



Comparative Study of the Butterfly Diversity and Species

Richness in North Maharashtra India

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DOI - 10.5281/zenodo.10043236

Abstract:

Bioindicators like butterflies must be conserved to maintain biodiversity and the environment. From June through July, species abundance in North Maharashtra rose, peaking in August and September. Species declined from December to May. Random sampling and line transect analyzed northern Maharashtra butterfly diversity. In this research, Papilionidae, Pieridae, Nymphalidae, Lycaenidae, and Hesperidae butterfly species were found. Nymphalidae, Lycaenidae, Pieridae, Papilionidae, and Hesperidae dominate the present analyses. The research found 95 species in Nashik, 80 in Dhule, 77 in Jalgaon, and 90 in Nandurbar. Four northern Maharashtra districts have comparable butterfly diversity. Nashik has the most butterflies, showing a significant biodiversity. Behavioral abnormalities including basking, unpalatability, mimicry, sexual dimorphism, seasonal dimorphism, polymorphism, and polyphenism were studied alongside diversification studies. Habitat deterioration will persist. Population dynamics study is needed. Recording the North Maharashtra butterfly species can help preserve it.

Keywords: *Butterfly Diversity, North Maharashtra, Statistical Analysis.*

Introduction:

Insects are the most frequent class of living things on Earth, both in terms of the ecological role they play (insects are responsible for half of all known species) and the taxonomic diversity they display. Insects make up the vast bulk of species throughout almost all different types of environments. Within the realm of insects, the butterfly has proven to be an excellent representative species for conservation

efforts. Butterflies are a type of insects that are well-known for both their capacity to adjust to their environments and the wonderful colours and patterns that can be seen on their wings. Butterflies are also known as "flying flowers." Because of India's very varied geography, climate, and vegetation, the country is home to an exceptionally large range of plant and animal species. There are about 1,501 different species of butterflies in India (1-

3). These butterflies are from five different families, including the Papilionidae, Pieridae, Lycaenidae, Nymphalidae, and Hesperidae. Of these species, 350 can be found in peninsular India, while 333 can be found in the Western Ghats alone. Due to the fact that they are very sensitive to any kind of change that may occur in their environment, butterflies are considered to be excellent biological indicators. As a consequence of this, the variety of butterfly species present in an area is a good indicator of the state of the ecosystem there (figure a). In addition to having a diverse range of flora, temperature, and geography, the Indian subcontinent is home to 1,504 distinct species of butterflies. There are 336 of them in all in the Western Ghats and Peninsular India (4).

Kharat et al. (2018) used line transects and random surveys as the research approach for their work in order to investigate and explain the diversity of butterfly species that can be found in North Maharashtra, which includes the Nashik District. They discovered 91 different species of butterflies in North Maharashtra. These butterflies belonged to 65 different genera and 5 different families, which included the Papilionidae, Pieridae, Nymphalidae, Lycaenidae, and Hesperidae families. In their study, Gurule et al. (2012) looked at the distribution of several kinds of butterflies in the Nashik and Dhule districts (5). A total of 88

species were divided across five classifications and 61 families or genera. An investigation was conducted on the alpha and beta variety of the data. The diversity index in Nashik District is 1.5361, which is greater than the diversity index in Dhule District, which is 1.4123. The value of 0.8266 that Sorenson found to be the similarity index between the two areas demonstrates that there is less diversity in the types of butterflies. In recent years, a number of researchers have been focusing their attention on butterflies in the protected areas, rural areas, and urban areas in North Maharashtra. This research was initiated with the intention of examining the many different kinds of butterflies that may be found in north Maharashtra. because the butterfly checklist for this tehsil has not been kept up to date. This study may provide light on the existing status of butterflies that are found in a tehsil and provide a foundation for future research by laying the foundations for further inquiries (6, 7).

