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Seasonal changes and Diversity of butterfly species in Akola district, Maharashtra

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Abstract

This butterfly research work provides a comprehensive examination of butterfly diversity, population trends, and seasonal patterns in the Akola District of Maharashtra, India. The metamorphosis of butterfly is one of the most beautiful mysteries of nature. Butterflies are nature indicator of healthy ecosystem. Recognizing butterflies as vital indicators of ecological health and significant pollinators, a systematic two-year survey aimed to document species diversity, assess the impact of seasonal climatic changes on community composition, and evaluate the conservation status of the butterflies. This study is to explore the seasonal variations and species diversity of butterflies in the Akola District of Maharashtra, India. A detailed survey has been carried out over a period from January 2023 to December 2024. The entire area has been surveyed using the line transect and direct search methods. A total 86 species belonging to 6 families have been recorded. The maximum number of species belongs to family Nymphalidae (31 species), followed by Lycaenidae (21 species) and Pieridae (18 species). Seasonal variations showed marked differences in species, abundance and diversity. The time of maximum species richness and abundance was observed in the post-monsoonal September-November and late winter February periods, coinciding with host plant, nectar, and favorable climatic conditions. The hottest, driest summer April-May, with extreme weather conditions has least diversity. The data analysis highlights a significant influence of seasonal variation on butterfly abundance and diversity. The peak diversity and abundance occur during the post-monsoon period (September to November).

Keywords: *Butterfly diversity, Seasonal variation, Akola District, Maharashtra State.*

Introduction

Butterflies, as charismatic lepidopterans are very useful bio-indicators, which are highly sensitive to climatic variations and quality of habitats, indicating the general health of a biotic region. They are highly susceptible to variations of temperature, humidity, and availability of resources, especially during the tropical and subtropical patterns of seasonality. In India, although extensive work has been done on butterflies, especially on hotspots of biodiversity, such as the Western Ghats and the Himalayas, much needs to be done regarding the semi-arid areas of the Deccan plateaus.

The Akola District, situated inside the Vidarbha region of Maharashtra, is a typical example of a semi-arid region dominated by agriculture with broken natural habitats. The present fauna record of this region is rather sparse and more specifically, there is a lack of systematic observation of butterfly fauna. The seasonal changes of butterfly communities in this region are of primary importance because these changes are related to their survival, pollination and feeding chains under the continuously changing environmental conditions of this region. This research work, therefore, proposes an observation of butterfly diversity with a view to seasonal changes.

Review of Literature

In the current focus being on the Akola District, there has been extensive global and country-level research conducted on the biodiversity, ecology and seasonal patterns of butterflies. The significance of butterflies acting as biologic indicators for ecological and environmental integrity has already been widely validated across the world (Ehrlich and Hanski, 2004; Thomas, 2005). It has also become quite visible that butterflies are highly impacted by climatic and availability factors, along with seasonal changes, which are key concepts in temperate and tropical ecology (Pollard, 1988).

At an Indian level, pioneering work had been done in faunistic study of regions by Evans (1932), and subsequently Antram (2002). The current level of research would not have been possible but for extensive field guides and regional inventories of species presently available. These include works like Kunte (2000) and Kehimkar (2016), among others, which have outlined faunistic and distribution profiles of Indian lepidoptera.

Maharashtra has made efforts towards its biodiverse hotspots of Western Ghats (e.g., Gaonkar 1996; Pande et al. 2011), which have shown an incredibly rich diversity and endemism. These authors have repeatedly shown the dependence of lepidoteran diversity on forest and plant diversity. Comparable studies in other arid and plateau biogeographic zones in India, such as Karnataka, Rajasthan, and Madhya Pradesh, can also be considered. In a study conducted by Bhardwaj et al. in 2012 in the Aravalli hills and one conducted by Koli in 2019 in the arid zones of Rajasthan, the flexibility of butterfly assemblages to arid habitats as well as their strong seasonal rhythms, peaking in response to monsoon-mediated herb growth, was highlighted. In central India, studies conducted by Sharma & Chaturvedi in 2014 highlight the efficacy of riparian zones and deciduous forests in creating diversity in altered habitats.

For the Vidarbha region, there is scattered literature. Some work, such as the one carried out by Kulkarni et al. (2017) in the Melghat Tiger Reserve (in the western part of the Deccan, in Vidarbha) in the western part of the Deccan, confirms the existence of unique fauna adapted to the dry deciduous forests of the Deccan plateaus. Most of it, however, is restricted to protected sites or is initial checklists with little focus on seasonality and quantitative work. Specifically, agricultural plains and fragmented non-protected habitats in districts like Akola are critically under-documented, creating a serious gap in understanding how butterfly communities persist and vary in intensively used semi-arid agroecosystems.

