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A STUDY ON BUTTERFLY DIVERSITY IN SILAPATHAR, DISTRICT OF DHEMAJI, ASSAM, INDIA

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Abstract

Butterfly is one of the most diverse groups of sensitive insects of order Lepidoptera, which is one of the key indicators of the health of an ecosystem and plays a crucial role in ecosystem functioning. They feed on nectar from flowers; butterflies inadvertently transfer pollen from one flower to another, facilitating plant reproduction. The present study was carried out in Silapathar, in the district of Dhemaji, Assam, India from January to May 2024 to explore the diversity and to compare the butterfly diversity in different habitats such as grassland, agriculture field and urban area. In this study, a total of 54 species, 1375 individuals, representing five families viz. Papilionidae, Pieridae, Lycaenidae, Riodinidae and Nymphalidae from 34 genera were recorded from the study area. The dominance of Nymphalidae across different families of butterflies within the study area provided the best explanation for the greatest number of butterfly species in the location.

Keywords: Butterfly diversity, Lepidoptera, dominance, Nymphalidae

Introduction

Insects comprise more than half of earth's diversity of species (May, P.G. 1992). They are often considered to be the best taxonomically studied group of insects (Robbins and Opler, 1997). The order Lepidoptera, which means "scaly wing," is a large group of insects, including butterflies. They stand out for their large, colourful

different wings and their proboscis, which they use to sip flower nectar. Throughout different phases of their life cycle, they have highly precise requirements and are sensitive to even the smallest change in environmental conditions (Ramana, S.V. 2010). Reduction of vegetation causes a region's thermal gradient to alter dramatically, which makes it difficult for butterflies to survive (Smetacek, P. 2017).

Butterflies play an important role in ecosystems worldwide, serving as pollinators, indicators of environmental health. They have a significant role in ecosystems and the co-evolutionary relationship between them and plants as well as their lives are interlinked (Ghazanfar *et al.,* 2016). They have also diversified in response to interactions with other organisms, such as plants and predators. Apart from their ecological role, butterflies serve as a food source for many predators such as lizards, birds, spiders, and other creatures (Kasambe, 2018).

Braby (2004) explained that there are six families of butterflies in the world which are Hesperidae, Papilionidae, Pieridae, Nymphalidae, Riodinidae, and Lycanidae. There are around 19238 known butterfly species recorded worldwide (Heppner, 1998) i.e Indian butterflie is one fifth of total amount of the world butterfly species (Kunte, 2000). There are around 1,504 different butterfly species that have been observed in the India (Smetacek, P.1992; Gaonkar, 1996). North-East India and Eastern Himalayas harbour around half of the total butterfly species detailed from India (Gupta and Mondal, 2005). In the Assam 962 butterfly species from five families and subfamilies have been described, of which 69 species of Papilionidae, 57 Pieridae, 269 Lycaenidae, 356 Nymphalidae 211 species belonging to family Hesperiidae (Evans WH. 1932).

Silapathar, located in the Dhemaji district of Assam, India, is characterized by its unique ecological setting, contributing to a diverse insect population. The region's rich biodiversity is influenced by its geographical features, including the Brahmaputra River and the surrounding landscape. Silapathar's agricultural landscapes contribute to butterfly habitats. Fields of seasonal crops attract butterflies in search of nectar and the presence of diverse plant species in and around the cultivated areas sustains a thriving butterfly community. Because they depend on the plants, the diversity of butterflies in a specific location may be a reflection of the diversity of plants generally (Padhye *et al.,* 2006). The butterfly diversity in Silapathar can be attributed to the variety of ecosystems present in the region. The lush greenery of forests, open fields and the proximity to the Brahmaputra River contribute to a multitude of habitats suitable for different butterfly species. Hence, the present study was undertaken to provide baseline information of butterflies and their diversity in the study area taking the following objectives.

a) To explore the diversity of butterfly species found in Silapathar.
b) To compare the butterfly diversity in different habitats of the study area undertaken.

Materials and methods

Survey area

Physiography and location

The survey of butterfly diversity was carried out in Silapathar, district of Dhemaji, Assam, India which lies between latitudes- 27°35′43″N and longitudes 94°43′12″E. This area with an elevation of 117.00m/383.86ft, covering an area is about 376.58 km^2 is situated on the north bank of the Brahmaputra River and is about 471 kilometres from the city of Guwahati and 50 kilometres from the Dibrugarh town and borders Arunachal Pradesh which is only 6 kilometres away from the Town. Silapathar has a subtropical, humid, dry winter climate. Annual temperature remains approx. 25.49 degree Celsius. Bogibeel Bridge, which connects Silapathar and Dibrugarh town, is the longest rail bridge and second longest road bridge in India. Historical Malinithan mandir is located around 10 km away from Silapathar.