Literature Review:

According to Whitaker and Captain (2008), there are around 10 million unique species that may be discovered on earth, making it a very varied location. This diversity is essential to the continued existence of ecosystems (8). Those aspects of a species that give it the capacity to provide people with goods and services of a material kind. Studies of a species'

diversity at a regional level make it possible to evaluate the species' potential value (9). According to this theory, it is essential to investigate the diversity of species if one want to comprehend how the presence of humans impacts the consistency and viability of an ecosystem. Several studies of Koh and Sodhi, (2004) have shown that insects provide ecological services in both terrestrial and aquatic habitats (10). These services include pollination, the control of pests, the breakdown of nutrients, and the preservation of species. Insects perform these functions in both environments. Insects, and butterflies in particular, are among the most intriguing animals that can be found on our planet. They play a very important role in the process of pollination (11). As adults, butterflies feed on nectar and pollen, but caterpillars need the leaves of certain host plants in order to develop properly (12). Both Thomas (2005) and Bonebrake et al. (2010) assert that butterflies are among the finest indicators of the overall health of any specific terrestrial ecosystem (13, 14). Butterflies, because of their significance as a model group, have been the subject of a significant amount of research for the purpose of gaining insight into ecological and conservation concerns. In this particular environment, the preservation of butterflies is essential to maintaining the uninterrupted supply of a number of ecosystem services that are essential to the

well-being of humans. The objective of the researchers that participated in this study was to produce a numerical figure for the abundance of butterfly species in the Isapur Wildlife Sanctuary, which is located in the state of Maharashtra in India (15). This was done to assist in the management of conservation activities so as to better take into account the important function that insects play in the upkeep of healthy ecosystems. It is intended that the results of this research will enhance the ecological functions that are performed by butterfly species in the northern Maharashtra Wildlife Sanctuary and the areas around it. Not only will these findings help with conservation efforts, but it is also hoped that they will improve these roles (13-15).

Material and Methods:

Study Area:

From 2020 to 2023, a quantitative survey of butterfly diversity was conducted in North Maharashtra. Four districts comprise North Maharashtra: Nashik, Dhule, Jalgaon, and Nandurbar (Figure b). This area is bordered on the north-west by Gujarat's Dang forest, on the north by Madhya Pradesh, on the east by the Marathawada region, on the south by the Ahmednagar district, and on the south-west by the Thane district. It stretches from 18⁰ 33' to 21⁰ 61' north and 73⁰ 16' to 76⁰ 28' east and covers 4⁰,346 square kilometers. A total of 44 locations

were chosen from the complete survey area (Table a).

Butterfly Collection:

If necessary, a specimen net was used in the collecting process to gather the butterflies. For identification, the collected specimens were narcotized by adding menthol crystals to the vial (16-18). Using photography, the most butterflies possible were captured. In Nashik city; four sample locations were chosen for the current research viz. The gathered butterflies have now been moved to a killing jar (Figure c).

Determination of Abundance:

The species were further classified into four categories based on their frequency in the study area: Very Common (VC), Common (C), Not Rare (NR), and Rare (R). Any species with a count of fewer than ten was categorized as rare, those with a count of ten to fifteen as not uncommon, those with a count of fifteen to twenty as common, and those with a count of more than twenty as extremely common (19, 20).

Identification of the Butterfly Species:

The identification of the butterfly species in the field was confirmed using identification keys such as Haribal, 2003, Kunte, 2008, and periodic photographs. Species of plants were identified using the available literature (21, 22). Events of opportunistic sampling that occurred in other areas of the campus were also recorded and considered for the research.

The research was conducted between November 2020 and June 2023.

Statistical Analysis:

Shannon index - H':

The Shannon Index, which takes into account the number of species and relative abundance of each species within a location, was used to calculate the diversity of the alpha species.

$$H' = - \sum_{i=1}^R p_i \ln p_i$$

H' is defined by two parameters: the proportion of the species in the community (p_i) and their abundance distribution (or equity).

Pielou's Evenness index (Equitability) or J':

The relative number or percentage of individuals within the species determines its evenness. The evenness of a species reflects the distribution of that species' relative abundance within a given sample or area (16).

$$J' = H' / \ln S$$

Here, S represents the number of species at the site. The value of J' varies between 0 and 1.

Sørensen's Similarity Index:

With values ranging from 0 (no species overlap) to 1 (exactly the same species are found in both groups), the Sørensen's index is an easy-to-use indicator of beta diversity.

