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Altitudinal Distribution of Moths (Lepidoptera) in District Bagh, Azad Jammu and Kashmir

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SUMMARY

Biodiversity is unevenly distributed globally, with sharp environmental changes visible in various regions. Early biogeography foundations detail environmental variations along latitude and elevation. Negative species richness correlations with decreasing latitude and increasing elevation are universal ecological relationships. Understanding these patterns is central to ecological research. Biological diversity is crucial for various aspects of life, including scientific, economic, social, cultural, aesthetically, ethnomedicinally, educationally, and biological control. It is niche time stability dependent, with higher species numbers in natural habitats and richness in anthropogenically modified landscapes. This study aims to identify and study the diversity of moth species in the AJK area, which still lacks fresh documentation of moth fauna.

Keywords: Moths, Fauna, Distribution, Diversity, Altitude

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INTRODUCTION

Biodiversity is not evenly distributed across the world. Environmental changes can be easily observed, ranging from arid deserts and lush tropical rainforests to lowland forests and alpine grasslands. Over the past two centuries, explorers and naturalists have laid the groundwork for biogeography, examining various examples of environmental variations based on latitude and elevation (Lomolino, 2001). One of the most widely recognized ecological relationships is the negative correlation between species richness and decreasing latitude or increasing elevation. Initially, this was attributed to the decline in favorable climatic conditions as latitude decreases or elevation increases. Understanding the patterns and causes of biodiversity's global distribution is a fundamental aspect of ecological research (Hillebrand, 2004).

However, studies of biodiversity along latitude are some of the most difficult and expensive ecological methodologies. In contrast, elevational gradients aggregate steep changes in climatic conditions across a small spatial scale ((Körner, 2007) thus are logistically easier to sample. Because elevational gradients are generally common over the world, they soon established themselves as an appealing option for biogeographical investigations (Rahbek, 2005), allowing researchers to easily study the causes of spatial variation in species diversity. The consequences of rising elevation on insects have been extensively studied (Rasmann et al., 2014).

Moths are a valuable subject for studying conservation and ecology, along with other insects. Most moth species are active at night and can be easily attracted to light traps, which makes it convenient for researchers to estimate their relative abundance and understand their geographic distribution (Choi, 2008). Moths can serve as indicators of habitat quality and are responsive to human disturbances and changes in natural processes (Hilt and Fiedler, 2006). Different groups of moths have varying levels of vulnerability to environmental changes, so it is important to monitor moth communities as an effective tool for biological conservation (New, 2004). Changes in vegetation can have an impact on the prevalence of endemic moth species and can also affect the abundance of common species, which could indicate potential shifts in the abundance of rare species. For instance, intensive farming and grazing can accelerate changes in plant communities and result in the loss of endemic host plants, subsequently leading to a decline in specialist moth fauna (White, 1991).

Biological diversity is vital scientifically (Heyer et al., 2014), economically (McNeely, 1988), socially (Cilliers, 2010), culturally (Maffi, 2005; Altaf et al., 2017), aesthetically (Lindemann-Matthies et al., 2010), ethnomedicinally (Umair et al., 2017; Altaf et al., 2018b; Farooq et al., 2019), educationally (Caro et al., 2003) and also important for biological control (Saba et al., 2020) pollutant indicator (Sidra et al., 2019). Diversity is the number of species present (Altaf et al., 2013; Altaf, 2016). Diversity is niche time stability dependent which means if many niche are present than it would support rich diversity (Daly et al., 1978; Wiens and Graham, 2005). Higher numbers of species are present in the natural habitats while richness is higher in anthropogenically moderately modified landscapes (Altaf et al., 2018a).

Several studies have been conducted on the biodiversity in AJK area regarding reptiles, insects in Bagh, mammals, amphibians and but study on moth was conducted first time. The aim of the present work was to identify and study the diversity of moth species from study area which still was lacking fresh documentation of moth fauna. So this study was designed to know the the diversity of the moth and elevation impacts on diversity of moth in study area.

MATERIALS AND METHODS

The study was conducted from January 2021 to December 2021 to examine the Moth fauna at Bagh Azad Jammu and Kashmir. Various research and survey methods were used, which were categorized into two groups: "direct field observations" and "indirect observations." Direct field observations involved observing Moths in their natural habitat, while indirect observations included examining Moth body parts, carcasses, and gathering information from local residents through meetings.