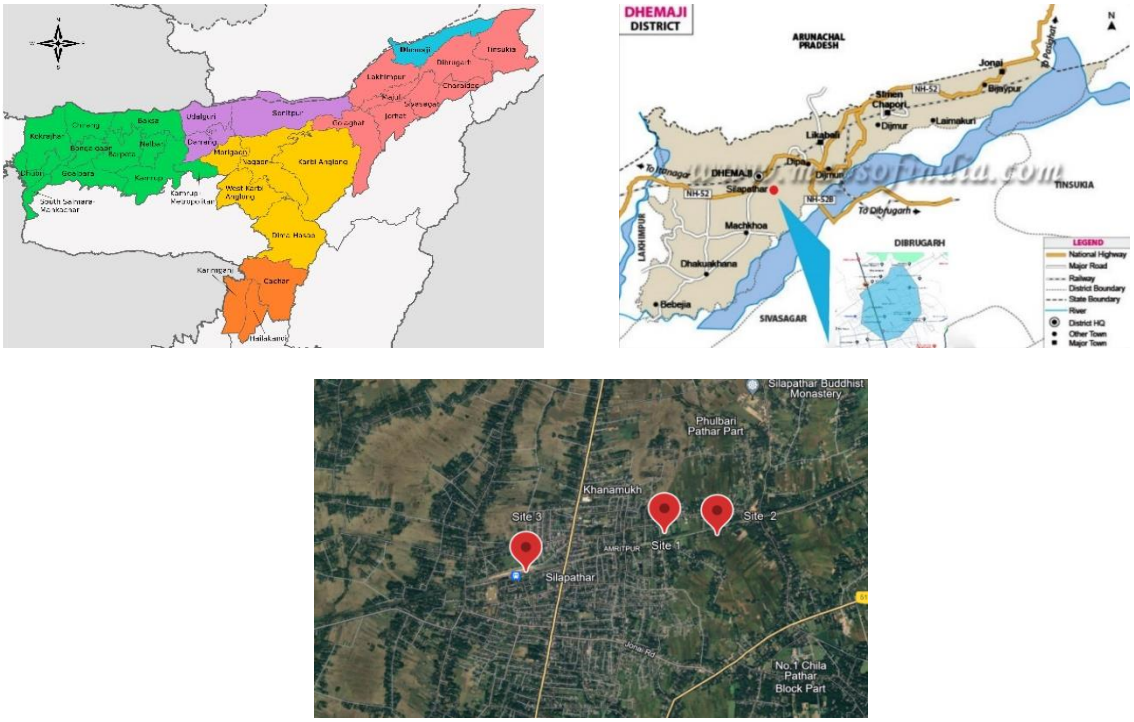


Figure 1: *The map showing the study area of Silapathar district of Dhemaji, Assam along with different habitats.*

Vegetation and habitat types

Silapathar, a town located in the Dhemaji district of Assam, India, features a rich and diverse range of vegetation owing to its unique geographical and climatic conditions. This region, situated in the northeastern part of India, experiences a humid subtropical climate, characterized by heavy rainfall during the monsoon season, which significantly influences its flora. Its lush vegetation includes a mix of tropical and subtropical species.

The grasslands are characterized by a mix of native grasses and herbs that thrive in the local climate. This area provides a crucial habitat for a variety of wildlife, including birds, small mammals, and insects, playing a vital role in maintaining the region's biodiversity. Common grasses include *Leucas aspera*, *Chromolaena odorata*, *Billygoat weed*and*Diplazium* etc. The fertile alluvial soil, enriched by the Brahmaputra River, supports the growth of rice, which is the predominant crop. Besides rice, farmers cultivate mustard, pulses, sugarcane, and a variety of vegetables. The agricultural landscape is characterized by neatly arranged paddy fields, interspersed with

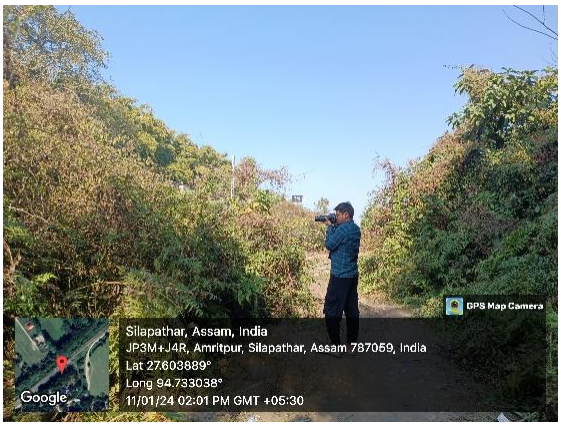
irrigation channels and small farm ponds. The vegetation in these urban spaces includes ornamental plants, garden trees, and small patches of greenery maintained by residents and municipal authorities. Common urban trees include neem (*Azadirachta indica*), banyan (*Ficus benghalensis*), and various flowering plants that add to the aesthetic appeal of the town.

