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Biodiversity Indices Pattern of Butterfly in Nasik District (M.S.) India

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Abstract: Due to their high sensitivity to pollution, butterflies have been considered as bio-indicators to gauge the degree of pollution. In addition to being an essential link in the food chain, they play a crucial role in the pollination of many blooming plants. Many different butterfly species are attracted to various plant species and environments in the Nashik area. The goal of the current study was to count the diversity and abundance of butterflies. The study was conducted in Nashik from January 2021 to December 2021. A review of literature throws light on the importance of butterfly diversity. We have therefore surveyed to know butterfly diversity in Nashik locality by using quantitative techniques. The data was analyzed to understand α and ß diversity. K.G.D.M. College campus, Trimbakeshwar, Nandur Madhyameshwar, Vani, and Lasalgaon are the five sites selected for butterfly study. The aims and objective of the study diversity of butterflies are to understand the taxonomic status of butterflies from the study area to see if there was variation in the butterfly community across various sites and to study seasonal distribution, abundance patterns in the butterfly community and diversity indices patterns.

Keywords: Biodiversity indices, Abundance, Bio-indicator, Endemic species, Landscape, Pollinators, Butterfly

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Introduction

To preserve biodiversity and the ecosystem, it is necessary to safeguard butterflies, one of the most unique and fascinating insect groups. Due to the presence of a variety of habitats, a wide range of altitudinal gradients, and associated microclimatic regimes, the butterfly fauna of the southern half of the Indian peninsula is far more abundant and diversified than that of other regions of the peninsula. India has a tropical temperature, a variety of physical features, and habitation patterns that are ideal for supporting a wide range of butterfly fauna (Venkataramani, 1986).

The scaly-winged insects belong to the Order Lepidoptera, which includes butterflies and moths.

Scaly wings distinguish both of them. The antennae of butterflies are rounded. Moths do not have clubbed antennae. It could have thread-like or branched antennae that occasionally have hairy outgrowths covering them (Aluri, 2002). When butterflies are at rest, they fold their wings over and hold them straight. They are folded in the same plane as the body by moths, which also spread them flat. Butterflies are undoubtedly the most well-known and prominent category of insects. They play an important role in ecosystems, and their abundance and variety are thought to be reliable indicators of the condition of any particular terrestrial biotope (Kunte, 2007).

The rich diversity of butterflies indicates good health in a particular habitat as butterflies are host specific. The aesthetic value of butterflies is enormous. They must be preserved because they are aesthetically pleasing and colorful and are a part of the nation's heritage. Lepidoptera, which includes butterflies and moths, provides an excellent opportunity for studies on population and community ecology. As a group, the silk strands support the butterfly pupae, which may hang freely or form a "body band." They occasionally occur among leaf litter but are typically found on plants, usually under a leaf or twig. A "body band" is not used to support moth pupae (Kunte, 2007).

Many species of butterflies are purely seasonal and have a narrow range of habitat preferences. Even still, studies on the community structures, population dynamics, and eco-climatic factors that affect butterflies are scarce and often ignored by community ecologists. They are useful for formulating conservation plans since they are good indicators of climatic conditions as well as seasonal and ecological changes. However, both conservation biologists and decision-makers have mostly ignored them. Therefore, it is promising that programs for prioritizing biodiversity conservation now include research on butterflies (Pollard and Yates, 1993).

Butterfly species are the greatest class of insects to study patterns of biodiversity, according to insect ecologists. These insects are crucial to the economy. Along with essential pollination services, they also contribute significantly to the food chains of birds, reptiles, spiders, and predatory insects. Due to their tight dependence on plants, butterflies are a delicate biota that is greatly impacted by changes in the environment and the structure of the forest. Even though the Western Ghats only account for about 25% of India's total butterfly variety, it is notable for having high alpha diversity of butterflies in several areas. They are extremely quick to respond to any disturbance and changes in habitat quality, making them useful indicators for analyzing variations in habitat and landscape structure (Gaonkar, 1996).

Butterflies of the Indian Region, published by Wynter-Blyth (1957) contained a detailed account of the ecology and biology of Indian butterflies with good coverage for species from the Western Ghats. Gaonkar (1996) studied butterflies of Western Ghats and recorded 17 additional species from Kerala, Tamilnadu, and the Karnataka region of Western Ghats. Recently, Gunathilagaraj *et al*. (1998) published a book on the butterflies of south India.

