



Studies On The Diversity And Abundance Of Butterfly (Lepidoptera) Fauna In Three Parks Situated Along The Rural Urban Gradient In Kolkata, West Bengal, India

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Abstract: Butterflies serve as vital bioindicators, reflecting the health of ecosystems across forests, grasslands, and urban areas. This study highlights that tropical and subtropical regions host exceptional butterfly diversity due to favorable climates and rich vegetation. Seasonal changes play a crucial role, with species richness peaking in warm, wet conditions when nectar and breeding opportunities abound. However, human activities like urbanization and deforestation significantly reduce butterfly diversity, especially in cities where natural habitats are scarce. To protect these delicate creatures and sustain biodiversity, conservation strategies, habitat preservation, and green spaces in urban areas are essential to mitigate climate change's impact and ensure thriving butterfly populations.

Keywords – Butterfly Diversity, Lepidoptera Fauna, Ecosystem Bioindicators, Urbanization and Biodiversity, Butterfly, Conservation Strategies, Species Richness and Evenness, Kolkata Urban Gradient, Pollinator Diversity, Environmental Sensitivity of Butterflies, Shannon-Weiner Diversity Index

1. INTRODUCTION

Butterflies are the best group of insects for examining patterns of terrestrial biotic diversity and distribution (Robbins & Opler, 1997) and are also good indicators of environmental changes as they are sensitive to habitat degradation (Kunte, 2000). Habitat destruction for developmental activities and unscientific management of natural resources is responsible for the fast disappearance of native butterflies (Nair et al., 2014). Butterflies are very good pollution indicators and their diversity are good signs of a healthy environment. They depend on preferred host and nectar plants during their larval and adult stages respectively and the lack of these sources indicate degraded habitats with low species richness. Ongoing unplanned anthropogenic activities like habitat modification results in loss of biodiversity. Kolkata the city of joy, is home to diverse array of butterfly species. Random sampling of rural, suburban, and urban sites in and around Kolkata metropolis revealed the presence of 96 butterfly species, dominated by Lycaenidae (31.25%) over Nymphalidae (28.13%), Hesperidae (18.75%), Pieridae (12.50%), and Papilionidae (9.38%). Butterflies are often used to study the effects of climate change because of their sensitivity to climatic variables. Temperature strongly affects butterflies throughout their life histories. Direct or indirect effects of temperature have been observed in choice of oviposition sites, egg-laying rates, larval development and survival rates, and range shifts and expansions (Manzoor and Sadat, 2013).

2. OBJECTIVES OF THE STUDY

The objective of the presented study is to observe and identify specimens belonging to the butterfly (Lepidoptera) families from the study area and to estimate the diversity gradient of butterflies along with associated flora and vegetation to determine the interaction and interdependence of the species with the flora. The study also involves studying the effect of changing environmental factors and urbanization on the butterfly diversity and collective impact on the vegetation and flora.

Table 1: description of the study areas with latitudes and longitudes.

Site no.	Site Name	Latitude and Longitude	Description
1	Nature Park Kolkata (Rural to Semi-urban)	Latitude: 22.523 Longitude: 88.2963	Situated at Paharpur road, This large park with grassy areas, lakes and a miniature zoo is popular for picnicking & boating. It houses a large no. of plants, birds, including butterflies and some mammals. The park also has a small nursery maintained by the local people which invites large no. of butterfly species during the late winters and spring seasons
2	Parnasree Vivekanandan Kanan (Urban)	Latitude: 22.589 Longitude: 88.4618	Situated at Parnasree area, this park is popular among the local people for morning and evening walks. This park also has few common rides such as swings and slides for kids. The park contains flowering and non-flowering shrubs including a small manmade lake and thus attracts wide diversity of birds and butterflies including other insects.
3	Gopal Kanan Park (Urban)	Latitude: 22.507 Longitude: 88.3058	Situated at Ring Road, Dhopapara, Parnasree, this park is also popular among the local people for evening and morning walks and also for leisure activities. It consists of a manmade lake and trees including flowering and non-flowering shrubs attracting a wide diversity of birds and butterflies during the late winters and spring season.

