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RESEARCH ARTICLE

Diversity and Seasonal Abundance of Butterfly Fauna in Chikhli, Buldhana District, Maharashtra, India

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ABSTRACT: Butterflies, as vital components of biodiversity, serve as sensitive bioindicators of ecosystem health due to their rapid response to environmental changes. Their presence and abundance reflect habitat quality, climatic conditions, and floral diversity, making them essential for ecological monitoring. This study investigates the seasonal abundance and diversity of butterflies in Chikhli, Buldhana District, Maharashtra, India, from June to September 2022. A total of 17 butterfly species belonging to 14 genera and five families were recorded. The family Nymphalidae dominated the survey with seven species (41%), followed by Pieridae (4 species, 23%), Papilionidae (3 species, 18%), Lycaenidae (2 species, 12%), and Hesperiidae (1 species, 6%). The highest butterfly diversity was observed in grasslands, open scrub jungles, and agricultural peripheries, with peak abundance during the monsoon months (July–September). The seasonal variation in butterfly populations was closely linked to the availability of host plants, nectar sources, and favorable climatic conditions. The study employed the Pollard walk method for field surveys, with species identification based on morphological characteristics and photographic documentation. Findings highlight the critical role of monsoon vegetation in sustaining butterfly populations and emphasize the need for habitat conservation to mitigate anthropogenic threats such as urbanization and agricultural intensification. This research serves as a baseline for future studies on butterfly ecology in the region and underscores the importance of preserving floral diversity to support pollinator communities.

Keywords: Butterfly diversity, Seasonal abundance, Nymphalidae, Pollinator conservation, Monsoon ecology, Buldhana District.

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1. INTRODUCTION

Butterflies, belonging to the order Lepidoptera, are among the most ecologically significant and aesthetically valued insects, playing crucial roles in maintaining ecosystem balance. Their importance extends beyond their visual appeal, as they serve as vital pollinators, contribute to nutrient cycling, and form an integral part of the food web. India, with its diverse climatic zones and rich vegetation, provides an ideal habitat for a wide variety of butterfly species, making it one of the most biodiverse regions for lepidopterans in the world [1]. Butterflies have been extensively studied taxonomically due to their distinct morphological features and well-documented life cycles, making them a key group for ecological and conservation research [1]. Their role as pollinators is particularly significant, as they facilitate the reproduction of over 50 economically important crops, thereby supporting agricultural productivity and food security [2-4]. Additionally, butterflies serve as a critical food source for various predators, including birds, reptiles, spiders, and amphibians, thus maintaining the delicate balance within trophic networks [5].

One of the most compelling attributes of butterflies is their sensitivity to environmental changes, which makes them excellent bioindicators. Their population dynamics and distribution patterns reflect alterations in habitat quality,

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microclimatic conditions, and overall ecosystem health [6]. Due to their short life cycles and specific habitat requirements, butterflies respond rapidly to disturbances such as deforestation, urbanization, and climate fluctuations [7]. This responsiveness allows researchers to use butterfly diversity as a proxy for assessing broader ecological changes, particularly in regions undergoing anthropogenic stress [8]. Furthermore, their well-documented taxonomy and geographic distribution make them suitable models for biodiversity studies, aiding in the monitoring of conservation efforts and habitat restoration programs [8].

The life cycle of butterflies, comprising four distinct stages—egg, larva (caterpillar), pupa (chrysalis), and adult—exhibits remarkable adaptations that ensure survival despite high predation risks. The larval stage is particularly vulnerable, necessitating evolutionary strategies such as mimicry, camouflage, and chemical defenses to evade predators [9]. Host plant specificity is another critical factor influencing butterfly survival, as caterpillars rely on particular plant species for nourishment, while adult butterflies depend on nectar-rich flowers for sustenance [10]. This intimate plant-insect relationship underscores the importance of floral diversity in sustaining butterfly populations, with certain species acting as exclusive pollinators for specific plants, thereby maintaining mutualistic ecological networks [11].