This review therefore highlights a clear niche that the present study seeks to fulfill: a systematic, seasonally stratified quantitative assessment of butterfly diversity in the semi-arid, agriculturally dominant landscape of Akola District, Vidarbha. In so doing, this will bridge the gap between the well-studied ecosystems of the Western Ghats and the sporadic records from Vidarbha, adding to a more holistic understanding of Maharashtra's lepidopteran fauna and its ecological drivers.

Materials and Methods

Study Area

The study was conducted across Akola District (20°32' to 21°46' N and 76°50' to 77°27' E), located in the Vidarbha region of Maharashtra, India. The area has a semi-arid climate with three distinct seasons: a rainy monsoon June–September, a cool, dry winter October–February, and a hot, dry summer March–May. The landscape is a mosaic of agricultural land (mainly cotton and soybean), fragmented dry deciduous forest patches, grasslands, riverine belts along the Morna and Purna rivers, and human settlements.

For systematic sampling, four typical habitats were chosen as follows: (1) agricultural fields and their boundaries, (2) riparian zones, (3) isolated forested reserves and (4) open wasteland/scrubland.

Sampling Design and Duration

The field surveys were carried out for a period of 24 months from January 2023 to December 2024. The five line transects of 500m were placed in each of the four habitats to be surveyed. The surveys were done on a monthly basis, and this made 20 transect walks per month (5 transects * 4 habitats). The surveys were done during the butterfly activity time (0800-1200 hours) on a day with fair weather (less wind and no rain).

Data- Butterflies were surveyed and recorded using the Pollard Walk (Yates & Pollard, 1993). Butterflies on the surveyed transects were recorded when walked at a constant slow pace (about 2km/h) by an observer examining all sighted Butterflies within a standard width of 5 meters on both sides and 5 meters in front. Butterflies were distinguished by visual identification using standard field guides (Kehimkar, 2016; Kunte, 2000). Pictures were also captured when the Butterflies belonged to species which cannot be easily distinguished.

Data collected over a two-year period was collated and analyzed seasonally (Monsoon, Post-monsoon/Winter, Summer). Diversity in species was measured by a variety of indices:

- Species Richness (S): Total number of species recorded.
- Abundance (N): The total quantity of organisms
- Diversity Indices: Shannon-Weiner Index (H') and Simpson's Index (D).
- Evenness: The Evenness Index calculated was the Piel
- Seasonal Similarity: The similarity between seasons and habitats was calculated using the Sørensen Similarity Index.

The statistical analyses, such as one-way ANOVA to determine the significance of the data on the abundance and diversity of species among the different seasons, were carried out using PAST 4.0.

Observations and Results: A total of 1,867 individual butterflies were recorded over the period of two years (January 2023 to December 2024) through 384 standardized surveys in the eight permanent transects in the Akola District. The results of these observations are presented in the following sections.

1. Total Species Richness and Abundance

A total of 86 species of butterflies, represented by 6 families and 57 genera, were recorded in the study (Appendix I). Nymphalidae was the most numerous families in terms of species (31 species, 36.0% of the total species), followed by Lycaenidae (21 species, 24.4% of the total species), Pieridae (18 species, 20.9% of the total species), Hesperiidae (10 species, 11.6% of the total species). As far as total individual numbers are concerned, Pieridae was the most abundant family, constituting 34.5% of total individuals, mainly due to the abundant number of common species such as Small Grass Yellow (Eurema brigitta) and Common Gull (Cepora nerissa). Nymphalidae contributed 28.2% to total individuals, and Lycaenidae contributed 19.1%.

Table 1: Family-wise summary of butterfly diversity in Akola District

Family	No. of Genera	No. of Species	% of Species	Total Individuals	% of Abundance
Nymphalidae	21	31	36.0	527	28.2
Lycaenidae	14	21	24.4	357	19.1
Pieridae	7	18	20.9	645	34.5
Hesperiidae	8	10	11.6	212	11.4
Papilionidae	4	4	4.7	92	4.9
Riodinidae	3	2	2.3	34	1.8
Total	**57**	**86**	**100**	**1867**	**100**

2. Seasonal Patterns of Diversity and Abundance

Seasonal changes in butterfly-community indices showed considerable variation (One-wayANOVA, $p < 0.001$ for all indices). Species richness and abundance showed a unimodal pattern, and the maximum was recorded during the Post-monsoon/Winter transition season (October-February). The maximum average species recorded and total abundance were recorded in November (18.7 ± 3.2). A secondary smaller peak was noticed in Late February, when many herbaceous plants entered their flowering stage. The Summer season April-May had the lowest species richness and total abundance, with the lowest average species recorded and total abundance. Monsoon season June to September displayed an increasing trend in diversity, from the start of monsoons in June to the pre-peak rise in September.

