INVENTORY OF BUTTERFLY SPECIES IN BELAURI MUNICIPALITY, KANCHANPUR, NEPAL

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Submitted to

Central Department of Zoology

Institute of Science and Technology

Tribhuvan University Kirtipur,

Kathmandu Nepal

September, 2023

DECLARATION

I hereby declare that the work presented in this thesis has been done by myself and has not been submitted elsewhere for the award of any degree. All the sources of information have been specifically acknowledged by reference to the authors or institutions.

Date 2080/05/31

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RECOMMENDATION

This is to recommend that the thesis entitled "**Inventory of Butterfly Species in Belauri Municipality, Kanchanpur, Nepal**" has been carried out by Mr. Guru Dev Chaudhary for partial fulfillment of Master's Degree of science in Zoology with special paper Entomology. This is his original work and has been carried out under my supervision. To the best of my knowledge, this work has not been submitted for any other degree in any institutions.

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CERTIFICATE OF ACCEPTANCE

This thesis work submitted by Mr. Guru Dev Chaudhary entitled **"Inventory of Butterfly Species in Belauri Municipality, Kanchanpur, Nepal"** has been accepted as a partial fulfillment for the requirement of Master's Degree of Science in Zoology with special paper Entomology.

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LIST OF ABBREVIATIONS

NHM	: Natural History Museum
viz.	: Namely
T.U.	: Tribhuvan University
MFSC	: Ministry of Forest and Soil Conservation

ABSTRACT

Butterflies are the large coloured scaly winged creatures, marvelous shapes, having a conspicuous fluttering and graceful flight which give pleasure to everyone. The present study was conducted to explore the butterflies diversity in Belauri Municipality, Kanchanpur, Sudur Paschim Province, Nepal. The field work was carried from March-April (Pre-monsoon) and September-October (Post-monsoon) 2022 in three different habitats viz. forest, grassland and agricultural area**.** Random three plots had been made in agricultural land and grassland of size 50 m X 50 m, 100 m apart. Line transect method had been used in forest area to collect the data of butterfly. All together 745 individuals representing 39 species belonging to 26 genera under four families were identified. Nymphalidae contributed 23 species (59%) followed by Pieridae 10 species (26%) and Papilionidae each with four species (10%) and Lycaenidae with two species (5%). Shannon-Weiner diversity index (H') was 3.29 and Pielou's species evenness (J) was 0.89 in the study area. Among 39 species,18 species were found as very common, 9 species found as common and 12 species found as rare. Butterfly diversity were the highest in grasslands areas (42%) followed by forest (30%) and agricultural areas (28%). Sorensen's similarity index is maximum between grassland and agricultural area was 0.3818 followed by forest and grassland 0.3036 and least between agricultural and forest area 0.2857. Butterfly Evenness was found highest in Post-monsoon season (0.88) than Pre-monsoon season (0.87) but number of individuals was recorded higher in Pre-monsoon (390) than Post-monsoon (355). The result of this study could be the baseline for further research on butterflies in the Belauri Municipality**.**

सार संक्षेप

पुतलीहरु कीरावर्गको पखेटा भएका धेरै सुन्दर तथा आकर्षक प्राणी हुन्। हालको अध्ययन नेपालको सुदुर पश्चिम प्रदेशको बेलौरी नगरपालिका, कञ्चनपुरमा पुतलीको विविधताको खोजी गर्न गरिएको हो। सो अध्ययनको लागी फिल्ड कार्य मार्च- अप्रिल र सेप्टेम्बर- अक्टोबर २०२२ मा तीन अलग अलग बासस्थानमा जस्तै वन क्षेत्र, घाँसे मैदान र कृषि क्षेत्रमा गरिएको थियो। पुतलीको तथ्याङ्क संकलन गर्न कृषियोग्य जमिन र घाँसे मैदानमा ५० देखी ५० मिटर का तिन तिन प्लट बनाईएको थियो र वन क्षेत्रमा लाईन ट्रानसेक्ट विधि प्रयोग गरिएको थियो। सो अध्ययनको दौरानमा त्यस अध्ययन क्षेत्र बाट ४ वर्गिकृत परिवार अन्तर्गत २६ वटा जात (Genus) भित्र पर्ने ३९ प्रजातिका (Species) का ७४५ सङ्ख्याको पुतलीहरुको पहिचान गरिएको थियो। जसमध्ये Nymphalidae २३ प्रजातिहरू (५९%), Pieridae १० प्रजातिहरू (२६%), Papilionidae ४ प्रजातिहरू (१०%) र Lycaenidae २ प्रजातिहरू (५%) पाईएको थियो। अध्ययन क्षेत्रमा Shannon-Weiner विविधता सूचकांक (H') ३.२९ र Pielou को प्रजाति समानता (J) ०.८९ थियो। ३९ प्रजाति मध्ये १८ प्रजाति धेरै सामान्य, ९ प्रजाति सामान्य र १२ प्रजाति दुर्लभ पाइयो। पुतलीको विविधता घाँसे मैदानमा सबै भन्दा बढी (४२%) त्यस पछि वनमा (३०%) र कृषि क्षेत्रमा (२८%) पाईएको थियो। Sorensen को समानता सूचकांक घाँसे मैदान र कृषि क्षेत्र बीच अधिकतम 0.3818, त्यसपछि वन र घाँसे मैदान 0.3036 र न्यूनतम कृषि र वन क्षेत्र 0.2857 मा थियो। Pielou को प्रजाति समानता मनसुन अघि (०.८७) को भन्दा मनसुन पछि (०.८८) बढी थियो तर पुतलीको संख्या मनसुन पछि(३५५) भन्दा मनसुन अघि (३९०) बढी रहेको थियो। यस अध्ययनको नतिजा बेलौरी नगरपालिकामा पुतलीहरूमा थप अनुसन्धानको लागि आधारभूत हुन सक्छ।

1. INTRODUCTION

1.1. Background

Insect consists more than half of earth diversity of species (Alarape *et al.,* 2015). Lepidoptera (Butterflies) is the second largest group of insects (Barsi & Jakaria, 2021). Butterflies are the large coloured scaly winged creatures, having a conspicuous, fluttering flight (Rai, 2017; Dar *et al.,* 2022) and females are usually larger than males (Thapa, 2008). Butterflies have been regarded as the symbol of prettiness and grace (Hasan *et al.,* 2018). Butterflies are diurnal, marvelous shapes and graceful flight which give pleasure to everyone (Perveen & Ahmed, 2012). Butterflies prefer warm weather with a constant short and long day lengths to remain reproductive (Thapa, 2008). Butterflies are generally regarded as one of the best taxonomically studied group of insects (Khan *et al.,* 2015; Ghazoul, 2002; Bonebrake *et al.,* 2010) and have been studied since the early 18th century (Sundufu & Dumbuya, 2008) as they are easy to monitored, capture, tagged and identified (Rai, 2017; Ulrich & Buszko, 2003; Iman *et al.,* 2020). The diversity of colors and patterns on the wings of butterflies has caught the attention of evolutionary biologists for more than a century (Perveen & Ahmed, 2012). They have been studied for economic value as well as aesthetic value (Thapa, 2008).

1.1.1 Diversity of butterfly

Nepal occupies 0.01% of global area, but it contains 3.2% of the world's floral diversity and 1.1% of global faunal diversity (MFSC, 2014). Butterflies count for 1.87% of the global insect fauna (Dar *et al.,* 2022). The estimated species of the butterflies has been reported to be 28,000, fifteen families throughout the world (Battol & Hussain, 2016). Butterfly species are reported to be 305 species belonging to 10 families in Bangladesh (Hasan *et al.,* 2018), 242 in Srilanka and 1500 species in India (Sah, 2019). In Nepal, of all the insect types butterflies have the oldest collection record (Thapa, 2008) and study was started by researchers Gen. Th. Hardwick since 1826 (Khanal & Smith, 1997). Nepal alone recorded 11 of the world's 15 families of butterflies (Resmi, 2001; Smith 1981; Smith, 2011a). Maj. W.G.H. Gough recorded 150 species of butterflies from Nepal in Gough (1935). Following this, Lt. Col. F.M. Bailey (1951) listed of 365 species. Similarly, 660

species of butterflies under 263 genera are listed from Nepal (Smith, 2010). Subedi *et al.*, (2021); K.C, (2020) recorded 672 species under 263 genera, which is about 4.3% of globally known species from Nepal. There have been recent records that have escalated the number of species up to as high as 680 (K.C, 2022). About 13%, 80% and 50% butterflies are found in Highland, Midland and Terai ecological zone respectively of Nepal (Smith, 2011; Sah, 2019). In the Chure (Siwalik Hills) Landscape of Nepal, 279 species of butterflies are found (Singh, 2017; Uprety *et al.*, 2023). Rawat *et al.*, (2021) present a checklist of 111 butterfly species from Shuklaphanta National Park. In Nepal, there are more than 672 butterfly species (Smith, 1989; Rawat *et al.*, 2021) of which 29 species and subspecies have been listed as endemic (Smith, 1993) and 20 species have been found as endangered or vulnerable of Kathmandu valley (Thapa, 2008). Many endemics butterflies of Nepal are fast disappearing and about 18% species of the mid hill zones are considered as threatened (ICIMOD, 2007; Bhusal *et al.*, 2018; Bhusal & Khanal, 2008; Thapa & Bhusal, 2009). A total of 142 species of butterflies found are under the IUCN red list category, among which 87 are susceptible, 43 are vulnerable, and 12 are endangered in Nepal. (Subedi *et al.*, 2021; Paudel *et al.*, 2012). Butterfly species abundance depends on variable like flower color, plant category, and corolla type and climate (Subedi *et al.*, 2021).

