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BUTTERFLY SPECIES RICHNESS AND MICROHABITAT ASSOCIATIONS IN DNYANGANGA WILDLIFE SANCTUARY, BULDANA DISTRICT, MAHARASHTRA

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Abstract: The present study was conducted in Dnyanganga Wildlife Sanctuary (DWS), located in Buldana district, Maharashtra, to assess butterfly diversity across five major families: Papilionidae, Pieridae, Nymphalidae, Lycaenidae, and Hesperidae. Using diversity indices such as the Shannon-Wiener Index (H), Simpson's Index (D), Evenness (E), and Species Richness (S), the study revealed significant variation in species composition and ecological dominance. A total of 79 species were recorded, with Nymphalidae (32.91%) emerged as the most abundant and diverse family, indicating high ecological stability and adaptability, followed by Lycaenidae (25.31%) and Pieridae (17.72%). Hesperidae (12.66%) and Papilionidae (11.40%) showed lower diversity and more restricted habitat representation. The results underscore the significance of ecological traits like dispersal ability and host plant range in shaping diversity, and highlight the need to conserve varied habitats to support both dominant and sensitive butterfly families.

Keywords: Biodiversity indices, Butterfly diversity, DWS, Microhabitat, Species inventory.

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INTRODUCTION

Dnyanganga Wildlife Sanctuary (DWS) offers a favorable environment for butterfly fauna due to its rich floral diversity, varied topography, and relatively undisturbed habitats. The sanctuary's landscape comprising dry and moist deciduous forests, well open grasslands, and riverine ecosystems, provides a mosaic of microhabitats essential for different butterfly species. The availability of host plants for caterpillars and nectar-rich flowers for adult butterflies supports various life stages of Lepidoptera. Seasonal streams help maintain adequate humidity and vegetation growth, particularly during the monsoon, which triggers butterfly emergence and breeding activity.

The butterflies are classified under the order Lepidoptera, the second-largest group within the class Insecta (largest class of animals), which

includes both butterflies and moths (Arya, 2003; Verma, 2017; Verma and Prakash, 2020). They are considered among the most beautiful and visually appealing insects (Dawar *et al.,* 2024; Arya, 2019). Butterflies are distributed worldwide and inhabit a wide range of suitable environments, including forests, deserts, plains, valleys, and hills, with the exception of the Polar regions (Nair *et al.,* 2018; Abdullahi *et al.,* 2019; Kumari *et al.,* 2023). India supports a rich butterfly diversity, with an estimated 1,504 species found throughout the country. Of these, the Indian Peninsular region supports about 351 species, while the Western Ghats are home to around 334 species (Mohapatra *et al.,* 2013; Ayesha *et al.,* 2022). In the Vidarbha region alone, 167 butterfly species have been identified, belonging to 90 different genera (Tiple, 2011).

The butterflies represent a vital component of biodiversity (Wadatkar and Kasambe, 2009). In addition to their aesthetic appeal, they serve as reliable bioindicators of habitat quality and overall environmental health (Padhye *et al.,* 2012). Their role in ecosystem functioning is also significant, particularly through pollination and interactions with various plant and animal species. By feeding on nectar and unintentionally transferring pollen between flowers, butterflies play a crucial role in plant reproduction, which is essential for preserving plant biodiversity (Pahade, 2024). Both the larval and adult stages of butterflies are key elements in the food web, serving as prey for birds, reptiles, spiders, and other predatory insects (Chande *et al.,* 2013; Sharma and Goswami, 2021). The butterflies are highly sensitive organisms that are significantly impacted by changes in environmental factors such as temperature, rainfall patterns, and humidity. Additionally, human activities, including deforestation, construction, pollution, grazing, agricultural practices, and urbanization, pose significant threats to entire biota including butterflies (Parandhaman *et al.,* 2012; Prakash and Verma, 2022; Singh *et al.,* 2023). This study focuses on documenting the butterfly fauna across these microhabitats and evaluating diversity patterns to better understand their ecological preferences and to support conservation strategies in this lesser-known sanctuary.