Methods of study

Study design

Field survey on butterflies was conducted thrice in a month in the selected habitats from January 2024 to May' 24. Butterflies were accessed from 1.00 pm to 3.00 pm on sunny days by random observations during walking in each habitat. Three distinct habitats have been taken within Silapathar for the collection of butterflies, which are the Agricultural field (Site 1), Grassland (Site 2) and the Urban area (Site 3).

Agriculture field (site 1)



Grassland (site 2)

Urban area (site 3)

Photo plate 1: Photograph showing the three selected sampling sites of the study area.

Data collection

During the study, butterflies were recorded by walking on fixed transects (Pollard and Yates, 1993) in the different habitats. Most of the butterfly species were captured by Digital Camera (NIKON D5300) in their natural habitat from different angles as often as possible to obtain sufficient photographs to enable correct identification of species and the specimens whom were difficult to identify in the field were collected with the help of aerial

nets, placed in glass bottles and released after identification. The species was recorded along with the date, time, place, and other important taxonomic details including weather. The survey sites were recorded with the help of GPS camera (version 1.4.42).

Identification of Butterfly species

By observing the morphology as well as the particular behaviour of butterflies, they were identified. Sometimes colour patterns, sizes and shapes as well as their designs were considered in the identification of the species of butterfly and Google Lens is also used when confused to identification. Moreover, identification was done followed after Haribal (1992) and cross checked with Evans (1932), Bingham (1905), Kehimker (2008), Kunte (2000) and Ahmed *et al*. (2016). As per Evan (1932), every attempt has been made to utilize the most recent nomenclature and common names. All common names and scientific names followed in the current study were in accordance with Evan (1932).

Data processing and statistical analysis

The data were analysed by using MS - Excel and diversity indexes such as Berger-Parker Dominance, Shannon-Wiener diversity index and Margalef's richness and Pielou's Evenness were done in PAST.

Berger-Parker Dominance

Dominance index is a simple measure that quantifies the numerical importance of the most abundant species in a sample.

It's denoted as **'d'** and calculated using the following formula-

$$\mathbf{d} = \frac{\square\square\square\square}{\square}$$

Where,

N_{max}= The number of individuals which species are most abundant.

N = Total number of individuals in the sample.

Shannon-Wiener diversity index

The **Shannon Diversity Index**, also known as the **Shannon-Wiener Index**, is a measure used in ecology to assess the diversity of species within a community.

It's denoted as **'H′'** and calculated using the following formula-

$$\mathbf{H'} = \sum_{i=1}^{\square} \square\square\square\square(\square\square)$$

Where,

P_i = proportion of individuals belonging to the *i*-th species

(i.e., $pi = \frac{\square\square}{\square}$,Where, $\boldsymbol{n_i}$is the number of individuals of species *i* and N is the total number of individuals across all species).

ln = The natural log.

Σ = The sum of the calculations.

Margalef's richnessdibersity index

The **Margalef's richness index** is a species richness index which provides insights into the complexity and heterogeneity of species composition within a community.

It's denoted as **'D'** and calculated using the following formula-

$$\mathbf{D} = \frac{(\square - \square)}{\square\square\,(\square)}$$

Where,

D = Margalef's richness diversity index.

S = Total number of species.

N = The total number of individuals in the community.

Pielou's Evenness

Pielou's Evenness index is a measure used in ecology to quantify how evenly individuals are distributed across different species in a community. This index is derived from the Shannon-Wiener diversity index (H'), providing insight into the diversity and relative abundance of species.

It's denoted as 'J'' and calculated using the following formula-

$$\mathbf{J'} = \frac{\square'}{\square\square(\square)}$$

Where:

H′ = Shannon-Wiener diversity index.

S = Total number of species.

ln = The natural log.

Results

Butterfly diversity and distribution

Altogether 54 butterfly species belonging to 34 genera within five families and single order were recorded during the study period (Table 1). It was found that most of the butterflies recorded in the study period belonged to the family Nymphalidae 28 species. Among the others, 15 species were from Pieridae, 7 species from Lycaenidae, 3 species from Papilionidae and single species was recorded from Riodinidae (Table 1).

Table 1: Different types of Butterfly species recorded in the study area.