1.1.2 Butterflies as pollinators

Butterflies are phytophagous insects that feed on nectar and occasionally pollen due to presence of their sectorial proboscis (Subedi *et al.*, 2021). They provide economic and ecological benefits (Chinaru & Joseph, 2011; Sah, 2019). They play a signifcant role in pollinaton (Iman *et al.*, 2020) and there by contribute to forest regeneration (Hasan *et al.*, 2018). They are active during day and visit a variety of flowers (Sah, 2019). Their pollination efficiency is higher than that of bees at higher elevations (Dar *et al.*, 2022). Their floral preferences are influenced by flower color, nectar quality and quantity, nectar concentration, flower structure, flower size, and shape (Subedi *et al.*, 2021). They are important for biomass converter, agent of controlling weeds, source of drugs and genetic material for the development of new breeds (Mohagan *et al.*, 2011).

larvae of butterflies act as the pest (Perveen & Ahmed, 2012) and devour foliage and shoots of trees and crops (Thapa, 2008). They have a close association with the vegetation (Dar *et al.,* 2022) and can exhibits a interesting phenomena of mimicry and migration (Kunte, 2000; Rai, 2017).

1.1.3 Butterflies as an ecological indicator

Butterfies can function as sensors of environmental change (Khan *et al.,* 2023). They are quite sensitve to environmental factors such as temperature, humidity, rainfall (Dar *et al.,* 2022), solar radiaton, wind, and availability of larval host plants (Koirala *et al.,* 2020). They are known to be biological indicator species for their interacton with the environment (Hasan *et al.,* 2018) due to wide spread distribution, different land-use systems and land cover types (Dar *et al.,* 2022). Butterflies have become the preferred indicator for monitoring and evaluating environmental changes in their habitats due to their sensitivity to environmental changes (Ren *et al.,* 2022). They can contribute significantly to promote the ecotourism which can attract several nature tourists and researchers (Khanal, 2019)

1.1.4 Threat of butterflies

Globally, population of butterflies have experienced major declines over the past few decades due to habitat degradation, climate change, loss of native host and nectar plants, use of pesticide, periodic fire, grazing and deforestation (Bhusal *et al.,* 2018; Opler, 1995; Cushman & Murphy, 1993; Iftner *et al.,* 1992; Kremen *et al.,* 1993; Murphy, 1990; Sah, 2019; Rai, 2017)**.** Habitat fragmentation and deterioration of habitat quality are the two major threats to biodiversity loss (Bhusal *et al.,* 2018). Changes in their habitat may lead to either local extinction or migration if the required attention is not given (Kunte, 1997) as many species require specific host plants for sites of reproduction or food (Subedi *et al.,* 2021).

Belauri Muncipality lies in terai region of Kanchanpur district, Sudur Pashim Province, Nepal. It is situated at an altitude of 160 meters from sea level in the south to 1528 meters in the north with an area of the municipality is 123.4 sq km. The study area consists of land with different features such as forest land, grassland and cultivated land which shows wide range of biodiversity. Different types of vegetations were found in different habitats. In forest, vegetation like *Shorea robusta*,

Mallotus philippensis, Michelia spp., *Ficus* spp., Bamboo, *Clerodendrum viscosum Dalbergia sisoo,* etc. are found. Grassland habitat is herb-dominated in the transect with sparsely located trees like *Eupatorium odoratum, Lantana camara, Ageratum houstonianum, xanthium strumarium, Dioscorea deltoidea, Cynodon dactylon, Parthenium hysterophorus, Chromolaena odorata, Solanum nigrum,* etc. *Oryzae sativa, Bidens pilosa,* Zea mays, *Solanum lycopersicum, Curcuma longa, Coriandrum sativum, Oxalis corniculata, etc.* are the flora found in cultivated land. Documentation of butterflies provides ingredients for monitering species in future.Some population of butterflies have experienced major declines as a result of habitat loss, landscape modification, intensification in agriculture, and even climate change, the conservation of butterflies is of major concern and to study about the status of butterflies from the local level is important to assist their conservation.

1.2. Objectives

1.2.1. General objective:

- Inventory of butterfly species in Belauri Municipality, Kanchanpur.

1.2.2 Specific objectives:

- To compare the butterflies in different habitats.
- To determine seasonal variation of butterfly species.

1.3. Rationale of the study

Many species of butterflies plays an important role in pollination, immature stages of many species are economically important as pest of agricultural as well as horticultural crops. Few species are identified as bioindicators which being very sensitive towards any type of change in their habitat. This study will make an important contribution to understand the relation between the butterfly and environment and was not studied previously. So, this study is an attempt to find the current status of butterfly for future conservation.

1.3.1. Limitations of the study:

- Only two season data was obtained.
- Only morpholoical identification was carried so that there could be some contradiction of seasonal polymorphic species

2. LITERATURE REVIEW

2.1. Diversity of butterflies

Mohagan *et al.,* (2011) surveyed on diversity of butterflies in the Selected Key biodiversity areas of Mindanao, Philippines and listed 247 butterflies species. Majumder *et al.,* (2012) studied Butterfly species richness and diversity in the Trishna Wildlife Sanctuary in South Asia and recorded 59 butterfly species that included 21 unique species and 9 species listed in the threatened category. Munyuli (2012) studied butterfly diversity from farm lands of central Uganda and recorded 331 species under 95 genera and six families. Perveen and Ahmed (2012) listed 21 species belonging to 3 different families from Kohat, Pakistan. Among them Nymphalidae was the most domonant species. Tiwari and rawat (2013) studied butterfly Fauna of Jhilmil Jheel Conservation Reserve, Haridwar, Uttarakhand, India and listed 134 species belonging to 81 genera and 8 families. Sharmila and Thatheyus (2013) listed 101 species representing five families from the Alagarhills, Tamil Nadu, South India. Nymphalidae and Hisperiidae was the most prevalent family and the least represented family respectively. Addai and Baidoo (2013) listed 119 butterflies species belonging to 5 families from the Bosomkese Forest Reserve, Brong Ahafo Region, Ghana. Nymphalidae and Hesperidae was the most prevalent family and the least represented family respectively. Khandokar *et al.,*(2013) studied Species diversity and abundance of Butterflies in the Lawachara National Park, Bangladesh and documented 159 species of butterflies from 10 families.

Dayanand (2014) studied diversity of butterfly fauna in and around Gudavi bird sanctuary, Sorab, Karnataka and recorded 115 species representing 78 genera belonging to five families and 15 subfamilies. Of these, the family Nymphalidae was found to be the most dominant with (40) species followed by Lycaenidae (25 species), Hesperiidae (18 species), Papilionidae and Pieridae (16 species). Nudip (2015) conducted study on diversity of butterflies in Royal Manas National Park, Gelephu, Bhutan and recorded 181 species of butterflies belonging to five families. Among them Nymphalidae was dominant families and the Hesperiidae was least. Mukherjee *et al.,* (2015) studied on butterfly diversity in Kolkata, India and recorded 96 butterfly species, dominated by Lycaenidae followed by Nymphalidae, Hesperiidae, Pieridae, and Papilionidae.

Koneri and Maabuat (2016) studied the diversity of butterflies in the area of Manembo-Nembo Wildlife Reserve, North Sulawesi and recorded 44 species belonging to four families. Carvalho *et al.,* (2017) reviewed the occurrence and diversity of the sphragis in butterflies (Lepidoptera, Papilionoidea), Australia and listed 273 butterfly species, representing 72 species of Papilionidae under 13 genera, and 201 species of Nymphalidae under 9 genera. Haider *et al.,* (2017) conducted a study on the butterflies of the Chitagong University Campus (CUC), Bangladesh and listed 142 species of buterlies belonging to 87 genera and six families.

Iman *et al.,* (2020) studied butterfy species richness and diversity in rural and urban areas of Sirajganj, Bangladesh and recorded 65 species belonging to five families and 12 subfamilies. Lycaenidae (37%) over Nymphalidae (33%) were found dominant followed by Pieridae (19%), Hesperiidae (7%), and Papilionidae (4%). Koirala *et al.,* (2020) studied buterfy diversity in Gidakom Forest Management Unit, Thimphu, Bhutan and recorded 90 species belonging to 52 genera and fve families. Nymphalidae was dominant with 38 species, followed by Lycaenidae with 19, Pieridae with 15, Papilionidae with 11 and Hesperiidae with seven species.