MATERIALS AND METHODS

Study Area

The Dnyanganga Wildlife Sanctuary (fig. 1) located in Buldana District, Maharashtra, is a biodiversity-rich area that plays a crucial role in the conservation of flora and fauna. The sanctuary spans approximately 205 square kilometers, with varying 76°15' E to 76°27' E longitude and 20°28' N to 20°39' N latitude, providing diverse microhabitats such as Forest Edges, Grasslands, Riparian Zones, Rocky Outcrops, and Shrublands. These diverse microhabitats provide shelter, food, and breeding grounds for a variety of species, including numerous butterfly species, which are important pollinators and bioindicators of ecosystem health. The sanctuary is named after the Dnyanganga River, which flows through the region and provides a key water source for both wildlife and vegetation.

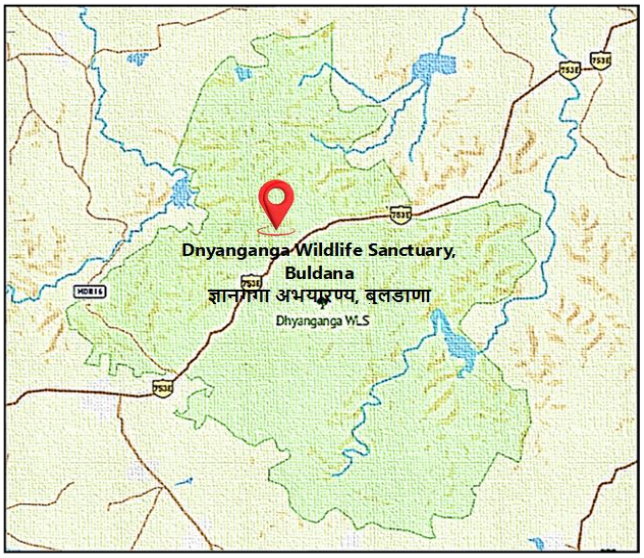

Fig.1: Study area of Dnyanganga Wildlife Sanctuary, Buldana (Source: Google Earth).

Survey method

Field surveys were conducted from October 2023 to December 2024, covering both dry and wet seasons to capture seasonal variation in butterfly presence. The observations were carried out in the morning between 8:00 and 11:00 am and in the afternoon between 2:00 and 4:00 pm by using the line transect method, with each 500-meter transect walked slowly during favorable weather conditions.

Species Identification and Documentation

Species were photographed using a NIKON COOLPIX P950 camera. The aim was to capture sufficient photographs for positive species identification. Colour patterns, sizes, and shapes, as well as their designs, were considered in the identification of the species of butterfly. Species identified using standard field guide keys, including The Book of Indian Butterflies by (Kehimkar, 2008) and Guide to Butterflies of Western Ghats (India) by (Bhakare and Ogale, 2018) as well as research papers, articles, and websites.

Species Diversity analysis

Butterfly Diversity indices were calculated using statistical methods, including the Shannon-Wiener Diversity Index (H), Species Richness (S), Evenness Index (E), and Simpson's Diversity Index (D).

a) Shannon-Wiener Diversity Index (H):

$H = \Sigma [(Pi) \ln (Pi)]$

Where, H = Shannon-Weiner Index

Pi = ni/N

Σ = Sum

Where, ni = Number of individuals of each species

N= Total number of individuals of all species

Ln = Natural logarithm

b) Species Richness (S):

Margalef's Index = $(S-1) / \ln N$

Where, S = Total species number

N = Total number of individuals in sample

Ln = Natural logarithm

c) Evenness Index (E):

$E = H / \ln S$

Where, S= Total number of species

N= Total number of individuals of all the species

H = Index of diversity sampling of butterflies

d) Simpson's Diversity Index (D):

$D = \sum n_i(n_i-1)/N (N-1)$

Where, D = Simpson Index of Diversity

Σ = Sum of (Total)

n = the number of individuals of each different species

N = the total number of individuals of all the species

RESULTS AND DISCUSSION

The analysis of butterfly diversity across five major families like Papilionidae, Pieridae, Nymphalidae, Lycaenidae, and Hesperiidae, reveals distinct patterns in diversity and ecological dominance (table 1).