Sl. No	Order	Family	Scientific name	Common Name	IUCN Status
1			*Argyreus hyperbius*	Indian fritillary	NE
2			*Ariadne merione*	Common castor butterfly	NE
3	Lepidoptera	Nymphalidae	*Bicyclus safitza*	Common Bush Brown	LC
4			*Cethosia cyane*	Leopard Lacewing	NE
5			*Cyrestis thyodamas*	Common Mapwings	NE

6		*Danaus chrysippus*	Plain Tiger	LC
7		*Danaus genutia*	Striped tiger	NE
8		*Elymnias hypermnestra*	Common Palmfly	NE
9		*Euploea midamus*	Blue Spotted Crow	NE
10		*Euploea radamanthus*	Magpie crow	VU
11		*Hypolimnas anomola*	Malayan Eggfly	NE
12		*Hypolimnas bolina*	Common Eggfly	NE
13		*Junonia almana*	Peacock pansy	LC
14		*Junonia atlites*	Grey Pansy	NE
15		*Junonia iphita*	Chocolate pansy	NE
16		*Junonia lemonias*	Lemon Pansy	NE
17		*Kallima inachus*	Orange oakleaf	NE
18		*Neptis hylas*	Common Sailor	NE
19		*Neptis pryeri*	Clear Sailor	NE
20		*Orsotriaena medus*	Medus Brown	NE
21		*Parantica aglea*	Grassy Tiger	NE
22		*Phalanta phalantha*	Common Leopard	LC
23		*Polyura athamas*	Common Nawab	NE
24		*Rohana parisatis*	Black Prince	NE
25		*Thaumantis diores*	Jungle glory	NE
26		*Ypthima baldus*	Common five ring	NE
27		*Ypthima huebneri*	Common Four-Ring	NE
28		*Ypthima similis*	Eastern Five ring	NE
29		*Appias drusilla*	Florida white	NE
30		*Appias lalage*	Common Puffin	NE
31		*Appias lyncida eleonora*	Striped Albatross	NE
32		*Appias lyncida formosana*	Chocolate albatross	NE
33	Pieridae	*Appias paulina*	Yellow albatross	NE
34		*Catopsilia florella*	African emigrant	LC
35		*Catopsilia pomona*	Common emigrant	NE
36		*Catopsilia pyranthe*	Mottled emigrant	NE
37		*Eurema blanda*	Three-spot grass yellow	NE
38		*Eurema brigitta*	Small grass yellow	LC
39		*Eurema hecabe*	Common Grass Yellow	LC

40		*Eurema lacteola*	scarce grass yellow	NE
41		*Leptosia nina*	Wandering Psyche	NE
42		*Pieris canidia*	Indian cabbage white	NE
43		*Pieris mannii*	Southern Small White	LC
44		*Graphium sarpedon*	Common bluebottle	LC
45	Papilionidae	*Pantoporia paraka*	Common lascar	NE
46		*Papilio polytes*	Common Mormon	NE
47		*Anthene emolus*	Ciliate Blue	NE
48		*Castalius rosimon*	Common Pierrot	NE
49		*Cupido minimus*	Small blue	LC
50	Lycaenidae	*Heliophorus brahma*	Golden Sapphire	NE
51		*Jamides bochus*	Dark cerulean	NE
52		*Talicada nyseus*	Red Pierrot	NE
53		*Zizina labradus*	Common Grass-blue	NE
54	Riodinidae	*Zemeros flegyas*	Himalayan Punchinello.	NE

Note* LC = Least Concern, VU= Vulnerable, NE= Not Evaluated

Number of families

The family Nymphalidae was the dominant contributing 61% of individuals followed by Pieridae with 24%, Lycaenidae with 9% Papilionidae with 5% and Riodinidae with 1% individuals being the least (Table 2, Figure2)

Table 2: Percentage of total number of butterfly species from different families

Family	**Total no. of species**	**Percentage**
Lycaenidae	129	9%
Nymphalidae	841	61%
Papilionidae	65	5%
Pieridae	327	24%
Riodinidae	13	1%

Likewise, with family distribution concern family Nymphiladae contributed highest with 841 individuals of species whereas the family Riodinidae of with 13 individuals of species recorded throughout the study period (Table 2).

