycaenidae; 6 species belonged to Papilionidae and 2 species belonged to Hesperidae. Among these 62 species of butterflies was recorded from the study area; where 4 species of butterflies have found to be protected under the Wildlife Protection Act; 1972. Gaudy Baron (*Euthalia lubentina*) belongs to Schedule IV; Danaid Eggfly (*Hypolimnas misippus*) belongs to Schedule I; Lime Blue (*Chilades lajus*) belong to Schedule II and Gram Blue (*Euchrysops cnejus*) belongs to Schedule II. A previous study [20] had identified two peak seasons; March- April and October; for abundance of butterfly in India. The butterfly list along with their abundance of different families is given in (Table 2; Fig. 3). The results show that the highest relative abundance of butterflies was recorded from the family Nymphalidae (2.133) and least abundant family was Hesperidae with (0.223) than the other families given in (Table 2; Fig. 3). Table 2 shows the diversity of butterfly in different families has been calculated by Simpson Diversity Index (D). Family Nymphalidae shows highest diversity index (0.85) and the lowest diversity was recorded from the family Hesperidae (0.38) (Table 2; Fig. 2). In the present observation estimation; highest genera percentage were recorded of the family Nymphalidae and Lycaenidae 15 genera (33.33%) followed by Pieridae 10 genera (22.22%); Papilionidae 3 genera (6.66%) and Hesperidae 2 genera (4.44%) given in (Table 3; Fig. 4). The highest species percentage composition of butterfly were recorded from the family Nymphalidae 24 species

(38.70%) followed by Pieridae 14 species (22.58%); Lycaenidae 16 species (25.80%); Papilionidae 6 (9.67%) and Hesperidae 2 species (3.22%) given in (Table 3; Fig. 4). Butterfly Park in Nawab Wajid Ali Shah provides a better prospect to shield biodiversity and set a paradigm of how wildlife can be secluded and conserved close to urban areas; without encumbering the development of the same. The study area also provides a better opportunity to promote eco-tourism; since it is located in Lucknow Zoo [21]. Matter et al.; [22] suggested that the abundance of individuals is assumed to increase proportionately with habitat area. The results are in tune with the findings of Venkataramana [23] who reported that the relative abundance of butterfly species of Eastern Ghats in Andhra Pradesh under categories like very common; common; less common; rare and very rare. Similar results were also reported by Deokar and Shukla [24]; who reported that the 65 species of butterflies from Kolamarka Conservation Reserve; Central India and the highest number of species was observed from family Nymphalidae and the lowest from Hesperidae. Thakur and Bhardwaj [25]; Harsh [26] and Shiva and Swamy [27] also reported that the family Nymphalidae is the most diverse family in Himachal Pradesh; Madhya Pradesh and Andhra Pradesh; India respectively. Further; the results are supported by Rajagopal et al.; [28] who observed that the relative abundance of butterfly species diversity usually increases with diversity of plant species in Arignar Anna Zoological Park; Tamil Nadu during 2005 to 2006.



Fig. 1. Map of the study area

**Table 1. Status of each butterfly species recorded in the butterfly park of Nawab Wajid Ali Shah Zoological Garden; Lucknow during study period**

