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Ecological Insights into Butterfly Diversity of Hari Ghel, Pakistan's Himalayan Foothills

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ABSTRACT

This study, conducted in Hari Ghel, Azad Jammu and Kashmir, from January 2020 to December 2021, examines the diversity and ecology of various butterfly species. The study shown a rich diversity of butterflies in Hari Ghel, with a total of 239 specimens collected from various localities. Ultimately, 27 different species (*Borbo bevani*, *Odontoptilum angulate*, *Aricia agestis*, *Heliophorus sena*, *Pseudozizeeria maha*, *Zizeeria karsandra*, *Argynnis hyberbius*, *Aulocera swaha*, *Callerebia annada*, *Junonia iphitha*, *J. orithya*, *Lasiommata schakra*, *Lethe confuse*, *Libythea lepita*, *Neptis Sappho*, *Vanessa cardui*, *Byasa dasarada*, *B. polyeuctes*, *Papilio demoleus*, *P. polytes*, *P. protenor*, *P. bianor*, *P. machaon*, *Colias erate*, *C. fieldii*, *Pontia daplidiceand* *Dodona durga*) belonging to six (i.e. Riodinidae, Hesperidae, Pieridae, Lycaenidae, Papilionidae and Nymphalidae) and 20 genera (i.e. *Borbo*, *Odontoptilum*, *Aricia*, *Heliophorus*, *Pseudozizeeria*, *Zizeeria*, *Argynnis*, *Aulocera*, *Callerebia*, *Lasiommata*, *Lethe*, *Libythea*, *Neptis*, *Vanessa*, *Pontia*, *Dodona*, *Junonia*, *Byasa*, *Colias* and *Papilio*). The research used a variety of diversity measures to assess butterfly biodiversity, including dominance (0.06522), Simpson Diversity Index (0.9348), Shannon Diversity Index (2.96), Evenness Index (0.7146), and Margalef Index (4.748). Most dominant species of butterflies in the study area are Painted lady, Common peacock, Blue pansy, Common Mormon, Common wall, Indian fritillary, Common yellow swallowtail, Great windmill and Common windmill.

KEYWORDS: Butterflies, Hari Ghel, Richness, Diversity, Himalayan

INTRODUCTION

In order to understand biodiversity, we study its biological indicators (Babar & Kanwal, 2021; Jacob *et al.*, 2024) and their Ecology (Hussain & Tanveer, 2023). The biodiversity of arthropods has been documented extensively in Pakistan (Bashir & Saddam, 2024; Jahangeer *et al.*, 2025; Shehzad *et al.*, 2025). Among insects, the lepidopteran fauna, particularly butterflies, serves as a notable indicator due to their abundant populations, short generation times, extensive movements, and high sensitivity to environmental changes (Pallottini *et al.*, 2023).

Insects constitute 53% of the 1.4 million species discovered on Earth, while the global population of butterflies is estimated to range between 15,000 to 16,000 species. Pakistan is home to approximately 5,000 species of insects, including 400 species of butterflies and moths. Butterflies are known to symbolize beauty and grace (Hassan, 1994; Khan *et al.*, 2007; Rafi, 2000). As diurnal insects, they are easily recognizable due to their vibrant colors and remarkable shapes. In addition, butterflies are noted for their artistic value as well as their effectiveness in

pollination, thus holding significant commercial value (Adams *et al.*, 2014; Nijhout, 1981).

Butterflies are among the most familiar insects to humans, known for their large size, vibrant colors, and affinity for sunlight. Their brilliant coloration captivates us and has earned them a prominent place in the literature and poetry of various cultures. Children, in particular, are often fascinated by these insects. Butterflies serve as important pollinators, ranking just after bees. The success of angiosperms relies heavily on these pollinating agents. In India, butterflies account for one-fifth of the world's total butterfly species, with the Himalayan mountain range hosting a significant portion of India's butterfly diversity (Haribal, 2000).