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

Here, S1 represents the total number of species registered in the first

community, S2 represents the total number of species recorded in the second community, and c represents the total number of species shared by both communities.

Bray Curtis similarity index:

The percentage of similarity was determined using the Bray-Curtis similarity index, which took into account both the existence or absence of species and the number of individuals belonging to each species. Dendrograms were developed to understand patterns in certain districts (23).

Margalef's species richness index:

To assess species richness across seasons and landscape components, Margalef created the species richness index. The formula is used to calculate the index,

$$R = (S-1) / \ln N$$

Here S is the number of species; N is the total number of individuals.

Berger-Parker index:

This index tells the proportion of the most dominant species in a given site) (24).

$$\text{Berger-Parker index} = n_{\max}/N$$

Here n_{\max} is the abundance of the most dominant species and N is the total abundance in the given site. Identification of species was done using the standard reference literature.

Result and Discussion:

On the college campus, the major purpose of the research was to amass

fundamental information on the variety of butterfly species and the resources available to them, such as plants that cater to butterfly larvae. There is a strong connection between the variety of native species and their high population density and the availability of edible plants. At the location of the study, researchers found a rather large number of edible plant species. The region known as North Maharashtra is home to 91 different species of butterflies, as well as 65 different genera and five different families of butterflies: Papilionidae, Pieridae, Nymphalidae, and Lycaenidae. There were 91 species total, with 34 belonging to the family Nymphalidae, 26 to the family Lycaenidae, 18 to the family Pieridae, and 7 to the family Papilionidae. It was found that the Hesperidae family only has six different species total.

The district of Nashik has recorded 95 species, whereas the district of Dhule has recorded 80 species, the district of Jalgaon has recorded 77 species, and the district of Nandurbar has recorded 90 species. The following is a statistical analysis of the data on butterfly diversity that was collected from four different districts and is shown in the table and figures. Under the Indian Wild Life (Protection) Act of 1972, twelve of the 91 species that have been reported in North Maharashtra are given protection from extinction. *Castaliusrosimon*, you are Europe's Lethe. *Hypolimnas misippus* was

placed in the act's schedule I as an organism of concern.

The Wild Life Protection Act of 1972 identifies the species *Hypolimna smisippus*, *Appias albina*, *Jamidesalecto*, *Spindasiselima*, *Ceporanerissa*, *Pareronia valeria*, *Euchrysopsenejus*, *Lampidesboeticus*, and *Jamidesceleno* as being protected under Schedule II. The Wild Life Protection Act includes the *Euploea* core species on its Schedule IV list of endangered and threatened species. This reveals that there is a rich variety of butterflies in the region that was researched, including some species that are protected, and as a result, there is an urgent need to alter conservation strategies.

Shannon Index- H' :

The Shannon diversity index was used to calculate the diversity of Alfa (Table b). This index was above 4 during the study period, except in the district of Nandurbar, where it was below 4 in 2020. However, the Shannon diversity index was highest in the district of Nashik and lowest in the district of Dhule. This is due to the fact that Nashik district records the greatest number of butterfly species during the study period.

Pielou's Evenness index: (Equitability)

or J' :

The Pielou's evenness index (Table c) for four North Maharashtra districts was greater than 0.9, indicating less variation, i.e., less uniqueness and uniform

distribution of butterflies throughout the region. North Maharashtra's predominant vegetation type is a tropical moist deciduous forest interspersed with shrub jungle and bamboo. This demonstrates that the butterfly diversity in all four study districts is comparable.

Margalef's sp. richness index:

The species richness index of Margalef (Table d) has an exceptional capacity for discrimination. It quantifies the number of species for a given number of individuals. The Margalef sp. richness index was observed to be highest in 2020, followed by 2021 and 2022 for each district. This is because more individuals were recorded in 2020, followed by 2021 and 2022-23, respectively. Since 91 species were recorded in Nashik District, Margalef's index of species richness is highest in this district. Due to the disparity in area between Jalgaon and Dhule, the Margalef index for Jalgaon was lower than for Dhule, despite the fact that Jalgaon had a greater number of species recorded.

