Journal of Threatened Taxa

Building evidence for conservation globally

www.threatenedtaxa.org

ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)


COMMUNICATION

# BUTTERFLY DIVERSITY IN GIDAKOM FOREST MANAGEMENT UNIT, THIMPHU, BHUTAN

Thal Prasad Koirala, Bal Krishna Koirala & Jaganath Koirala

26 May 2020 | Vol. 12 | No. 8 | Pages: 15794–15803
DOI: 10.11609/jott.5117.12.8.15794-15803

Journal of Threatened Taxa | www.threatenedtaxa.org | 26 May 2020 | 12(8): 15794–15803
ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)
DOI: https://doi.org/10.11609/jott.5117.12.8.15794-15803
#5117 | Received 05 May 2019 | Final received 18 April 2020 | Finally accepted 27 April 2020
PLATINUM OPEN ACCESS

COMMUNICATION

# Butterfly diversity in Gidakom Forest Management Unit, Thimphu, Bhutan

**Thal Prasad Koirala [1], Bal Krishna Koirala [2] & Jaganath Koirala [3]**

[1] Thimphu Forest Division, Department of Forests and Park Services, P.O. box 11001, Thimphu, Bhutan.
[2] Tashigang Forest Division, Department of Forests and Park Services, P.O. box 42002, Tashigang, Bhutan.
[3] Sherubtse College, School of Life Science, Royal University of Bhutan, P.O. box 42002, Kanglung, Tashigang, Bhutan.
[1] thal_prasad@yahoo.com (corresponding author), [2] bkgelephu@gmail.com, [3] koiralakoirala08@gmail.com

**Abstract:** This study was carried out to establish the diversity and distribution of butterflies in Gidakom Forest Management Unit (GFMU), Thimphu, Bhutan. A survey was conducted from June 2016 to July 2017 in three locations within GFMU: Jamdo, Chimithanka, and Jedekha. A total of 90 species belonging to 52 genera and five families of butterflies were recorded. Nymphalidae was dominant with 38 species, followed by Lycaenidae with 19, Pieridae with 15, Papilionidae with 11, and Hesperiidae with seven species. Diversity of butterfly species was highest in farmland associated with pockets of forest cover in the lower valley, and a decreasing trend was observed towards higher elevations. The maximum species richness (83 species) was recorded from Chimithanka between 2500m & 2900m, where agriculture is associated with patches of forest, streams, forest edges, and open scrub land. Butterfly diversity was lowest at Jedekha above 2,900m (37 species), an area dominated by mixed conifer forest with little agriculture.

**Keywords:** Butterflies, Hesperiidae, Lepidoptera, Lycaenidae, Nymphalidae, Papilionidae, Pieridae, sweep net.

**Editor:** Anonymity requested.

**Date of publication:** 26 May 2020 (online & print)

**Citation:** Koirala, T.P., B.K. Koirala & J. Koirala (2020). Butterfly diversity in Gidakom Forest Management Unit, Thimphu, Bhutan. *Journal of Threatened Taxa* 12(8): 15794–15803. https://doi.org/10.11609/jott.5117.12.8.15794-15803



**Funding:** Nagao Natural Environment Foundation (NEF).

**Competing interests:** The authors declare no competing interests.

**Author details:** Mr. Thal Prasad Koirala is professional forester working under department of forest and park services for last 23 years. Working with local community for sustainable management and utilization of natural resources is subject of great interest as natural resources management is fundamental for long term sustainability. He is equally interested on the wild life with more focus on anurans and on butterflies of the high altitude. He is currently working as Senior Forest Range Officer of Gidakom Forest Management Unit under Thimphu Forest Division. Mr. Bal Krishna Koirala is forester by profession and currently working as Forestry Officer in Trashigang Forest Division under Department of Forest and Park Services. He has deep interest in wildlife ecology, natural history and various wildlife conservation works. Herpetofauna are his latest passion, and currently working on conservation of King Cobra and other venomous snakes in eastern Bhutan. Mr. Jaganath Koirala is former student of Sherubtse College, Department of Live Science, and Royal University of Bhutan. He is working as research assistant in the field of biodiversity conservation work in Bhutan. He has deep interest in entomology, particularly in wild bees and butterflies of Bhutan.