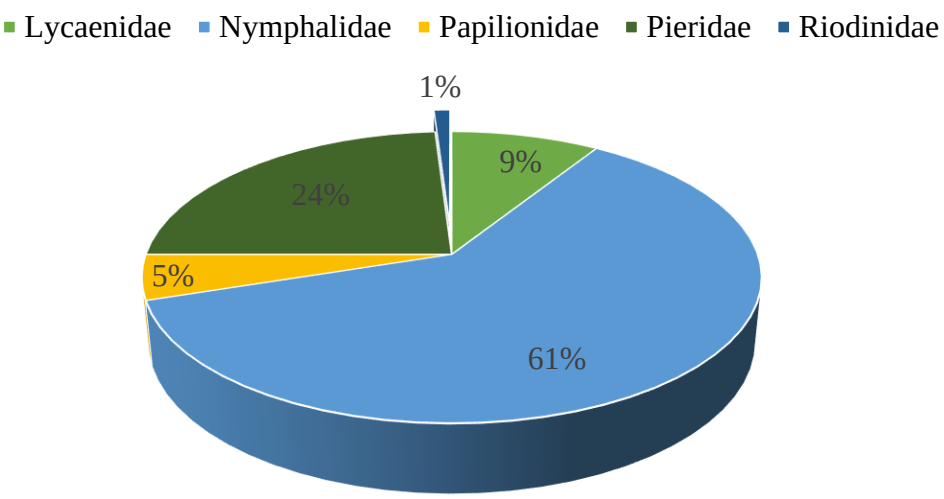


Figure 2: *Family wise distribution of butterfly species recorded in the study sites.*

Threat categories

From the 54 species,43 (80%) species are categorised as Not Evaluated (NE) followed by Least Concern (LC) with 10 (18%) species and Vulnerable (VU) with single species (2%) (Table 3, figure 3).

Table 3: Percentage of the conservation status of the butterflies in the study area.

IUCN status	Percentage of species	Number of Species
LC	18%	10
NE	80%	43
VU	2%	1

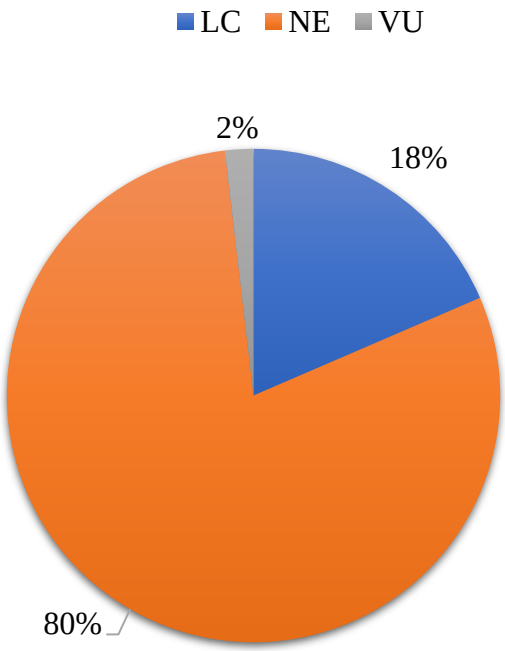


Figure 3: *Pie chart showing percentage of the conservation status of the butterflies in the study area.*

Family: Nymphalidae

Argyreus hyperbius

Ariadne merione

Bicyclus safitza

Cethosia cyane

Cyrestis thyodamas

Danaus chrysippus

Danaus genutia

Elymnias hypermnestra

Euploea midamus

Euploea radamanthus

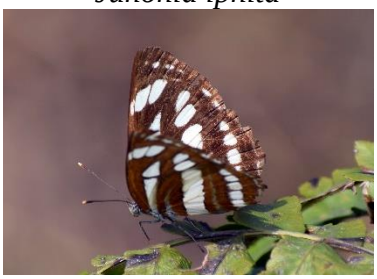
Hypolimnas anomola

Hypolimnas bolina

Junonia almana

Junonia atlites

Junonia iphita



Junonia lemonias

Kallima inachus

Neptis hylas

Neptis pryeri

Orsotriaena medus

Parantica aglea

Phalanta phalantha

Polyura athamas

Rohana parisatis


Thaumantis diores


Ypthima baldus


Ypthima huebneri


Ypthima similis

Family: Pieridae


Appias drusilla


Appias lalage


Appias lyncida eleonora


Appias lyncida formosana


Appias paulina


Catopsilia florella


Catopsilia pomona


Catopsilia pyranthe


Eurema blanda


Eurema brigitta


Eurema hecabe


Eurema lacteola


Leptosia nina


Pieris canidia


Pieris mannii

Family: Papilionidae


Graphium sarpedon


Pantoporia paraka


Papilio polytes

Family: Lycaenidae


Anthene emolus


Castalius rosimon


Cupido minimus


Heliophorus brahma

Jamides bochus

Talicada nyseus

Zizina labradus

Family: Riodinidae

Zemeros flegyas

Photo plate 2: List of butterfly species recorded during the study period in the Silapathar area.

Butterfly diversity in different habitats

Among three different habitats such as Agricultural field, Grassland and Urban area, the diversity of butterfly was maximum in Grassland (3.50) followed by Agricultural field (3.16) and Urban area (2.18) (Table 4). The most Margalef's richness was found in the Grassland with 6.69 followed by Agriculture field (4.79) and Urban area (2.08) (Table 4).