S.N.	Common Name	Scientific Name	Status
<b>Family-Papilionidae 3/6 (Genera/Species)</b>			
1	Common Rose	<i>Atrophaneura aristolochiae</i> (Fabricius)	R
2	Common Mormon	<i>Papilio polytes</i> (Linnaeus)	VC
3	Lime Butterfly	<i>Papilio demoleus</i> (Linnaeus)	C
4	Common Jay	<i>Graphium doson</i> (Linnaeus)	VC
5	Tailed Jay	<i>Graphium agamemnon</i> (Linnaeus)	R
6	Spot Swordtail	<i>Graphium nomius</i> (Esper)	R
<b>Family-Pieridae 10/14 (Genera/Species)</b>			
7	Psyche	<i>Leptosia nina</i> (Fabricius)	C
8	Three- Spot Grass Yellow	<i>Eurema blanda</i> (Boisduval)	VC
9	Small Grass Yellow	<i>Eurema brigitta</i> (Cramer)	VC
10	Pioneer	<i>Belenois aurota</i> (Fabricius)	R
11	Yellow Orange Tip	<i>Ixias pyrene</i> (Linnaeus)	R
12	Common Gull	<i>Cepora nerissa</i> (Fabricius)	R
13	Common Jezebel	<i>Delias eucharis</i> (Drury)	C
14	Mottled Emigrant	<i>Catopsilia pyranthe</i> (Linnaeus)	VC
15	Common Wanderer	<i>Pareronia valeria</i> (Cramer)	C
16	Common Emigrant	<i>Catopsilia pomona</i> (Fabricius)	VC
17	Spotless Grass Yellow	<i>Eurema laeta</i> (Boisduval)	C
18	Common Grass Yellow	<i>Eurema hecabe</i> (Linnaeus)	VC
19	Indian Cabbage White	<i>Pieris canidia</i> (Evans)	R
20	Tree Yellow	<i>Gandaca harina</i> (Horsfield)	VC
<b>Family-Nymphalidae 15/24 (Genera/Species)</b>			
21	Blue Tiger	<i>Tirumala limniace</i> (Cramer)	C
22	Striped Tiger	<i>Danaus genutia</i> (Cramer)	C
23	Plain Tiger	<i>Danaus chrysippus</i> (Linnaeus)	VC
24	Common Crow	<i>Euploea core</i> (Cramer)	VC
25	Black Rajah	<i>Charaxes solon</i> (Fabricius)	R
26	Common Palmfly	<i>Elymnias hypermnestra</i> (Linnaeus)	C
27	Common Bush Brown	<i>Mycalasis perseus</i> (Fabricius)	C
28	Tawny Coster	<i>Acraea violae</i> (Fabricius)	R
29	Common Leopard	<i>Phalanta phalantha</i> (Drury)	R
30	Common Baron	<i>Euthalia aconthea</i> (Cramer)	C
31	Gaudy Baron	<i>Euthalia lubentina</i> (Cramer)	R
32	Painted Lady	<i>Vanessa cardui</i> (Linnaeus)	C
33	Yellow Pansy	<i>Junonia hierta</i> (Fabricius)	R
34	Chocolate Pansy	<i>Junonia iphita</i> (Cramer)	VC
35	Lemon Pansy	<i>Junonia lemonias</i> (Linnaeus)	R
36	Peacock Pansy	<i>Junonia almana</i> (Linnaeus)	VC
37	Grey Pansy	<i>Junonia atlites</i> (Linnaeus)	R
38	Great Eggfly	<i>Hypolimnas bolina</i> (Linnaeus)	VC
39	Danaid Eggfly	<i>Hypolimnas misippus</i> (Linnaeus)	R
40	Angled Castor	<i>Ariadne ariadne</i> (Linnaeus)	VC
41	Common Castor	<i>Ariadne merione</i> (Cramer)	VC
42	Common Evening Brown	<i>Melantia leda</i> (Linnaeus)	C
43	Dark Evening Brown	<i>Melanitis phedima</i> (Cramer)	C
44	Commander	<i>Moduza procris</i> (Cramer)	R
<b>Family-Lycanidae 15/16 (Genera/Species)</b>			
45	Gram Blue	<i>Euchrysops cnejus</i> (Fabricius)	C
46	Plains Cupid	<i>Chilades pandava</i> (Horsfield)	VC
47	Common Hedge Blue	<i>Actolepis puspa</i> (Horsfield)	C
48	Pale Grass Blue	<i>Pseudozizeeria maha</i> (Kollar)	C