Butterflies are among the most beautiful and fascinating insects, distinguishing them from the other order Lepidoptera. The butterflies aid in pollination by flying from one plant to another. Most butterfly species are seasonally specific and prefer a certain, and they are excellent indicators of undesirable activities and disruptions in the ecosystem (Hassan, 1994; Kocher & Williams, 2000). Butterflies are

potentially effective biological indicators of urbanization because they respond to changes in microclimate (Pallottini *et al.*, 2023; Parmesan, 2003). The biodiversity of butterflies in Hari Ghel remains unknown. This study seeks to determine the diversity of butterflies in Hari Ghel, Pakistan's Himalayan Foothills.

MATERIALS AND METHODS

This study, conducted in Hari Ghel, Pakistan's Himalayan Foothills from January 2020 to December 2021, focuses on the diversity and ecology of different species of butterflies. Field work comprised both direct and indirect methods. Direct methods consisted of field photo and sight records. Indirect methods involved the collection of butterfly parts and local interviews to document knowledge. These

combined methods were helpful in providing information on the biological diversity of species, their habitats, and the ecological importance of butterflies in the region. add species identification details

Study area: The area of Hari Ghel is found in the lesser Himalayas (Figure 1). The area of research falls under moisture in excess of monsoon. Some small area of Hari Ghel is different from other areas regarding rainfall and humidity because there is variation in altitudes within the region. Summers are fairly mild while winters are very cold and snowy at higher levels. The mean rainfall recorded was: 150mm (Figure 1). Forest types is Himalayan Mixed Temperate Forests (Altaf & Umair, 2022; Bibi *et al.*, 2013; DRU, 2007; Imtiaz *et al.*, 2023).

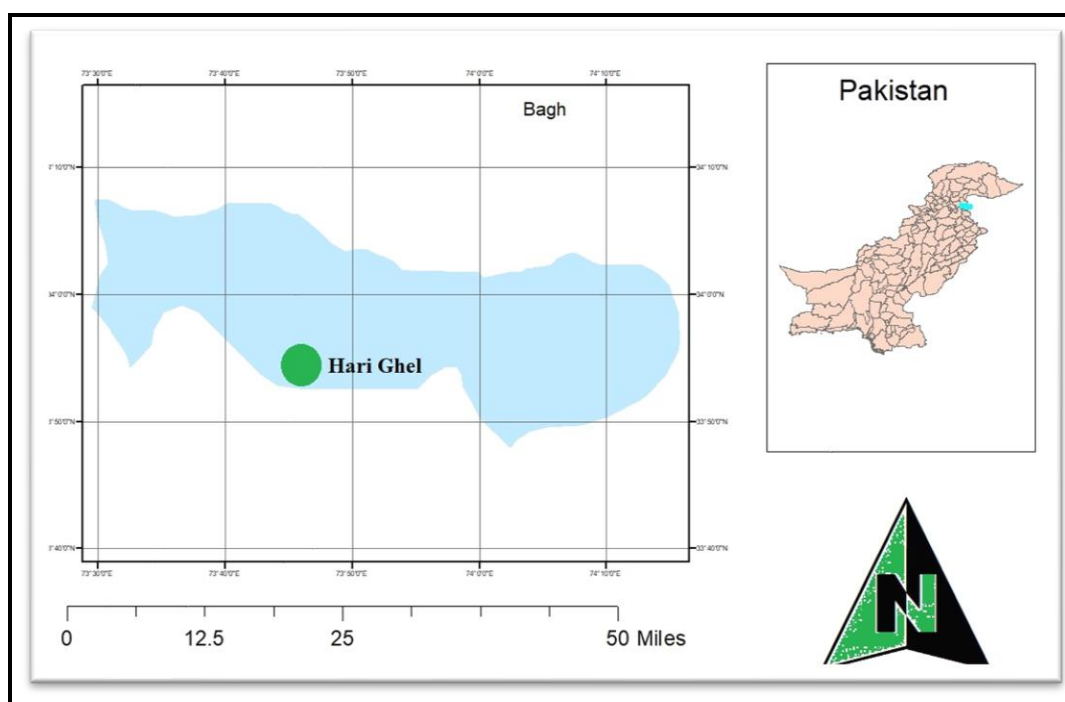


Figure 1. Map of the study area.

