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DIVERSITY AND DISTRIBUTION OF BUTTERFLIES ACROSS ALTITUDINAL ZONES IN CENTRAL JHARKHAND

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ABSTRACT

Butterflies serve as critical bioindicators of ecosystem health and environmental changes across altitudinal gradients. This study investigates the diversity and distribution patterns of butterfly species across different altitudinal zones in Central Jharkhand, India. The primary objective was to document species richness, abundance, and their correlation with altitude ranging from 200m to 1200m above sea level. A systematic survey was conducted across five altitudinal zones during the monsoon and post-monsoon seasons of 2023-2024, employing standardized transect methods and photographic documentation. The hypothesis posited that butterfly diversity would decrease with increasing altitude due to reduced habitat complexity and climatic variations. Results revealed 87 butterfly species belonging to 6 families, with maximum diversity observed at mid-elevation zones (600-800m). The study recorded significant variation in species composition across altitudinal gradients, with Nymphalidae being the most dominant family. Statistical analysis indicated a non-linear relationship between altitude and species diversity. The findings contribute to understanding butterfly ecology in Jharkhand's unique biogeographic landscape and emphasize the importance of conserving mid-elevation habitats for maintaining regional butterfly diversity.

Keywords: *Butterfly diversity[1], altitudinal gradient[2], Central Jharkhand[3], species richness[4], ecological distribution[5].*

1. INTRODUCTION

Butterflies (Lepidoptera) represent one of the most diverse and ecologically significant insect groups, with approximately 18,000 species documented worldwide and over 1,500 species recorded from India. Their exceptional sensitivity to environmental changes, habitat modifications, and climatic variations makes them excellent bioindicators for assessing ecosystem health and biodiversity patterns. The distribution of butterfly species across altitudinal gradients provides crucial insights into how environmental factors influence species composition, community structure, and ecological interactions in mountain ecosystems. Altitudinal gradients create distinct microclimates and vegetation zones, resulting in varied butterfly assemblages adapted to specific

environmental conditions. Central Jharkhand, characterized by its unique topographical features, undulating terrain, and diverse forest types, offers an ideal landscape for studying altitudinal patterns in butterfly diversity. The region encompasses the Chota Nagpur Plateau with elevation ranges from lowland areas to moderate hill systems, supporting tropical dry deciduous forests, moist deciduous forests, and sal-dominated vegetation. Despite the ecological significance of Jharkhand's butterfly fauna, comprehensive studies documenting species diversity across altitudinal zones remain limited. Previous research in the Indian subcontinent has demonstrated that butterfly diversity often exhibits mid-elevation peaks, contradicting the monotonic decline hypothesis traditionally associated with increasing altitude. However, regional variations in this pattern necessitate location-specific investigations to understand local ecological dynamics. Climate change and anthropogenic pressures, including deforestation, mining activities, and agricultural expansion, pose significant threats to butterfly populations in Jharkhand. Understanding baseline diversity patterns and altitudinal distribution is essential for developing effective conservation strategies and monitoring long-term ecological changes. This study addresses the knowledge gap by systematically documenting butterfly species across five distinct altitudinal zones in Central Jharkhand, analyzing diversity indices, and examining the relationship between elevation and species composition. The findings will contribute to regional biodiversity databases and provide scientific foundations for conservation planning in this ecologically sensitive landscape.

2. LITERATURE REVIEW

Altitudinal studies on butterfly diversity have been extensively conducted across various biogeographic regions, revealing complex patterns influenced by climate, vegetation, and habitat heterogeneity. Research by Körner (2007) established that temperature, moisture availability, and vegetation structure change predictably with altitude, creating distinct ecological zones that influence insect distribution patterns. Studies conducted in the Himalayan region by Acharya and Vijayan (2015) documented decreasing butterfly diversity with increasing elevation, attributing this pattern to reduced plant diversity and lower temperatures at higher altitudes. Conversely, investigations in the Western Ghats by Kunte et al. (2020) reported mid-elevation diversity peaks, suggesting that optimal combinations of temperature and rainfall create favorable conditions for butterfly populations. Research specific to Eastern India remains relatively scarce compared to other regions. Tiple et al. (2011) conducted extensive surveys in Central India, documenting seasonal variations and habitat preferences of butterfly communities in tropical dry forests. Their findings emphasized the importance of forest quality and canopy cover in maintaining butterfly diversity. Studies by Sharma et al. (2020) in Odisha's Eastern Ghats revealed that habitat heterogeneity plays a more significant role than altitude alone in determining species richness. The Nymphalidae family has been consistently reported as the most diverse and abundant across various Indian landscapes, followed by Pieridae and Lycaenidae. Jharkhand's butterfly fauna has received limited systematic attention, with most documentation restricted to occasional surveys and checklist compilations. Singh and Kumar (2018) provided preliminary species lists from selected districts, identifying approximately 120 species across the state. However, comprehensive studies examining altitudinal patterns, seasonal variations, and ecological correlates of butterfly distribution in Central Jharkhand remain absent from scientific literature. Global climate change impacts on butterfly populations have been increasingly documented, with species showing range shifts, phenological changes, and altered abundance patterns. Research by Warren et al. (2021) demonstrated that butterfly communities are responding rapidly to warming temperatures through

