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STUDY ON DISTRIBUTION OF BUTTERFLY SPECIES IN SIKKIM INDIA

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ABSTRACT
Sikkim is a part of the Eastern Himalayas, which is one of the 34 hotspots for biodiversity in the world. With a total of 689 species, which makes up 50% of the species found in the Sikkim subcontinent, Sikkim has a very high diversity of butterflies given its limited geographic area. Sikkim's vegetation is primarily influenced by the climate, topography, and elevation. It varies significantly every 900 metres and can be divided into six main types. These vegetation types and altitudinal zones along the Teesta valley in Sikkim were the subject of our study on butterfly diversity. For butterfly sampling, we used a fixed width circular plot method, collecting data from 2,617 points along 23 transects at various elevations. During the course of this study, 6,075 butterflies from 251 species and five families were spotted. Richness, abundance, and diversity of butterfly species peaked in low elevation tropical semi-deciduous forests (300-900 m) and decreased as elevation rose to higher altitudes. Additionally, the proportions of exclusive species decreased monotonically with elevation. Of the five families, Nymphalidae had the most species and abundance in the butterfly community. According to cluster analysis, various types of forests are home to different butterfly community assemblages. A single vegetation type was home to 36% of the species, indicating their restricted distribution. Since butterflies only displayed a limited tolerance for changes in elevation and vegetation, it is crucial to preserve their habitats at the landscape scale for the survival of the butterfly fauna in Sikkim.

Keywords: Butterfly, conservation, vegetation zone

INTRODUCTION

The eastern part of the Himalaya is home to a wide range of ecosystems and features significant climatic and altitude diversity. Sikkim is located in the westernmost parts of the eastern Himalaya, which is known as one of the 34 global biodiversity hotspots. Sikkim is also known as the "Land of the Thunder Dragon." Sikkim is located in a zone that serves as a transition point between the zoogeographic realms of the Indian subcontinent, Indochinese area, and Indomalayan region.

Sikkim, a state in the Indian Union known for its harsh mountains and mountainous terrain, is physically separated from the rest of the country. It has mountain ranges surrounding it on three sides, giving it the appearance of a horseshoe. These mountain ranges include the Singalila and Kanchenjunga ridges on the west, the Rishipangola on the east, and the main axis of the Himalaya on the northern half. Through the southern flank, it provides access to the plains of India. The area that the river Teesta drains into is referred to as the catchment area for the state. Teesta, the largest river in Sikkim and a significant natural feature of the state, has its source at Cho Lhamo Lake (4800 metres above sea level) in northern Sikkim. Teesta primarily flows in a north-south direction throughout its entire length, dividing the state into two halves along its path. The Rangeet River, which originates in western Sikkim, meets the Teesta River in Melli, which is located close to the boundary between Sikkim and West Bengal (300 m amsl).

Sikkim is without a doubt the state in India that has the most variety of plant and animal life for its relatively limited land area (7096 km). Sikkim may only cover 0.21 percent of the landmass, yet it is

home to around 43 percent of the Indian subcontinent's mammalian species, 45 percent of the birds, 50 percent of the butterflies, and 11 percent of the flowering plants. Sikkim has a total forest cover of 3,357 square kilometres, which accounts for approximately 47% of the state's entire geographical area. This astonishing diversity is a result of the state's geographical location, which is unique in the globe, as well as its plate tectonic and paleoclimatic history, as well as its altitudinal and climatic regime, which is also one of a kind in the world. There is no question that the low human population densities, in addition to the biodiversity-dependent and varied human lifestyles, are the primary reasons why so much of the world's once-vast biodiversity still exists today.

Along with the changes in vegetation, altitude, precipitation, topography, and aspect, the faunal assemblages also change rapidly, going from tropical to subtropical, temperate, alpine, and finally cold desert forms. These changes occur concurrently with the other changes. As a direct consequence of this rapid transition, the distribution ranges of all of Sikkim's floral and faunal taxa are extremely limited within the state itself. Sikkim provides a one-of-a-kind opportunity for assessing biodiversity along an elevation and vegetation gradient as a result of the state's diverse physical and ecological features, as well as the high degree of variation among these features.