Sørensen's Similarity Index: β :

All four districts' qualitative Sorensen Similarity indices (table e) have values greater than 0.9. This index's high value indicates low beta diversity, i.e., less uniqueness in the butterfly diversity of North Maharashtra. The districts with the highest Sorensen Similarity index were Dhule, Nandurbar, and Jalgaon, indicating greater similarity between these districts.

Berger-Parker index: n_{max} / N :

In Dhule and Nandurbar district, the Berger-Parker index was high (Table f), indicating an increase in diversity and a decline in dominance. Dhule is the district with the highest Berger Parker index. This index was lowest in the district of Nashik, indicating a decline in diversity and an increase in dominance.

Bray Curtis similarity index:

Dendrograms (figures d, e, f) were generated utilizing a quantitative Similarity index, i.e. the Bray Curtis index. Jalgaon, Dhule, and Nandurbar districts constitute a cluster, indicating that butterflies from these districts share a similar diversity. Nashik alone creates a distinct cluster, indicating a slightly different butterfly assemblage.

Figures and Tables:

Figures :



Figure (a) Diversity of butterflies in North Maharashtra

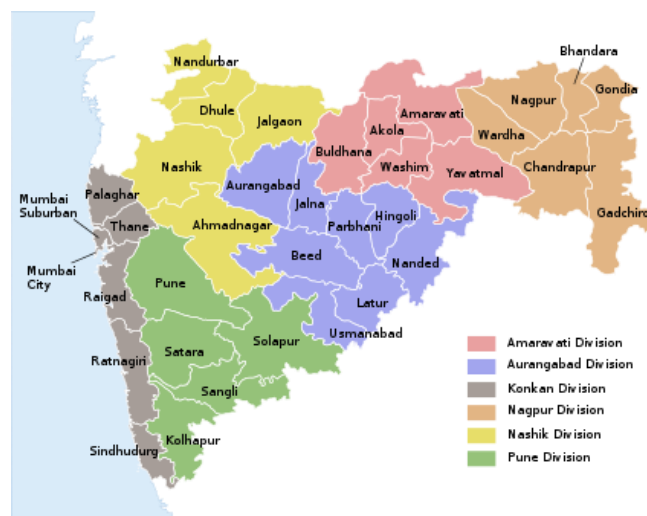


Figure (b) Maharashtra with all district.

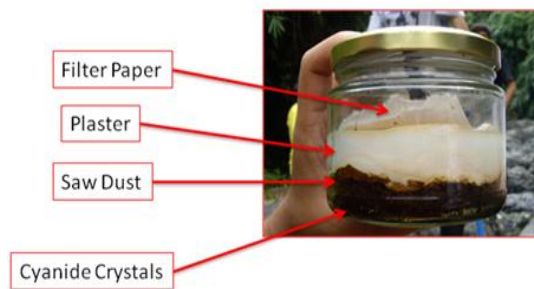


Figure (c) killing jar

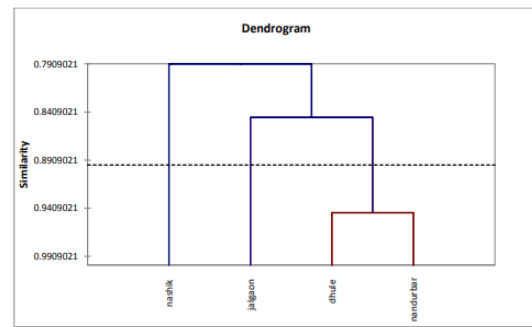


Figure (e) The Bray Curtis similarity index for 2021-22.