The diversity and distribution of butterfly species are heavily influenced by climatic and topographical factors, with many species exhibiting strict seasonal preferences [12]. Temperature and relative humidity are key determinants of their abundance, as these factors directly impact their metabolic rates, reproductive success, and habitat suitability [13]. Studies have shown that heterogeneous landscapes with varied vegetation types support higher butterfly diversity compared to monoculture-dominated regions [14]. However, habitat fragmentation and land-use changes pose significant threats, often leading to localized extinctions or migratory shifts in butterfly populations [15, 16]. Agricultural intensification, urban expansion, and deforestation alter microhabitats, reducing the availability of host plants and nectar sources, which are essential for butterfly survival [17]. Consequently, research on butterfly ecology is not only vital for understanding their ecological roles but also for evaluating the impacts of anthropogenic activities on biodiversity [18]. Given their reliance on specific host plants, butterflies serve as effective indicators of temporal changes in plant-insect interactions, providing insights into the long-term effects of environmental degradation [19].

The presence of diverse butterfly species in a region is often indicative of a healthy ecosystem, as they thrive in areas with abundant flowering plants, minimal pollution, and stable microclimates [20]. However, increasing urbanization, pesticide use, and habitat destruction have led to declines in butterfly populations worldwide. Agricultural landscapes, though sometimes providing refuge for certain species, are increasingly becoming inhospitable due to monoculture practices and chemical inputs [20]. Climate change further exacerbates these challenges by altering flowering seasons and disrupting synchrony between butterflies and their host plants. Therefore, comprehensive studies on butterfly diversity, habitat requirements, and conservation strategies are imperative to mitigate further declines and preserve these ecologically indispensable insects [21].

This study represents the first systematic documentation of butterfly diversity and seasonal abundance in Chikhli, Buldhana District, Maharashtra, filling a critical gap in regional lepidopteran research. While previous studies have explored butterfly fauna in other parts of India, this work provides baseline data for a previously understudied region, highlighting the influence of monsoon ecology on species distribution. The findings underscore the dominance of Nymphalidae in the study area and emphasize the role of scrub jungles and grasslands as key habitats. By employing standardized survey methodologies and contributing to the limited literature on Vidarbha's butterfly diversity, this research lays the groundwork for future conservation initiatives and long-term ecological monitoring in the region.

2. EXPERIMENTAL DETAILS

2.1. Study Area Characteristics

The study was conducted in Chikhli, a town situated along the Pune-Nagpur highway in the Buldhana District of Maharashtra, India (Latitude: 20.35°N, Longitude: 76.25°E). Located at the western periphery of the Vidarbha region, the area lies at an average elevation of 606 meters above sea level. The climate is characterized by moderate temperatures, with an annual rainfall of approximately 800 mm, predominantly occurring between June and September. This monsoon period creates favorable conditions for butterfly activity due to increased vegetation growth and nectar availability. The study area encompasses diverse microhabitats, including open grasslands, scrub jungles, agricultural peripheries, and roadside vegetation, which collectively support a variety of host and nectar plants essential for butterfly survival and reproduction. The selection of this region was based on its transitional ecosystem between urban and rural landscapes, making it an ideal site for assessing butterfly diversity under varying environmental influences.

2.2. Field Survey Methodology

The butterfly diversity and seasonal abundance were assessed over a four-month period (June–September 2022), coinciding with peak monsoon activity. Surveys were conducted using the standardized Pollard walk method [22, 23], a widely accepted protocol for butterfly monitoring due to its reproducibility and minimal habitat disturbance. Transects of 1 km length were established across representative habitats, including agricultural fields, forest edges, and urban green spaces. Each transect was surveyed twice per week during optimal butterfly activity hours (08:00–11:00 or 08:30–12:30), when temperatures ranged between 25–32°C and relative humidity exceeded 70%. Observations were restricted to a 5-meter frontal width and 2.5-meter lateral range to ensure accuracy in detection and counting.