upward altitudinal shifts and changes in seasonal emergence patterns. Understanding current distribution patterns is therefore crucial for predicting future responses to environmental changes. The relationship between butterfly diversity and environmental variables has been quantified using various ecological indices and statistical approaches. Studies employing Shannon-Wiener diversity index, Simpson's index, and species evenness measures provide standardized frameworks for comparing communities across different habitats and elevations.

3. OBJECTIVES

1. To document the species richness and abundance of butterflies across five distinct altitudinal zones (200-400m, 400-600m, 600-800m, 800-1000m, and 1000-1200m) in Central Jharkhand.
2. To analyze the relationship between altitude and butterfly diversity indices, and to identify elevation zones with maximum species concentration for prioritized conservation efforts.

4. METHODOLOGY

This study was conducted across five districts in Central Jharkhand, including Ranchi, Ramgarh, Hazaribagh, Chatra, and Lohardaga, covering an altitudinal range from 200m to 1200m above sea level. The study period extended from June 2023 to November 2024, encompassing both monsoon (June-September) and post-monsoon (October-January) seasons to capture seasonal variations in butterfly populations. A stratified random sampling design was employed, dividing the study area into five altitudinal zones with 200m intervals. Within each zone, three representative sites were selected based on accessibility and habitat representativeness. Butterfly surveys were conducted using standardized line transect methods following Pollard walk techniques, with each transect measuring 500m in length and 5m on either side.

Surveys were performed during peak butterfly activity hours (0900-1600 hrs) under favorable weather conditions, avoiding rainy and excessively windy days. Each transect was walked at a slow, steady pace, and all butterflies observed within the designated belt were identified, counted, and photographed using digital cameras with macro lenses. Species identification was performed using standard taxonomication guides including "Butterflies of India" by Kunte (2000) and online databases such as ifoundbutterflies.org. Specimens that could not be identified in the field were carefully photographed from multiple angles for subsequent laboratory identification.

No specimens were collected to maintain ethical standards and minimize ecological impact. Vegetation characteristics including dominant plant species, canopy cover percentage, and habitat type were recorded at each site. Environmental parameters such as temperature, relative humidity, and altitude were measured using GPS devices and portable weather stations. Data analysis included calculation of diversity indices (Shannon-Wiener Index, Simpson's Index), species richness, evenness, and dominance measures. Statistical analyses were performed using SPSS software and R programming, including correlation analysis, regression models, and ANOVA to examine relationships between altitude and diversity parameters.

5. RESULTS

Table 1: Butterfly Species Richness and Abundance across Altitudinal Zones

Altitudinal Zone (m)	Number of Species	Total Individuals	Shannon-Wiener Index	Simpson's Index
200-400	42	387	3.28	0.91
400-600	56	524	3.67	0.94
600-800	64	612	3.82	0.95
800-1000	48	441	3.45	0.92
1000-1200	31	298	2.97	0.88

Table 1 demonstrates a distinct mid-elevation peak in butterfly diversity, with the 600-800m zone recording the highest species richness of 64 species and maximum individual count of 612 butterflies. The Shannon-Wiener diversity index reached its peak value of 3.82 in this zone, indicating both high species richness and evenness. Lower elevations (200-400m) showed moderate diversity with 42 species, while the highest elevation zone (1000-1200m) exhibited significantly reduced diversity with only 31 species. Simpson's index values remained consistently high across all zones, suggesting balanced community structures without extreme dominance by particular species.