Kunte (2000) studied Butterfly diversity in Pune city along the human impact gradient. Further, he has published a book, "India - a life scape: Butterflies of Peninsular India". Geetha *et al*. (2004) studied patterns of diversity and distribution of butterflies from the Western Ghats in which they studied the Nashik region. Season and landscape-wise distribution of butterflies in Tamhni has been reported by Padhye *et al.* (2006). The review on butterflies has been published by Isaac Kehimkar (2008).

We have therefore surveyed to know butterfly diversity in Nashik locality by using quantitative techniques. The data was analyzed to understand α and ß diversity. K.G.D.M. College campus, Trimbakeshwar, Nandur Madhyameshwar, Vani, and Lasalgaon are the five sites selected for butterfly study. The aim and objective of the study

was to understand the taxonomic status and diversity of butterflies from the study area to see if there was variation in the butterfly community across various sites and to study seasonal distribution, abundance patterns in the butterfly community and diversity indices patterns.

Materials and Methods

Study area and site selection:

Nashik district is lying between 19°35 and 20°52' North latitude and 73°16 and 74°56 East latitude (Fig. 1). The climate of this district is characterized by dryness except in the southwest monsoon season. K.G.D.M. College campus, Trimbakeshwar, Nandur Madhyameshwar, Vani, and Lasalgaon were the five sites selected for butterfly study from this region.

Data collection:

Data were collected during January 2021 to December 2021 through two sampling methods, a random survey was done to record butterfly species and the line transect method was used to study the diversity of butterflies. During the early morning hours, random surveys using every search strategy were used to compile data on the butterfly fauna. Identification of the butterflies was primarily done directly in the field and by using standard reference materials. We could observe 56 species belonging to 48 genera.

Five lines of transacts were walked at a constant pace for approximately half an hour. Transact were walked between 8 am to 11 am when butterflies were more active. These transact were walked twice every month for each site to record the sighting of butterfly species along each transact. Butterflies were identified in the field itself with the help of a standard reference book. Those species which were difficult to identify were captured with the help of a butterfly net, observed, photographed, and released. Some voucher specimens were brought to the laboratory and preserved which were difficult to identify in the field. Pauses were made at sites with high butterfly activity until all the individuals were recorded in the datasheet.

Statistical Analysis:

Shannon index H': Species diversity was calculated using the Shannon Index, which combines the number of species within a site with the relative abundance of each species (Shannon 1948; Magurran, 1988, Odum, 1997; Krebs, 1989).

$$H\text{--}\Sigma piin\ pi$$

Where pi is the proportion of the i-th species in the community and their evenness in abundance (or equitability) are the two parameters that define H'.

Pielou's Evenness index (Equitability) or J': The species' evenness is the relative abundance or proportion of individuals among the species. The evenness of species reveals how their relative abundance is distributed in a particular sample or site (Pielou's, 1969; Magurran, 1988).

$$J\text{-}H/In\ S$$

Where S is the number of species present on the site. The value of J' ranges from 0 to 1.The less in communities between the species, the higher the value of J.

Sorensen's Similarity Index:

$$B=2c/(S1+S2)$$

Where SI= the total number of species recorded in the first community, S2= the total number of species recorded in the second community, and c = the number of species common to both communities. The Sorensen index (Sorensen, 1948) is a very simple measure of beta diversity, ranging from a value of 0 where there is no species overlap between the communities, to a value of 1 when the same species are found in both communities.

Results and Discussion

The study revealed the presence of 56 species belonging to five families and 48 genera from all five sites during sampling surveys. Out of the recorded species family, Nyphalidae is the most dominant species followed by Pieridae, Lycaenidae, Papiliniodae and Hespiridae. The