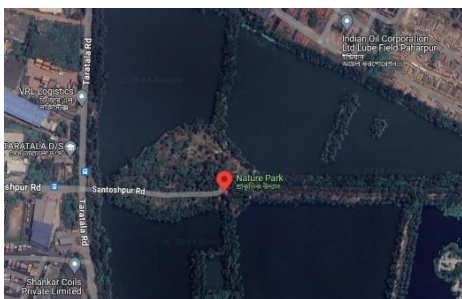


Figure 3: nature park



Figure 2: vivekananda kanan



Figure 1: gopal kanan

3. LIFE CYCLE OF A BUTTERFLY

Egg: The life cycle starts when the adult female butterfly lays a cluster of small, round eggs on plants. These plants will become food for the caterpillars that hatch 4-6 days after the eggs are laid.

Caterpillar (Larva): This is the feeding stage. The caterpillar, which emerges from the egg, has only one job to do, and that is to eat. They feed almost exclusively on leaves, which provide them with the necessary nutrients for rapid growth.

Pupa (Chrysalis): After the caterpillar attains its full-grown size, it stops eating and enters its chrysalis for the pupal stage¹. Inside the chrysalis, a remarkable transformation occurs called metamorphosis. During this stage, the caterpillar's body structures are broken down and reorganized into the form of an adult butterfly.

Adult (Imago): In this stage, the chrysalis opens, and the adult butterfly comes out. The adult butterfly has long antennae, long legs, and compound eyes. Once fit for its first flight, the butterfly takes off in search of nectar-producing flowers. Adult females fly from one place to another to find plants suitable for laying eggs.

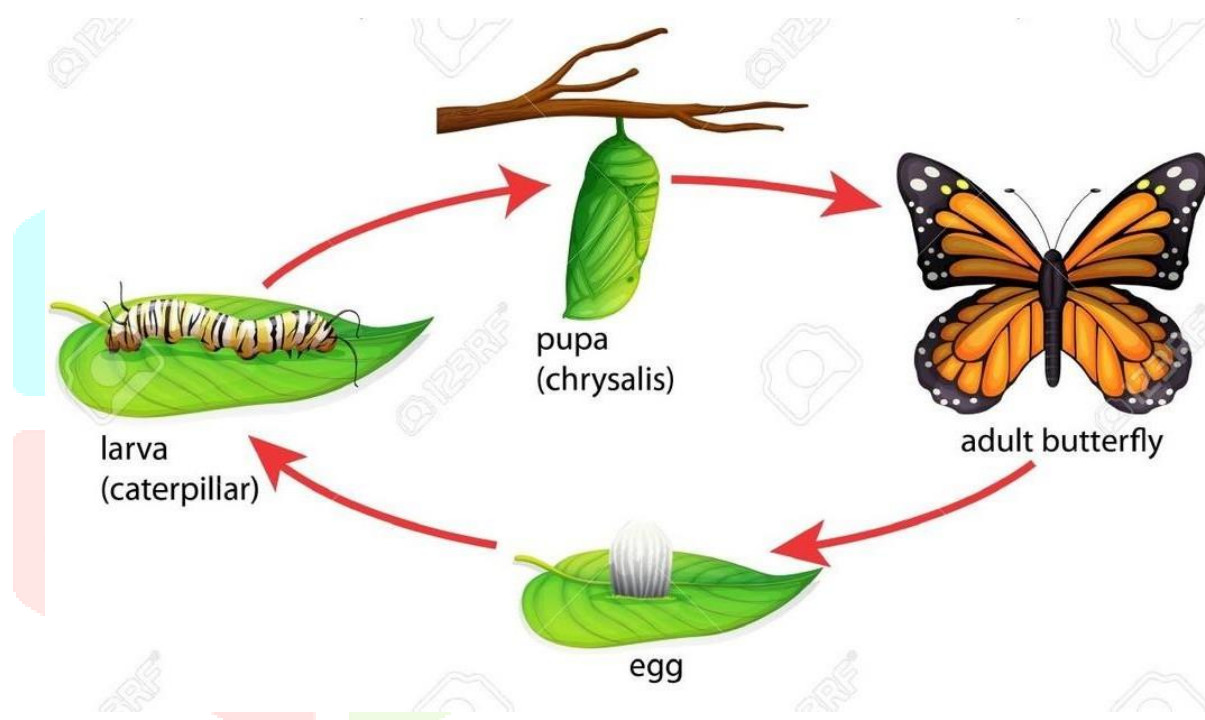


Figure 4: life cycle of a butterfly

4. MATERIALS AND METHODS FOLLOWED

The findings presented here are based on random surveys carried out from February, 2024 -May, 2024. The total area of the three study sites were surveyed from morning 10 a.m. till 4 p.m. in the evening. Butterflies were primarily identified directly in the field. All identified species names followed in the present study are in accordance with **BNHS-field guide Butterflies of INDIA** by Isaac Kehimkar. The observed butterflies were categorized in five categories on the basis of their abundance