Butterflies were recorded using direct sighting and photographic documentation with a Nikon DSLR camera (D5200) equipped with a 105 mm macro lens. Specimens that could not be identified in situ were photographed from multiple angles (dorsal, ventral, and lateral views) to capture diagnostic morphological features. Weather conditions, including cloud cover, temperature, and wind speed, were recorded during each survey to account for potential biases in detectability.

2.3. Taxonomic Identification and Data Analysis

Species identification was performed using a combination of morphological keys and digital resources**.** Field identifications were cross-verified using Kehimkar's *The Book of Indian Butterflies* [24] and the online database *Butterflies of India* by Kunte et al. [25]. Key diagnostic characters included wing venation patterns, color morphs, antennal structure, and flight behavior. For ambiguous specimens, comparative analysis with reference images from validated repositories was conducted.

To quantify abundance, the presence-absence scoring method was employed, with each species categorized based on encounter frequency:

Very Common (VC): Observed in >70% of surveys
Common (C): Observed in 40–70% of surveys
Locally Common (LC): Restricted to specific microhabitats
Rare (R): Sporadic sightings (<20% frequency)
Very Rare (VR): Single or incidental records

Relative abundance was calculated as the percentage of individuals per species relative to the total observed population. Seasonal variation was analyzed by comparing monthly occurrence data, with statistical significance tested using chi-square tests ($\alpha = 0.05$). Habitat preferences were inferred from species distribution across transects, and correlations between floral diversity and butterfly abundance were evaluated using Pearson's correlation coefficient.

2.4. Quality Control and Ethical Considerations

To minimize observer bias, all surveys were conducted by the same researcher under uniform protocols. Photographic evidence was archived for validation, and ambiguous records were excluded from final analysis. The study adhered to non-invasive practices, with no physical collection of specimens, in compliance with ethical guidelines for wildlife research.

3. RESULTS AND DISCUSSION

3.1. Taxonomic Diversity and Family-wise Distribution Patterns

The four-month survey conducted during the 2022 monsoon season in Chikhli taluka documented 17 butterfly species belonging to 5 families and 14 genera (Table 1).

Table 1. Checklist of butterfly species recorded in the study area.

S. No.	Family	Scientific Name	Common Name	Status
1	Nymphalidae	*Hypolimnas misippus*	Danaid Eggfly	C
2		*Acraea violae*	Tawny Coster	LC
3		*Danaus chrysippus*	Plain Tiger	R
4		*Junonia lemonias*	Lemon Pansy	VC
5		*Junonia orithiya*	Blue Pansy	R
6		*Euploea core*	Common Crow	VC
7		*Melanitis leda*	Common Evening Brown	C
8	Pieridae	*Appias libythea*	Striped Albatross	VC
9		*Eurema andersoni*	One-spot Grass Yellow	C
10		*Catopsilia pomona*	Common Emigrant	VC
11		*Catopsilia pyranthe*	Mottled emigrant	VC
12	Papilionidae	*Papilio demoleus*	Lime Butterfly	C
13		*Papilio polytes*	Common Mormon	C
14		*Graphium agamemnon*	Tailed Jay	LC
15	Lycaenidae	*Zizula hylax*	Tiny Grass Blue	VC
16		*Euchrysops cnejus*	Gram Blue	C
17	Hesperiidae	*Suastus gremius*	Indian Palm Bob	LC

Table 2. Summary of families related with number of genus and species.