Statistical Analysis: The diversity parameters like Dominance, Simpson Diversity Index, Shannon Diversity Index, Evenness Index, and Margalef Index/ Richness were calculated using PAST Statistical Software (Version 5.1). Graphs are designed with the help of OrginPro (2023b) statistical software.

RESULTS AND DISCUSSION

In this study, a total of 239 specimens were collected from various localities from Arja. Total 27 different species (i.e. *Borbo bevani*, *Odontoptilum angulate*, *Aricia agestis*, *Heliophorus sena*, *Pseudozizeeria maha*, *Zizeeria karsandra*, *Argynnis hyberbius*, *Aulocera swaha*, *Callerebia annada*, *Junonia ipthita*, *J. orithya*, *Lasiommata schakra*, *Lethe confuse*, *Libythea lepita*, *Neptis Sappho*, *Vanessa cardui*, *Byasa dasarada*, *B. polyeuctes*, *Papilio demoleus*, *P. polytes*, *P. protenor*, *P. bianor*, *P. machaon*, *Colias erate*, *C. fieldii*, *Pontia daplidiceand* *Dodona durga*) (Table 1) belonging to

six families (i.e. Riodinidae, Hesperidae, Pieridae, Lycaenidae, Papilionidae and Nymphalidae) (Figure 2) and 20 genera (i.e. *Borbo*, *Odontoptilum*, *Aricia*, *Heliophorus*, *Pseudozizeeria*, *Zizeeria*, *Argynnis*, *Aulocera*, *Callerebia*, *Lasiommata*, *Lethe*, *Libythea*, *Neptis*, *Vanessa*, *Pontia*, *Dodona*, *Junonia*, *Byasa*, *Colias* and *Papilio*) (Figure 3) were identified. This research represents a comprehensive exploration of butterflies in the Hari Ghel, AJK, Pakistan. Details of the collected species can be found in Table 1. Most dominant species in Hari Ghel, are Painted lady (*Vanessa cardui*), Common peacock (*Papilio bianor*), Blue pansy (*Junonia orithya*), Common Mormon (*Papilio polytes*), Common wall (*Lasiommata*

schakra), Indian fritillary (*Argynnis hyberbius*), windmill (*Byasa dasarada*) and Common windmill
Common yellow swallowtail (*Papilo machaon*), Great (*B. polyeuctes*) (Figure 4)

Table 1: Diversity of butterflies in Hari Ghel, AJ&K.