Nymphalidae emerges as the most dominant family in terms of both abundance and diversity, with the highest number of individuals (510) and species richness (S = 26). It also records the highest Shannon-Wiener Diversity Index (H = 3.1201) and Evenness Index (E = 0.9576), indicating a well-balanced species distribution with minimal dominance by any single species. It's Simpson's Diversity Index (D = 0.9382) further confirms high biodiversity and ecological stability, suggesting that this family occupies a wide range of ecological niches and likely benefits from a broad host plant range and habitat adaptability. Closely following Nymphalidae, the family Lycaenidae ranks second, with 478 individuals and 20 species, and strong diversity scores (H = 2.5737, D = 0.9328, E = 0.8591), suggesting a similarly stable and well-distributed population (table 2). This family's performance indicates strong habitat suitability and a diverse assemblage that is moderately evenly distributed.

Table 1: Butterfly diversity found in Dnyanganga Wildlife Sanctuary, Buldana.

S. No.	Common Name	Scientific Name	Microhabitat type
Family: Papilionidae			
1.	Common Windmill	*Byasa polyeuctes*	FE, RZ,
2.	Tailed Jay	*Graphium agamemnon* (Linnaeus)	FE, G, RZ
3.	Glassy Bluebottle	*Graphium cloanthus*	FE, RZ

4.	Spot Swordtail	*Graphium nomius* (Esper)	FE, RZ
5.	Common Bluebottle	*Graphium sarpedon* (Linnaeus)	FE, RZ
6.	Common Rose	*Pachliopta aristolochiae* (Fabricius)	FE, RZ
7.	Crimson Rose	*Pachliopta hector* (Linnaeus)	FE, RZ
8.	Lime Butterfly	*Papilio demoleus* (Linnaeus)	FE, G, S
9.	Common Mormon	*Papilio polytes* (Linnaeus)	FE, G, RZ, S
Family: Pieridae			
10.	Pioneer	*Anaphaeis aurota* (Fabricius)	G, RO, S
11.	Common Emigrant	*Catopsilia pomona* (Fabricius)	FE, G, RZ, S
12.	Mottled Emigrant	*Catopsilia pyranthe* (Linnaeus)	FE, G, RZ, S
13.	Common Gull	*Cepora nerissa* (Fabricius)	FE, RZ
14.	Small Salmon Arab	*Colotis amata* (Butler)	G, RO, S
15.	Crimson Tip	*Colotis danae* (Fabricius)	G, RO, S
16.	Small Orange Tip	*Colotis etrida* (Boisduval)	G, RO, S
17.	Plain Orange Tip	*Colotis eucharis* (Fabricius)	G, S
18.	Three-spot Grass Yellow	*Eurema blanda* (Boisduval)	FE, G, RZ, S
19.	Small Grass Yellow	*Eurema brigitta* (Cramer)	FE, G, RZ, S
20.	Common Grass Yellow	*Eurema hecabe* (Linnaeus)	FE, G, RZ, S
21.	White Orange Tip	*Ixias marianne* (Cramer)	G, RO, S
22.	Psyche	*Leptosia nina* (Fabricius)	FE, RZ, S
23.	Common Wanderer	*Pareronia valeria* (Cramer)	FE, RZ
Family: Nymphalidae			
24.	Indian Fritillary	*Argynnis hyperbius*	FE, RO
25.	Common Castor	*Ariadne merione* (Cramer)	FE, S
26.	Great Satyr	*Aulocera padma*	FE, RO
27.	Painted Lady	*Cynthia cardui* (Linnaeus)	FE, G, RO, S
28.	Common Mapwing	*Cyrestis thyodamas*	FE, RZ
29.	Plain Tiger	*Danaus chrysippus* (Linnaeus)	FE, G, RZ, S
30.	Striped Tiger	*Danaus genutia* (Cramer)	FE, G, RZ, S
31.	CommonBaron	*Euthalia aconthea* (Cramer)	FE
32.	Purple Sapphire	*Heliophorus epicles*	FE, RO
33.	Great Egg Fly	*Hypolimnas bolina* (Linnaeus)	FE, RZ, S
34.	Queen Of Spain Fritillary	*Issoria issaea* (Doherty)	FE, RO
35.	Grey Pansy	*Junonia atlites* (Linnaeus)	FE, G, RZ, RO, S
36.	Chocolate Pansy	*Junoni aiphita* (Cramer)	FE, G, RZ, RO, S
37.	Lemon Pansy	*Junonia lemonias* (Linnaeus)	FE, G, RZ, RO, S
38.	Blue Pansy	*Junonia orithya* (Linnaeus)	FE, G, RZ, RO, S
39.	Orange Oakleaf	*Kallima inachus*	FE
40.	Blue Admiral Butterfly	*Kaniska canace*	FE
41.	Common Treebrown	*Lethe rohria* (Fabricius)	FE