Table 4: Species wise representation of diversity index from different habitats.

Habitats/Diversity index	Agriculture field	Grassland	Urban area
Shannon's Diversity Index (H)	3.16	3.50	2.18
Margalef's richness	4.79	6.69	2.08
Evenness	0.79	0.73	0.74
Dominance	0.05	0.04	0.13

The highest evenness was found in agriculture filed (0.79) followed by Urban area (0.74) and Grassland (0.73) (Table 4). Greatest dominance was found in the Urban area with 0.13 followed by Grassland (0.04) and Agriculture field (0.05) (Table 4).

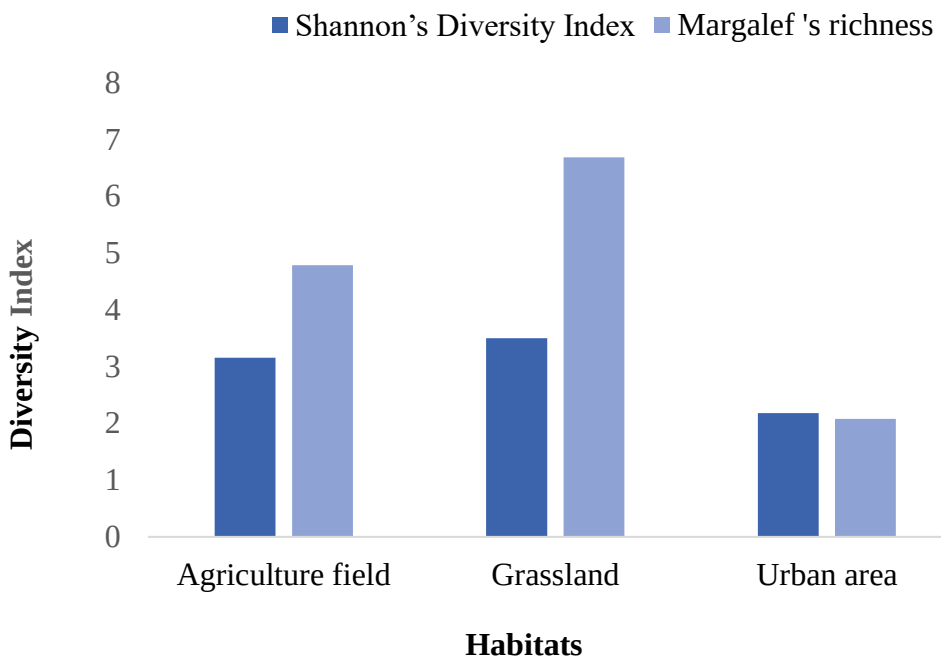


Figure 4: *Species wise butterfly diversity index and richness from different habitats.*

Diversity index (Family wise)

Among the five families, the diversity of butterfly family was maximum in Pieridae (1.04) followed by family Lycaenidae (0.39), Nymphalidae (1.00), Papilionidae (0.63) and Riodinidae (0) (Table5). The greatest Margalef's richness was found in the family Papilionidae with 0.48 followed by Lycaenidae (0.21), Nymphalidae (0.30), Pieridae (0.35) and zero in the family Riodinidae (Table 5).

Table 5: Family wise representation of diversity index and richness.

Family/Diversity index	**Lycaenidae**	**Nymphalidae**	**Papilionidae**	**Pieridae**	**Riodinidae**
Shannon's diversity index	0.39	1.00	0.63	1.04	0.00
Margalef's richness	0.21	0.30	0.48	0.35	0.00
Evenness	0.74	0.90	0.62	0.94	1.00
Dominance	0.77	0.39	0.64	0.38	1.00

The highest Evenness was found in the family Riodinidae (1) followed by Lycaenidae (0.74), Nymphalidae (0.90), Papilionidae (0.62) and Pieridae (0.94). Highest dominance was found Riodinidae family with 1 and least in Pieridae (0.38) (Table 5).