Barsi and Jakaria (2021) studied butterfly communities (Insecta: Lepidoptera) at two recreational areas in Sungai Petani, Kedah, Peninsular Malaysia and recorded 13 species from four families of butterflies. The most abundant species were recorded from the family Nymphalidae. Singh and Ahmed (2021) studyed a report on butterfly diversity in a regenerated forest area in Atvan, Lonavala, Maharashtra, India and 90 species of butterflies were documented from the survey area where butterflies of family Nymphalidae (35) were found to be dominant, followed by Lycaenidae (18), Pereidae (14), Hesperiidae (14), Papilionidae (8), Riodinidae (1). Nijagal and Hema (2021) conducted the study of butterfly (Lepidoptera) fauna of Krishnarajanagar Town, Mysore District, Karnataka and recorded 46 genera and 60 species belonging to five families. The relative abundance of butterflies of different families such as the Nymphalidae family was 43.33%, followed by families Lycaenidae, Hesperidae, Pieridae and Papilionidae representing 18.33%, 15%, 13.33% and 10% in the study area respectively. De *et al.,* (2022) studied a primary inventory of the buterfy diversity of the Upper Ganga River Ramsar site in Utar Pradesh, India and recorded 44 species of buterfies belonging to 34 genera and five families. Sulaiman *et al.,* (2022) carried out the study of butterfly species diversity in Chemerong Amenity

Forest, Terengganu, Malaysia and listed 198 butterfly species belonging to six families. Verma and Arya (2022) conducted a study butterfly diversity and abundance in a sub-tropical wetland environment of Shyamlatal, Western Himalaya and recorded 64 species and 45 genera under six families. Tiple and Bhagwat (2023) carried out the study of butterfly species in the Tadoba National Park, Chandrapur, Maharastra, Central India and listed 134 species belonging to six families.

Ren *et al.,* (2022) analyzed butterfly community diversity in the Qinling Mountains. They observed a total of 9626 butterflies belonging to 427 species across 175 genera and 5 families and found abundant and the highest diversity at the middle altitudes (1000–2000 m). Stankovic (2022) examined an example of the species diversity and abundance of butterflies of the forest edge in the vicinity of Jagodina (Serbia) and recorded 47 species belonging to six families.

Khanal (1999) recorded 71 species blonging to eight families of butterflies of Kailai and Kanchanpur districts of far western part of Nepal. Shrestha *et al.,* (1999) recorded about 124 species from southern flood plain of Karnali (Kailali) area. Bhusal (2001) recorded 40 species of butterflies belonging to 28 genera and eight families from Churiya range of eastern Nepal ranging in altitude from 250-1150 m with Nymphalidae as the highest dominant family. Khanal (2020) studied inventories on butterflies in the northern Sindupalchok District of central Nepal and listed 114 species of butterflies. Among the recorded butterflies 19 species were assessed as locally rare species. Subedi *et al.,* (2020) conducted the study in butterfly species diversity and their floral preferences in the Rupa Wetland of Nepal and recorded 138 species representing six families. Shrestha *et al.,* (2005) studied on the species diversity in the Chitwan districts of Central Nepal and listed 68 species belonging to 8 genera. Among them 12 are rare, 50 common and 37 are uncommon.

Khanal (2006) recorded 54 species categorized under seven families from Koshi Tappu Wildlife Reserve, Eastern Nepal. He also mentioned altitudinal range and global distribution of each and every recorded species. Khanal (2008) listed 85 species belonging to 64 genera and 10 families based on national status list from four districts (Dangdeukhuri, Banke, Bardia and Surkhet) of Western Nepal. Thapa (2008) studied diversity of butterflies in Thankot and Syuchatar VDCs of Kathmandu District, Nepal and recorded 43 species of butterflies belonging to 32 genera and 9

families. Nymphalidae as the most commonly recorded Family and Libytheidae and Acreidae as the least recorded families. Subba and Tumbahangfe (2015) conducted study on butterfly fauna of Biratnagar, Nepal and recorded 31 species of butterfly belonging to 26 genera under six families. Dhakal (2017) surveyed on butterfly fauna of Madi Rambeni area, Eastern Mid-Hill Region, Sankhuwasabha. A total of 31 species belonging to 27 genera under nine families were documented. Nymphalidae and Satyridae were the most dominant families contributing 25.81% and 19.35% species respectively where the families Acraeidae and Hesperiidae were least observed contributing 3.23% each. Rai (2017) conducted in Ghandruk area of mid-mountain, Nepal and recorded 37 species belonging to 30 genera and seven families**.** Nymphalidae and Pieridae were the dominating families whereas Papilionidae and Nemobiidae were the least.

Shrestha *et al.,* (2018) conducted the study on diversity and status of butterflies at different sacred forests of Kathmandu valley, Nepal and recorded 77 butterfly species under 56 genera and six families. They found family Nymphalidae represented the highest butterfly abundance and richness and dominated in all sacred forest. They also recorded *Pieris canidia* as most abundant species throughout the study period. Oli and sharma (2019) conducted the study in butterfly species richness in T.U. campus area, kirtipur, Kathmandu and listed 43 species of butterfly were recorded under 32 genera and 9 families. They found 29 species were very common whereas 6 species were common and 8 species were rare in study area. Sah (2019) conducted a study on butterflies diversity in Shambhunath area, Saptari, Nepal and identified 23 species belonging 19 genera under 8 families. Sharma and Paudel (2021) conducted study in the Kumakh Rural Municipality; northern part of Salyan district, Karnali Province and listed 45 species of butterflies belong to five families. Among them Family Nymphalidae was dominant in the study area. Miya *et al.,* (2021) conducted a research on diversity and abundance of butterflies in Byas Municipality of Tanahun district and recorded 149 butterfly species from 92 genera and six families.

2.2 Habitat variation of butterfly diversity

Nidup *et al.,* (2014) studied Taxon diversity of butterflies in different habitat types in Royal Manas National Park, Bhutan and recorded 91 species belonging to five major families. Among them Nymphalidae was the most common and the lowest was

Hesperidae. Lein *et al.*, (2015) examined butterfly diversity and habitat variation in a disturbed forest in northern Vietnam and listed 147 species. In the same year, Ojianwuna investigated climatic variables as factors affecting diversity and abundance of butterflies in Okomu National Park, Edo State, Nigeria and listed 76 species belonging to five families. Hasan *et al.*, (2018) studied an inventory of butterfly species in relation to food sources and climatic factors influencing their diversity and richness in a semi evergreen forest of Bangladesh and recorded 195 butterfly species representing 125 genera under 21 subfamilies and 6 families. Nymphalidae was the more dominant family of the total species followed by Lycaenidae, Hesperiidae, Pieridae, Papilionidae and Riodinidae.

Khanal *et al.,* (2012) studied occurance and status of butterflies with respect of altitudional raise in Langtang National Park and listed 126 species. They concluded the population are at declining state due to consequences of habitat loss anad human interferences. Khanal *et al.,* (2013) studied the population status and prevailing threats of *Phaedyma aspasia kathmandia* an endangered and endemic subspecies of butterfly in Godavari forest of Central Nepal. They concluded that the increasing deforestation leading to habitat loss has been considered seriously for the decline of butterfly species.

2.3Seasonal variation of butterfly diversity

Bhusal and Khanal (2008) study on the butterfly diversity at churiya range of Eastern Nepal in winter and spring season and documented 40 species of butterflies belonging 28 genera and 8 families. They revealed the occurrence of rich diversity in spring than winter. Khanal *et al.*, (2014) studied population status, associated habitats and prevailing threats of *Teinopalpus imperialis* an endangered species in Phulchoki Mountain (Lalitpur District), Nagarjun–Shivapuri National Park (Kathmandu District) and Nagarkot Mountain (Bhaktapur District). They concluded that the rainfall, forest type, and season accounted for most variance in the Papilionid abundance. The destruction of natural forest and over-collection has threatened this butterfly species.

Prajapati *et al.,* (2000) studied seasonal and monthly variation of butterfly species in Daman area of Makawanpur district, Central Nepal. They recorded 65 species of butterflies belonging to 48 genera and 8 families with Nymphalidae and Lycaenidae as most common Acraeidae as least common. They concluded that the species

richness was higher in autumn (September - October) than in spring (March - April). Chapagai (2001) recorded 34 Species of butterflies belonging to 23 genera and seven families from Koshi Tapu Wildlife reserve during taxonomic survey in winter and spring. Neupane and Miya (2021) conducted the study on butterfly diversity of Putalibazar Muncipality, Syangja district, Gandaki province and recorded 180 butterflies species from 108 genera and six families. They obserbed highest species richness in the monsoon season, which might be due to high rainfall and humidity that results in high plant diversity.

3. MATERIALS AND METHODS

3.1 The Study Area

The present study was carried out from March-April (Pre monsoon) and September-October (Post monsoon) 2022 in Belauri Muncipality, Kanchanpur district. It lies in longitude 80°20'28.5" East and latitude 28°40'52.0" North in terai region of Sudur pashim Province, Nepal. It is situated at an altitude of 160 meters from sea level in the south to 1528 meters in the north. The total area of the municipality is 123.4 sq km. The study area consists of land with different features such as forest land, grassland and cultivated land which shows wide range of biodiversity. Different types of vegetations were found in three different habitats. In forest, vegetation like *Shorea robusta, Mallotus philippensis, Michelia* spp., *Ficus* spp., Bamboo, *Clerodendrum viscosum Dalbergia sisoo,* etc. are found. Grassland habitat is herb-dominated in the transect with sparsely located trees like *Eupatorium odoratum, Lantana camara, Ageratum houstonianum, xanthium strumarium, Dioscorea deltoidea, Cynodon dactylon, Parthenium hysterophorus, Chromolaena odorata, Solanum nigrum,*etc. *Oryzae sativa, Bidens pilosa,* Zea mays, *Solanum lycopersicum, Curcuma longa, Coriandrum sativum, Oxalis corniculata, etc.* are the flora found in cultivated land.

In general, Belauri Muncipality comprises tropical and sub tropical climate having great vegetation variation.