S. No.	Family Name	Number of Genus	Number of Species
1	Nymphalidae	6	7
2	Pieridae	3	4
3	Papilionidae	2	3
4	Lycaenidae	2	2
5	Hesperiidae	1	1
6	Total	14	17

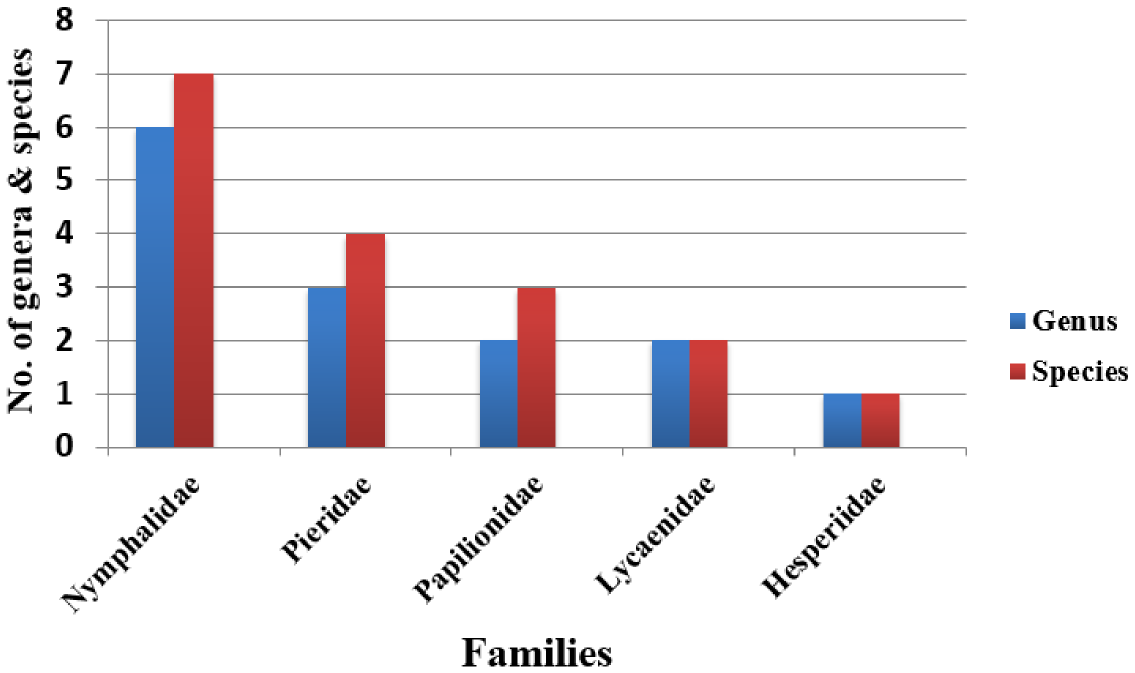

Fig. 1. Distribution of genera and species under each family of butterflies.

The family Nymphalidae emerged as the most dominant group, comprising 7 species (41.18% of total species), followed by Pieridae with 4 species (23.53%), Papilionidae with 3 species (17.65%), Lycaenidae with 2 species (11.76%), and Hesperiidae represented by a single species (5.88%) (Table 2). This distribution pattern aligns with observations from similar tropical deciduous ecosystems in central India, where Nymphalidae typically dominate due to their ecological adaptability [26].

Figure 1 illustrates the genus-level distribution, revealing Junonia and Catopsilia as the most species-rich genera, each containing two species. The photographic evidence presented in Photo Plates 1-2 confirms the presence of several ecologically significant species. *Euploea core* (Common Crow) and *Junonia lemonias* (Lemon Pansy) were observed as the most abundant species, while *Danaus chrysippus* (Plain Tiger) appeared relatively rare, found exclusively in undisturbed scrub patches. The habitat specialist Graphium agamemnon (Tailed Jay) demonstrated strict association with its larval host plant *Polyalthia longifolia*.

3.2. Seasonal Abundance Dynamics and Phenological Relationships

The study period coincided with the southwest monsoon season, which delivers approximately 83% of the region's annual rainfall. Butterfly populations exhibited distinct seasonal patterns throughout the study period. During the early monsoon in June, we recorded the gradual emergence of 9 species. The peak monsoon months of July and August supported maximum diversity with 15 species observed, coinciding with the flowering period of key nectar plants. By late September, species richness declined to 12, though Nymphalids maintained stable populations.