42.	Common Evening Brown	*Melanitis leda* (Linnaeus)	FE, G, RZ, S
43.	Common Bushbrown	*Mycalesis perseus* (Fabricius)	FE, S
44.	Common Sailer	*Neptis hylas* (Linnaeus)	FE, RZ,
45.	Chestnut Tiger	*Parantica sita*	FE, RZ
46.	Common Leopard	*Phalanta phalantha* (Drury)	FE, G, RZ, S
47.	Blue Tiger	*Tirumala limniace* (Cramer)	FE, RZ,
48.	Indian Red Admiral	*Vanessa indica*	FE, RO
49.	Large Three Ring	*Ypthima nareda*	FE, G, S
Family: Lycaenidae			
50.	Common Hedge Blue	*Acytolepis puspa* (Horsfield)	FE, RZ, S
51.	Leaf Blue	*Amblypodia anita* (Hewitson)	FE
52.	Large Oak Blue	*Arhopala amantes* (Hewitson)	FE
53.	Bright Babul Blue	*Azanus ubaldus* (Stoll)	G, RO, S
54.	Common Pierrot	*Castalius rosimon* (Fabricius)	FE, G, S
55.	Forget-Me-Not	*Catochrysops strabo* (Fabricius)	FE, G, S
56.	Lime Blue	*Chilades laius* (Stoll)	FE, G, S
57.	Plains Cupid	*Chilades pandava* (Horsfield)	FE, G, S
58.	Small Cupid	*Chilades parrhasius* (Butler)	FE, G, S
59.	Grass Jewel	*Chilades trochylus* (Freyer)	FE, G, S
60.	Gram Blue	*Euchrysops cnejus* (Fabricius)	FE, G, S
61.	Common Cerulean	*Jamides celeno* (Cramer)	FE, G, S
62.	Pea Blue	*Lampides boeticus* (Linnaeus)	FE, G, S
63.	Zebra Blue	*Leptotes plinius* (Fabricius)	FE, G, S
64.	Common Line Blue	*Prosotas nora* (C. Felder)	FE, S
65.	Pale Grass Blue	*Psuedozizeeria maha* (Kollar)	FE, G, S
66.	Shot Silverline	*Spindasis ictis* (Hewitson)	FE, S
67.	Common Silverline	*Spindasis vulcanus* (Fabricius)	FE, G, S
68.	Common Guava Blue	*Virachola isocrates* (Fabricius)	FE, S
69.	Tiny Grass Blue	*Zizula hylax* (Fabricius)	FE, G, S
Family: Hesperidae			
70.	Rice Swift	*Borbo cinnara* (Wallace)	FE, G, S
71.	Common Banded Awl	*Hasora chromus* (Cramer)	FE, RZ, S
72.	Plain Banded Awl	*Hasora vitta* (Butler)	FE, RZ
73.	Common Red eye	*Matapa aria* (Moore)	FE
74.	Indian/Common Dartlet	*Oriens goloides* (Moore)	FE, S
75.	Small Branded Swift	*Pelopidas mathias* (Fabricius)	FE, G, S
76.	Fulvous Pied Flat	*Pseudocoladenia dan* (Fabricius)	FE, G, S
77.	Common Small Flat	*Sarangesa dasahara*	FE, G, S
78.	Indian Palm Bob	*Suastus gremius* (Fabricius)	FE, G, S
79.	Indian Skipper	*Spialia galba* (Fabricius)	FE, RZ, S