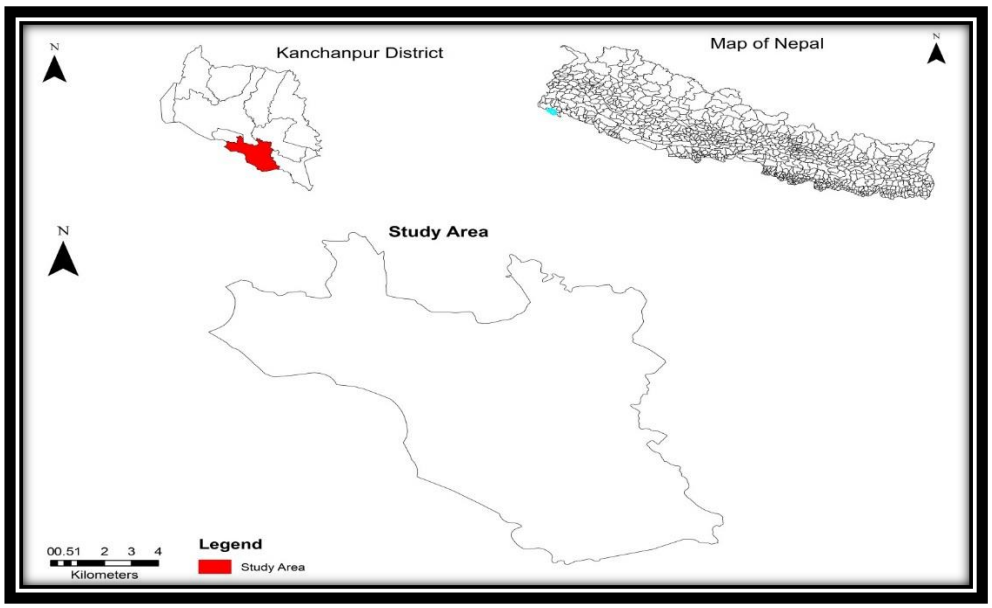

Figure 1: Map of the study area

3.2 Materials

- Sweeping net.
- Hand lens.
- Triangular paper envelops
- Measuring tape.
- Checklist book of Nepal's butterflies.

3.3 Sampling

Three sites were selected for the collection of the butterfly. The sampling sites were chiefly designed to include different types of habitats. The study was conducted at three habitats viz. agricultural land, grassland and forest area during two seasons i.e. Pre-monsoon and Post-monsoon. Random three plots had been made in agricultural land and grassland of size 50 m X 50 m, 100 m apart. Line transect method had been used in forest area to collect the data of butterfly. Three transects of 500 m long each, 500 m apart were arranged in a stratified and random manner. The butterflies within a 2.5 metre range on both sides of transect was observed and unidetified butterflies was captured while walking. Samplings was done on March-April and September-October, 2022 between 09 am to 03 pm.

3.4 Collection of butterflies

The net was swept to capture the specimen. Each habitat had been observed daily 09 am to 03 pm on sunny day. The data collection was carried for 15 days in each Season i.e. Pre-monsoon (March and April) and Post-monsoon (September and October), 2022. An unidentified butterfly species were captured and kept in triangular shaped paper envelops.

3.5 Identification of butterflies

Butterfly photos were sorted and the species were identified using literature (Khanal & Smith, 19997; Rawat *et al.,* 2021; Smith, 1993)**.** Confused specimens were reconfirmed by tally method at the Natural History Museum Swayambhu, Kathmandu.

3.6 Local status of butterflies

The status of butterfly species was made on the basis of abundance encountered during the study period. The status of recorded butterflies were categorized into three categories; 1-5 abundance- Rare (R), 6-15 abundance- Common (C) and 16< abundance- Very Common (VC).

3.7Data analysis

The data was analyzed by using MS-Excel and statistical test such as Shannon-Wiener diversity index; Sorenson's Coefficient and Pielou's evenness index were calculated.

Shannon-Wiener diversity index (H'): It is the index that is commonly used to characterize species diversity in a community (Shannon and Wiener, 1948).

Shannon-Wiener diversity index (H') = -∑pi * ln (Pi)Where,

P = the proportion (n/N) of individuals of one particular species found (n) divided by the total number of individuals found (N)

ln = the natural log

Σ = the sum of the calculations.

Pielou's evenness index (J): It is used to analyze the closeness of number of each species in an environment (Pielou, 1996).

J′ = H' / ln(S) Where,

H' = Shannon diversity index

ln = the natural log

S = total number of species

The value of J ranges from 0 to 1. Lesser the variation in the communities between the species, the higher will be the value of J.

Sorenson's Coefficient: It is the statistical technique for comparing the similarity of two samples or habitats (Sorenson, 1948).

Sorenson’s Coefficient (CC) = 2C / (S1 + S2) Where,

C = the number of species the two communities have in common

S1 = the total number of species found in community 1

S2 = the total number of species found in community 2

4. RESULTS

4.1 Diversity of butterflies

A total of 745 individuals 39 species belonging to 26 genera under four families were recorded during the entire study period in Belauri Municipility (Table 1). Among 39 species family Nymphalidae contributed 23 species (59%) under 16 genera followed by Pieridae with 10 species (26%) under 6 genera, Papilionidae each with four species (10%) under two genera and Lycaenidae with two species (5%) under 2 genera (Figure 2). Among them Peacock Pansy, (*Junonia almana*, 65 individual) and Small Grass Yellow (*Eurema brigitta*, 54 individual) butterflies were the most abundant species, followed by Common Grass Yellow (*Eurema hecabe*, 49 individual), Plain Tiger (*Danaus chryssipus*, 48 individual), Common Emigrant (*Catopsilia pomona*, 40 individual). Common Palmfly (*Elymnias hypermnestra undularis*) and Painted Lady (*Vanessa cardui*) are least with one individual each recorded throughout the sampling period in study area (Figure 3). Shannon- Weiner diversity index (H) was 3.29 and Pielou's species evenness(J) was 0.89 in the study area (Appendix. 4).

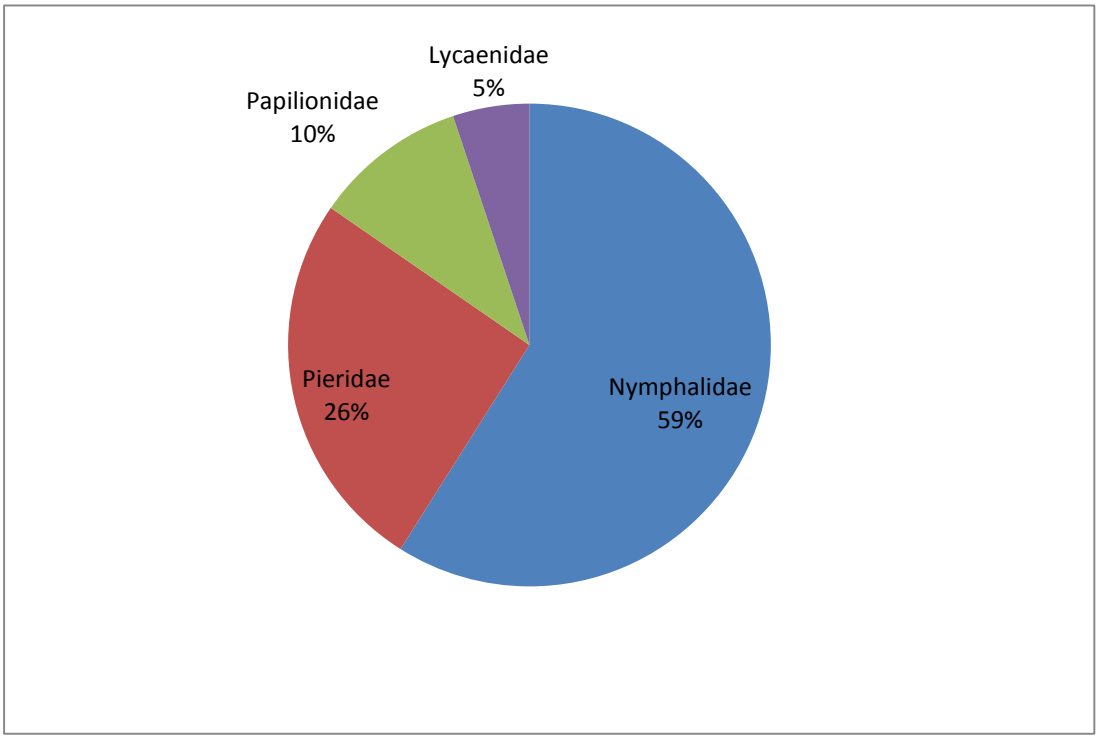

Figure 2: Family wise composition of species.

Table 1: Checklists and status of recorded butterfly species from the study.