Common Name	Scientific Name	Species authority	Family	Relative abundance
Bevan's swift	<i>Borbo bevani</i>	(Moore, 1878)	Hesperiidae	0.03766
Chestnut angle	<i>Odontoptilum angulata</i>	(C. Felder, 1862)	Hesperiidae	0.00837
Common argus	<i>Arícia agestis</i>	(Denis & Schiffermüller, 1775)	Lycaenidae	0.01255
Sorrel sapphire	<i>Heliophorus sena</i>	(Kollar, 1844)	Lycaenidae	0.00837
Pale grass blue	<i>Pseudozizeeria maha</i>	(Kollar, 1844)	Lycaenidae	0.03347
Dark grass blue	<i>Zizeeria karsandra</i>	Moore, 1865	Lycaenidae	0.00837
Indian fritillary	<i>Argynnis hyberbius</i>	(Linnaeus, 1763)	Nymphalidae	0.06276
Common stayr	<i>Aulocera swaha</i>	Kollar, 1844	Nymphalidae	0.01674
Ringed argus	<i>Callerebia annada</i>	Moore, 1857	Nymphalidae	0.00837
Chocolate pansy	<i>Junonia iphitha</i>	(Cramer, 1779)	Nymphalidae	0.0251
Blue pansy	<i>Junonia orithya</i>	(Linnaeus, 1758)	Nymphalidae	0.08787
Common wall	<i>Lasiommata schakra</i>	(Kollar, 1844)	Nymphalidae	0.07531
Banded treebrown	<i>Lethe confusa</i>	Aurivillius, 1897	Nymphalidae	0.01255
Common beak	<i>Libythea lepita</i>	Moore, 1857	Nymphalidae	0.03347
Pallas sailer	<i>Neptis sappho</i>	Pallas, 1771	Nymphalidae	0.02092
Painted lady	<i>Vanessa cardui</i>	(Linnaeus, 1758)	Nymphalidae	0.13808
Great windmill	<i>Byasa dasarada</i>	(Moore, 1857)	Papilionidae	0.05858
Common windmill	<i>Byasa polyeuctes</i>	(Doubleday, 1842)	Papilionidae	0.04603
Common lime	<i>Papilio demoleus</i>	Linnaeus, 1758	Papilionidae	0.00837
Common mormon	<i>Papilio polytes</i>	Linnaeus, 1758	Papilionidae	0.08787
Spangle	<i>Papilio protenor</i>	Cramer, 1775	Papilionidae	0.00418
Common peacock	<i>Papilo bianor</i>	Cramer, 1777	Papilionidae	0.09623
Common yellow swallowtail	<i>Papilo machaon</i>	Linnaeus, 1758	Papilionidae	0.06276
Pale clouded yellow	<i>Colias erate</i>	(Esper, 1805)	Pieridae	0.00837
Dark clouded yellow	<i>Colias fieldii</i>	Ménétriés, 1855	Pieridae	0.01674
Bath white	<i>Pontia daplidice</i>	(Linnaeus, 1758)	Pieridae	0.00837
Common punch	<i>Dodona durga</i>	(Kollar & Redtenbacher, 1844)	Riodinidae	0.01255

Table 2: Statistical analysis of Butterflies of the study area.

Diversity Indices	Number
Species	27
Population	239
Dominance	0.0652
Simpson diversity index	0.9348
Shannon diversity index	2.96
Evenness index	0.7146
Margalef/ Richness index	4.748

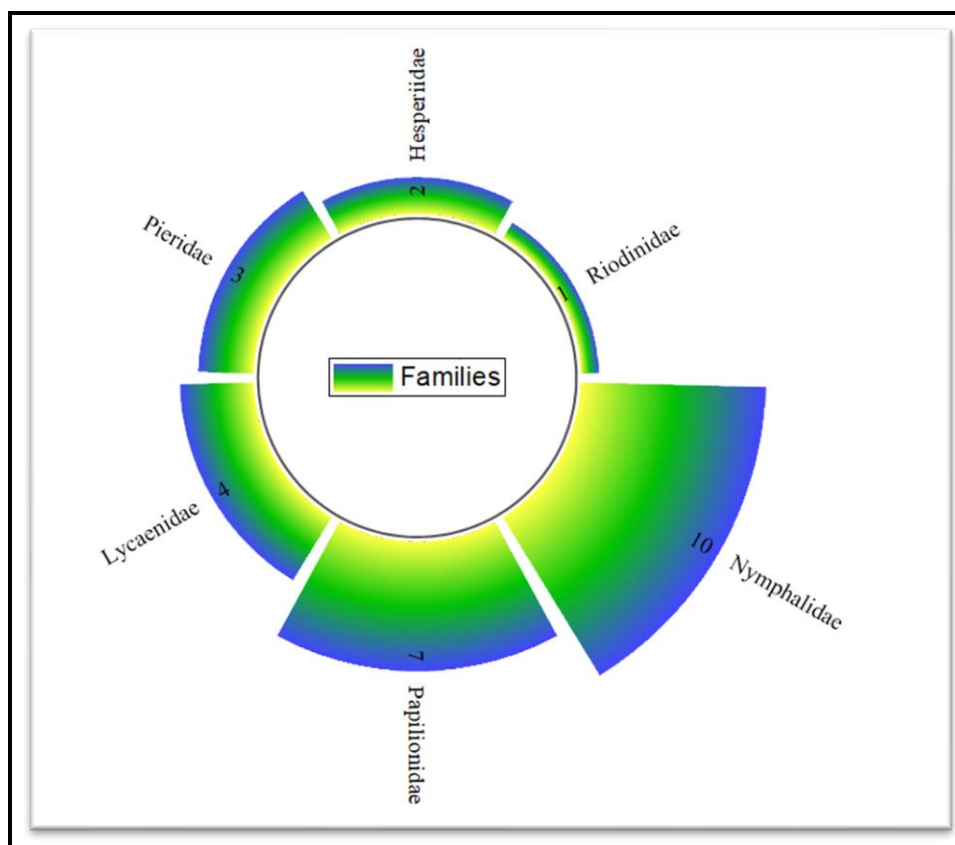


Figure 2: Families of butterflies in the study area.