STUDY AREA

Bagh area is located in lesser Himalayas (DRU, 2007). The study area lies in moist area in access of monsoon. Small area of Bagh has difference in rainfall and humidity in different parts due to variations in altitudes. The summer is moderate and the winter is harshly cold; and snowfall occurs at higher elevations. The average rainfall was recorded as; 150mm (Figure 1). The forest types are as; 1) Sub-tropical pine forests and 2) Himalayan mixed temperate forests (Bibi et al., 2013).

STATISTICAL ANALYSIS

MS Excel and Past statistical Software were applied to know diversity of Moth.

RESULTS

During the research total 42 species of moth were documented, while out maximum 42 species were documented from Raira, 41 species were captured from Bagh city, 32 species were noted from Dhirkot while 13 species were seen at Ganga choti. It is noted that increase with elevation diversity and density are declined (Figure1 and Tables 1, 2, 3, 4, and 5).

Table 1: Distributions of Moths in different sites and elevations.

Sr.	Name	Raira (RA)	Bagh city (RA)	Dhirkot (RA)	Ganga Choti (RA)
1.	*Agrius convolvuli* Pterophoridae	0.02	0.01	0.00	0.00
2.	*Aloa lactinea* Arctiidae	0.02	0.03	0.02	0.00
3.	*Aloa lactinea* Erebidae	0.03	0.02	0.00	0.00
4.	*Amphipyra pyramidea* Noctuidae	0.02	0.03	0.02	0.07
5.	*Areas galactina* Erebidae	0.02	0.04	0.00	0.07
6.	*Automeris io* Saturniidae	0.03	0.01	0.00	0.00
7.	*Campaea margaritata* Geometridae	0.02	0.03	0.02	0.07
8.	*Catocala serena* Erebidae	0.01	0.04	0.04	0.07
9.	*Ceratomia undulosa* Pterophoridae	0.02	0.05	0.04	0.13
10.	*Clanis Deucalion* Sphingidae	0.03	0.02	0.02	0.00
11.	*Cleora sublunaria* Geometridae	0.03	0.03	0.04	0.07
12.	*Condica videns* Noctuidae	0.04	0.01	0.02	0.07
13.	*Corymica pryeri* Geometridae	0.05	0.03	0.06	0.00
14.	*Costaconvexa centrostrigaria* Geometridae	0.03	0.04	0.02	0.00
15.	Creatonotos gangis Erebidae	0.02	0.04	0.02	0.00
16.	*Cyclophora packardi* Geometridae	0.01	0.05	0.06	0.00
17.	*Drasteria divergens*	0.02	0.05	0.04	0.00

	Erebidae				
18.	*Dysgonia algira* Noctuidae	0.02	0.02	0.02	0.00
19.	*Eacles imperialis* Saturniidae	0.03	0.03	0.02	0.00
20.	*Euproctis lutea* Lymantriinae	0.04	0.03	0.02	0.00
21.	*Eutelia pulcherrima* Euteliidae	0.05	0.03	0.02	0.07
22.	*Helicoverpa armigera* Noctuidae	0.01	0.02	0.02	0.00
23.	*Hellinsia homodactyla* Pterophoridae	0.02	0.02	0.04	0.00
24.	*Herpetogramma sphingealis* Crambidae	0.03	0.02	0.06	0.00
25.	*Hyles lineate* Pterophoridae	0.02	0.04	0.07	0.00
26.	*Idaea filicata* Geometridae	0.01	0.01	0.04	0.00
27.	*Leucania Phragmitidicola* Noctuidae	0.02	0.01	0.06	0.07
28.	*Lymantria todara* Erebidae	0.05	0.03	0.02	0.00
29.	*Mocis mayeri* Erebidae	0.05	0.04	0.04	0.13
30.	*Nephelimorpha argentilinea* Limacodidae	0.02	0.00	0.06	0.00
31.	*Nycteola revayana* Nolidae	0.02	0.02	0.02	0.07
32.	*Pachysphinx modesta* Pterophoridae	0.01	0.03	0.00	0.00
33.	*Palpita annulifer* Crambidae	0.02	0.01	0.00	0.00
34.	*Proxenus Miranda* Noctuidae	0.03	0.01	0.00	0.00
35.	*Rhodometra sacraria* Geometridae	0.02	0.01	0.02	0.00
36.	*Sameodes cancellalis* Crambidae	0.01	0.03	0.00	0.00
37.	*Spilosoma luteum* Erebidae	0.01	0.04	0.02	0.07
38.	*Spodoptera litura* Noctuidae	0.02	0.01	0.04	0.00
39.	*Tosale oviplagalis* Pyralidae	0.03	0.01	0.00	0.07
40.	*Tribe arctiini*	0.01	0.01	0.02	0.00