FE: Forest Edges, **G**: Grasslands, **RZ**: Riparian Zones, **RO**: Rocky Outcrops, **S**: Shrublands

Table 2: Family wise diversity indices of different butterfly species at Dnyanganga Wildlife Sanctuary, Buldana.

S. No.	Family	Number of Individuals	Shannon-Wiener Diversity Index (H)	Species Richness (S)	Evenness Index (E)	Simpson's Diversity Index (D)
1.	Papilionidae	171	1.7182	09	0.7825	0.7935
2.	Pieridae	256	2.2433	14	0.8499	0.8649
3.	Nymphalidae	510	3.1201	26	0.9576	0.9382
4.	Lycaenidae	478	2.5737	20	0.8591	0.9328
5.	Hesperidae	141	1.7513	10	0.7970	0.8032

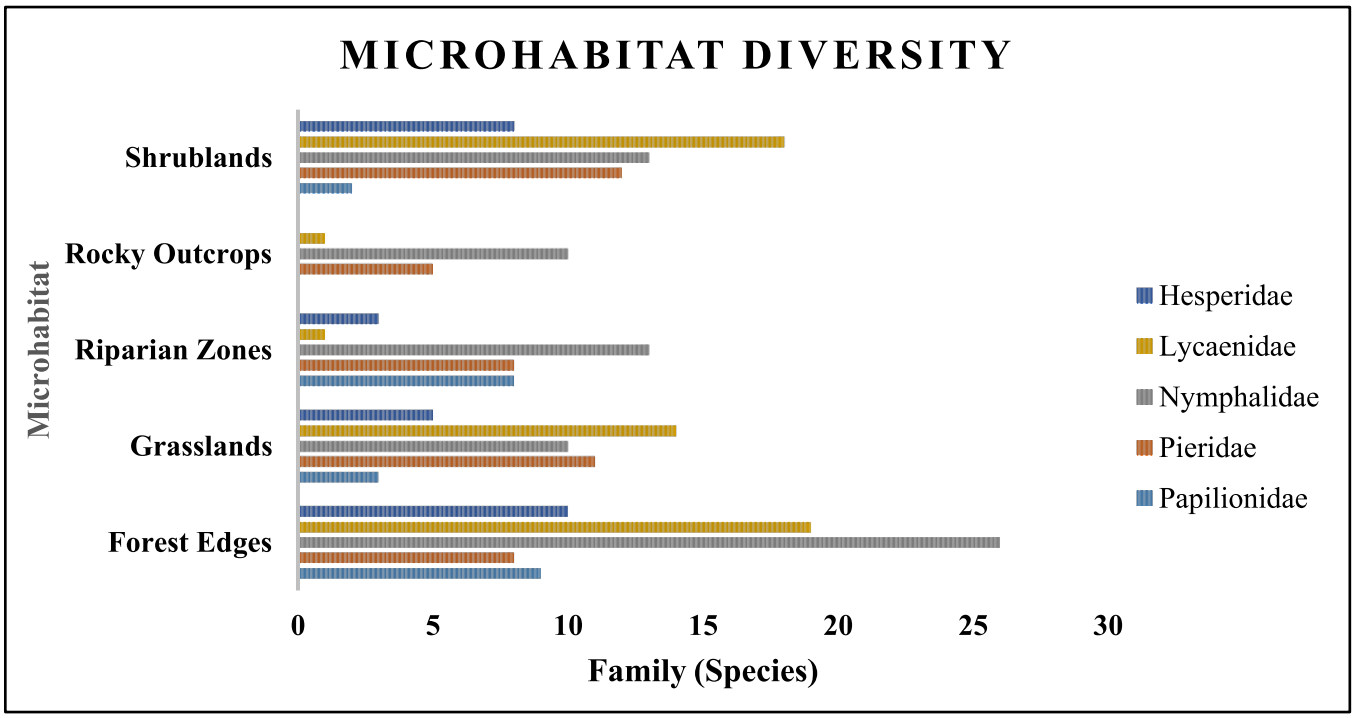

Fig. 2: Butterfly diversity varied significantly across microhabitats at Dnyanganga Wildlife Sanctuary, Buldana.

Table 3: Butterfly diversity varied significantly across microhabitats in Dnyanganga Wildlife Sanctuary, Buldana.

Family	Papilionidae	Pieridae	Nymphalidae	Lycaenidae	Hesperidae
Forest Edges	09	08	26	19	10
Grasslands	03	11	10	14	05
Riparian Zones	08	08	13	01	03
Rocky Outcrops	00	05	10	01	00
Shrublands	02	12	13	18	08