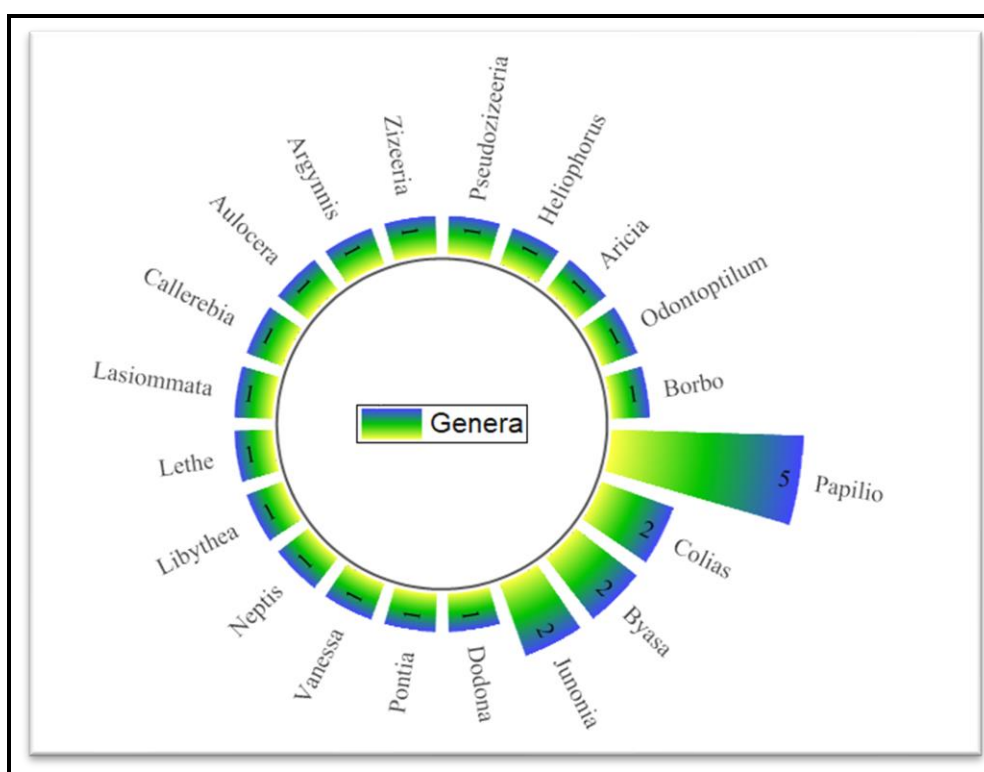


Figure 3. Genera of butterflies in the study area.