	Erebidae				
41.	*Xylophanes tersa*	0.03	0.01	0.04	0.00
	Pterophoridae				
42.	*Zamarada eogenaria*	0.04	0.02	0.00	0.00
	Geometridae				
Total Species		42	41	32	13

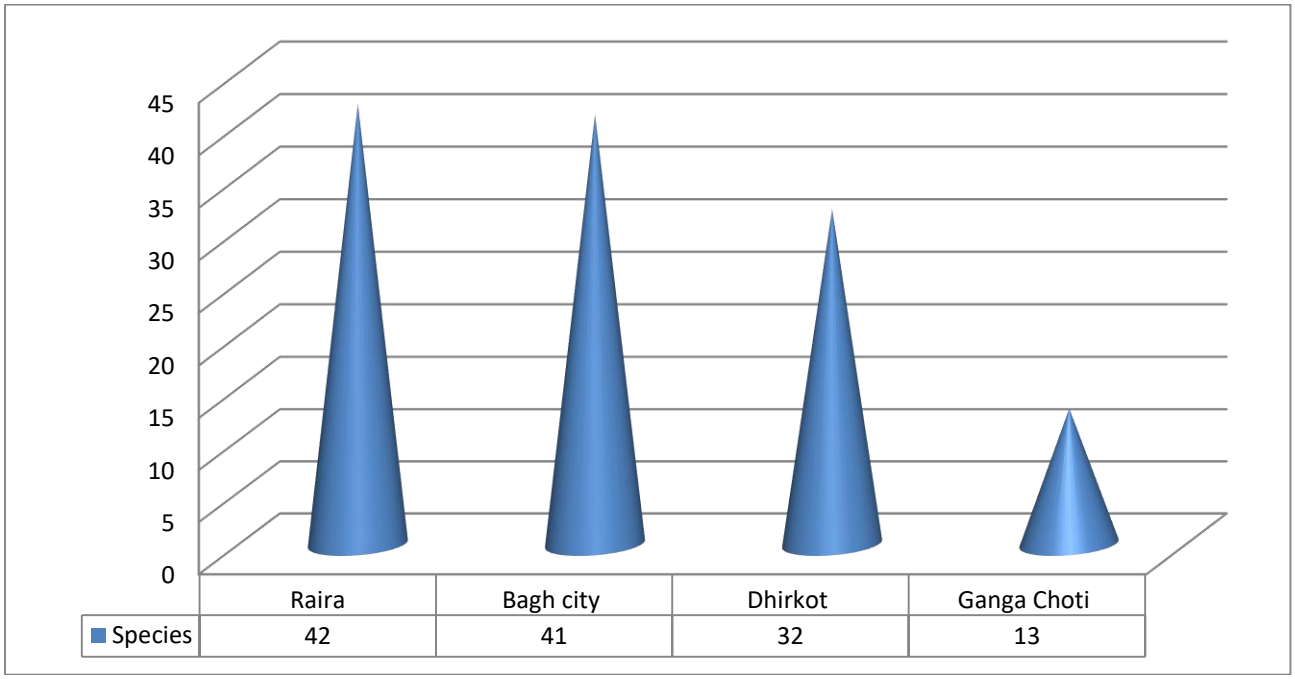

Figure 1: Diversity of moths at different sites.