**Author contribution:** TPK—field surveys, and data collection, and manuscript writing; BKK— data analysis & editing; JK—data collection.

**Acknowledgements:** Authors would like to extend immense gratitude to Nagao Natural Environmental Foundation (NEF) Japan for the financial support to carry out this research work. We are very grateful to Ugyen Wangchuck Institute for Conservation and Environment (UWICER) under Department of Forest and Park Services (DoFPS) for providing research clearance to conduct this research work in the study area. The authors would like to extend gratitude to Jatishwor Singh Irungbam, Faculty of Science, The University of South Bohemia, Ceske Budejovice, Czech Republic and Karma Wangdi from Ugyen Wangchuck Institute for Conservation and Environment (UWICER) for their immense help with species identification. The authors are also very grateful to J.B. Rai, Sukuna Subba, and Sonam Lhaki Dema (Forest Rangers) of Gidakom forest management unit for their immense support in the field for data collection. We extend our gratitude to Gyeltshen Dukpa, Divisional Forest Officer (DFO) Thimphu Forest Division for his encouraging words to take up this research. Our sincere thanks go to Mr Norbu Wangchuk (Forester) for his contribution as a photographer in the initial stage of survey. Last but not the least, we owe special thanks to Abiskhar Koirala (student) for his active participation during the weekend for reporting the presence of butterflies with great interest.

## INTRODUCTION

Butterflies are quite sensitive to environmental factors such as temperature, humidity, rainfall, solar radiation, wind, and availability of larval host plants (Hill et al. 2002; Ribeiro & Freitas 2012). This sensitivity makes butterflies ideal indicators of habitat disturbance (Kocher & Williams 2000; Bonebrake et al. 2010; Castro & Espinosa 2015).

The first study of butterflies in Bhutan was reported in 1905 by (Binghan 1905). Since then estimates of total species in the country have ranged from 800–900 (ven der Poel & Wangchuk 2007), to 670 (Singh & Chib 2015). It should be noted, however, that butterfly data is lacking from many parts of Bhutan. Of the several checklists available (Harada 1987 a,b; van der Poel & Wangchuck 2007**;** Wangdi & Sherub 2012 a,b; Singh & Chib 2015; Sbordoni et al. 2015; Wangdi & Sherub 2015; Singh 2016), none cover Gidakom Forest Management Unit (GFMU), situated in Thimphu District, western Bhutan. This study aims to address that gap.

## MATERIAL AND METHODS

### Study area

The overall study area under Gidakom Forest Management Unit is situated in northwestern Bhutan between (27.571–27.382 $^0$N and 89.481–89.592 $^0$E). The overall study area consists of farmland between 2,100m & 2,900m with pockets of forest cover, and a mountain ridge with complete forest cover above 2,900m. Traditional wood extraction has long been practiced by the local community, and scientific commercial timber logging in the area began in 1990. Annually, more than 5000m$^3$ of wood are removed as per the management plan (Phuntsho 2012).

The study area is divided into three sites based on altitude, forest type and land use.

Site-I: Jamdo, 2100–2500 m; this forest is quite degraded due to past overexploitation and forest fires. The dominant forest type in the area is young blue pine stands, followed by oak forest and *Populus* sp. along the stream adjacent to the settlement. Agriculture is dominated by paddy cultivation, apple orchards and vegetable gardens. The annual average maximum temperature ranges from 26.7–9.6 $^0$C. The highest temperatures are recorded in July, and the lowest during January and December. The highest precipitation occurs in August (130mm) and the lowest in December (12mm) only.