Conservation and Management Planning for Butterflies

Studies of biodiversity that follow elevation gradients have become a significant technique for the quick identification of biodiversity hotspots, particularly in nations with a mountainous terrain. The information that was acquired in this manner would be used to rank areas for the purposes of planning conservation and management. The pattern of species distribution along elevation varies depending on the taxon, area, technique, and elevation range that are being evaluated. In the past, it was believed that the pattern of species richness along elevation mirrored the pattern of species richness along latitude, and it was claimed to follow a monotonic fall from low elevation to high elevation. But in more recent times, a number of other patterns, such as monotonic fall, low elevation peak, mid height peak, and monotonic rise in species richness with elevation, have been observed.

Status of Butterflies in Sikkim

Due to the intricacy of the physiographical conditions in Sikkim, which allow for species of varying status categories to coexist, the butterflies of Sikkim hold a unique significance. Even though the study of butterflies was first conducted in this nation some 150 years ago, there are still many places, especially the highlands, that have not been examined to this day. The primary obstacle to overcome in order to carry out a comprehensive research of butterflies over the entirety of the country is the insufficient number of experts.

Several desirable habitats, including those ranging from lowlands in the south to higher belts in the north, have been identified, according to Smith (1989), for a total of 650 different species.

This nation encompasses both the Palearctic and the Oriental realms in its territory. The Oriental ecoregion covers the vast majority of land, whereas the Palearctic ecoregion extends from an elevation of 3,000 metres to its northern limit and covers a lower altitude. There are fewer Palearctic species than there are species in other regions, but those that do exist include the following: Parnassiusepaphus, Parnassiusacdestis, Coliascoccandica, Colisladakensis, Gonepteryxrhamni, Kukenthaleillamackinnoni, Meliteaarcasia, Vanessa cardui, Polygonia agnicola, Polyomm Species that are unique to the Himalayas, such as Parnassiushardwickei, Teinopalpusimperialis, Meandrusagyas, Graphium euros, and Graphiumglycerion, have been documented inside the borders of the nation. The

rest of the species that have been documented in this nation exhibit characteristics that are more typical of the Oriental area.

The bottom belt of the nation is warm and humid, and it offers a variety of butterfly species environments that are ideal for their survival. Flosareste, Surendra todara, Loxuraatymnas, Spindasiselima, Tarucussps., Cirrochroatyche, Vindulaerota, Sumaliazayla, Lebadeamartha, Nemetismekara, and Mycalesissps. are just some of the many interesting species that can be found between an elevation of 62 and 1000 meters.

The subtropical climate within 1000 to 2000m, which also touches many mountainous parts, is home to a variety of interesting species. These include Troidesaeacus, Troideshelena, Leptosianina, Deliaspasithoe, Deliasacallis, Anaemorphaagostina, Charaxesmarmax, Sephisachandra, Precis sps, Mycalesismals

The temperate bioclimatic zone that extends from an elevation of 2,000 to 4,000 metres is home to a wide variety of plant and animal species, including Coliasfieldii, Coliaserate, Lethe insana, Dilipamorgiana, Hestinanama, Euthaliaaconthea, Neptisnysteus, Neptisarmandia, Neptisananta, Zemerosflegyas

OBJECTIVES

1. Documentation of butterfly diversity at different altitudinal zonation of Central Nepal.
2. Assessment to biophysical gradients correlating to diversity at vertical ecological zones

METHODS

Observation and identification of butterflies in the field were carried out with sufficient accuracy, primarily through direct observation and with the use of the capture-and-release method for a few species that were confusing. During the course of my lengthy employment at the Regional Museum of Natural History in Sikkim, I was able to amass sufficient knowledge for the identification of butterflies in their natural habitat. The use of the butterfly net allowed for the collection of specimens that could not be identified. All of the collected specimens were placed inside of paper envelopes in the shape of a transparent triangle. Every specimen, whether it was collected or merely observed, was meticulously recorded alongside its associated field data. The triangular envelopes were used to store all of the specimens that were collected in the field, and naphthalene balls were used as a preservative for the specimens. In order to complete this task, entomological pins were utilized, in conjunction with a setting board, to spread the collected specimens of butterflies out on their wings. In order to press the wings onto the setting board, strips of paper were used. After a period of two days, these samples were prepared to be submitted for analysis and classification. This research was carried out within the boundaries of the preexisting quadrates and via linear walk at elevations ranging from 550 to 4500 meters. The section on vegetation analysis includes an explanation of the quardrate, which includes details such as their size, number, and distribution. The species that were recorded at various ranges were analysed with the Shannon and Weiner Diversity Index and Equitability Index (Southwood and Henderson 2000), as well as the Pearson's tool in Minitab Software, in order to determine the Coefficient of Correlation of butterfly diversity with various gradients.