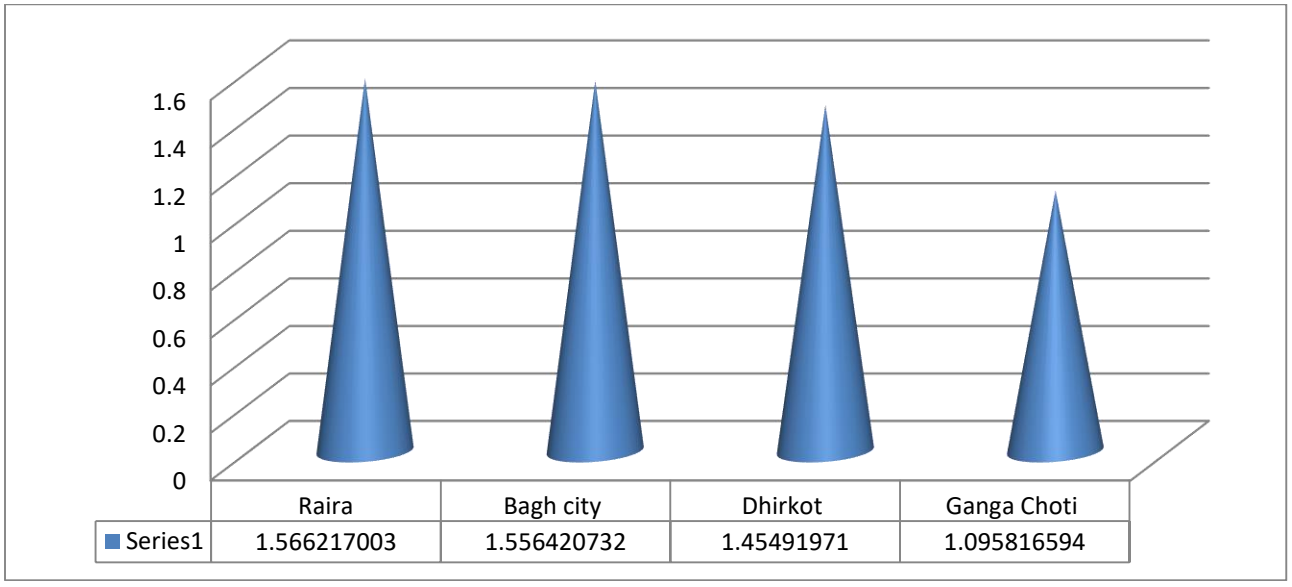

Figure 2: Shanon-weiner Diversity Index of moths at different sites.

During the research total 42 species of moth were documented, 1.566217 Shanon-weiner Diversity Index was documented from Raira, 1.556421 Shanon-

weiner Diversity Index was documented from from Bagh city, 1.45492 Shanon-weiner Diversity Index was documented from from Dhirkot while 1.095817 Shanon-weiner Diversity Index was documented from Ganga choti. It is noted that increase with elevation diversity and Shanon-weiner Diversity Index are declined (Figure 2).

Table 2: Diversity of Moth in Raira.

Names	Raira	RA (Pi)	LoPi	PiLogPi
Agrius convolvuli	2	0.02	-1.81624	-0.02773
Aloa lactinea	3	0.02	-1.64015	-0.03756
Aloa lactinea	4	0.03	-1.51521	-0.04627
Amphipyra pyramidea	2	0.02	-1.81624	-0.02773
Areas galactina	3	0.02	-1.64015	-0.03756
Automeris io	4	0.03	-1.51521	-0.04627
Campaea margaritata	2	0.02	-1.81624	-0.02773
Catocala serena	1	0.01	-2.11727	-0.01616
Ceratomia undulosa	3	0.02	-1.64015	-0.03756
Clanis Deucalion	4	0.03	-1.51521	-0.04627
Cleora sublunaria	4	0.03	-1.51521	-0.04627
Condica videns	5	0.04	-1.4183	-0.05413
Corymica pryeri	6	0.05	-1.33912	-0.06133
Costaconvexa centrostrigaria	4	0.03	-1.51521	-0.04627
Creatonotos gangis	2	0.02	-1.81624	-0.02773
Cyclophora packardi	1	0.01	-2.11727	-0.01616
Drasteria divergens	3	0.02	-1.64015	-0.03756
Dysgonia algira	3	0.02	-1.64015	-0.03756
Eacles imperialis	4	0.03	-1.51521	-0.04627
Euproctis lutea	5	0.04	-1.4183	-0.05413
Eutelia pulcherrima	6	0.05	-1.33912	-0.06133
Helicoverpa armigera	1	0.01	-2.11727	-0.01616
Hellinsia homodactyla	3	0.02	-1.64015	-0.03756
Herpetogramma sphingealis	4	0.03	-1.51521	-0.04627
Hyles lineate	2	0.02	-1.81624	-0.02773
Idaea filicata	1	0.01	-2.11727	-0.01616
Leucania Phragmitidicola	3	0.02	-1.64015	-0.03756
Lymantria todara	6	0.05	-1.33912	-0.06133
Mocis mayeri	7	0.05	-1.27217	-0.06798
Nephelimorpha argentilinea	2	0.02	-1.81624	-0.02773
Nycteola revayana	2	0.02	-1.81624	-0.02773
Pachysphinx modesta	1	0.01	-2.11727	-0.01616
Palpita annulifer	3	0.02	-1.64015	-0.03756
Proxenus Miranda	4	0.03	-1.51521	-0.04627

Rhodometra sacraria	2	0.02	-1.81624	-0.02773
Sameodes cancellalis	1	0.01	-2.11727	-0.01616
Spilosoma luteum	1	0.01	-2.11727	-0.01616
Spodoptera litura	3	0.02	-1.64015	-0.03756
Tosale oviplagalis	4	0.03	-1.51521	-0.04627
Tribe arctiini	1	0.01	-2.11727	-0.01616
Xylophanes tersa	4	0.03	-1.51521	-0.04627
Zamarada eogenaria	5	0.04	-1.4183	-0.05413
Shanon-weiner Diversity Index (H')				-1.56622

Table 3: Diversity of Moth in Bagh city.