Site-II: Chimithanka 2500–2900 m. More than 60% of the total study area is under good forest cover of young Blue pine forest as a dominant species in the lower valley up to 2800m followed by mixed conifer species like Spruce *Picea spinulosa* and Hemlock *Tsuga dumosa* and broad-leaved species like Oak *Quercus semecarpifolia*. The lower region is characterized by scrub land, streams, and farmlands. Agricultural farming is confined to vegetable cultivation, orchards and livestock rearing. The annual average maximum temperature of the area recorded is 24.7°C and minimum is 7.6°C.

Site-III: Jedekha, 2900–3400 m. The vegetation here is characterized by mixed conifer forest, largely dominated by Fir *Abies densa*; different species of Rhododendron also occur above 3000m. Agriculture farming is very limited in this area, but timber logging is done for rural and commercial purposes. Precipitation is 90mm annually and the temperature often falls below freezing point during winter months.

### Methods

A sweep net butterfly survey was conducted in the study areas described above from June 2016 to July 2017. The three altitude zones: 2100–2500 m, 2500–2900 m, and 2900–3400 m were further divided into eight habitat types. A 500m transect was established at each site, and attempts were made to catch every butterfly seen following Pollard's transect walking technique (Pollard et al.1975; Pollard & Yates 1993). Each study site was visited three times a month, and four man hours were spent in each survey event for a total of 432.

Most observations were recorded in the morning (08.00–12.00 h), with surveys also conducted 16.30–17.00 h for shade-loving butterflies. Considering the geographical location of the study sites, morning hours were preferred as this specific time is usually characterized by warm sunny weather providing favorable conditions for surveying butterflies. Preferred butterfly habitats such as closed canopy, forest openings, forest edges, roads, trails, shrub land, crop fields, farmland, and river/stream beds were scanned at 2,100–3,300 m. Whenever possible, photographs of specimens were taken using a digital camera (Canon EOS 70D with Canon-EF 100mm f/2.8L Macro IS USM Lens). The elevation and geospatial location of each species was recorded using GPS. Specimens were identified following ven der Poel & Wangchuck (2007). In addition, Nymphalidae and Papilionidae were identified with the help of field guides (Wangdi & Sherab 2012a,b). Identifications of Pieridae and Lycaenidae were guided by the recent study of Wangdi & Sherab (2015). Other