S.N.	Common Name	Scientific Name	Status
49	Indian Sunbeam	<i>Caretis thetis</i> (Drury)	R
50	Forget–Me–Not	<i>Catochrysops strabo</i> (Fabricius)	R
51	Quaker	<i>Neopithecops zalmora</i> (Butler)	R
52	Dark Cerulean	<i>Jamides bochus</i> (Stoll)	R
53	Common Line blue	<i>Prosotas nora</i> (C.felder)	R
54	Dark Grass Blue	<i>Zezeeria karsandra</i> (Moore)	C
55	Lime Blue	<i>Chilades lajus</i> (Stoll)	C
56	Pea Blue	<i>Lampides boeticus</i> (Cramer)	R
57	Common Pierrot	<i>Castalius rosimon</i> (Fabricius)	R
58	Zebra Blue	<i>Leptotes plinius</i> (Fabricius)	R
59	Cornelian	<i>Deudorix epijarbas</i> (Moore)	C
60	Silver Streak blue	<i>Iraota timoleona</i> (Stoll)	R
<b>Family-Hesperiidae 2/2 (Genera/Species)</b>			
61	Rice Swift	<i>Borbo cinnara</i> (Wallace)	VC
62	Small branded swift	<i>Pelopidas mathias</i> (Fabricius)	C

VC = Very Common; C = Common; R = Rare.

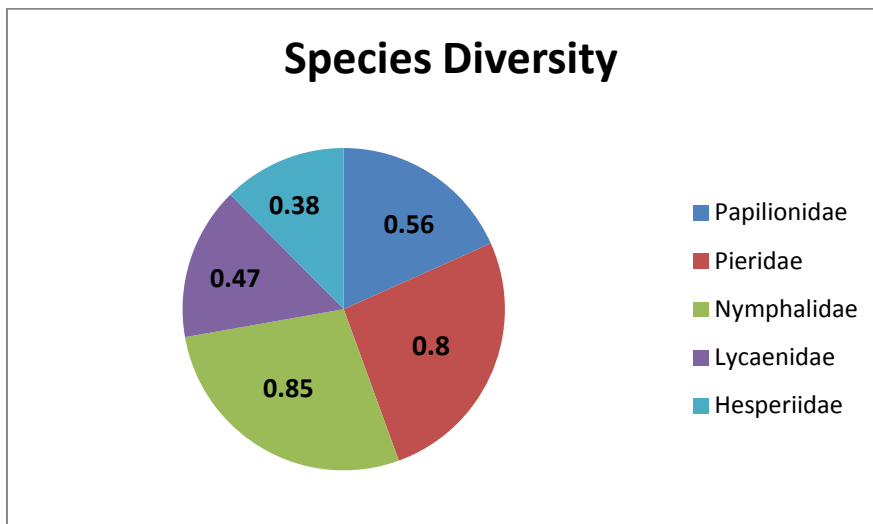


Fig. 2. Species diversity of Butterfly families recorded during study period

Table 2. Total number of individuals; species diversity and relative abundance of butterfly in Nawab Wajid Ali Shah Zoological Garden; Lucknow

S.N.	Family	Total no. of individuals	Species diversity	Relative abundance
1	Papilionidae	5144	0.56	0.958
2	Pieridae	11434	0.8	1.787
3	Nymphalidae	12212	0.85	2.113
4	Lycaenidae	9302	0.47	0.855
5	Hesperidae	2718	0.38	0.223

Table 3. List of families with number of genus and species of butterflies recorded from the butterfly park of Nawab Wajid Ali Shah Zoological Garden; Lucknow

S. N.	Family	Genus (45)	Species (62)	Genus (%)	Species (%)
1	Papilionidae	3	6	6.66	9.67
2	Pieridae	10	14	22.22	22.58
3	Nymphalidae	15	24	33.33	38.70
4	Lycaenidae	15	16	33.33	25.80
5	Hesperidae	2	2	4.44	3.22