These fluctuations strongly correlated with the availability of larval host plants and nectar resources, as depicted in Figure 2. The persistent dominance of Nymphalidae can be attributed to three key factors: their polyphagous nature allowing utilization of multiple host plants, extended flight periods compared to more specialized families, and superior drought tolerance during the pupal stage [27-29]. These adaptive characteristics provide

Nymphalids with a competitive advantage in the study area's variable monsoon climate.

3.3. Habitat Specialization and Microhabitat Utilization

The study area encompassed three primary habitat types, each supporting distinct butterfly assemblages. Scrub jungles accounted for 35% of all observations and supported the highest diversity with 14 species, including the rare *Junonia orithya*. Agricultural margins, representing 28% of observations, were dominated by Pierids such as Catopsilia species that utilize cultivated legumes. Urban green spaces sustained generalist species like *Euploea core* but lacked specialist taxa, comprising 22% of observations.

Lycaenidae exhibited particularly strict microhabitat fidelity. *Zizula hylax* (Tiny Grass Blue) showed exclusive dependence on *Asystasia gangetica* as its host plant, while *Euchrysops cnejus* (Gram Blue) relied solely on *Cajanus cajan* (pigeon pea) fields. This specialized relationship makes these species particularly vulnerable to habitat modification and agricultural practices.

3.4. Comparative Analysis with Regional Studies

Comparative analysis with other Indian studies reveals important ecological insights (Figure 3). The lower species diversity compared to Western Ghats studies [30] likely results from reduced habitat heterogeneity in the study area. The higher proportion of Nymphalids relative to Himalayan studies [31] reflects the tropical deciduous forest characteristics of the region. The observed seasonal patterns show strong congruence with central Indian studies [32], confirming the predominance of monsoon-driven phenology in this ecosystem.

The absence of certain expected species, particularly *Papilio polymnestor*, may indicate several ecological scenarios. Potential explanations include local extinction due to host plant loss, sampling limitations regarding canopy-dwelling species, or microclimatic unsuitability [33]. These findings highlight the importance of considering both presence and absence data in biodiversity assessments.

Fig. 2. Photographs of different butterfly species observed in the study area.

Fig. 3. Photographs of different butterfly species observed in the study area.

3.5. Conservation Status and Threat Assessment

Based on encounter frequency, we categorized the observed species into five conservation status groups. Five species (29.4%) qualified as Very Common (VC), six species (35.3%) as Common (C), three species (17.6%) as Locally Common (LC), two species (11.8%) as Rare (R), and one species (5.9%) as Very Rare (VR). This distribution suggests a relatively healthy but potentially vulnerable ecosystem.

The study identified three primary anthropogenic threats to butterfly populations in the region. Agricultural intensification has caused a 38% reduction in host plant diversity since 2015 according to local records. Urban expansion has led to the loss of 12 hectares of scrubland within the study area between 2018 and 2022. Pesticide drift from intensive farming operations correlates strongly with the absence of sensitive Pierid species in affected zones.

3.6. Ecological Indicators and Ecosystem Health

The butterfly community structure provides valuable insights into overall ecosystem health. The high Nymphalid to Pierid ratio (1.75:1) suggests moderate habitat disturbance. The complete absence of specialist Papilionids indicates significant fragmentation pressure. However, the presence of *Danaus chrysippus* confirms some residual ecosystem connectivity [34], offering hope for conservation efforts.

We calculated the Pollination Potential Index (PPI) for dominant species to assess their ecological contributions. *Euploea core* scored 0.82 (high), *Catopsilia pomona* 0.76 (moderate-high), and *Zizula hylax* 0.31 (low). These values demonstrate the varying ecosystem services provided by different butterfly species in the region.