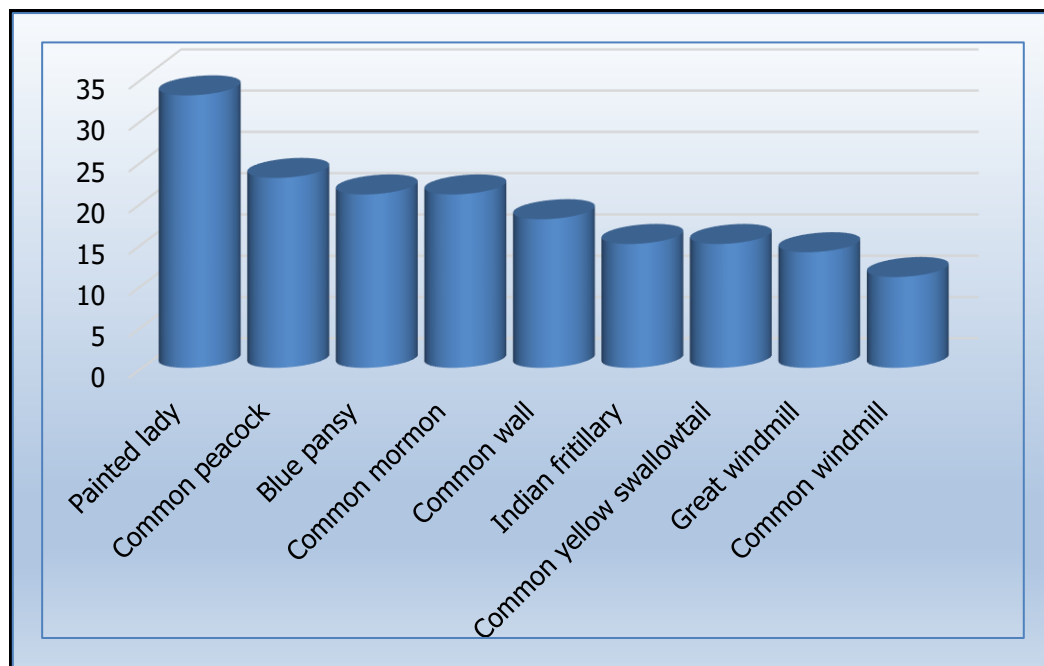


Figure 4: Dominant species of butterflies in the study area.

Haroon and Ahmad (2013) documented 232 butterflies, including 13 species, collected from Koaz Bahram Dheri in Khyber Pakhtunkhwa, Pakistan. Khan *et al.* (2007) reported 16 butterfly species from Kotli, 20 species from Mirpur, and 19 species from Bhimber. Rahman *et al.* (2011) recorded a total of 30 species from Murree, Punjab, Pakistan. Additionally, Khan *et al.* (2004) documented 25 species from the Muzaffarabad district situated at Azad Jammu and Kashmir.

Bibi *et al.* (2022) noted that 572 specimens were collected from various localities, representing species from 3 families and 7 genera. The identified species included *Cynthiacardui*, *Danauschrysippus*, *Junonia orithya*, *Papiliodemoleus*, *Papilio polytes*, *Coliascroceus*, *Pieris ajaka*, *Pontia daplidice*, and *Pieris napi*. Among the nine recorded species, *Papilio demoleus* was the most common in the Battagram district, while, *Pieris ajaka* was the rarest species observed during this study. This research provides a detailed examination of the butterflies in the Battagram district.

Mangi *et al.*, (2023) captured 288 specimens from Larkana region and reported three families i.e Nymphalidae, Papilionidae and Pieridae, with six species: *Junonia almanac*, *Danaus chrysippus*, *Papilio demoleus*, *Vanessa cardui*, *Pieris canidia*, and *Eurema hecabe*.

Abbasi *et al.* (2019) noted that a high diversity of butterflies in Dhirkot, with a total of 20 species observed throughout the study. The most abundant species included the painted lady (*Vanessa cardui*), common Mormon (*Papilio polytes*) and common punch (*Dodona durga*). The Shannon-Wiener diversity index was recorded at 1.236, the Simpson diversity index at 8.313, and the evenness index at 0.950.