Very Common (more than 100 sightings) (abbreviated as VC)

Common (50-100 sightings) (abbreviated as C)

Not Rare (15-50 sightings) (abbreviated as NR)

Rare (10-15 sightings) (abbreviated as R)

Very Rare (1-5 sightings) (abbreviated as VR)

5. DATA CALCULATION FORMULA

The **relative abundances** of the species (%) were calculated using the equation n/N , where n is the species $\times$ the total number of individuals captured, N is the total number of all species.

Butterfly diversity in each site was compared using the Shannon and Weaver (1949) formula (H') (Magurran et al. 2004).

As,

$$H' = -\sum p_i \ln(p_i)$$

Where, H' is the diversity index

p_i is the proportion of each species in the sample

$\ln p_i$ is the natural logarithms of the proportion.

The value of Shannon index ranges from 1.5 to 3.5.

Evenness index (E) was calculated using the ratio of observed diversity to maximum diversity (Magurran, 2004)

As,

$$E = H'/H_{max}$$

Where H' is the Shannon-Weiner Diversity index

H_{max} is the natural logarithm of total number of species. The value of Evenness index ranges from 0 to 1.

The closer the value to 1 means the evenness of species is high in the site.

6. RESULTS AND DISCUSSION

Table 2: diversity in study site 1 nature park.

Sl no	common name	scientific name	family	relative abundance (%)	sightings
1	Crimson Rose	<i>Pachliopta hector</i>	Papilionidae	1.17	R
2	Tree yellow	<i>Gandaca harina</i>	Peridae	7.04	C
3	Common Evening Brown	<i>Melanitis leda</i>	Nymphalidae	8.21	C
4	Angeled Castor	<i>Ariadne ariadne</i>	Nymphalidae	5.86	C
5	Common crow	<i>Euploea core</i>	Nymphalidae	11.7	VC
6	Common Palmfly (male)	<i>Elymnias hypermnestra</i>	Nymphalidae	11.7	VC

7	Common Palmfly (female)	<i>Elymnias hypermnestra agina</i>	Nymphalidae	11.7	VC
8	Glassy Tiger	<i>Parantica aglea</i>	Nymphalidae	2.34	NR
9	Cabbage White	<i>Pieris rapae</i>	Peridae	11.7	VC
10	Little Grass Blue	<i>Zizula hylax</i>	Lycaenidae	9.38	C
11	Psyche	<i>Leptosia nina</i>	Peridae	3.52	NR
12	Common Grass Yellow	<i>Eurema hecabe</i>	Peridae	11.7	VC
13	Common Pierrot	<i>Castalius rosimon</i>	Lycaenidae	0.23	VR
14	Common Mormon	<i>Papilio polytes</i>	Papilionidae	3.52	NR

Table 3: diversity in study site 2 vivekanandan kanan.

Sl no	common name	scientific name	family	relative abundance (%)	sightings
1	Cabbage White	<i>Pieris rapae</i>	Peridae	20.5	VC
2	Common Palmfly (female)	<i>Elymnias hypermnestra agina</i>	Nymphalidae	13.2	C
3	Common Crow	<i>Euploea core</i>	Nymphalidae	9.34	C
4	Glassy Tiger	<i>Parantica aglea</i>	Nymphalidae	1.43	R
5	Common Evening Brown	<i>Melanitis leda</i>	Nymphalidae	2.45	NR
6	Common Grass Yellow	<i>Eurema hecabe</i>	Peridae	22.5	VC
7	Little Grass Blue	<i>Zizula hylax</i>	Lycaenidae	20.3	C
8	Psyche	<i>Leptosia nina</i>	Peridae	5.1	NR

Table 4: diversity in study site 3 gopal kanan.