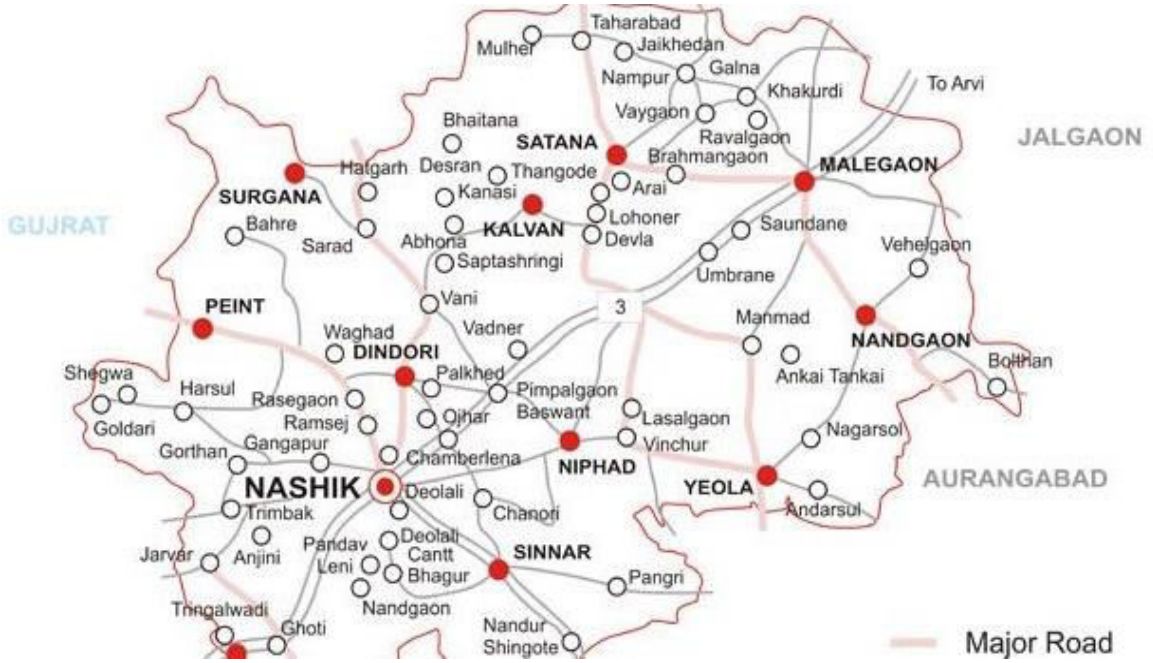

Fig. 1: Map showing location of Nashik.

maximum number of species, as well as a maximum number of individuals, was recorded post- monsoon i.e. in October and November and minimum in April and May.

In the present study, we recorded 56 species of butterflies from 5 families. These are-- family Papiliniodae which showed 7 species [*Pachliopta aristolochiae* (Fabricius, 1775); *Pachliopta hector* (Linnaeus, 1758); *Graphium agamemnon* (Linnaeus, 1758); *Graphium doson* (C. & R. Felder, 1864); *Papilio demoleus* Linnaeus, 1758; *Papilio polytes* Linnaeus, 1758; *Papilio polymnestor* Cramer, 1775]; family Pieridae showed 12 butterfly species [*Catopsilia pomona* (Fabricius, 1775); *Catopsilia pyranthe* (Linnaeus, 1758); *Eurema brigitta* (Cramer, 1780); *Eurema hecabe* (Linnaeus, 1758); *Eurema laeta* (Boisduval, 1836); *Eurema blanda* (Boisduval, 1836); *Delias eucharis* (Drury, 1773); *Leptosia nina* (Fabricius, 1793); *Cepora nerissa* (Fabricius, 1775); *Ixias marianne* (Cramer, 1779); *Ixias pyrene* (*Linnaeus*, 1764); *Pareronia valeria* (Cramer, 1776); *Anaphaeis aurota* (Fabricius, 1793). Family Nymphalidae is the largest family of the butterfly which showed 24 species these are -- *Melanitis leda* (Linnaeus, 1758); *Mycalesis perseus* (Fabricius, 1775); *Ypthima baldus* (Fabricius, 1775); *Ypthima huebneri* Kirby, 1871; *Acraea violae* (Fabricius, 1793); *Phalanta phalantha* (Drury, 1773); *Neptis hylas* Moore, 1872; *Athyma perius* (Linnaeus, 1758); *Euthalia aconthea* Cramer, 1779; *Charaxes solon* Fabricius, 1793; *Ariadne ariadne* (Linnaeus, 1763); *Ariadne merione* Cramer, 1779; *Junonia lemonias* (Linnaeus, 1758); *Junonia almanac* (Linnaeus, 1758); *Junonia lemonias* (Linnaeus, 1758); *Junonia orithya* (Linnaeus, 1758); *Junonia hierta* (Fabricius, 1798); *Precis iphita* (Cramer, 1779); *Cynthia cardui* (Linnaeus, 1758); *Hypolimnas misippus* (Linnaeus, 1764); *Hypolimnas bolina* (Linnaeus, 1758); *Tirumala limniace* (Cramer, 1775); *Danaus chrysippus* (Linnaeus, 1758); *Danaus agenutia* (Cramer, 1779); *Euploea core* (Cramer, 1780); *Parantica aglea* (Stoll, 1782); *Byblia ilithyia* Drury, 1773; *Kallima horsfteldii* Kollar, 1848. Family Lycaenidae represented by 9 butterflies these are – *Castalius rosimon* (Fabricius, 1775); *Caleta elna* (Hawiston, 1876); *Tarucus nara* Kollar, 1848; *Jamides celeno* (Cramer, 1775); *Pseudozizeeria maha* (Kollar, 1844); *Freyeria trochylus* (Freyer, 1844); *Euchrysops cnejus* (Fabricius, 1798); *Abisara echerius* (Stoll, 1790); *Curetis thetis* (Drury, 1773);