Names	**Bagh city**	**RA (Pi)**	**LoPi**	**PiLogPi**
Agrius convolvuli	1	0.01	-2.017	-0.0194
Aloa lactinea	3	0.03	-1.5399	-0.0444
Aloa lactinea	2	0.02	-1.716	-0.033
Amphipyra pyramidea	3	0.03	-1.5399	-0.0444
Areas galactina	4	0.04	-1.415	-0.0544
Automeris io	1	0.01	-2.017	-0.0194
Campaea margaritata	3	0.03	-1.5399	-0.0444
Catocala serena	4	0.04	-1.415	-0.0544
Ceratomia undulosa	5	0.05	-1.3181	-0.0634
Clanis Deucalion	2	0.02	-1.716	-0.033
Cleora sublunaria	3	0.03	-1.5399	-0.0444
Condica videns	1	0.01	-2.017	-0.0194
Corymica pryeri	3	0.03	-1.5399	-0.0444
Costaconvexa centrostrigaria	4	0.04	-1.415	-0.0544
Creatonotos gangis	4	0.04	-1.415	-0.0544
Cyclophora packardi	5	0.05	-1.3181	-0.0634
Drasteria divergens	5	0.05	-1.3181	-0.0634
Dysgonia algira	2	0.02	-1.716	-0.033
Eacles imperialis	3	0.03	-1.5399	-0.0444
Euproctis lutea	3	0.03	-1.5399	-0.0444
Eutelia pulcherrima	3	0.03	-1.5399	-0.0444
Helicoverpa armigera	2	0.02	-1.716	-0.033
Hellinsia homodactyla	2	0.02	-1.716	-0.033
Herpetogramma sphingealis	2	0.02	-1.716	-0.033
Hyles lineate	4	0.04	-1.415	-0.0544
Idaea filicata	1	0.01	-2.017	-0.0194
Leucania Phragmitidicola	1	0.01	-2.017	-0.0194
Lymantria todara	3	0.03	-1.5399	-0.0444
Mocis mayeri	4	0.04	-1.415	-0.0544

Nycteola revayana	2	0.02	-1.716	-0.033
Pachysphinx modesta	3	0.03	-1.5399	-0.0444
Palpita annulifer	1	0.01	-2.017	-0.0194
Proxenus Miranda	1	0.01	-2.017	-0.0194
Rhodometra sacraria	1	0.01	-2.017	-0.0194
Sameodes cancellalis	3	0.03	-1.5399	-0.0444
Spilosoma luteum	4	0.04	-1.415	-0.0544
Spodoptera litura	1	0.01	-2.017	-0.0194
Tosale oviplagalis	1	0.01	-2.017	-0.0194
Tribe arctiini	1	0.01	-2.017	-0.0194
Xylophanes tersa	1	0.01	-2.017	-0.0194
Zamarada eogenaria	2	0.02	-1.716	-0.033
Shanon-weiner Diversity Index (H')				-1.5564

Table 4: Diversity of Moth in Dhirkot.

