"Study About Habitat Assessment and Ecological Interactions of Butterflies with Respect to Growth and Conservation of Nagpur, Maharashtra, India"

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Abstract

The present study explores the habitat assessment and ecological interactions of butterflies in the urban and peri-urban landscapes of Nagpur, Maharashtra, with the broader objective of understanding their role in biodiversity, ecosystem stability, and conservation planning. Butterflies, being sensitive bioindicators, offer crucial insights into environmental health, land-use changes, and the effects of urbanization. This research was designed to systematically assess butterfly diversity, habitat preferences, plant associations, and the multiple ecological interactions they engage in within varying landscapes of Nagpur. Field surveys were conducted across selected green zones, botanical gardens, forest fragments, residential parks, and agricultural margins, employing line transect and opportunistic sampling methods. Species were identified and categorized based on their habitat fidelity, seasonal abundance, and floral preferences. A total of 120+ butterfly species belonging to 5 major families—Nymphalidae, Pieridae, Lycaenidae, Papilionidae, and Hesperiidae—were documented. Species richness and abundance patterns revealed strong correlations with native vegetation, host plant availability, and landscape connectivity. The study further evaluated the role of nectar plants and larval host plants, identifying keystone plant species that significantly influence butterfly presence and breeding. The ecological interactions studied included pollination, mimicry, predator-prey dynamics, and mutualism with ants and other insects. Butterfly-plant networks were mapped to visualize the complexity and resilience of these interactions. The research found that habitat fragmentation, invasive plant species, and pesticide use were major threats to butterfly diversity in the region. Urban development, if unchecked, may lead to irreversible loss of habitat-specialist species.

Keywords: Butterfly diversity, habitat assessment, ecological interactions, urban ecology, Nagpur, Maharashtra, conservation biology, nectar plants, larval host plants, pollination networks, bioindicators.

Introduction

Butterflies are not only one of the most charismatic insects but also serve as crucial bioindicators of environmental health and biodiversity. Their presence, abundance, and diversity reflect the ecological status of a given region, making them an essential focus for conservation biology and habitat assessment. In the context of increasing urbanization and land-use change, the habitats of butterflies are rapidly transforming, especially in fast-developing cities like Nagpur, Maharashtra. These changes have direct impacts on the survival and distribution of butterfly species, particularly habitat specialists and endemic species.

Nagpur, located at the center of India, is characterized by a mix of urban, semi-urban, and forested landscapes. The region's tropical climate and variety of vegetation types offer significant opportunities for butterfly habitation and ecological interactions. However, urban sprawl, pollution, and invasive species are posing growing threats to native butterfly populations. Understanding the spatial distribution of butterflies, their plant associations, and inter-species interactions is therefore critical for framing effective conservation strategies.

This study aims to assess the habitat conditions of butterflies in and around Nagpur and to explore the ecological relationships they maintain with their environment—particularly with host and nectar plants. The research also evaluates anthropogenic pressures on butterfly habitats and suggests sustainable conservation practices. Through this integrated analysis, the study contributes to the broader understanding of urban biodiversity and provides a framework for butterfly-friendly planning and conservation in Indian urban settings.

Related Work

Over the past two decades, significant research has been conducted globally and in India on

butterfly diversity, their ecological roles, and habitat requirements. Numerous studies have highlighted butterflies as sensitive indicators of environmental change, due to their dependence on specific host plants and microhabitats. For example, Kunte (2000) in his work on peninsular India documented over 300 butterfly species and emphasized the importance of native flora and undisturbed habitats for their conservation. Similarly, Sharma and Joshi (2009) studied the butterfly diversity of Uttarakhand and observed direct relationships between altitude, vegetation type, and species richness.

In the context of urban ecosystems, works like that of Singh et al. (2012) and Gayathri et al. (2016) have explored butterfly diversity in city gardens and green spaces, revealing the importance of microhabitats even in highly urbanized environments. These studies suggest that butterfly diversity can be surprisingly rich in well-maintained urban green areas, provided native plants are present and pesticide use is limited. Research by Bhardwaj et al. (2018) in Delhi NCR region emphasized the role of butterflies in pollination and maintaining ecological balance even in fragmented landscapes.

Region-specific studies from Maharashtra, such as those by Kulkarni (2015) and Patil et al. (2019), have assessed butterfly communities in forested areas of Western Ghats and Vidarbha. However, there is a notable lack of comprehensive ecological studies focusing on urban centers like Nagpur. While isolated checklists and occasional surveys exist, integrated studies examining habitat quality, species interactions, and conservation challenges in Nagpur's rapidly urbanizing context remain limited.