Sl no.	common name	scientific name	family	relative abundance (%)	sighting s
1	Cabbage White	<i>Pieris rapae</i>	Peridae	21.3	VC
2	Common Palmfly (male)	<i>Elymnias hypermnestra</i>	Nymphalidae	10.4	C
3	Common Palmfly (female)	<i>Elymnias hypermnestra agina</i>	Nymphalidae	12.57	C
4	Common Crow	<i>Euploea core</i>	Nymphalidae	3.56	NR
5	Common Grass Yellow	<i>Eurema hecabe</i>	Peridae	20.9	VC
6	Little Grass Blue	<i>Zizula hylax</i>	Lycaenidae	18.8	VC
7	Psyche	<i>Leptosia nina</i>	Peridae	4.19	NR
8	Common Evening Brown	<i>Melanitis leda</i>	Nymphalidae	0.62	VR
9	Tree Yellow	<i>Gandaca harina</i>	Peridae	7.33	NR

Table 5: calculations and comparisons of results from the data collected in table 2, table 3, and table 4.

Site name	Species richness (S)	Shannon diversity value (H')	Shannon maximum value (Hmax)	Evenness (E)
Nature Park	14	2.42	6.74	0.35
Vivekanand Kanan	9	1.94	6.16	0.31
Gopal Kanan	8	1.91	6.16	0.31

7. COMPARISON BETWEEN THE THREE STUDY SITES.

A comparison between Nature Park, Vivekananda Kanan and Gopal Kanan stated that, all three study sites had an average level of butterfly diversity. Where Nature Park had a level of diversity comparatively higher ($H'=2.42$) than Vivekananda Kanan ($H'=1.94$) and Gopal Kanan ($H'=1.91$). Presence of wide variety of plant species and diverse flora in the study sites as the study sites being artificially established with attractive flowers and other plantations favored the attraction of several pollinators (Rajah et al. 2019). But Evenness value showed that none of the sites had an even distribution of species. The study also shows an almost equal level of diversity at Vivekananda Kanan and Gopal Kanan as both the areas were located within a distance of 2 km.

Further the results suggest that the study site 1 (Nature Park) being a rural to semi-urban area holds much more diversity and abundance of species compared to the study sites 2 (Vivekananda Kanan) and 3 (Gopal Kanan) which are comparatively urbanized areas. This suggests that urbanization has led to loss of diversity of butterflies.