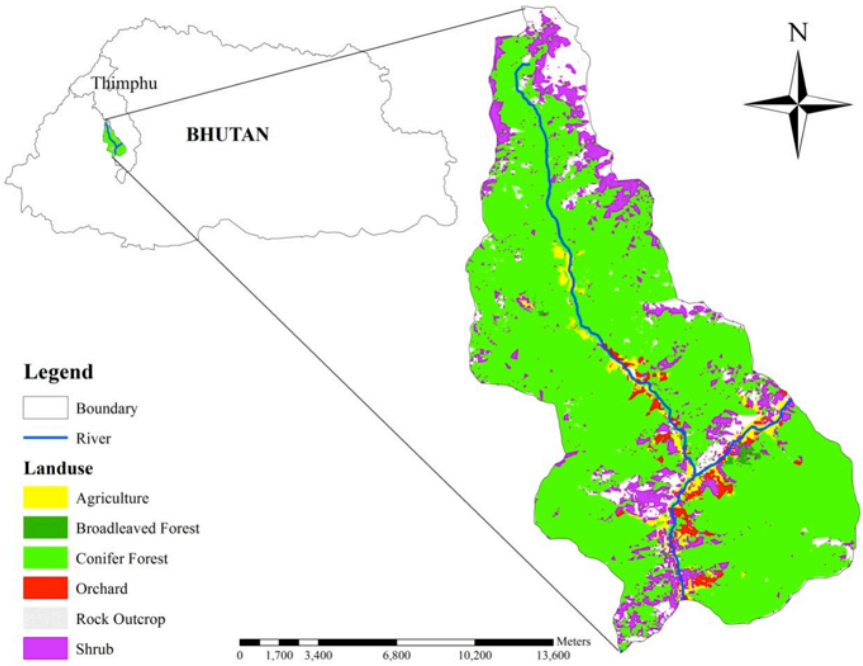


**Figure 1. Study area, Gidakom Forest Magagement Unit, Bhutan.**

sources for identification of butterflies included Singh & Chib (2014); Singh (2016); and Sondhi & Kunte (2016). Data were analyzed using Microsoft Excel 2010 and SPSS (Statistical Package for the Social Sciences). The Shannon diversity index (H') was used to calculate diversity in different study sites.

## RESULTS

### Diversity

A total of 90 species belonging to 52 genera, distributed among five families were recorded in this study (Table 1). Family Nymphalidae was dominant among the five families with 38 (42%) species belonging to 25 (48.07%) genera, followed by Lycaenidae comprising of 19 (21%) species from 12 (23.07%) genera, Pieridae with composition of 15 species (16%) belonging to seven genera (13.46%), Papilionidae with 11 species (12%) from three genera (5.76%) and Hesperiidae with seven species (8%) from five genera (9.61%). A maximum of 83 species of butterflies were recorded from Chimithanka (2,500–2,900 m), this was followed by Jamdo (2,100–2,500 m) with 72 species, and minimum of 37 species were recorded from Jedekha.

### Species composition based on habitat types

Of the 90 species recorded, the maximum species richness was observed in agricultural fields with 24 species (22.64%), followed by scrublands with 17 species (16.03%), forest edge and river bank 16 species (15.09%) each, forest opening 13 species (12.26%), barren ground with eight species (7.54%), forest road with (5.66%) and minimum number of species were recorded in forest canopy accounting for only five species (4.71%) of the total species recorded (Figure 3).

Large Tawny Wall *Rhaphicera satricus*, Doherty's Satyr *Aulocera loha*, Larger Silver Stripe *Argynnis childreni*, Common Wood Brown *Lethe sidonis*, Small Wood Brown *L. nicetella*, Treble Silverstripe *L. baladeva*, Veined Labyrinth *Neope pulaha*, Scarce Labyrinth *Neope pulahina*, Chocolate *Junionia iphita*, Nepal Comma *Polygonia agnicula*, Common Yellow Swallowtail *Papilio machaon*, Common Peacock *Papilio bianor*, Chumbi Wall *Chonala masoni*, Common Baron *Euthalia aconthea*, Mountain Tortoiseshell *Aglais rizana*, Blue Admiral *Kaniska canace*, and Indian Fritillary *Argynnis hyperbius* were primarily recorded from forest opening and forest edge only. It was observed that distribution of Lycaenidae and Peiridae species primarily occupied farmland, apple orchards, scrubland and open grassy fields. Nymphalidae species were common in forested areas as well as farmland. Papilionidae were commonly recorded in forest openings and edges, and along the stream bank and from moist or wet ground. Hesperiidae were sighted in areas close to wet ground and in open grassy fields.