S.N.	Family	Scientific Name	Common Name	Frequency	Local Status
1	Nymphalidae	*Apalina opalina*	Himalayan Sergent	9	**
2		*Ariadne merione*	Common Castor	21	***
3		*Argynnis hyperbilus*	Indian Fritillary	3	*
4		*Columella ophiana*	Short Banded Sailer	3	*
5		*Danus genutia*	Common Tiger	25	***
6		*Danaus chryssipus*	Plain Tiger	48	***
7		*Elymnias hypermnestra*	Common Palmfly	1	*
8		*Euploea core core*	Common Indian Crow	27	***
9		*Euploea mulciber*	Striped Blue Crow	12	**
10		*Euthalia aconthea*	Common Baron	2	*
11		*Hypolimnas bolina*	Great Eggfly	2	*
12		*Junonia almanac*	Peacock Pansy	65	***
13		*Junonia atlites*	Grey Pansy	19	***
14		*Junonia iphita*	Chocolate Pansy	12	**
15		*Junonia lemonias*	Lemon Pansy	4	*
16		*Melanitis leda*	Common Evening Brown	33	***
17		*Melanitis zitenius*	Great Evening Brown	3	*
18		*Melanitis phedima*	Common Evening	12	**

			Brown		
19		*Mycalesis mineus*	Dark Brand Brushbrown	5	*
20		*Neptis hylas*	Common Sailer	6	**
21		*Phalanta phalanta*	Common Leopard	3	*
22		*Vanessa cardui*	Painted Lady	1	*
23		*Ypthima huebneri*	Common Fourring	32	***
24	Pieridae	*Catopsilia Pomona*	Common Emigrant	40	***
25		*Catopsilia pyranthe*	Mottled Emigrant	31	***
26		*Cepora nirissa*	Common Gull	30	***
27		*Eurema blanda*	Three-spot Grass Yellow	10	**
28		*Eurema brigitta*	Small Grass Yellow	54	***
29		*Eurema hecabe*	Common Grass Yellow	49	***
30		*Erate lativilla*	Pale Clouded Yellow	8	**
31		*Gandaca harina*	Tree Yellow	31	***
32		*Pieris brassicae*	Large Cabbage White	21	***
33		*Pieris canidia*	Indian cabbage White	15	**
34	Paplionidae	*Pachliopta aristolochiae*	Common Rose	5	*
35		*Papilio polytes*	Common Mormon	23	***
36		*Papilio demoleus*	Lime Swallowtail	11	**
37		*Papilio polytes*	Common Mormon	29	***
38	Lycaenidae	*Catochrysops Strabo*	Forget-me-not	38	***
39		*Curetis bulis*	Bright Sunbean	2	*

NOTE: "***" = Very common "**" = Common "*" = Rare

Nymphalidae contributed highest number with 348 individuals followed by Pieridae with 289 individuals and Paplionidae with 68 individuals whereas the family Lycaenidae of with 40 individuals of species recorded throughout the study period (Figure 3). *Junonia almana* were adundant in number with 65 individuals followed by *Danaus chryssipus* with 48 individuals, *Melanitis leda* with 33 individuals, *Ypthima huebneri* with 32 individuals where as *Vanessa cardui* and *Elymnias hypermnestra* were least in number with one individuals in family Nymphalidae. Similarly, *Eurema brigitta* were adundent in number with 54 individuals followed by *Catopsilia pomona* with 40 individuals, *Eurema hecabe* with 49 individuals, *Catopsilia pyranthe* with 31 individuals in family pieridae. *Catochrysops strabo* were 38 individuals and *Curetis bulis* were two in number from family Lycaenidae.

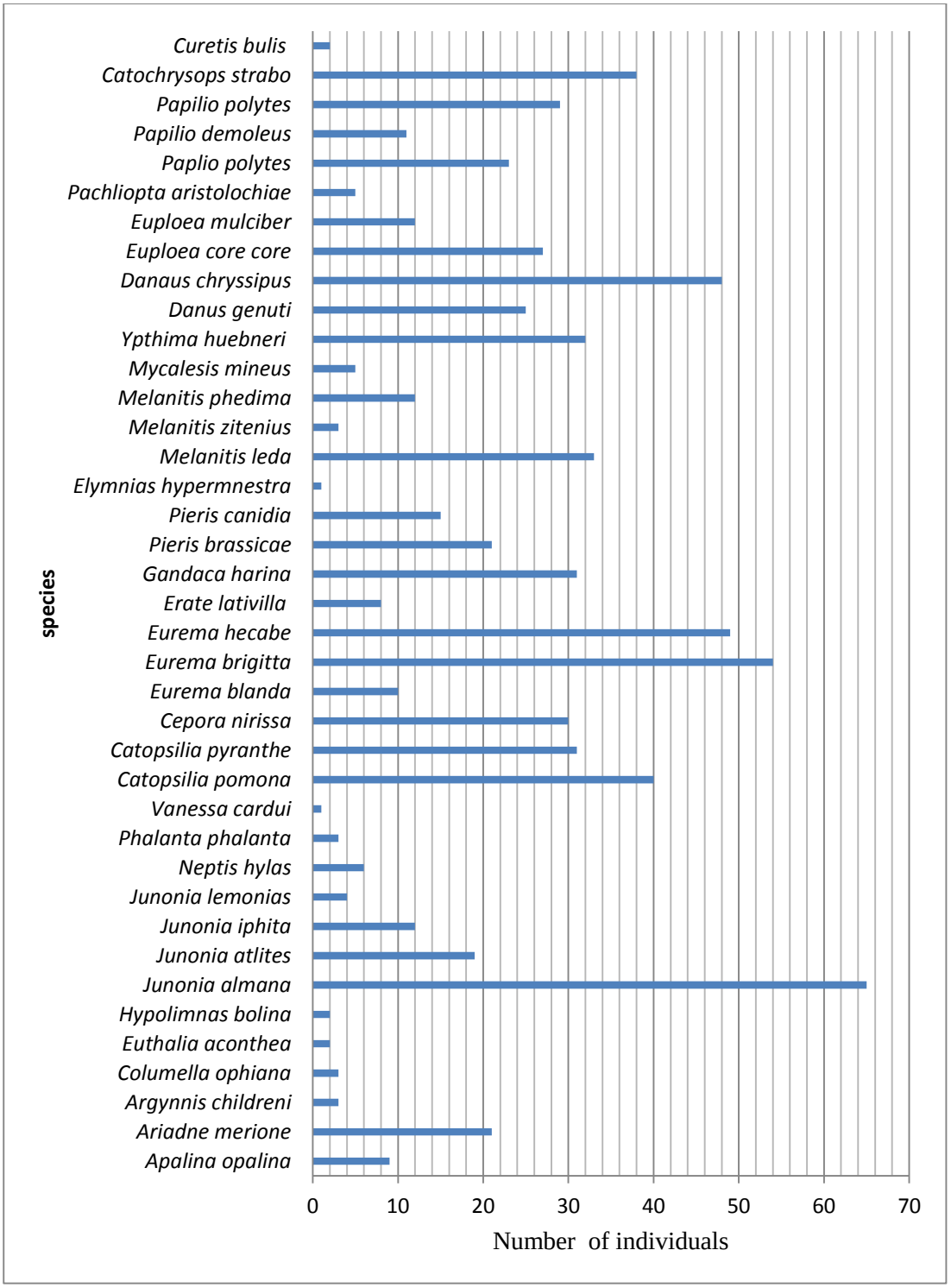

Figure 3: Rank abundance of species

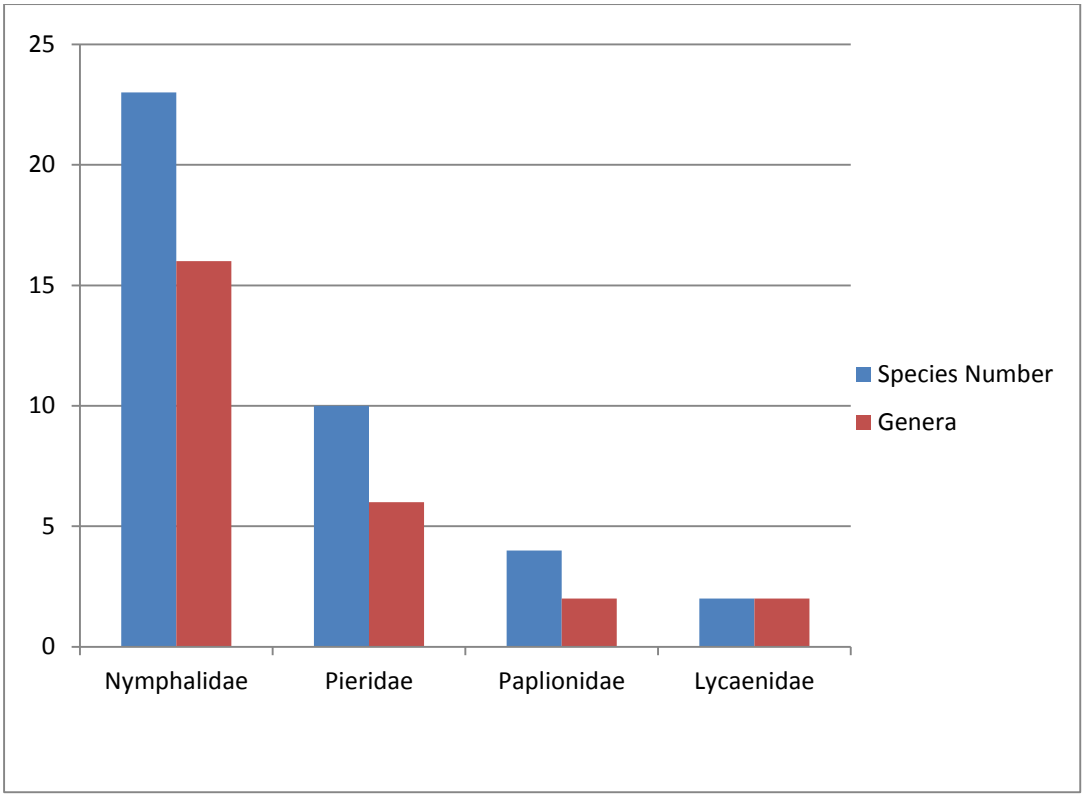

Figure 4: Family wise number of species and genera.