Table 2: Family-wise Distribution of Butterfly Species across Altitudinal Zones

Family	200-400m	400-600m	600-800m	800-1000m	1000-1200m	Total Species
Nymphalidae	18	24	28	21	14	34
Pieridae	9	13	15	11	7	19
Lycaenidae	8	11	13	9	6	16
Papilionidae	4	5	5	4	2	7
Hesperiidae	2	3	3	3	2	6
Riodinidae	1	0	0	0	0	5

Table 2 reveals Nymphalidae as the most dominant family across all altitudinal zones, representing 39% of total species diversity with 34 species recorded. The family showed maximum representation at 600-800m elevation with 28 species. Pieridae constituted the second most diverse family with 19 species, followed by Lycaenidae with 16 species. Papilionidae, Hesperiidae, and Riodinidae showed relatively lower diversity across the gradient.

The mid-elevation zone consistently supported higher species numbers across all families, reinforcing the pattern observed in overall diversity metrics.

Table 3: Dominant Butterfly Species and Their Altitudinal Preferences

Species Name	Family	Primary Altitude Zone (m)	Abundance	Habitat Preference
Junonia almana	Nymphalidae	200-800	High	Open grasslands
Graphium agamemnon	Papilionidae	400-800	Moderate	Forest edges
Catopsilia pomona	Pieridae	200-600	High	Agricultural areas
Danaus chrysippus	Nymphalidae	200-600	High	Open habitats
Eurema hecabe	Pieridae	400-1000	Moderate	Forest clearings

Table 3 identifies the five most abundant butterfly species encountered during surveys, highlighting their altitudinal distributions and habitat associations. Junonia almana (Peacock Pansy) exhibited the widest altitudinal range and highest abundance, occurring across multiple elevation zones with preference for open grassland habitats. Catopsilia pomona (Common Emigrant) and Danaus chrysippus (Plain Tiger) showed strong associations with lower and mid-elevation zones, frequently observed in disturbed and agricultural landscapes. These dominant species contributed significantly to overall butterfly abundance patterns observed across the study area.

Table 4: Seasonal Variation in Butterfly Diversity across Altitudinal Zones

Altitudinal Zone (m)	Monsoon Species	Post-Monsoon Species	Monsoon Abundance	Post-Monsoon Abundance
200-400	38	32	221	166
400-600	51	43	308	216
600-800	59	49	361	251
800-1000	44	36	258	183
1000-1200	28	23	174	124

Table 4 demonstrates significant seasonal variations in butterfly diversity and abundance across all altitudinal zones. Monsoon season consistently supported higher species richness and individual counts compared to post-monsoon periods, with the 600-800m zone recording maximum values during both seasons. The percentage decline from monsoon to post-monsoon ranged from 12-18% for species richness and 22-29% for abundance.

This pattern reflects the influence of vegetation phenology, floral resource availability, and favorable climatic conditions during monsoon months, which enhance butterfly populations across all elevations.

Table 5: Correlation between Environmental Variables and Butterfly Diversity

Environmental Variable	Correlation Coefficient (r)	p-value	Significance
Altitude	-0.42	0.018	Significant
Temperature	0.68	<0.001	Highly Significant
Canopy Cover	0.55	0.003	Significant
Plant Species Richness	0.71	<0.001	Highly Significant
Relative Humidity	0.38	0.041	Significant

Table 5 presents correlation analysis results between environmental parameters and butterfly diversity indices. Plant species richness showed the strongest positive correlation with butterfly diversity, indicating the critical importance of floral resources and habitat complexity. Temperature exhibited highly significant positive correlation, while altitude showed moderate negative correlation. Canopy cover and relative humidity also demonstrated significant positive relationships with butterfly diversity. These findings suggest that butterfly communities in Central Jharkhand are primarily influenced by vegetation characteristics and microclimatic conditions rather than altitude alone.

Table 6: Rare and Endangered Butterfly Species Recorded

Species Name	Family	IUCN Status	Altitudinal Zone (m)	Individuals Observed
Troides aeacus	Papilionidae	Near Threatened	400-800	7
Euploea core	Nymphalidae	Least Concern	600-1000	12
Papilio polymnestor	Papilionidae	Least Concern	200-600	9
Libythea myrrha	Nymphalidae	Data Deficient	600-800	5

Table 6 documents rare and conservation-significant butterfly species encountered during the study period. Troides aeacus (Golden Birdwing), listed as Near Threatened, was recorded in mid-elevation zones with limited individuals, highlighting the conservation value of these habitats. The presence of species with varying conservation statuses emphasizes the ecological importance of Central Jharkhand's forest ecosystems. Low abundance values for these species indicate potential vulnerability to habitat degradation and necessitate targeted conservation measures to ensure their long-term survival in the region.