Names	**Dhirkot**	**RA (Pi)**	**LoPi**	**PiLogPi**
Aloa lactinea	1	0.02	-1.73239376	-0.03208137
Amphipyra pyramidea	1	0.02	-1.73239376	-0.03208137
Campaea margaritata	1	0.02	-1.73239376	-0.03208137
Catocala serena	2	0.04	-1.431363764	-0.05301347
Ceratomia undulosa	2	0.04	-1.431363764	-0.05301347
Clanis Deucalion	1	0.02	-1.73239376	-0.03208137
Cleora sublunaria	2	0.04	-1.431363764	-0.05301347
Condica videns	1	0.02	-1.73239376	-0.03208137
Corymica pryeri	3	0.06	-1.255272505	-0.06973736
Costaconvexa centrostrigaria	1	0.02	-1.73239376	-0.03208137
Creatonotos gangis	1	0.02	-1.73239376	-0.03208137
Cyclophora packardi	3	0.06	-1.255272505	-0.06973736
Drasteria divergens	2	0.04	-1.431363764	-0.05301347
Dysgonia algira	1	0.02	-1.73239376	-0.03208137
Eacles imperialis	1	0.02	-1.73239376	-0.03208137
Euproctis lutea	1	0.02	-1.73239376	-0.03208137
Eutelia pulcherrima	1	0.02	-1.73239376	-0.03208137
Helicoverpa armigera	1	0.02	-1.73239376	-0.03208137
Hellinsia homodactyla	2	0.04	-1.431363764	-0.05301347
Herpetogramma sphingealis	3	0.06	-1.255272505	-0.06973736
Hyles lineate	4	0.07	-1.130333768	-0.08372843
Idaea filicata	2	0.04	-1.431363764	-0.05301347
Leucania Phragmitidicola	3	0.06	-1.255272505	-0.06973736
Lymantria todara	1	0.02	-1.73239376	-0.03208137
Mocis mayeri	2	0.04	-1.431363764	-0.05301347

Nephelimorpha argentilinea	3	0.06	-1.255272505	-0.06973736
Nycteola revayana	1	0.02	-1.73239376	-0.03208137
Rhodometra sacraria	1	0.02	-1.73239376	-0.03208137
Spilosoma luteum	1	0.02	-1.73239376	-0.03208137
Spodoptera litura	2	0.04	-1.431363764	-0.05301347
Tribe arctiini	1	0.02	-1.73239376	-0.03208137
Xylophanes tersa	2	0.04	-1.431363764	-0.05301347
Shanon-weiner Diversity Index (H')				-1.45491971

Table 5: Diversity of Moth in Ganga Choti.

Names	Ganga Choti	RA (Pi)	LoPi	PiLogPi
Amphipyra pyramidea	1	0.07	-1.176091	-0.078
Areas galactina	1	0.07	-1.176091	-0.078
Campaea margaritata	1	0.07	-1.176091	-0.078
Catocala serena	1	0.07	-1.176091	-0.078
Ceratomia undulosa	2	0.13	-0.875061	-0.117
Cleora sublunaria	1	0.07	-1.176091	-0.078
Condica videns	1	0.07	-1.176091	-0.078
Eutelia pulcherrima	1	0.07	-1.176091	-0.078
Leucania Phragmitidicola	1	0.07	-1.176091	-0.078
Mocis mayeri	2	0.13	-0.875061	-0.117
Nycteola revayana	1	0.07	-1.176091	-0.078
Spilosoma luteum	1	0.07	-1.176091	-0.078
Tosale oviplagalis	1	0.07	-1.176091	-0.078
Shanon-weiner Diversity Index (H')				-1.096

DISCUSSION

Moths are valuable for conservation and ecology studies due to their nocturnal nature and ability to be easily attracted to light traps. They are bio-indicators of habitat quality and respond to human disturbances and successional processes. Monitoring moth communities responding to habitat changes is crucial for biological conservation richness (Choi, 2008). Changes in vegetation can alter the prevalence of endemic moth species, promoting changes in common species abundance and potentially shifting rare species abundance (Hilt and Fiedler, 2006). For example, intensive agriculture and grazing can accelerate changes in plant species composition and abundance, leading to the loss of specialist moth fauna. Throughout the field investigation, we recorded a total of 42 moth species. The highest number of species, 42, were reported in Raira, followed by 41 species in Bagh city, 32 species in Dhirkot, and 13 species at Ganga Choti. The data shown in Figure 1 and Tables 1, 2, and 3 indicate a decrease in both variety and density as elevation increases. A comprehensive study found a total of 42 moth species. The Shanon-Weiner Diversity Index was recorded as 1.566217 in Raira, 1.556421 in Bagh City, 1.45492 in Dhirkot,

and 1.095817 in Ganga Choti. The data shows a decrease in both elevation diversity and the Shanon-Weiner Diversity Index.

Scientists have extensively recorded the impacts of higher altitude on insects. It impacts several aspects of their physical structure, physiological processes, behaviour, ability to reproduce, spatial arrangement, variety, and population size (Hodkinson, 2005). The study of changes in biodiversity along elevational gradients in this context has given us many chances to better understand what's going on at small spatial scales while keeping historical and biogeographical effects clear in different places (Rasmann et al., 2014). We believe that this study will help the researcher to make better documentation on the moths of AJK, Pakistan, and also in understanding the distribution pattern.

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