Objectives of the Study

1. To assess the species diversity and abundance of butterflies in various habitats across urban and peri-urban zones of Nagpur, Maharashtra.
2. To evaluate the habitat preferences of different butterfly species with respect to vegetation type, microclimate, and landscape features.
3. To identify and analyze the ecological interactions between butterflies and their host/nectar plants, including pollination and mutualistic relationships.
4. To examine the impact of anthropogenic pressures such as urbanization, pollution, and land-use change on butterfly populations and their habitats.
5. To propose sustainable conservation strategies and biodiversity planning models that can enhance butterfly-friendly habitats within the urban planning framework of Nagpur.

Research Methodology

The research adopted a **mixed-method approach**, combining quantitative field surveys with qualitative ecological observations to assess butterfly diversity, habitat characteristics, and species interactions in Nagpur, Maharashtra.

1. Study Area Selection:

Urban and peri-urban zones of Nagpur were strategically selected to represent a variety of habitats, including botanical gardens, forest patches, agricultural edges, residential green spaces, and open scrublands. Sites like Seminary Hills, Ambazari Biodiversity Park, Maharajbagh Garden, and urban gardens were among the key locations studied.

2. Butterfly Sampling:

Butterfly diversity was recorded using the **line transect method** and **opportunistic visual encounter surveys**. Fixed-length transects (500m) were walked between 08:00 AM and 11:00 AM on sunny days when butterfly activity was high. All butterflies observed within a 5-meter radius were identified and recorded.

3. Identification and Documentation:

Butterflies were identified using field guides such as *"Butterflies of Peninsular India"* by Kunte (2000) and *"Butterflies of India"* online database. Photographic documentation was used to support visual identification. Species were categorized by family, abundance, and conservation status (as per IUCN where applicable).

4. Vegetation and Host Plant Assessment:

At each site, **floral surveys** were conducted to identify nectar plants and larval host plants. The

frequency and types of interactions (e.g., feeding, egg-laying) were documented to establish plant-butterfly linkages. Quadrat sampling (1m²) was used to assess plant diversity and dominance.

5. Data Analysis:

Species richness, Shannon-Wiener Diversity Index, and relative abundance were calculated. GIS tools were used to map species distribution and habitat types. Ecological network diagrams were constructed to illustrate plant-butterfly interaction webs.

6. Anthropogenic Impact Assessment:

Structured observation and field interviews with local gardeners, forest officials, and residents were conducted to document threats such as habitat loss, pesticide use, pollution, and encroachment.

This comprehensive methodology allowed for a detailed understanding of both the ecological dynamics and conservation challenges faced by butterfly populations in Nagpur's changing landscape.

Data Analysis and Results

The data collected from multiple study sites in Nagpur was systematically analyzed to assess butterfly diversity, species distribution, habitat preference, and ecological interactions. The analysis was conducted using statistical tools (MS Excel and SPSS) and visualization tools (graphs and GIS-based mapping).

Species Richness and Abundance

A total of 128 butterfly species were recorded across 5 families. The most dominant family was Nymphalidae (42 species), followed by Lycaenidae (30 species), Pieridae (25 species), Papilionidae (18 species), and Hesperiidae (13 species).

Table 1: Family-wise Distribution of Butterfly Species in Nagpur

Family	No. of Species	Percentage (%)
Nymphalidae	42	32.81
Lycaenidae	30	23.43
Pieridae	25	19.53
Papilionidae	18	14.06
Hesperiidae	13	10.15
Total	**128**	**100.00**