Vegetation Analysis

The quadrate method was chosen for the analysis of the vegetation, and quadrates were placed at intervals of 500 metres in elevation up to a range of 4300 meters. The size of the quadrate that was

taken into consideration for this study was 50 metres by 50 meters. At each altitudinal station, anywhere from three to five quadrates were utilized, for a grand total of 165 quadrates. Within the quadrate, we determined the density, diversity, and frequency of the butterfly and plant species, as well as the species composition of the vegetations. Using this analysis, we were able to deduce the relationship between butterflies and vegetation. The most important factor that was taken into consideration in this research was how the diversity of butterfly species changed in correlation with the shifting floral communities found at various elevations. Herbarium was prepared for plant specimens that could not be properly identified and brought to Kathmandu for proper identification at the Natural History Museum, the National herbarium in Godavari (Lalitpur), and consulting with experts to confirm the names of the species.

Data Analysis

A. Identificationofbutterfly

The morphological characteristics of butterfly specimens served as the basis for the identification process. Identification relied on characteristics such as wing venation, markings, spots, wing size, and tails, among other things. All of the species that could be identified were catalogued under their appropriate families. The data from the field were recorded, including things like altitude, location, month, year, temperature, and humidity. According to the formula provided by Trivedi et al., the absolute and relative densities of butterflies were calculated for each of the research locations.

B. Vegetation Analysis

The analysis of the vegetation was carried out using quadrates that were 50 metres by 50 metres in size. At each of the study stations, anywhere from three to five quadrates were set up. We analysed the vegetation from the ground up to the tree canopy along the perimeter of each quadrate. The direct observation method was utilised in regions that could not make use of the quadrate due to the complexity of the terrain. This was accomplished by recognising and tallying the number of members of each species of tree and shrub that could be seen growing naturally in such environments. The total number of each tree species was counted, and then the relative density of each tree species was calculated using the formula that is presented below. In a similar manner, the overall density in each quadrate was determined by tallying up the total number of tree species that were present in that particular quadrate. The same method was utilised for the different species of shrubs. Herb species alone were included in the record for diversity purposes.

The following formula was used to determine the densities of the various vegetations: The total number of species in relation to the total area covered

The following formula was used to calculate the relative density: The total number of specimens of each species multiplied by the total number of specimens across all species to get the percentage.

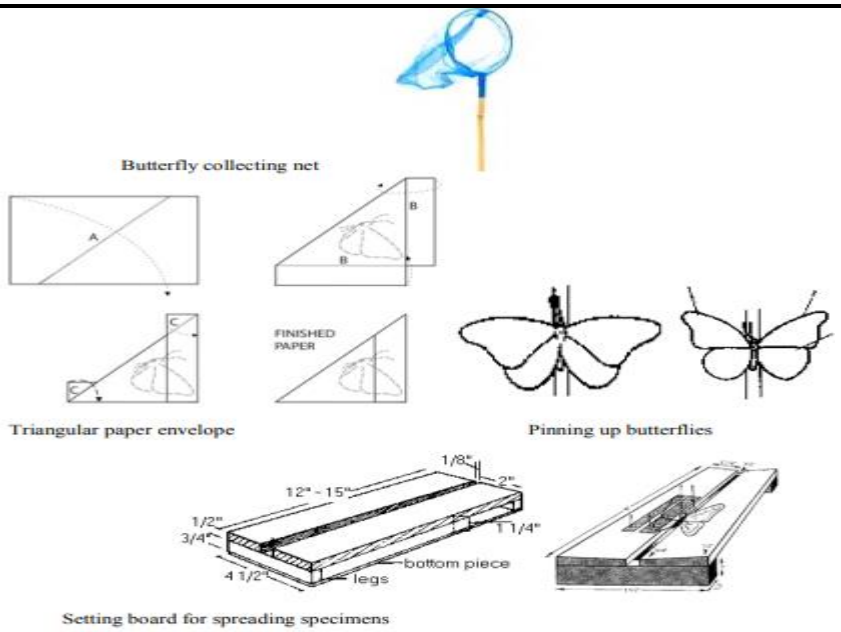

Fig.1.Tools for Gathering and Arranging Butterflies

Table 1. Butterfly Species Distribution, Relative Density, and Local Status at 800 m