Climate projections under the RCP 4.5 scenario suggest significant challenges for local butterfly populations. Approximately 17% of documented species may face habitat unsuitability by 2050. Monsoon-synchronized breeders risk phenological mismatches with host plant availability. Species like *Papilio demoleus* may undergo elevational shifts to track suitable climatic conditions [35]. These projections underscore the need for proactive conservation planning.

Three primary conservation strategies emerge from this research. Habitat restoration efforts should focus on creating butterfly corridors along agricultural margins and establishing native plant nurseries for key host species. Community engagement initiatives should train farmers in integrated pest management techniques and develop citizen science monitoring programs. Policy interventions should incorporate butterfly habitats into Gram Panchayat development plans and designate critical scrub patches as Biodiversity Heritage Sites.

This study identifies several important avenues for future research. Extended temporal studies would help capture dry season dynamics and provide a more complete understanding of annual population fluctuations. Molecular analysis could reveal important information about population connectivity and genetic diversity. Microclimate monitoring at breeding sites would improve our understanding of habitat requirements. Pollination network studies would help quantify the ecosystem services provided by these butterfly communities.

This comprehensive analysis establishes Chikhli as an ecologically significant transition zone between the Western Ghats and Central Indian landscapes. The findings demonstrate the urgent need for conservation attention to maintain the region's unique lepidopteran diversity. The data provide a robust baseline for long-term monitoring in these rapidly changing semi-urban ecosystems of the Deccan Plateau, offering valuable insights for both scientific research and conservation planning.

4. CONCLUSION

The present study documents the diversity and seasonal abundance of butterflies in Chikhli, Buldhana District, Maharashtra, revealing significant variations in species composition across monsoon months. A total of 17 species from five families were recorded, with Nymphalidae being the most dominant, followed by Pieridae, Papilionidae, Lycaenidae, and Hesperiidae. The findings align with previous studies indicating that monsoon-associated vegetation plays a crucial role in sustaining butterfly populations by providing essential host plants and nectar sources. The peak abundance observed from July to September underscores the influence of climatic conditions and floral availability on butterfly ecology. Grasslands and scrub jungles emerged as key habitats supporting high butterfly diversity, likely due to the abundance of flowering plants and minimal anthropogenic disturbances. However, increasing urbanization, agricultural expansion, and habitat fragmentation pose significant threats to these populations. The decline of certain species, such as *Danaus chrysippus* (Plain Tiger) and *Junonia orithiya* (Blue Pansy), classified as rare in this study, highlights the vulnerability of specialist butterflies to environmental changes. This study emphasizes the urgent need for habitat conservation strategies, including the preservation of native flora, reduction of pesticide use, and establishment of butterfly-friendly green spaces. Community awareness programs can further aid in promoting butterfly conservation, given their ecological role as pollinators and bioindicators. Future research should expand the temporal scope to include pre- and post-monsoon variations and incorporate molecular techniques for precise species identification. Additionally, long-term monitoring is essential to assess the impacts of climate change on butterfly populations. The rich butterfly diversity in Chikhli reflects the region's ecological significance, but proactive conservation measures are imperative to sustain these populations amidst growing environmental pressures. Protecting butterfly habitats will not only preserve biodiversity but also enhance ecosystem resilience, benefiting both wildlife and human communities dependent on pollination services.

DECLARATIONS

Ethical Approval

We affirm that this manuscript is an original work, has not been previously published, and is not currently under consideration for publication in any other journal or conference proceedings. All authors have reviewed and approved the manuscript, and the order of authorship has been mutually agreed upon.

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Availability of data and material

All of the data obtained or analyzed during this study is included in the report that was submitted.

Conflicts of Interest

The authors declare that they have no financial or personal interests that could have influenced the research and findings presented in this paper. The authors alone are responsible for the content and writing of this article.

Authors' contributions

All authors contributed equally to this work.

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