4.2 To compare butterflies in different habitats.

Among the three habitats, most of the species were found in grassland,12 species viz. *Junonia almana, Melanitis leda, Melanitis phedima, Ypthima huebneri, Danus genutia, Danaus chryssipus, Euploea core core, Catopsilia pomona, Eurema brigitta, Eurema hecabe, Gandaca harina* and *Catochrysops strabo* were found in all habitats, 23 species were found in forest area, 11 species were found in grassland area and 10 species were found in agricultural area (Table 2). *Apalina opalina, Junonia iphita, Euploea mulciber, Paplio polytes* and *Papilio demoleus* were found on both forest and grassland. *Ariadne merione, Junonia atlites, Neptis hylas, Catopsilia pyranthe, Cepora nirissa, Eurema blanda, Erate lativilla, Pieris brassicae, Pieris canidia* and *Papilio polytes* were found on both grassland and agricultural area. *Argynnis hyperbilus, Columella ophiana, Euthalia aconthea, Hypolimnas bolina, Junonia lemonias, Phalanta phalanta, Vanessa cardui, Elymnias hypermnestra,Melanitis zitenius, Mycalesis mineus, Pachliopta aristolochiae* and *Curetis bulis* were found only in any one of the habitat.

Table 2. Showing presence of butterfly species in different habitats

Habitats	**Number of species**
Forest area	11
Grassland	21
Agricultural area	10
Forest and Grassland	7
Grassland and Agricultural area	10
Agricultural and Forest area	0
All habitats	12

Table 3. The species richness, Frequency, Shannon diversity index and evenness in different habitats

Habitat	**Forest area**	**Grassland**	**Agricultural area**
Species richnes	23 (30.36%)	33 (38.18%)	22 (28.57%)
Individual	125	327	293
Shannons Diversity index (H')	2.95345	3.33045	2.86679
Evenness (J)	0.9293	0.9525	0.92745

Table 4. Showing Sorensen's similarity index between different habitats

Habitat	**Sorensen's similarity index**
Forest and Grassland area	0.3036
Grassland and Aricultural area	0.3818
Aricultural and Forest area	0.2857

4.3 To determine seasonal variationof butterfly species

Butterfly species of families Nymphalidae, Pieridae, Papilionidae and Lycaenidae were recorded in both seasons. The butterfly diversity of Pre-monsoon was found 3.1709 and Post-monsoon 3.2464. Butterfly Evenness was found highest in Post-monsoon season (0.88) than Pre-monsoon season (0.87) but number of individuals was recorded higher in Pre-monsoon (390) than Post-monsoon (355) (Table.5 and Table.6).

Table 5. The Shannon's diversity index and evenness in different seasons

Season	Abundace	Shannon's diversity index	Evenness
Pre-monsoon	390	3.17091	0.8717
Post-monsoon	355	3.24639	0.8861

Table 6. Frequency of butterfly species in different seasons

S.N.	Scientific Name	Pre monsoon				Post monsoon			
		FA	GA	AA	Frequency	FA	GA	AA	Frequency
1	*Apalina opalina*	-	4	-	4	2	3	-	5
2	*Ariadne merione*	-	5		5	-	11	5	16
3	*Argynnis childreni*	3	-	-	3	-	-	-	-
4	*Columella ophiana*	-	-	-	-	-	3	-	3
5	*Euthalia aconthea*	-	-	-	-	2	-	-	2
6	*Hypolimnas bolina*	2	-	-	2	-	-	-	-
7	*Junonia almana*	3	7	26	36	4	5	20	29
8	*Junonia atlites*	-	4	6	10	-	4	5	9
9	*Junonia iphita*	3	5	-	8	2	2	-	4
10	*Junonia*	-	4	-	4	-	-	-	-

	lemonias								
11	*Neptis hylas*	-	2		2	-	2	2	4
12	*Phalanta phalanta*	-	3	-	3	-	-	-	-
13	*Vanessa cardui*	-	-	-	-	-	1	-	1
14	*Catopsilia pomona*	4	4	5	13	9	13	5	27
15	*Catopsilia pyranthe*	-	6	7	13	-	10	8	18
16	*Cepora nirissa*	-	8	7	15	-	9	6	15
17	*Eurema blanda*	-	2		2	-	4	4	8
18	*Eurema brigitta*	8	15	13	36	2	10	6	18
19	*Eurema hecabe*	2	12	16	30	5	3	11	19
20	*Erate lativilla*	-	1	2	3	-	3	2	5
21	*Gandaca harina*	-	5	5	10	5	7	9	21
22	*Pieris brassicae*	-	2	9	11	-	4	6	10
23	*Pieris canidia*	-	3	3	6	-	4	5	9
24	*Elymnias hypermnestra*		-	-	-	1	-	-	1
25	*Melanitis leda*	-	3	11	14	2	10	7	19
26	*Melanitis zitenius*	-	3	-	3	-	-	-	-
27	*Melanitis phedima*	3	3	4	10	-	2		2
28	*Mycalesis mineus*	-	5	-	5	-	-	-	-
29	*Ypthima huebneri*	6	5	11	22	-	6	4	10
30	*Danus genutia*	2	7	3	12	3	7	3	13
31	*Danaus chryssipus*	5	10	13	28	3	6	11	20
32	*Euploea core*	-	6	3	9	7	6	5	18
33	*Euploea mulciber*	3	9	-	12	-	-	-	-

34	*Pachliopta aristolochiae*	5	-	-	5	-	-	-	-
35	*Papilio polytes*	4	10	-	14	4	5	-	9
36	*Papilio demoleus*	3	1	-	4	3	4	-	7
37	*Papilio polytes*	-	9	7	16	-	7	6	13
38	*Catochrysops Strabo*	6	8	4	18	7	6	7	20
39	*Curetis bulis*	2	-	-	2	-	-	-	-
					390				355

5. DISCUSSION

5.1 Butterfly diversity

In this study, the family that recorded the highest species richness was Nymphaidae followed by Pieridae and papilionidae. Lycaenidae had the least species number. Members of the Nymphalidae were dominant because of their ecological adaptation (Jiggins *et al.,* 1996), high dispersal ability (Adler *et al.,* 1994) and polyphagous in nature (Bora & Meitei, 2014), consequently helping them to live in all the habitats. Another possible reason is that many species of this family are strong, active fliers that might help them in searching for resources in large areas (Raut & Pendharkar, 2010; Eswaran & Pramod, 2005; Krishna Kumar *et al.,* 2007; Bora & Meitei, 2014). Family Nymphalidae represents nearly one-third of the known butterflies of the world (Rai, 2017) and its high proportion indicates high host plant richness (Bora & Meitei, 2014). Rawat *et al.,* (2021) recorded Nymphalidae family contributed the highest species number where as Riodinidae contribute least species number from Shuklaphanta National Parks, Kanchanpur districts, Nepal. Bhusal and Khanal (2008) obtained Nymphalidae was found to be the highest family and Nemobiidae to be the lowest in the Eastern Siwalik of Nepal. Thapa and Bhusal (2009) had also obtained the similar result that Nymphalidae and Satyridae contribute the highest and least species number respectively at Kathmandu valley. Arya *et al.,* (2014) obtained similar result that Pieridae family contributed the highest species number whereas Lycaenidae contribute least species number in and around Kumaun University, Nainital, Uttarakhand, India. The low species belonging to families Lycaenidae might be due to the small-sized that are difficult to identify, unable to fly for long stretches and thus often landing on vegetation to rest and are less noticeable (Subedi *et al.,* 2021). Sharma and Paudel (2021) recorded families Nymphalidae contributed the highest butterfly species whereas Papilionidae contributed least in Kumakh Rural Municipality; northern part of Salyan district, Karnali Province which supports the present study. Nymphalidae contributed the highest butterfly species due to the similar temperature, ecological adaptation and high dispersal ability whereas Papilionidae contributed least due to active fliers, eye-catching, and colorful butterflies (Subedi *et al.,* 2021).

Similarly, Miya *et al.*, (2021); Joshi and Dhyani (2014); Neupane and Miya (2021); Dwari and Mondal (2015); Shrestha *et al.*, (2018); Sharma and Paudel (2021); Rai (2017); Dakal (2017); Sharmila and Joesph Thatheyus (2013) recorded Nymphalidae as the dominant families. It might be due to availability of food plants (Bhusal *et al*., 2018).

However, Subba and Tumbahangfe (2015) documented families Lycaenidae contributed the highest butterfly species whereas Satyridae contributed least in Biratnagar, Nepal. Similarly, Mukherjee *et al.*, (2015) recorded highest butterfly diversity of family Lycaenidae followed by Nymphalidae where as Papilionidae contributed least which contradict with this study. It might be due to unmanaged and unplanned urbanization, industrialization and land use pattern.