SN	Family	Genus and species	Individul Count	Relative Density	Local Status
1.	Pieridae	*Catopsilia pomana* Fabricius	7	5.38%	Common
2.		*Eurema hecabe* Linnaeus	19	14.61%	Common
3.	Lycaenidae	*Zizeeria maha* Kollar	18	13.84%	Common
4.	Nymphalidae	*Neptis hylas* Moore	6	4.61%	Common
5.		*Neptis cartica* Moore	3	2.30%	Rare
6.		*Athyma jina* Moore	4	3.07%	Uncommon
7.		*Athyma perius* Linnaeus	7	5.38%	Common
8.		*Vagrens egista* Cramer	7	5.38%	Uncommon
9.		*Precis lemonias* Linnaeus	8	6.15%	Common
10.		*Hypolymnas bolina* Linnaeus	6	4.61%	Common

11.	Papilionidae	*Papilio memnon* Linnaeus	5	3.84%	Uncommon
12.		*Papilio polytes* Linnaeus	5	3.84%	Common
13.		*Achillides polyctor* Boisduval	4	3.07%	Uncommon
14.		*Graphium sarpedon* Linnaeus	9	6.92%	Common
15.	Danaidae	*Euploea core* Cramer	7	5.38%	Common
16.		*Danaus chryssipus* Linnaeus	11	8.46%	Common
17.	Hesperiidae	*Pseudocoladenia dan* Fabricius	4	3.07%	Uncommon

Indices;Shannon and Weiner Index = 2.692, Equitability Index = 0.9503, Density = 2.6/m^2.

Significant observations: Diversity is significantly more than the elevation that was discussed earlier, but it is still modest. The density of butterflies is 2.6 per square metre and is more or less evenly dispersed. The dominant species is the Euremahecabe (Pieridae), which accounts for 14.61 percent. The species with the lowest percentage of occurrence are Athymajina (Nymphalidae) and Pseudocoladenia dan (Hesperiidae), both of which have 4%.

Table 2. Butterfly Species Distribution, Relative Density, and Local Status At 1000 M Altitude

SN	Family	Genus and species	Individual Count	Relative Density	Local Status
1.	Pieridae	*Catopsilia pomana* Fabricius	10	7.63%	Common
2.		*Appias lyncida* Cramer	2	1.52%	Rare
3.		*Pontia daplidice* Linnaeus	22	16.80%	Common
4.		*Eurema hecabe* Linnaeus	12	9.16%	Common
5.		*Gonepteryx rhamni* Linnaeus	5	3.81%	Uncommon
6.	Nymphalidae	*Athyma opalina* Kollar	7	5.34%	Common
7.		*Precis almana* Linnaeus	7	5.34%	Common
8.		*Precis lemonias* Linnaeus	5	3.81%	Common
9.		*Hypolymnas bolina* Linnaeus	6	4.58%	Common

10.	Papilionidae	*Papilio demoleus* Linnaeus	5	3.81%	Common
11.		*Papilio polytes* Linnaeus	9	6.87%	Common
12.		*Papilio memnon* Linnaeus	3	2.30%	Rare
13.		*Achillides polyctor* Boisduval	6	4.58%	Common
14.		*Atrophaneura latrellei* Donavan	7	5.34%	Common
15.		*Graphium sarpedon* Linnaeus	10	7.63%	Common
16.		*Pazala euros* Leech	2	1.52%	Rare
17.	Danaidae	*Euploea core* Cramer	6	4.58%	Common
18.		*Danaus genutia* Cramer	7	5.34%	Common

Indices: Shannon and Weiner Index = 2.737, Equitability Index = 0.9456, Density = 2.62/m^2.

Significant observations: Diversity is about average (2.737), but there is less consistency in distribution. In a square measuring 50 by 50 meters, there are 2.62 individuals of the species for every square meter. The Pontiadaplidice (Pieridae) family is in the lead with a relative frequency of 16.80%. The Appiaslyncida (Pieridae) species has the lowest percentage of representation at this elevation, with only 1.52%.

CONCLUSION

Despite the fact that numerous studies on the butterflies of Sikkim, particularly those of the Himalayan regions, have been carried out in the past, these studies have been restricted to the taxonomy and distribution of the butterflies. The purpose of this study was to collect as much information as possible regarding the ecology, diversity, and influence of biophysical gradients on the distribution of butterflies at various altitudinal levels in central Nepal. This study also evaluated the local threats to butterfly populations and the conservation status of butterfly populations.

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