Zizula hylax (Fabricius, 1775); *Spindasis vulcanus* (Fabricius, 1775); *Talicada nyseus* (Guérin-Méneville, 1843). Family Hespiridae exhibited 4 butterfly species which are--*Borbo cinnara* (Wallace, 1866); *Hasora chromus* (Cramer, 1780); *Udaspes folus* (Cramer, 1775); *Telicota ancilla* (Herrich-Schäffer, 1869). Annual average population density of Butterfly in KGDM College was 12.83±8.23, in Nandur Madhmeshwar 14.71±9.26, in Trimbakeshwar 17.77±8.075, in Vani 11.89±9.61 and in Lasalgaon 9.16±9.54 (Table 1).

Triambakeshwar has the most diversity with 55 out of 56 species recorded in the current study. The minimal diversity in the Lasalgaon region is 39 species out of 56, and the Shannon index is 3.8501. Most species were discovered in Trimbakeshwar, which has a higher host plant availability score of 0.9225, and in Lasalgaon, which has a lower host plant diversity score of 0.9217. Pielou's Evenness index-J' of all the five locations that were chosen displays a greater value reflecting the even distribution of species in each area (Table 2).

Shannon index was highest in Trimbakeshwar and it is lowest in Lasalgaon due to less species richness. Fewer species were recorded from the Lasalgaon area, this could be because it is mainly an agricultural area and it is under the high influence of human interference. Less availability of host plants could be the reason for less number of species. The highest numbers of species were recorded from Trimbakeshwar indicating more host plant availability. Pielou's Evenness index-J' of all the selected five sites shows a higher value indicating the even distribution of species in the respective areas.

Diversity Index, Simpson's index (λ) which varied from 0 to 1, gives the probability that two individuals drawn at random from a population belong to the same species. If the probability was high that both individuals belong to the same species, then the diversity of the community sample was low. Shannon's index (H'), combines species richness and species evenness components as one overall index of diversity. The higher value of Shannon's Index (H'), indicated greater species diversity. The greater species diversity means a larger food chain and more cases of inter-specific interactions and greater possibilities for negative feedback control which reduced oscillations and hence increases the stability of the community.

As compared to 42 species recorded from the same area by Geetha *et al.* (2004), the present study observed 56 species belonging to 48 genera. However, we could not observe 12 species recorded by Geetha *et al.* (2004), but could record 26 additional species. The seasonal distribution pattern showed two peaks of species richness and Shannon diversity index, one in summer and the other in the post-monsoon season. This observation is supported by Padhye *et al*. (2006) in their study of the season and landscape-wise distribution of butterflies in Tamhini, Northern Western Ghat. The same observation is contradictory with Kunte (2000), who studied four tropical habitationsin Northern Western Ghats. Kunte (2000) reported no evidence of a peak in summer, however two peaks, 1st peak in late monsoon and 2nd in winter. Data reveal more species richness in October and November.