**Table 1. Checklist of butterflies recorded in Gidakom Forest Management Unit (June 2016–July 2017).**

| | Family | Scientific name | Common name |
|---|---|---|---|
| 1 | Hesperiidae | *Borbo bevani* (Moore, 1878) | Bevan's Swift |
| 2 | Hesperiidae | *Caltoris tulsi* de Nicéville, 1883 | Purple Swift |
| 3 | Hesperiidae | *Parnara bada* (Moore, 1878) | Grey Swift |
| 4 | Hesperiidae | *Parnara guttata* (Bremer & Gray, 1852) | Straight Swift |
| 5 | Hesperiidae | *Pelopidas conjuncta* (Herrich-Schaffer, 1869) | Conjoined Swift |
| 6 | Hesperiidae | *Taractrocera danna* ( Moore, 1865) | Himalayan Grass Dart |
| 7 | Hesperiidae | *Taractrocera meavius* (Fabricius, 1793) | Common Grass Dart |
| 8 | Lycaenidae | *Acytolepis puspa* (Horsfield, 1828) | Common Hedge Blue |
| 9 | Lycaenidae | *Celastrina argiolus* (Linnaeus, 1758) | Hill Hedge Blue |
| 10 | Lycaenidae | *Celastrina huegelii* (Moore, 1882) | Large Hedge Blue |
| 11 | Lycaenidae | *Celastrina lavendularis* (Moore, 1877) | Plain Hedge Blue |
| 12 | Lycaenidae | *Celatoxia marginata* (de Niceville, [1894]) | Margined Hedge Blue |
| 13 | Lycaenidae | *Cupido argiades* (Pallas, 1771) | Tailed Blue |
| 14 | Lycaenidae | *Everes lacturnus* (Godaet, [1824]) | Oriental Cupid |
| 15 | Lycaenidae | *Heliophorus brahma* (Moore, 1857) | Golden Sapphire |
| 16 | Lycaenidae | *Heliophorus epicles* (Godart, [1824]) | Purple Sapphire |
| 17 | Lycaenidae | *Heliophorus moorei* (Hewitson, 1865) | Azure Sapphire |
| 18 | Lycaenidae | *Heliophorus tamu* (Kollar, [1848]) | Powdery Green Sapphire |
| 19 | Lycaenidae | *Lampides boeticus* (Linnaeus, 1767) | Pea Blue |
| 20 | Lycaenidae | *Lycaena panava* (Kollar, 1848) | White-Bordered Copper |
| 21 | Lycaenidae | *Lycaena phlaeas* (Linnaeus, 1761) | Small Copper |
| 22 | Lycaenidae | *Phengaris atroguttata* (Oberthür, 1876) | Great Spotted Blue |
| 23 | Lycaenidae | *Pseudozizeeria maha* (Kollar, [1844]) | Pale Grass Blue |
| 24 | Lycaenidae | *Rapala nissa* (Kollar, [1844]) | Common Flash |
| 25 | Lycaenidae | *Udara dilecta* (Moore, 1879) | Pale Hedge Blue |
| 26 | Lycaenidae | *Zizeeria karsandra* (Moore, 1865) | Dark Grass Blue |
| 27 | Nymphalidae | *Aglais caschmirensis* (Kollar, [1848]) | Indian Tortoiseshell |
| 28 | Nymphalidae | *Aglais rizana* (Moore, 1872) | Mountain Tortoiseshell |
| 29 | Nymphalidae | *Argynnis altissima (*Elwes, 1882) | Mountain Silverspot |
| 30 | Nymphalidae | *Argynnis childreni* Gray, 1831 | Large Silverstripe |
| 31 | Nymphalidae | *Argynnis hyperbius* (Linnaeus, 1763) | Indian Fritillary |
| 32 | Nymphalidae | *Athyma opalina* (Kolar, [1844]) | Hill Sergeant |
| 33 | Nymphalidae | *Aulocera loha* Doherty, 1886 | Doherty's Satyr |
| 34 | Nymphalidae | *Aulocera padma* (Kollar, [1844]) | Great Satyr |
| 35 | Nymphalidae | *Aulocera saraswati* (Kollar, [1844]) | Striated Satyr |
| 36 | Nymphalidae | *Aulocera swaha* (Kollar, [1844]) | Common Satyr |
| 37 | Nymphalidae | *Chonala masoni* (Elwes, 1883) | Chumbi Wall |
| 38 | Nymphalidae | *Euthalia aconthea* (Cramer, [1777]) | Common Baron |
| 39 | Nymphalidae | *Euthalia telchinia* (Ménétriés, 1857) | Blue Baron |
| 40 | Nymphalidae | *Issoria issaea* (Moore, 1946) | Himalayan Queen of Spain Fritillary |
| 41 | Nymphalidae | *Junonia iphita* (Cramer, [1779]) | Chocolate Pansy |
| 42 | Nymphalidae | *Junonia orithya* (Linnaeus, 1758) | Blue Pansy |
| 43 | Nymphalidae | *Kaniska canace* (Linnaeus, 1763) | Blue Admiral |
| 44 | Nymphalidae | *Lethe baladeva* (Moore, 1865) | Treble Silverstripe |
| 45 | Nymphalidae | *Lethe maitrya* de Nicéville, 1880 | Barred Wood Brown |