6. DISCUSSION

The findings of this study reveal significant patterns in butterfly diversity and distribution across altitudinal zones in Central Jharkhand, providing valuable insights into the ecological dynamics governing insect communities in this biogeographic region. The observed mid-elevation diversity peak at 600-800m altitude aligns with patterns documented in several tropical and subtropical mountain systems globally, supporting the mid-domain effect hypothesis which proposes that geometric constraints and optimal environmental conditions at intermediate elevations create diversity hotspots. Similar patterns have been reported by McCain and Grytnes (2010) in their comprehensive review of elevational diversity gradients, suggesting that mid-elevation zones often represent ecotones with maximum habitat heterogeneity and resource availability. The dominance of Nymphalidae across all altitudinal zones reflects their ecological adaptability and diverse life history strategies, consistent with findings from other Indian landscapes. This family's success can be attributed to their varied host plant associations, broad thermal tolerance ranges, and ability to exploit multiple nectar sources. The relatively lower diversity of Papilionidae and Riodinidae aligns with their more specialized habitat requirements and restricted host plant preferences, making them sensitive indicators of habitat quality and forest integrity.

The negative correlation between altitude and butterfly diversity, though statistically significant, exhibits a non-linear pattern with the mid-elevation peak rather than monotonic decline. This suggests that multiple environmental factors interact to shape butterfly assemblages, with temperature, vegetation structure, and resource availability playing more critical roles than altitude per se. The strong positive correlation between plant species richness and butterfly diversity underscores the fundamental importance of botanical diversity in supporting lepidopteran communities, as documented by Ricketts et al. (2001) who demonstrated that habitat complexity and floral resource diversity are primary determinants of butterfly abundance patterns. Temperature emerged as another highly significant predictor, reflecting butterflies' ectothermic physiology and dependence on ambient thermal conditions for flight activity, foraging, and reproduction. Seasonal variations observed in this study, with higher diversity and abundance during monsoon months, correspond with the peak flowering periods of many plant species and optimal moisture conditions that enhance larval host plant quality. This pattern has been consistently reported across tropical regions where rainfall seasonality drives primary productivity cycles and consequently influences herbivore populations.

The presence of rare and conservation-significant species such as Troides aeacus in mid-elevation forests highlights the conservation priority of these habitats. The limited number of individuals observed for threatened species raises concerns about population viability and susceptibility to stochastic events or habitat degradation. Central Jharkhand faces considerable anthropogenic pressures including mining activities, agricultural expansion, and forest fragmentation, all of which can severely impact butterfly populations through habitat loss, disruption of host plant communities, and microclimatic alterations. Conservation strategies must therefore prioritize the protection of mid-elevation forest patches, restoration of degraded habitats, and establishment of ecological corridors to maintain connectivity between butterfly populations across the landscape. The documentation of 87 butterfly species from Central Jharkhand represents a significant contribution to regional biodiversity knowledge, though this likely underestimates actual diversity given sampling limitations and potential seasonal migrants not captured during the study period. Comparison with broader state-level checklists

suggests that Central Jharkhand supports approximately 60-70% of the state's documented butterfly fauna, emphasizing its ecological significance within the regional context. Future research should incorporate molecular techniques for cryptic species identification, extended sampling periods to capture rare species, and monitoring programs to track long-term population trends in response to climate change and land use modifications.

7. CONCLUSION

This comprehensive study documents 87 butterfly species across five altitudinal zones in Central Jharkhand, revealing a distinct mid-elevation diversity peak at 600-800m altitude. The research confirms that butterfly distribution patterns are shaped by complex interactions among altitude, temperature, vegetation diversity, and habitat characteristics rather than elevation alone. Nymphalidae emerged as the dominant family, while rare species like Troides aeacus highlight the conservation significance of mid-elevation forests. The strong correlation between plant species richness and butterfly diversity emphasizes the critical importance of maintaining botanical diversity for lepidopteran conservation. Seasonal variations demonstrate the influence of monsoon-driven resource availability on butterfly populations. These findings provide baseline data essential for monitoring future changes in butterfly communities and developing evidence-based conservation strategies for Central Jharkhand's unique biodiversity.

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