The most abundant species in all the five sites were common grass yellow and small grass yellow. The species which were rarely sighted were Blue Mormonand Black raja. Few species that were recorded during the random survey but could not be sighted during transacting.

Sorensen's Similarity Index - B was highest between K.G.D.M. College and the Nandur Madhmeshwar area. This could be because both the sites are located very close, so there is very much similarity in the habitat and they include almost the same species.

Conclusion

The present study will help in designing the conservation strategy of the study area. The presence of particular species in an area helps analyze the host plant's diversity. Total of 56

species of butterflies belonging to five families and 48 genera from all the five sites of the Nashik region. Variation in the butterfly community was observed across different sites. Butterflies were

Table 1: Annual average population densityof Butterfly in different sites at Nashik

S. No.	Common name	KGDM College	Nandur Madhmeshwar	Trimbakeshwar	Vani	Lasalgaon
1	Common rose	11±5	14.66±8.73	16.33±8.32	13.33±4.72	11.66±6.65
2	Crimson rose	7.66±4.04	13±5.19	15±10.53	15±7.54	0±0
3	Tailed jay	26±3.46	22±7.21	21.66±7.63	19.66±8.32	21±7.93
4	Common jay	14.66±11.71	12±12.16	12.66±13.31	11±7	0±0
5	Lime Butterfly	17.33±4.61	20.66±11.06	21.66±7.50	23±13.89	18±9.16
6	Common Mormon	26.66±13.65	29±14.93	28.66±14.74	26.33±14.36	23.33±12.05
7	Blue Mormon	4±3.60	2±2.64	2.33±2.08	5±3.46	0±0
8	Common Emigrant	26.33±13.27	27.33±16.07	29.66±17.38	27.33±17.47	26.66±12.50
9	Mottled Emigrant	23±14.10	23.66±5.68	25±7.21	19±13.74	21.33±12.66
10	Small Yellow Grass	25.66±9.29	31.66±18.00	32±18.02	0±0	27.33±10.11
11	Common Grass Yellow	26.33±13.31	35±11.53	36.66±21.73	27.66±9.60	24.33±11.84
12	Spotless Yellow Grass	14.33±7.02	16±9	18.33±6.11	0±0	0±0
13	Three Spot Grass Yellow	7±2.64	11.33±5.50	13±8	0±0	0±0
14	Common Jezebel	16.66±7.57	18.66±8.73	20.33±8.02	16.33±7.23	12.66±7.09
15	Psyche	7.66±3.21	9±5.29	12.33±10.01	7.33±5.03	8.33±4.61
16	Common Gull,	17.33±6.11	22.66±12.05	24.66±8.504	22.33±7.63	16±9.53
17	White Orange Tip	16.33±7.23	18.66±12.05	20±10.44	18.66±11.01	0±0
18	Yellow Orange Tip	5.33±3.05	7.33±6.02	10±5.56	8.66±3.21	0±0
19	Pioneer	18±10.58	23.66±10.40	25.66±14.74	27.66±16.28	0±0
20	Common Evening brown	13±7.54	17.66±6.65	18.33±8.14	19.66±5.85	17±7.21
21	Common Bushbrown	6±4	7.33±2.08	9.66±3.78	10.33±5.13	3.33±2.08
22	Five Common ring	9±6.24	10±3.60	11.67±5.77	12±5	9.66±6.65
23	Four Common ring	4.66±2.30	8.66±4.16	10±6.55	9.66±6.11	2.66±3.05
24	Tawny Coster	13.66±7.57	18.66±7.50	23±6.24	0±0	0±0
25	Common Leopard	19.66±9.07	25.66±5.85	27.33±8.62	0±0	0±0
26	Baronet	5.66±2.08	11.33±4.61	11±5.29	7.66±3.51	0±0
27	Common Sailor	7.66±5.13	11±7	14±11.13	13±8.88	0±0
28	Angled Castor	20.66±10.26	18.33±10.11	28.66±10.69	17±7.81	20±10.14
29	Common Castor	19.66±9.29	18.33±7.57	22±10	14.66±6.02	21±9.53
30	Blue Tiger	13.66±6.80	17±10.53	21±13.89	14.33±9.50	12.66±6.80
31	Plain Tiger	23.66±10.40	27.66±12.05	32±13.07	26.66±13.01	24±11.53