| | Family | Scientific name | Common name |
|---|---|---|---|
| 46 | Nymphalidae | *Lethe mekara* (Moore, 1858) | Common Red Forester |
| 47 | Nymphalidae | *Lethe nicetas* (Hewitson, 1863) | Yellow Wood Brown |
| 48 | Nymphalidae | *Lethe nicetella* de Nicéville, 1887 | Small Wood Brown |
| 49 | Nymphalidae | *Lethe sidonis* (Hewitson, 1863) | Common Wood Brown |
| 50 | Nymphalidae | *Libythea myrrha* Godart, 1819 | Club Beak |
| 51 | Nymphalidae | *Melanitis leda* (Linnaeus, 1758) | Common Evening Brown |
| 52 | Nymphalidae | *Mimathyma ambica* (Kollar, [1844]) | Indian Purple Emperor |
| 53 | Nymphalidae | *Neope pulaha* (Moore, 1858) | Veined Labyrinth, |
| 54 | Nymphalidae | *Neope pulahina* (Evans, 1923) | Scarce Labyrinth |
| 55 | Nymphalidae | *Nymphalis antiopa* (Linnaeus, 1758) | Camberwell Beauty |
| 56 | Nymphalidae | *Parantica sita* (Kollar, [1884]) | Chestnut Tiger |
| 57 | Nymphalidae | *Polygonia agnicula* (Moore, 1872) | Nepal Comma |
| 58 | Nymphalidae | *Rhaphicera moorei* (Butler, 1867) | Small Tawny Wall |
| 59 | Nymphalidae | *Sephisa chandra* (Moore, 1858) | Eastern Courtier |
| 60 | Nymphalidae | *Tirumala septentrionis* (Butler, 1874) | Dark Blue Tiger |
| 61 | Nymphalidae | *Vanessa cardui* (Linnaeus, 1758) | Painted Lady |
| 62 | Nymphalidae | *Vagrans egista* (Cramer, 1780) | Vagrant |
| 63 | Nymphalidae | *Vanessa indica* (Herbst, 1794) | Indian Red Admiral |
| 64 | Nymphalidae | *Ypthima parasakra* Eliot, 1987 | Dubious Five-Ring |
| 65 | Papilionidae | *Byasa dasarada* (Moore, 1857) | Great Windmill |
| 66 | Papilionidae | *Byasa latreillei* (Donovan, 1826) | Rose Windmill |
| 67 | Papilionidae | *Byasa polyeuctes* (Doubleday, 1842) | Common Windmill |
| 68 | Papilionidae | *Graphium cloanthus* (Westwood, 1841) | Glassy Bluebottle |
| 69 | Papilionidae | *Graphium paphus* (de Nicéville, 1886) | Spectacle Swordtail |
| 70 | Papilionidae | *Graphium sarpedon* (Linnaeus, 1758) | Common Bluebottle |
| 71 | Papilionidae | *Papilio arcturus* (Westwood, 1842) | Blue Peacock |
| 72 | Papilionidae | *Papilio bianor* (Cramer, [1777]) | Chinese Peacock |
| 73 | Papilionidae | *Papilio demoleus* (Linnaeus, 1758) | Lime Butterfly |
| 74 | Papilionidae | *Papilio helenus* (Linnaeus, 1758) | Red Helen |
| 75 | Papilionidae | *Papilio machaon* (Linnaeus, 1758) | Common Yellow Swallowtail |
| 76 | Pieridae | *Aporia agathon* Gray, 1831 | Great Blackvein |
| 77 | Pieridae | *Aporia harrietae* (de Niceville, [1892]) | Bhutan Blackvein |
| 78 | Pieridae | *Aporia peloria* (Hewitson, 1852) | Tibetan Blackvein |
| 79 | Pieridae | *Colias fieldii* (Menetries, 1855) | Dark Clouded Yellow |
| 80 | Pieridae | *Delias sanaca* (Moore, 1857) | Pale Jezebel |
| 81 | Pieridae | *Eurema andersonii* (Moore, 1886) | One Spot Grass Yellow |
| 82 | Pieridae | *Eurema blanda* (Boisduval, 1836) | Three- Spot Grass Yellow |
| 83 | Pieridae | *Eurema hecabe* (Linnaeus, 1758) | Common Grass Yellow |
| 84 | Pieridae | *Eurema laeta* (Boisduval, 1836) | Spotless Grass Yellow |
| 85 | Pieridae | *Gonepteryx mahaguru* Gistel, 1857 | Lesser Brimstone |
| 86 | Pieridae | *Gonepteryx rhamni* (Linnaeus, 1758) | Common Brimstone |
| 87 | Pieridae | *Ixias pyrene* (Linnaeus, 1764) | Yellow Orange Tip |
| 88 | Pieridae | *Pieris brassicae* (Linnaeus, 1758) | Large Cabbage White |
| 89 | Pieridae | *Pieris canidia* (Linnaeus, 1768) | Indian Cabbage White |
| 90 | Pieridae | *Pieris extensa bhutya* Poujade, 1888 | Bhutan Extended White |