5.2 Butterfly Diversity in different habitats

In the present study, the highest butterfly species richness was recorded in grassland (21), forest (11) and least at grassland (10). Butterfly species are associated with flowers and host plant for adult and larva respectively, and sunlight to stimulate their body (Nidup *et al.*, 2014). Abundance and species richness depends upon quality and quantity of nectar and pollen of host plants (Dyola *et al.*, 20022). Sah (2019) recorded highest butterfly diversity in grassland and least in cultivated land. Haider *et al*., (2017); Lien and Yuan (2003) and Kitahara *et al.*, (2008) had also obtained the similar result that least butterfly diversity in cultivated land (agricultural habitat) than grassland and forest habitat which supports present study. It may be due to monoculture habitat (Bhardwaj *et al.*, 2012; Ramesh *et al.*, 2010) and use of agricultural chemicals (Geiger *et al.*, 2010). Dyola *et al.*, (2022) recorded pollinator butterflies species much even in the open trail followed by Grassland. It might be due to a direct relation of insects with the presence of flower resources. Rai (2017) recorded highest numbers of species in human settlement area followed by cropland whereas the lowest species were recorded in forest which contradict with present study. It may be due to the activities of human interference in this forest (Khandokar *et al.*, 2013).

Butterfly evenness was recorded maximum in grassland (0.9525), forest (0.9293) and least at cultivated land (0.9275). According to Subedi *et al.*, (2021) visits of

butterflies were more frequent to the flowers of herbs and shrubs than to the flowers of trees. Abundance of butterfly species is found in grassland but *Junonia almanac* was found maximum abundance in all habitat. It might be presence of abundant host plant (Sah, 2019). High diversity of butterfly in grassland (bush) land might be due to the diversified vegetations (Bhusal *et al.*, 2018), presence of flowering herbs and high exposure of sunlight whereas low butterfly diversity in cultivated land could be due to non availability of host plant species, agricultural intensification, use of agricultural chemicals and monoculture crop (Sah, 2019; Benton *et al.*, 2003; Miya *et al.*, 2021).

Sorensen's similarity index is maximum between grassland and agricultural area was 0.3818 followed by forest and grassland 0.3036 and least between agricultural and forest area 0.2857. Herbaceous host plant species appear to offer attractive floral resources to butterflies, maintenance of native species of herbaceous plants in probable habitats may be suitable method to increase the richness and diversity of butterfly species (Subedi *et al.*, 2021).

5.3 Seasonal variation of butterfly species

In the present study, the Shannon's diversity index of Pre-monsoon was found 3.1709 and Post-monsoon was 3.2464. Butterfly species *Junonia almana, Catopsilia pomona, Eurema hecabe, Ypthima huebneri* and *Danaus chryssipus* were recorded during both seasons and and high butterfly diversity was recorded during Pre-monsoon season. The season for butterfly basically starts from the first week of March and lasts upto the end of November (Khanal, 2006). Sah (2019) reported similar results that Pre-monsoon contribute the least species number which support the present study. It might be due to the similar temperature. Khanal (2006) recorded *Eurema hecabe* all the year round due to their continuous brood in all season. Bhusal and Khanal (2008) had also obserbed high butterfly diversity in March than February which support the present study. It might be due to the availability of nectar rich host plants species, warmer days, high relative humidity and more rainfall (Saikia, 2014; Sah, 2019; Bhusal & Khanal, 2008). Prajapati *et al.*, (2000) recorded high butterfly diversity Post-monsoon than Pre-monsoon season, which is contradicted the present study. It might be due to hot and wet environmental conditions favorable for butterfly diversity (Ashish *et al.*, 2009). Saikia (2014) recorded higher butterfly diversity during Monsoon season whereas the low diversity during Winter season which is

contradicted the present study. It might be due to availability of host plants and favorable climatic conditions for the development and growth of butterflies. Singh *et al.,* (2020) obserbed density of *Pieris brassicae* butterfly is high in Post-monsoon than Pre-monsoon season. It may be due to susceptible host type with favorable environment. Some Nymphalids and Satyrids have remarkable display of seasonal variations (Khanal, 2008). Neupane and Miya (2021) observed highest species richness in Monsoon season followed by Pre-monsoon, Post-monsoon and Winter, which might be due to high rainfall and humidity that results in high plant diversity. Miya *et al.,* (2021) observed species abundance was highest in June, followed by October, and lowest in November. It might be due to the high plant diversity (Bhusal & Khanal , 2008).

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

From the present study following conclusions were derived:

- The butterfly of the families Nymphalidae and Pieridae were most dominant species reported and families Lycaenidae were contribute least number of species during study period.
- Butterflies have higher diversity in Non-cultivated land probably due to higher heterogeneity plant habitat and land low diversity in cultivated due to monoculture cultivation and other type of human enchrouchment.
- Butterfly Evenness was found highest in Post-monsoon season than Pre-monsoon season but number of individuals was recorded higher in Pre-monsoon than Post-monsoon.

6.2. Recommendations

This study would like to forward the following recommendation for the consideration of further studies in this under explored study area:

- Both temperal and spatial studies were needed to explore more species richness from the study area.
- Studies related to the ecological relation with the butterfly diversity should be done to determine the impact of environmental parameter in the dynamics of butterflies population in the study area.
- Some of the butterfly species show seasonal polymorphism and sexwise variation in their morphology so molecular identification is suitable for such species for accurate identification.

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APPENDICES

Appendix 1: GPS points of butterfly species recorded in study area:

S.N.	Family	Scientific Name	Citation	Latitude	Longitude
1	Nymphalidae	*Apalina opalina*	Elwes, 1888	28°41'26"	80°21'53"
2		*Ariadne merione*	Cramer, 1777	28°42'12"	80°22'09"
3		*Argynnis hyperbilus*	Grey, 1831	28°42'15"	80°22'13"
4		*Columella ophiana*	Cramer, 1780	28°42'17"	80°22'27"
5		*Danus genutia*	Linnaeus, 1758	28°41'45"	80°22'32"
6		*Danaus chryssipus*	Cramer, 1779	28°40'51"	80°21'44"
7		*Elymnias hypermnestra*	Linnaeus, 1763	28°42'12"	80°22'09"
8		*Euploea core*	Cramer, 1780	28°42'31"	80°22'18"
9		*Euploea mulciber*	Cramer, 1777	28°40'45"	80°21'26"
10		*Euthalia aconthea*	Cramer, 1777	28°40'45"	80°21'26"
11		*Hypolimnas bolina*	Linnaeus, 1758	28°42'43"	80°22'19"
12		*Junonia almana*	Linnaeus, 1758	28°41'49"	80°22'51"
13		*Junonia atlites*	Linnaeus, 1763	28°40'45"	80°21'26"
14		*Junonia iphita*	Cramer, 1779	28°40'33"	80°21'16"
15		*Junonia lemonias*	Linnaeus, 1758	28°40'17"	80°21'53"
16		*Melanitis leda*	Linnaneus,	28°42'17"	80°22'27"

			1758		
17		*Melanitis zitenius*	Herbst, 1976	28°40'45"	80°21'26"
18		*Melanitis phedima*	Cramer, 1782	28°40'45"	80°21'26"
19		*Mycalesis mineus*	Linnaneus, 1758	28°40'33"	80°21'16"
20		*Neptis hylas*	Linnaeus, 1758	28°41'45"	80°22'32"
21		*Phalanta phalanta*	Drury, 1773	28°40'51"	80°21'44"
22		*Vanessa cardui*	Linnaeus, 1758	28°42'31"	80°22'18"
23		*Ypthima huebneri*	Kirby,1871	28°40'17"	80°21'53"
24	Pieridae	*Catopsilia Pomona*	Fabricius, 1775	28°40'33"	80°21'41"
25		*Catopsilia pyranthe*	Linnaneus, 1758	28°41'43"	80°22'18"
26		*Cepora nirissa*	Fabricius, 1775	28°41'24"	80°22'16"
27		*Eurema blanda*	Biosduvai, 1836	28°40'46"	80°21'11"
28		*Eurema brigitta*	Stoll, 1780	28°40'48"	80°21'22"
29		*Eurema hecabe*	Linnaeus, 1758	28°40'41"	80°21'25"
30		*Erate lativilla*	Moore, 1882	28°40'78"	80°22'44"
31		*Gandaca harina*	Horsfield, 1829	28°41'56"	80°22'29"
32		*Pieris brassicae*	Hardwickii, 1883	28°40'45"	80°21'26"
33		*Pieris canidia*	Linnaneus, 1768	28°41'26"	80°21'53"
34	Paplionidae	*Pachliopta aristolochiae*	Fabricius, 1775	28°40'78"	80°22'44"
35		*Papilio polytes*	Linnaeus, 1758	28°41'56"	80°22'29"
36		*Papilio demoleus*	Linnaeus, 1758	28°40'45"	80°21'26"
37		*Papilio polytes*	Linnaneus, 1758	28°41'26"	80°21'53"
38	Lycaenidae	*Catochrysops Strabo*	Fabricius, 1793	28°42'12"	80°22'09"

39		*Curetis bulis*	Westwood, 1851	28°42'17"	80°22'27"

Appendix 2: Presence of butterfly species recorded in study area

S.N.	Family	Scientific Name	Common Name	Forest Area	Grassland Area	Agricultural Area
1	Nymphalidae	*Apalina opalina*	Himalayan Sergent	+	+	-
2		*Ariadne merione*	Common Castor	-	+	+
3		*Argynnis childreni*	Large Silverstripe	+	-	-
4		*Columella ophiana*	Short Banded Sailer	-	+	-
5		*Danus genutia*	Common Tiger	+	+	+
6		*Danaus chryssipus*	Plain Tiger	+	+	+
7		*Elymnias hypermnestra*	Common Palmfly	+	-	-
8		*Euploea core*	Common Indian Crow	+	+	+
9		*Euploea mulciber*	Striped Blue Crow	+	+	-
10		*Euthalia aconthea*	Common Baron	+	-	-
11		*Hypolimnas bolina*	Great Eggfly	+	-	-
12		*Junonia almana*	Peacock Pansy	+	+	+
13		*Junonia atlites*	Grey Pansy	-	+	+
14		*Junonia iphita*	Chocolate Pansy	+	+	-
15		*Junonia lemonias*	Lemon Pansy	-	+	-
16		*Melanitis leda*	Common Evening Brown	+	+	+