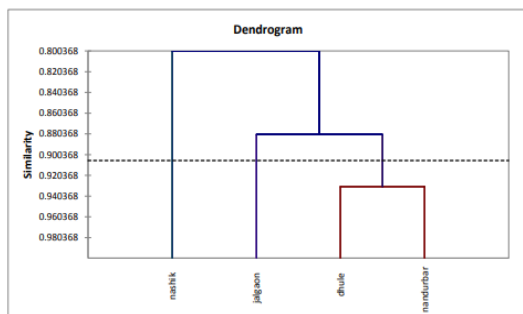


Figure (d) The Bray Curtis similarity index for 2020-21

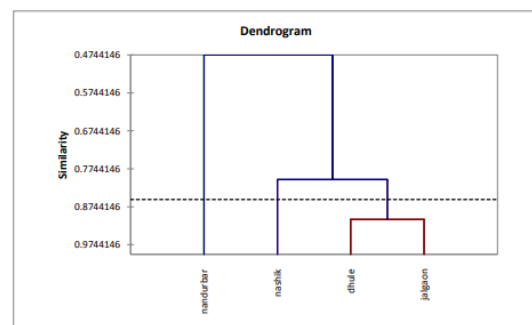


Figure (f) The Bray Curtis similarity index for 2022-23

Table (a) Study area

Name of District	Number of sites	Area per sq. km	Names of selected Survey site
Nashik	16	15, 530 (15 Tehsils)	Nashik city, Trimbakeshwar, Igatpuri, Sinnar, Saptashrungigadh, Lasalgaon, Vinchur, Dindori, Kalwan, Satana, Jaikhedan, Malegaon, Ankai, Peint, Surgana, Andarsul
Dhule	09	8,061 (04 Tehsils)	Dhule city, Lambkhani, Sakri, Varse, Chhadwel, Indva, Sindkheda, Shirpur, Boradi.
Jalgaon	12	11,765 (15 Tehsils)	Chalisingaon, Mehunbare, Pachora, Parola, Amalner, Chopda, Jalgaon city, Yaval, Bhusawal, Jamner, Edalabad, Raver.
Nandurbar	07	5, 034 (06 Tehsils)	Navapur, Nandurbar city, Shahada, Taloda, Dhadgaon, Toranmal, Akkalkuwa
Total sites	44		

Table (b) Shannon Index- H'

Year	Nashik	Dhule	Jalgaon	Nandurbar
2020-21	4.194	4.054	4.131	4.138
2021-22	4.352	4.093	4.182	4.162
2022-23	4.27	4.081	4.152	4.158

Table (c) Pielou's Evenness index: (Equitability) or J'

Year	Nashik	Dhule	Jalgaon	Nandurbar
2020-21	0.929	0.939	0.951	0.947
2021-22	0.964	0.948	0.962	0.952
2022-23	0.946	0.945	0.955	0.951

Table (d) Margalef's sp. richness index

Year	Nashik	Dhule	Jalgaon	Nandurbar
2020-21	11.36	10.13	9.501	10.11
2021-22	10.61	9.778	9.244	9.823
2022-23	11.01	9.938	9.345	9.943

Table (e) Sørensen's Similarity Index: β

	Nashik	Dhule	Jalgaon	Nandurbar
Nashik	1	0.9036	0.9166	0.9230
Dhule	-	1	0.9736	0.9480
Jalgaon	-	-	1	0.9487
Nandurbar	-	-	-	1

Table (f) Berger-Parker index: n_{\max} / N

Year	Nashik	Dhule	Jalgaon	Nandurbar
2020-21	0.0383	0.0475	0.0406	0.0407
2021-22	0.0255	0.0434	0.0298	0.0441
2022-23	0.0314	0.0455	0.0370	0.0407

Conclusion:

The current findings have shown the wide variety of butterfly species that may be found in northern Maharashtra. This will be helpful in the preservation of the many species that inhabit this area. North Maharashtra is positioned between

Mumbai, the commercial hub of India, and Gujarat, the paradise for entrepreneurs seeking to build enterprises (25-28). Mumbai is the commercial capital of India, while Gujarat is known as the place to establish a company. Even though North Maharashtra is a reasonably protected area

with an abundance of biodiversity, industrial expansion in the Mumbai and Gujarat regions would always have an effect on the biodiversity of North Maharashtra. According to the findings of the current inquiry, North Maharashtra is teeming with a diverse collection of butterfly species. The establishment of a butterfly sanctuary in North Maharashtra, as well as the cultivation and preservation of larval and nectar host plants that are utilised especially by these butterflies, as well as the protection and maintenance of butterfly mating places, would all contribute to the conservation of butterflies in that region (29, 30).

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