32	Striped Tiger	12±7.93	0±0	16.33±7.50	14±6.92	0±0
33	Common Indian Crow	9.66±0.57	12±6.55	12±5.56	10.33±4.50	10±3.60
34	Black Rajah	1±1.73	0±±0	6±3.60	0±0	0±0
35	Lemon Pansy	29.33±9.01	30.66±14.22	26.33±4.93	29.66±6.65	22.66±10.21
36	Blue Pansy	14.66±9.45	19.33±8.96	23.33±12.89	19±7.81	0±0
37	Yellow Pansy	16.66±8.32	16.33±6.02	19.66±10.40	17.66±9.29	17.66±9.29
38	Chocolate Pansy.	13.33±5.13	16±6.55	17.33±10.59	15.66±9.07	0±0
39	Danaid Eggfly	25.33±11.50	27.33±13.50	26±12	27.66±10.21	24.66±10.01
40	Great Eggfly	23.67±10.69	28.66±11.15	27.66±10.96	26±6.55	23±7.54
41	Angled Pierrot	7.66±3.51	10.66±7.57	4.33±7.50	9.33±4.04	6.66±3.51
42	Rounded Pierrot	13.33±6.02	14.66±7.50	18±8.71	7.33±3.05	12.66±5.50
43	Common Cerulean	13±7	16.66±7.50	21.66±10.06	0±0	0±0
44	Pale Grass Blue	6±3.67	8.66±4.72	9±5.29	0±0	7±5.56
45	Gram Blue	7.33±4.72	9.66±4.72	12.33±3.78	0±0	7.66±4.04
46	Tiny Grass Blue	22±9.53	22.33±12.09	0±0	25.33±12.58	23.33±18.0
47	Red Pierrot	9.66±3.78	14±7.54	15±9.53	0±0	7.66±4.72
48	Rice Swift	10.66±6.50	0±0	18±10.39	0±0	14±8.66
49	Common Banded Awl,	5.33±3.05	4.33±3.05	5.33±4.04	0±0	0±0
50	Grass Demon	6.66±4.04	9±3.60	12±3.60	7±3.60	9.66±5.85
51	Dark Palm Dart	3.33±3.05	6.33±2.51	7.66±4.04	4.33±2.88	5.33±3.51
52	Common Barom	0±0	7.33±5.77	10.66±4.72	8.66±5.50	0±0
53	Painted lady	0±0	0±0	19±11.53	10.66±6.65	0±0
54	Grey pancy	0±0	0±0	17.66±11.50	0±0	0±0
55	Common Pierrot	0±0	0±0	12±8.54	0±0	0±0
56	Plum Judy	0±0	0±0	23.66±12.01	0±0	0±0
Average Total		**12.83±8.23**	**14.71±9.26**	**17.77±8.075**	**11.89±9.61**	**9.16±9.54**

Table 2: Annual variations of Butterfly population andbiodiversity indices at Nashik

S. No.	Name of Site	Species recorded	Shannon index – *H'*	Pielou's Evenness index – *J'*
1.	K.G.D.M College	54	3.7290	0.9348
2.	Nandur Madhmeshwar	53	3.7147	0.9356
3.	Trimbakeshwar	55	3.8501	0.9225
4.	Vani	45	3.5607	0.9354
5.	Lasalgaon	39	3.3768	0.9217

more common in post-monsoon period i.e. in October and November in the study area. The study revealed significant variation in butterfly species distribution, richness, and diversity in different habitats in the Sanctuary due to the existing or changing pattern of vegetation and environmental conditions. It is observed that butterflies are sensitive to the changes in the habitat and climate, which influences their distribution and diversity. Observations suggest that butterfly species diversity generally increases with an increase in vegetation. Hence, the study on the diversity of butterflies contributes to taking conservation measures. The host plants are crucial

for maintaining butterfly diversity. It is vital to conserve them and their landscapes. This type of study could contribute to educating the younger generation about the importance of identification, documentation, and conservation of butterflies and their host plants. Therefore, further studies on the ecology and diversity of butterflies with special reference to their host plants and factors that affect their distribution, diversity, and abundance will be recommended.

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