17		*Melanitis zitenius*	Great Evening Brown	-	+	-
18		*Melanitis phedima*	Common Evening Brown	+	+	+
19		*Mycalesis mineus*	Dark Brand Brushbrown	-	+	-
20		*Neptis hylas*	Common Sailer	-	+	+
21		*Phalanta phalanta*	Common Leopard	-	+	-
22		*Vanessa cardui*	Painted Lady	-	+	-
23		*Ypthima huebneri*	Common Fourring	+	+	+
24	Pieridae	*Catopsilia Pomona*	Common Emigrant	+	+	+
25		*Catopsilia pyranthe*	Mottled Emigrant	-	+	+
26		*Cepora nirissa*	Common Gull	-	+	+
27		*Eurema blanda*	Three-spot Grass Yellow	-	+	+
28		*Eurema brigitta*	Small Grass Yellow	+	+	+
29		*Eurema hecabe*	Common Grass Yellow	+	+	+
30		*Erate lativilla*	Pale Clouded Yellow	-	+	+
31		*Gandaca harina*	Tree Yellow	+	+	+
32		*Pieris brassicae*	Large Cabbage White	-	+	+
33		*Pieris canidia*	Asian/Indian cabbage White	-	+	+
34	Paplionidae	*Pachliopta aristolochiae*	Common Rose	+	-	-
35		*Papilio polytes*	Common Mormon	+	+	-

36		*Papilio demoleus*	Lime Swallowtail	+	+	-
37		*Papilio polytes*	Common Mormon	-	+	+
38	Lycaenidae	*Catochrysops Strabo*	Forget-me-not	+	+	+
39		*Curetis bulis*	Bright Sunbean	+	-	-

(+) Sign indicates presence and (-) sign indicates absence of specimens.

Appendix 3: Calculation of Shannon- Weiner diversity index (H') in different habitats.

Habitats	Abundance	Pi	Ln(Pi)	Pi × Ln(Pi)
Forest Area	125	1	76.83927	2.95345
Grasslad Area	327	1	122.066	3.33046
Agricultural Area	293	1	73.3487534	2.86682

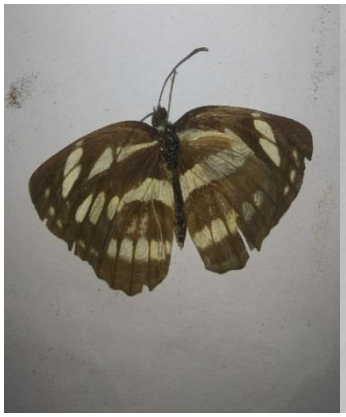
Appendix4: Calculation of Shannon- Weiner diversity index (H') and Pielou's species Evenness(J) in study area.

S.N.	Scientific Name	Abundance	Pi	Ln(Pi)	Pi × Ln(Pi)
1	*Apalina opalina*	9	0.01208054	-4.416159641	-0.05334958
2	*Ariadne merione*	21	0.02818792	-3.568861781	-0.100598788
3	*Argynnis children*	3	0.00402685	-5.51477193	-0.022207135
4	*Columella ophiana*	3	0.00402685	-5.51477193	-0.022207135
5	*Euthalia aconthea*	2	0.00268456	-5.920237038	-0.015893254
6	*Hypolimnas bolina*	2	0.00268456	-5.920237038	-0.015893254
7	*Junonia almanac*	65	0.08724832	-2.438996948	-0.212798391
8	*Junonia atlites*	19	0.02550336	-3.668945239	-0.093570415
9	*Junonia iphita*	12	0.01610738	-4.128477569	-0.066498968
10	*Junonia lemonias*	4	0.00536913	-5.227089857	-0.028064912

11	*Neptis hylas*	6	0.0080536 9	-4.821624749	-0.038831877
12	*Phalanta phalanta*	3	0.0040268 5	-5.51477193	-0.022207135
13	*Vanessa cardui*	1	0.0013422 8	-6.613384218	-0.008877026
14	*Catopsilia pomona*	40	0.0536912 8	-2.924504764	-0.15702039
15	*Catopsilia pyranthe*	31	0.0416107 4	-3.179397014	-0.132297057
16	*Cepora nirissa*	30	0.0402684 6	-3.212186837	-0.129349806
17	*Eurema blanda*	10	0.0134228 2	-4.310799125	-0.057863076
18	*Eurema brigitta*	54	0.0724832 2	-2.624400172	-0.190224979
19	*Eurema hecabe*	49	0.0657718 1	-2.72156392	-0.179002191
20	*Erate lativilla*	8	0.0107382 6	-4.533942677	-0.048686633
21	*Gandaca harina*	31	0.0416107 4	-3.179397014	-0.132297057
22	*Pieris brassicae*	21	0.0281879 2	-3.568861781	-0.100598788
23	*Pieris canidia*	15	0.0201342 3	-3.905334017	-0.078630886
24	*Elymnias hypermnestra*	1	0.0013422 8	-6.613384218	-0.008877026
25	*Melanitis leda*	33	0.0442953	-3.116876657	-0.138062993
26	*Melanitis zitenius*	3	0.0040268 5	-5.51477193	-0.022207135
27	*Melanitis phedima*	12	0.0161073 8	-4.128477569	-0.066498968
28	*Mycalesis mineus*	5	0.0067114 1	-5.003946306	-0.033583532
29	*Ypthima huebneri*	32	0.0429530 2	-3.147648316	-0.135201001
30	*Danus genutia*	25	0.0335570 5	-3.394508394	-0.113909678
31	*Danaus chryssipus*	48	0.0644295 3	-2.742183207	-0.176677576
32	*Euploea core*	27	0.0362416 1	-3.317547352	-0.12023326
33	*Euploea mulciber*	12	0.0161073 8	-4.128477569	-0.066498968
34	*Pachliopta aristolochiae*	5	0.0067114 1	-5.003946306	-0.033583532

35	*Papilio polytes*	23	0.03087248	-3.477890002	-0.107371101
36	*Papilio demoleus*	11	0.0147651	-4.215488946	-0.062242119
37	*Papilio polytes*	29	0.03892617	-3.246088388	-0.126357803
38	*Catochrysops Strabo*	38	0.05100671	-2.975798059	-0.151785673
39	*Curetis bulis*	2	0.00268456	-5.920237038	-0.015893254
		745			(H) =3.28595235
					(J) =0.896928363

PHOTOPLATES



Apalina opalina orientalis

Ariadne merione

Argynnis childreni

Columella ophiana

Euthalia aconthea

Hypolimnas bolina jacintha

Junonia almanac

Junonia atlites

Junonia iphita

Junonia lemonias

Neptis hylas

Phalanta phalanta

Catopsilia Pomona

Catopsilia pyranthe

Cepora nirissa

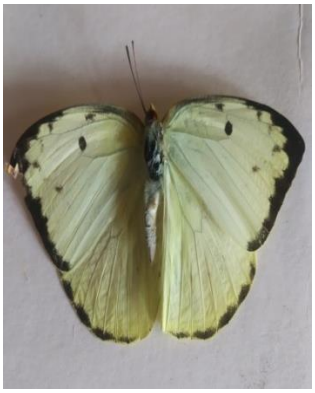
Eurema brigitta

Eurema hecabe

Erate lativilla

Gandaca harina

Elymnias hypermnestra



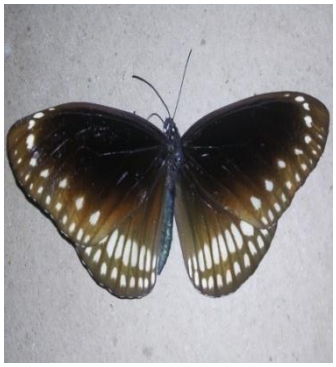
Pieris canidia

Melanitis leda ismene

Melanitis phedima

Mycalesis mineus

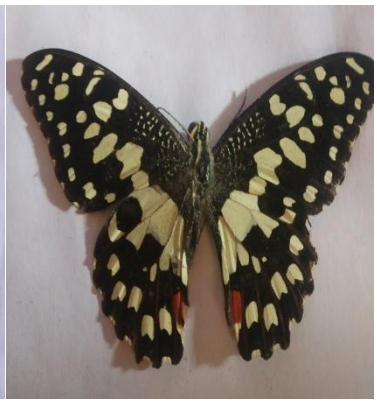
Danus genutia nepalensis



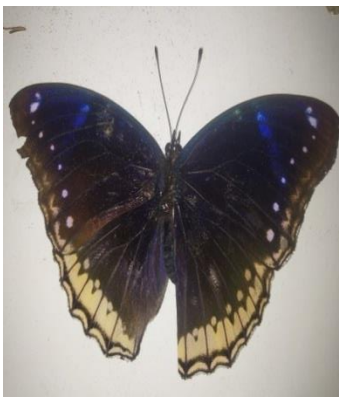
Euploea core core

Euploea mulciber

Pachliopta aristolochiae



Papilio demoleus



Hypolimnas bolina

Papilio polytes ormolus

Catochrysops Strabo

Ypthima heuebneri