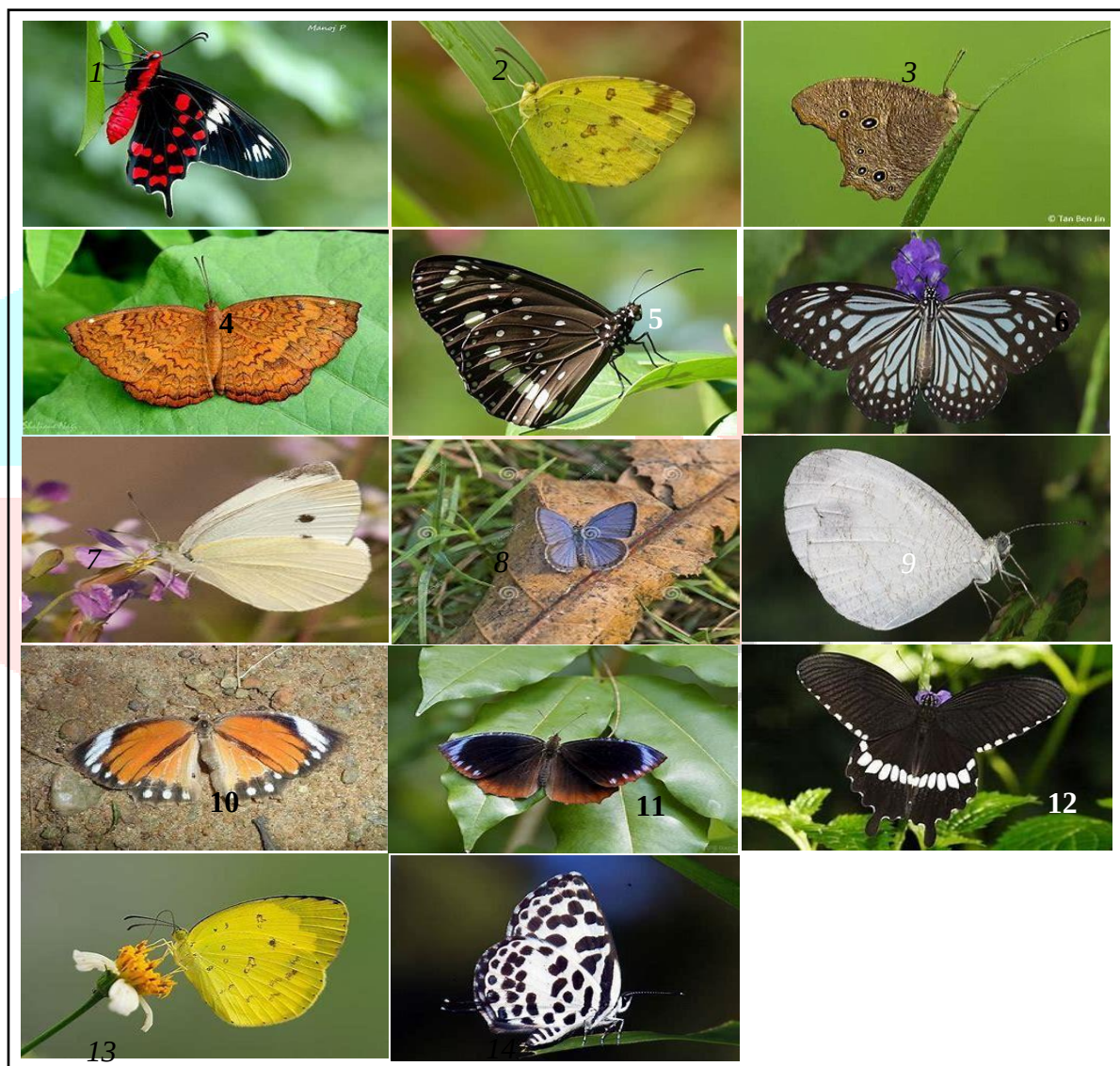


Figure 5: Pictorial presentation of butterfly species found during the study: 1.Crimson Rose (*Pachliopta hector*) 2.Tree Yellow (*Gandaca harina*) 3.Common Evening Brown (*Melanitis leda*) 4.Angeled Castor (*Ariadne Ariadne*) 5.Common Crow (*Euploea core*) 6.Glassy Tiger (*Parantica aglea*) 7.Cabbage White (*Pieris rapae*) 8.Little Grass Blue (*Zizula hylax*) 9.Psyche (*Leptosia nina*) 10.Common Palm Fly (Female) (*Elymnias hypermnestra agina*) 11.Common Palm Fly (Male) (*Elymnias hypermnestra*) 12.Common Mormon (*Papilio polytes*) 13.Common Grass Yellow (*Eurema hecabe*) 14.Common Pierrot (*Castalius rosimon*)

8. CONCLUSION

The areas under study represent well known examples of man-made ecosystems. The study was performed in three sites Nature Park, Vivekananda Kanan and Gopal Kanan from February to May 2024.

A total of 14 butterfly species were found in Nature Park. The most abundant being the Cabbage White, Common Crow, Common Palmfly (both male and female), and Common Grass Yellow. The family Nymphalidae and Peridae were found to be the most abundant of the species. The Nature Park revealed average butterfly diversity in the area being supported by the Shannon diversity index (2.42). The evenness (0.35) of the area was semi-balanced. The Vivekananda Kanan had a total of 9 butterfly species and the Common grass yellow, Cabbage White and Little Grass Blue was recorded the most abundant species. The family Pieridae, Nymphalidae and Lycaenidae was observed as the most frequent. The Vivekananda Kanan showed lower butterfly diversity in the area being supported by the Shannon diversity index (1.94). The evenness (0.31) of the area was semi-balanced. The Gopal Kanan had a total of 8 butterfly species and the Common Grass Yellow and Cabbage White being most abundant of all the species. The family peridae was observed as the most frequent. The Gopal Kanan showed lowest butterfly diversity in the area being supported by Shannon diversity index (1.91). the evenness (0.31) of the area was semi- balanced.

Concluding, in all the study sites the human disturbances, high decibel sound of picnic group, pollution etc. may have disrupted the biodiversity causing reduction in the number of species. It can also be estimated that due to Nature park being at a much quite locality shows comparatively higher number of species than the other two sites which are located just beside the major city roads.

9. REFERENCES

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