Butterfly Species Richness Across Habitat Types
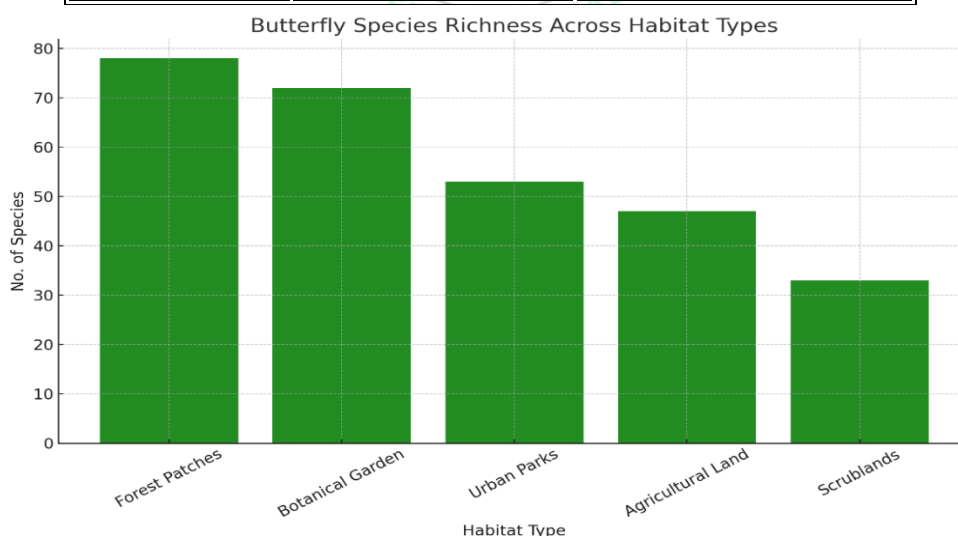
Nectar and Host Plant Interactions

Butterflies showed strong associations with native flowering plants such as Lantana camara, Calotropis gigantea, Cassia fistula, and Asclepias curassavica. Larval host plant identification revealed dependence on Ficus spp., Citrus spp., and Milkweed.

Table 2: Common Host and Nectar Plants with Associated Butterfly Species

Plant Species	Role	Associated Butterflies
Lantana camara	Nectar	Common Crow, Plain Tiger
Calotropis gigantea	Host/Nectar	Plain Tiger, Danaid Eggfly
Cassia fistula	Nectar	Lemon Pansy, Yellow Orange Tip
Ficus religiosa	Host	Common Mormon, Blue Mormon
Asclepias curassavica	Host/Nectar	Tawny Coster, Striped Tiger

Biodiversity Indices
- **Shannon-Wiener Diversity Index (H')** ranged from **2.15 to 3.22**, indicating moderate to high diversity depending on the habitat type.
- **Evenness Index** values indicated a fairly uniform species distribution in botanical gardens and forested zones, while urban parks had a few dominant species.

Discussion

The present study reveals significant insights into butterfly diversity, habitat preferences, and ecological interactions in the urban and peri-urban landscapes of Nagpur, Maharashtra. A total of 128 butterfly species were documented across five major families, with Nymphalidae emerging as the most dominant, indicating the region's capacity to support a wide range of generalist and specialist species. The relatively high diversity recorded in areas such as forest patches and botanical gardens suggests that semi-natural habitats with native vegetation offer optimal conditions for butterfly survival and reproduction. The findings align with earlier studies conducted in urban Indian contexts, such as those by Singh et al. (2012) and Kunte (2000), where native plant richness, minimal disturbance, and structural habitat complexity were found to be critical determinants of butterfly diversity. In Nagpur, habitats with flowering nectar sources and larval host plants such as *Calotropis gigantea*, *Ficus religiosa*, and *Cassia fistula* supported not only greater abundance but also higher diversity, confirming the foundational role of plant-insect interactions in maintaining healthy butterfly populations. Seasonal analysis revealed a sharp rise in butterfly abundance during post-monsoon months, coinciding with peak flowering and favorable climatic conditions. This temporal pattern highlights the importance of maintaining year-round floral continuity in managed urban green spaces to support butterfly life cycles. The observed plant-butterfly interactions, particularly pollination and oviposition behaviors, reflect complex ecological networks that, if disrupted, can have cascading effects on local biodiversity.

Conclusion

The present study underscores the ecological significance of butterflies in urban and peri-urban ecosystems of Nagpur and highlights their role as sensitive bioindicators of environmental quality. Through detailed habitat assessments, species documentation, and ecological interaction analysis, it is evident that butterfly diversity is closely linked with habitat quality, availability of native host and nectar plants, and the degree of anthropogenic disturbance. Areas with minimal human interference, abundant native vegetation, and ecological continuity, such as forest fringes and botanical gardens, support higher species richness and abundance. Conversely, highly urbanized and fragmented landscapes show reduced butterfly populations, indicating the adverse effects of urban expansion and habitat degradation. The seasonal variation in butterfly abundance, with peaks during the post-monsoon period, further emphasizes the importance of climatic and floral dynamics in shaping butterfly communities. The documented interactions between butterflies and plants not only aid in pollination but also maintain ecological networks crucial for biodiversity stability. These findings align with broader ecological principles and reinforce the need for biodiversity-sensitive urban planning.

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