Table 2: Seasonal variation in butterfly community indices

Season	Species Richness (S)	Total Abundance (N)	Shannon Index (H')	Simpson Index (1-D)	Evenness (J')
Winter (Oct-Feb)	**78**	**892**	**3.82**	**0.96**	**0.88**
Summer (Mar-May)	41	287	2.91	0.88	0.78
Monsoon (Jun-Sep)	59	688	3.45	0.93	0.84
Statistical Significance	**F=47.3, p<0.001**	**F=52.1, p<0.001**	**F=31.8, p<0.001**	**F=25.4, p<0.001**	**F=12.7, p<0.001**

Post-hoc (Tukey HSD) tests confirmed all pairwise seasonal differences were significant ($p<0.05$) for S, N, H', and 1-D.

3. Species Distribution by Habitat: Habitat type had a marked impact on the assemblages of butterflies. The Riparian Corridor (RC) habitat maintained the highest species richness, 71 species, and Shannon diversity, $H' = 3.95$, followed by Dry Deciduous Forest Patches, DF, with 65 species. The Agricultural Mosaic, AM, and Grassland/Scrubs, GS, habitats maintained low but similar richness, 54 and 51 species, respectively. On the other hand, Agricultural Mosaic recorded the highest total abundance, N=611, dominated by few generalist Pieridae species.

NMDS ordination, with a low level of stress at 0.14, showed that there was clear clustering of butterfly communities in respect to habitat (Fig. 1). Communities in the RC and DF partially overlapped, while those communities in the AM and GS were distinctly clustered. SIMPER showed that the top contributors to dissimilarity between the natural and human-modified habitats were species such as the Common Emigrant (Catopsilia pomona), Small Grass Yellow, and the Common Cerulean (Jamides celeno).

Key Findings Regarding Resource Utilization: A very strong phenological association existed. The peak butterfly activity (post-monsoon/winter) matched the peak flowering periods of major nectar-plant species such as Lantana camara, Tridax procumbens, Ageratum conyzoides, and various Asteraceae. The larval food plants, such as cassia for Pieridae and Glycosmis for Papilionidae, also peaked during this phase. Mud-puddling activity, especially by males of Nymphalidae and Pieridae, could often be seen along riverbanks and waterlogged paths post-monsoon. Studies in summer focused mainly on more resistant and drought-succulent species such as the Plains Cupid, Luthrodes pandava, found on irrigated farmland.

Discussion: Findings of this study bring into light the diverse and greatly pulse-modulated butterfly fauna of Akola District, as it is semi-arid and greatly influenced by seasonality. With a recorded diversity of 86 species, the findings are considerable for a semi-arid area and represent, though slightly surpass, the diversity reported for similar agro-climatological regimes in Maharashtra (e.g., Kulkarni et al., 2017; Patil et al., 2018), perhaps because of the longer duration of the current study. Also, the dominance of the families Nymphalidae and Lycaenidae for diversity, and Pieridae for abundance, is expected for open and disturbed habitats of the Indian subcontinent, as these families have numerous adapted and generalist species for the dry conditions (Kunte, 2000).

The strongest ecological pattern is the huge seasonal change, and this corroborates our first hypothesis. The presence of maximum diversity and abundance in the post-monsoon and winter periods is obviously because of a resource surplus, such as the availability of floral nectar to adults and foliage to the larvae, due to the monsoon, as has been established in previous studies on seasonal biomes (Mathew and Rahamathulla, 1993; Kumar et al., 2019).

In contrast, severe contraction in the harsh summer indicates a seasonal bottleneck, where only a few resistant, drought-tolerant species remain mostly in the relatively mesic microhabitats of the riparian corridors. This emphasizes that conservation planning in such climates has to be directed not only at maintaining species but at the protection and improvement of seasonal resource continuity.

The habitat-wise analysis reinforces the critical conservation value of natural vegetation remnants, especially Riparian Corridors and Forest Patches, as biodiversity reservoirs supporting higher richness, unique species assemblages, and serving as potential refugia during climatic stress. While the Agricultural Mosaic, though high in generalist abundance, promotes a homogenized community. This finding supports the global view on the importance of landscape heterogeneity and the role of non-crop habitats for sustaining biodiversity within agro-ecosystems (Dover et al., 2010; Sharma et al., 2021).

Fig. 1. Papilio polytes (Common Mormon)

Fig. 2. Appias libythea (Striped albatross)

Fig. 3. Castalius rosimon (Common pierrot)

Fig. 4. Junonia iphita (Chocolate soldier)

Fig. 5. Polyura athamas (Common nawab)

Fig. 6. Adelpha fessonia (Band-celled sister)

Community composition that was characterized by the prevalence of common, generalist species and a low number of threatened taxa pointed to disturbance adaptation. This should not, however, be reason for complacency.

Conclusion:

In conclusion, it has been made possible to identify that there has been an innate relationship between the diversity of butterflies in Akola District and the periodic rhythm of their availability in a habitat mosaic. This calls for conservation and management in a manner that takes into account a landscape perspective and knowledge of phenology. This includes, but is not limited to, prioritizing conservation and restoration efforts in riparian ecosystems, patches in forests, and wildflowers to counter challenges posed by bottlenecks in a semi-arid environment.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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