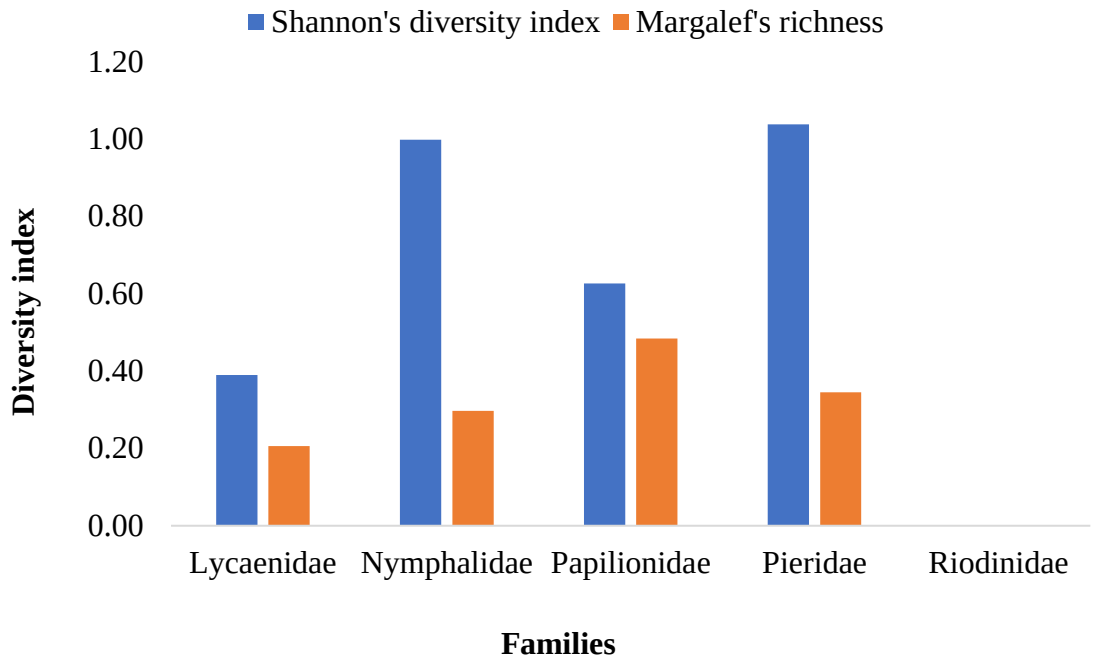


Figure 5: *Family wise diversity index and richnes during the survey.*

Diversity index (Month wise)

Butterfly species of families Nymphalidae, Pieridae, Lycaenidae, Papilionidae and Riodinidaewere recorded in three distinct habitats from the month of January 2024 to May 2024 (Table 6). The highest butterfly diversity was found in the month of May with 3.35 and followed by January (3.07), February (3.05), March (2.39) and April (3.24) (Table 6). The highest Margalef's richness was found in the month of May with 5.33 and least in the month of January with 4.36 followed by February (4.71), March (5.13) and April (4.90) (Table 6).

Table 6: Month wise representation of diversity index and species richness.

Months/Diversity index	**January**	**February**	**March**	**April**	**May**
Shannon's Diversity Index	3.07	3.05	3.29	3.24	3.35
Margalef's richness	4.36	4.71	5.13	4.90	5.33
Evenness	0.86	0.81	0.90	0.88	0.89
Dominance	0.05	0.06	0.04	0.04	0.03

Butterfly Evenness was found to be maximum in the month of March (0.90) and minimum in the month of February (0.81) followed by January (0.86), April (0.88) and May (0.89) (Table 6). The highest Dominance was found in the February with 0.06 and lowest in the May with 0.03 (Table 6).