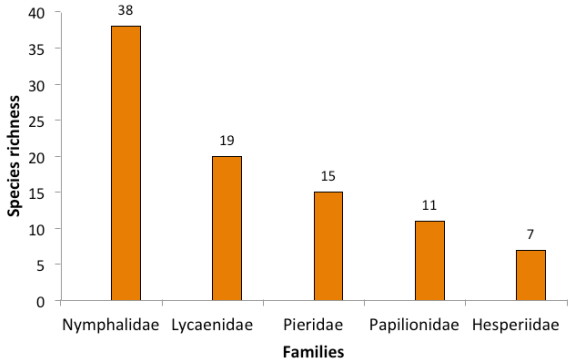


Figure 2. Family-wise distribution of butterfly species in Gidakom Forest.

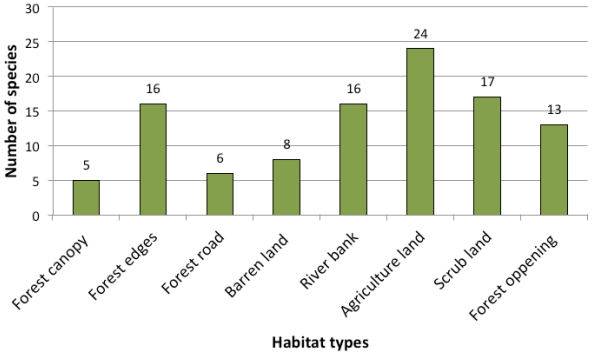


Figure 3. Distribution of butterfly species based on habitat types in Gidakom Forest