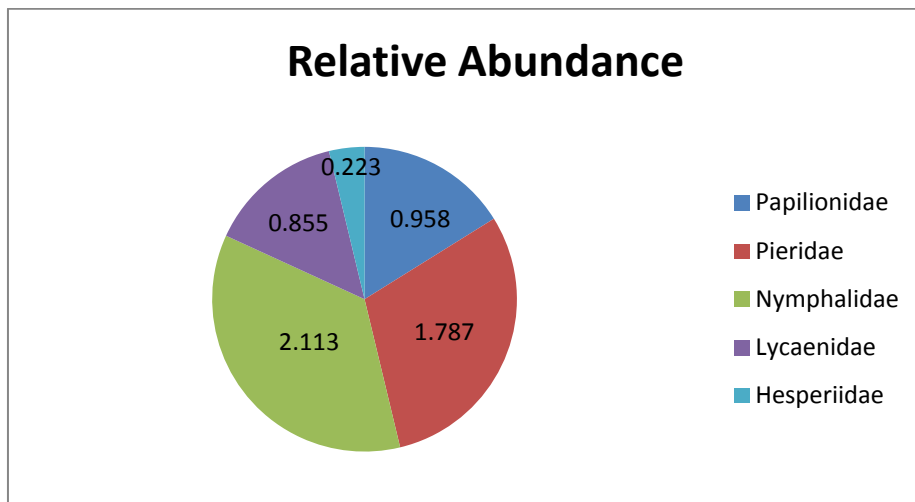


Fig. 3. Relative abundance of Butterfly families recorded from the study area.

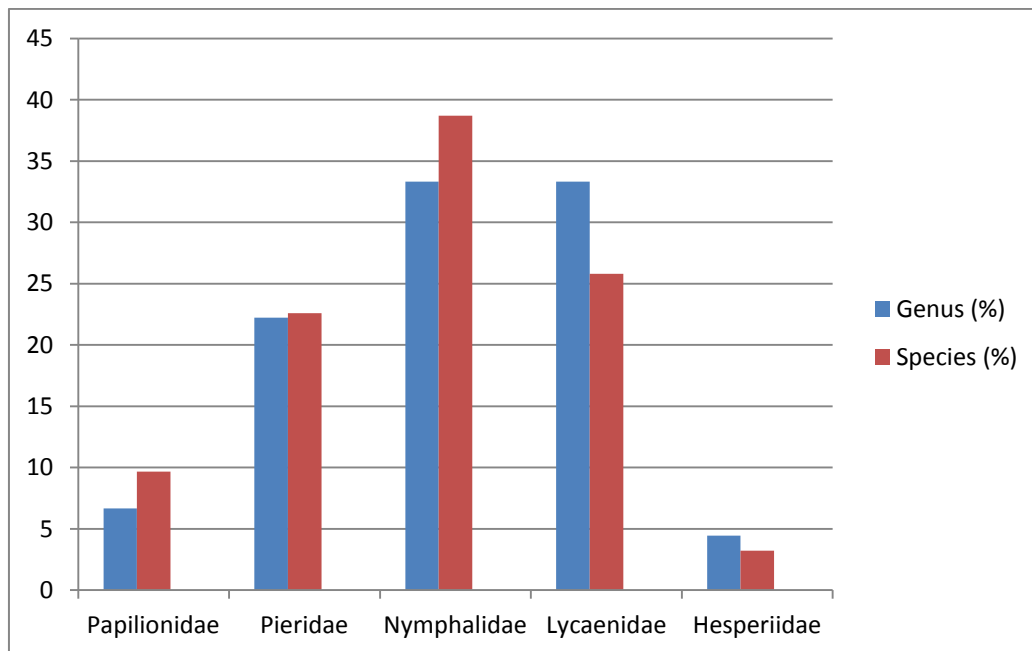


Fig. 4. Family wise percentage compositions of Butterflies species recorded in study area

#### 4. CONCLUSION

In the present study a total of 62 species of butterflies belonging to 45 genera and five families were recorded. Since there are about 58 species of butterflies recorded from the study area in the summer season [21]. Butterfly Park in Nawab Wajid Ali Shah Zoological Garden; Lucknow (Lucknow Zoo) have healthier natural vegetation; mud puddles and proper accessibility of food plants (host and nectar plants) that is favorable habitats for the development of butterfly communities and provides perfect condition for the flourishing of butterflies. We should require

conserving the biodiversity for achieving sustainable development that further improvement and maintenance of our ecosystems.

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**COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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