Abbasi *et al.* (2020) A total of 35 butterfly species (Himalayan brimstone *Gonepteryx nepalensis*, Common yellow swallowtail *Papilo machaon*, Common wall *Lasiommata schakra*, Common peacock *Papilo bianor polycitor*, Dark grass blue *Zizeeria karsandra*, Indian fritillary *Argynnis hyberbius*, Painted lady *Vanessa cardui*, Great windmill *Byasa dasarada*, Blue pansy *Junonia oriytha*, Chestnut angle *Odontoptilum angulate*, Bath white *Pontia daplidice*, Common Mormon *Papilio polytes*, Pale grass blue *Pseudozizeeria maha*, Cabbage white *Pieris rapae*, Common beak *Libythea lepita*, Large three- ring *Ypthima nareda*, Common punch *Dodona durga*, Brown argus *Aricua agestis*, Pallas sailer *Neptis Sappho*, Common windmill *Byasa polyeuctes*, Common stayr *Aulocera swaha*, Common lime *Papilio demoleus*, Banded treebrown *Lethe confuse*, Common argus *Aricia agestis*, Bevan's swift *Borbo bevani*, Common three-ring *Ypthima nikaia*, Ringed argus *Callerebia annada*, Dark clouded yellow *Colias fieldii*, Straight banded treebrown *Lethe verma*, Chocolate pansy *Junonia ipthia*, Clouded yellow *Colias croceus*, Sorrel sapphire *Heliophorus sena*, White edged rockbrown *Hipparchia parisatis*, Spangle *Papilio protenor* and Pale clouded yellow *Colias erate*) were spotted during the current study in Bagh, Azad Jammu and Kashmir, Pakistan. The most numerous butterflies were the common yellow swallowtail, common wall, common peacock, Indian fritillary, painted lady, big windmill, blue pansy, chestnut angle, and bath white. Shannon-wiener diversity index was reported as 1.4919, Simpson diversity index as 13.25098, and evenness index as 0.96621.

The research used a variety of diversity measures to assess butterfly biodiversity, including dominance (0.06522), Simpson Diversity Index

(0.9348), Shannon Diversity Index (2.96), Evenness Index (0.7146), and Margalef Index (4.748) (Table 2). Each of these metrics offered useful information about species richness, abundance distribution, and overall ecological balance in the butterfly communities investigated. The diversity measurements render the butterfly community in the Hari Ghel area as highly diverse and ecologically stable, matching the reports of previous studies conducted in mountainous and forested habitats (Abbasi *et al.*, 2020). A rather low dominance along with high values for these indices displays a more equitable distribution of species, where no single species is considerably dominating the populations an index of a mature and healthy ecosystem (Kunakh *et al.*, 2023). The evenness index and Margalef index further point towards a rich species composition and equitable distribution, indicating good conducive conditions and habitat heterogeneity (Bibi *et al.*, 2022; Chhangani *et al.*, 2022). All these factors combined emphasize the ecological importance of this region as a hotspot for butterflies, especially when compared to earlier studies carried out in other areas of Azad Jammu and Kashmir or at the Himalayan foothills.

CONCLUSION

In this investigation, 27 different species (*Borbo bevani*, *Odontoptilum angulate*, *Arícia agestis*, *Heliophorus sena*, *Pseudozizeeria maha*, *Zizeeria karsandra*, *Argynnis hyberbius*, *Aulocera swaha*, *Callerebia annada*, *Junonia ipthita*, *J. orithya*, *Lasiommata schakra*, *Lethe confuse*, *Libythea lepita*, *Neptis Sappho*, *Vanessa cardui*, *Byasa dasarada*, *B. polyeuctes*, *Papilio demoleus*, *P. polytes*, *P. protenor*, *P. bianor*, *P. machaon*, *Colias erate*, *C. fieldii*, *Pontia daplidiceand* *Dodona durga*) belonging to six (i.e. Riodinidae, Hesperidae, Pieridae, Lycaenidae, Papilionidae and Nymphalidae) and 20 genera (i.e. *Borbo*, *Odontoptilum*, *Arícia*, *Heliophorus*, *Pseudozizeeria*, *Zizeeria*, *Argynnis*, *Aulocera*, *Callerebia*, *Lasiommata*, *Lethe*, *Libythea*, *Neptis*, *Vanessa*, *Pontia*, *Dodona*, *Junonia*, *Byasa*, *Colias* and *Papilio*). The Hari Ghel is rich in flora and provides an ideal ecosystem and location for biodiversity. This study concludes that the butterfly fauna of the Hari Ghel district is extremely rich.

CONFLICTS OF INTEREST

We declare no competing interests affecting the work reported in this study.

AUTHORS' CONTRIBUTION

Altaf and Mustafa have designed study and collected data and Babu, Faiz and Altaf have critically reviewed manuscript and approved as final.

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