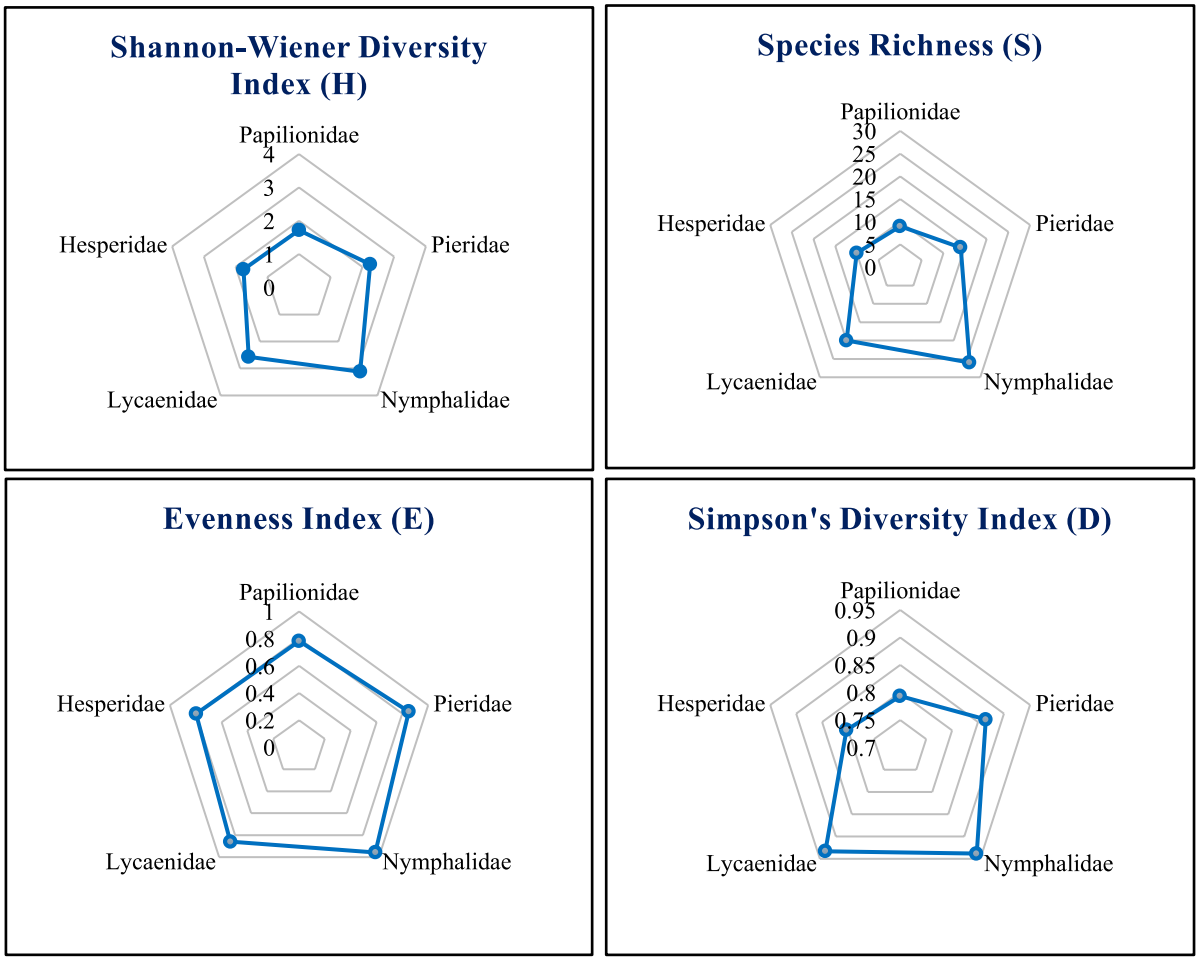

Fig. 3: Values of the butterfly diversity indices observed through the random sampling of butterflies in the Dnyanganga Wildlife Sanctuary (DWS).

Pieridae, with 256 individuals and 14 species, demonstrates moderate diversity (H = 2.2433, D = 0.8649, E = 0.8499), showing a balanced but less complex community compared to Nymphalidae and Lycaenidae. Hesperiidae has the lowest abundance (141 individuals) but slightly higher species richness (10 species) than Papilionidae, and records moderate diversity (H = 1.7513, D = 0.8032, E = 0.7970). In comparison, Papilionidae has 171 individuals and 9 species, with the lowest diversity values (H = 1.7182, D = 0.7935, E = 0.7825) except for slightly outperforming Hesperiidae in total abundance. While Nymphalidae and Lycaenidae dominate both in diversity and ecological spread, Pieridae occupies a middle ground, and Hesperiidae and Papilionidae show more limited ecological representation, possibly reflecting narrower habitat preferences or lower adaptability.

Diversity indices varied notably across butterfly families in Dnyanganga Wildlife Sanctuary, reflecting underlying biological and ecological differences. Families such as Nymphalidae, Lycaenidae, and Pieridae showed high diversity, likely due to broader ecological tolerance, larval host flexibility, and better dispersal capacity. In contrast, lower diversity in Papilionidae and Hesperiidae may suggest narrower ecological niches or sensitivity to habitat changes. Species distribution also varied across microhabitats such as Forest edges, Grasslands, Riparian zones, Rocky outcrops, and Shrublands (fig. 2; table 3). Generalist species like *Papilio polytes* and *Danaus genutia* occurred across multiple habitats, while specialists like *Kallima inachus* were restricted to shaded or moist environments. Grasslands and shrublands supported a high number of species due to the availability of host plants and nectar sources (fig. 3). These findings highlight the importance of microhabitat heterogeneity in maintaining butterfly diversity.

CONCLUSION

The present study of butterfly diversity in Dnyanganga Wildlife Sanctuary (DWS) reveals significant variation across families and microhabitats. Nymphalidae emerged as the most dominant and diverse, followed by Lycaenidae and Pieridae, indicating high adaptability and ecological range. Hesperiidae and Papilionidae showed lower diversity, suggesting narrower habitat preferences. These patterns reflect the influence of habitat heterogeneity on butterfly distribution. Maintaining diverse microhabitats is essential for conserving overall butterfly diversity, especially for ecologically sensitive species. The findings underscore the sanctuary's role as a vital refuge for both generalist and specialist butterfly species.

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