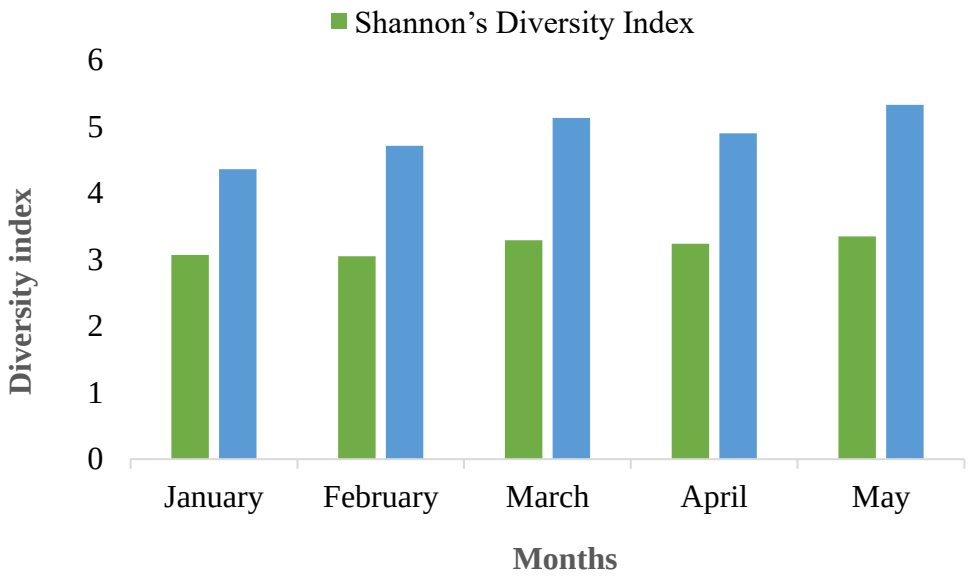


Figure 6: *Month wise species diversity Index and richness during the survey.*

Discussion

Altogether 54 butterfly species belonging to 34 genera within five families were recorded during the study period. The family Nymphalidae with 28 number of species was found to be most dominant and family Raiodinidae was found the least with single species. These findings are in accordance with the study conducted by Buragohain, D. and Acharjee, B. H. B. K. (2018), who in their study also reported the same trend of dominance of the Nymphalidae family with 22 species and Riodinidae family was represented by 2 species in the vicinity of IIT Guwahati Campus, Guwahati, Assam, India.

Butterflies' family varies in dominance and rarity across regions due to differences in habitat suitability, climate conditions, food availability, predation, competition, human impact, and evolutionary adaptations. Furthermore, Joshi, R. K., and Dhyani, S. (2014) conducted a survey in the Dibru-Saikhowa Biosphere Reserve in Assam, North-East India. Their findings indicated that the Nymphalidae family, as the dominant butterfly family, and the Hesperiidae family contributed as the least dominant species. Also, in the Karimganj region of Assam, Nymphalidae was the leading family with 20 species, followed by Hesperiidae with 3 species, according to the study conducted by Chakraborty, S., *et al.* (2014).

However, in the present survey, among the conservation status of the recorded species, one species was found to be recorded as Vulnerable (VU) (2%) which is of great concern. Similar study has also been conducted byJoshi, R. K., and Dhyani, S. (2014) identified 105 butterfly species in the Dibru-Saikhowa Biosphere Reserve, Assam. They found that 20 species (19.04%) were classified as Least Concern, 84 (80%) were Not Assessed, and 1 (0.95%) were considered Endangered. The conservation status for butterfly species varied due to differences in population size, habitat range, levels of threats, conservation efforts, data availability, and specific ecological requirements.

However, in the present study, diversity of butterflies can be found in different habitats due to the favourable climate, good vegetation and low population of human. During the survey period, the diversity and Margalef's richness of butterflies were found to be highest in grassland and lowest in urban areas, out of three

distinct habitats such as agricultural fields, grasslands, and urban areas. This finding is in accordance with the survey conducted by Modak, S., *et al.,* (2018), in Garbhanga Reserve Forest, Basistha, Assam and their findings indicate that Shannon-wiener diversity index (H) is also found to be highest in study site of plain forest area, however Margalef's richness index (D) were found to greater in the forest edges of plain forest area.

Moreover, variations in host plant specialization, life cycle timing, and habitat requirements lead to differences in species richness and diversity among butterfly families. Among the five families, the diversity was found to be maximum in the Pieridae family whereas lowest in the Riodinidae family. Similarly, the least Margalef's richness was found to be in the family Riodinidae, but the greatest was found in the family Papilionidae. Similar findings were reported by Das *et al.* (2024) in the Kaziranga National Orchid and Biodiversity Park, Assam, who in their studies have recorded the family Riodinidae to be the least diverse whereas, the Nymphalidae was determined to be the most diverse family.

The varying diversity of butterflies within a given month is partly caused by changes in the habitat, such as the blossoming of particular plants or the availability of host plants for caterpillars. In the current investigation, it was found that, the month of May had the largest butterfly diversity while February had the lowest. Similarly, species richness was also dominant in the May month, while January had the least number species. The same observation was suggested by Saikia, M. K., *et al.* (2010), in the Rani-Garbhanga Reserve Forest, Assam. In their study, they also reported the lowest diversity in the January, month and highest diversity was observed during the month of June with compared to other months of the year.

Conclusion

In conclusion, the study on butterfly diversity across different habitats highlights the substantial impact of environmental conditions on species distribution and abundance. Forest habitats exhibited the highest butterfly diversity, likely due to the availability of diverse food sources and suitable microclimates. In contrast, urban areas showed significantly lower diversity, attributed to habitat fragmentation, pollution, and reduced plant variety. Agricultural landscapes presented moderate diversity, influenced by farming practices and the presence of hedgerows and field margins.

These findings emphasize the critical role of habitat conservation and management in preserving butterfly populations. Protecting natural habitats and implementing biodiversity-friendly practices in urban and agricultural areas can help mitigate the negative effects of habitat loss. Further research should explore the long-term impacts of conservation efforts and the potential benefits of habitat restoration. Overall, maintaining diverse and healthy ecosystems is essential for the sustainability of butterfly species and the broader ecological balance.

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