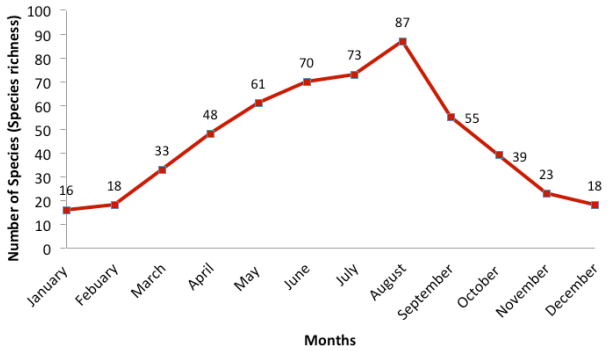


Figure 4. Temporal distribution of butterfly species in Gidakom Forest

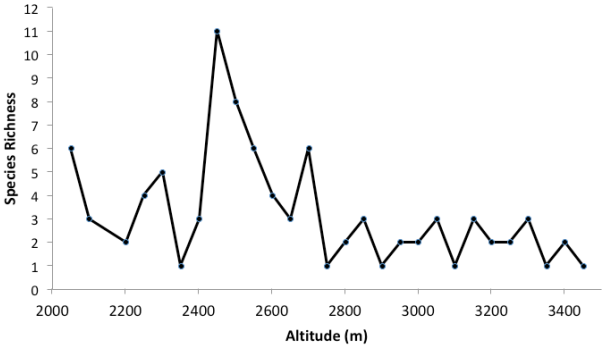


Figure 5. Distribution of butterfly species along the altitudinal gradients in Gidakom Forest.

**Temporal distribution of butterflies**

Most species were found in the monsoon season, particularly between May and August. Minimum species richness was observed during January (n=16, 17.77%) and a monotonic increasing trend of species occurrence was observed over succeeding months reaching a maximum (n=86, 95.55%) in August. From September a monotonic declining trend of species richness was observed until winter. The high numbers of butterflies during the monsoon season corresponded with the flowering of local plant species in the study locations.

Dark Clouded Yellow *Colias fieldii*, Large Cabbage White *Pieris brassicae*, Indian Cabbage White *Pieris canidia*, Green Veined White *Pieris napi*, Pale Clouded Yellow *Colias fieldii*, Lesser Brimstone *Gonepteryx mahaguru*, and Common Brimstone *Gonepteryx rhamni nepalensis* belonging to Peiridae family and species such as; Blue Pansy *Junonia orithiya*, Indian Red Admiral *Vanessa indica*, Indian Tortoiseshell *Aglais cashmiriensis*, Queen of Spain Fritillary *Issoria issaea*, Painted Lady *Vanessa cardui*, and Mountain Tortoiseshell *Aglais rizana* belonging to Nymphalidae family were recorded throughout the year. Of the 90 recorded species, about 14% of them were seen throughout the year in the study area.

**Spatial distribution**

The spatial distribution of butterflies (species richness) of Gidakom varied from 84 to 37 among study locations. Maximum species richness (S=83), diversity (H'=4.17) and relative abundance (42.75%) were observed in Chimithanka. This was followed by Jamdo, and minimum species richness (S= 42), diversity (H'=3.47), relative abundance (23.41%) was observed in Jedekha, however, there was marginal variation in species evenness among these three study locations (Table 2). Species richness pecked at an altitudinal range between 2400–2600 m with (32, 35.16%) of the total observed species and declining trend was observed in subsequent zones towards higher elevational (Figure 5). A total number of individuals recorded varied from 127 to four individuals. The calculated median value for each site is shown in (Figure 6).

The Blue Pansy *Junonia orithiya* was found to be most common and widely distributed species, followed by Straited Satyr *Aulocera saraswati*, Dark Clouded Yellow

**Table 2. Species composition in different study locations within Gidakom Forest.**

| | Study locations | | |
|---|---|---|---|
| Parameters | Jamdo | Chimithanka | Jedekha |
| Altitude (m) | 2100–2500 | 2500–2900 | 2900–3400 |
| Species richness | 72 | 83 | 37 |
| Diversity(H) | 3.90 | 4.15 | 3.34 |
| Evenness (E) | 0.91 | 0.93 | 0.92 |
| Relative abundance (%) | 33.82 | 42.75 | 23.41 |

*Colias fieldii*, Large Cabbage White *Pieris brassicae*, and Indian Cabbage White *Pieris canidia*. These species were found in all the three study sites.

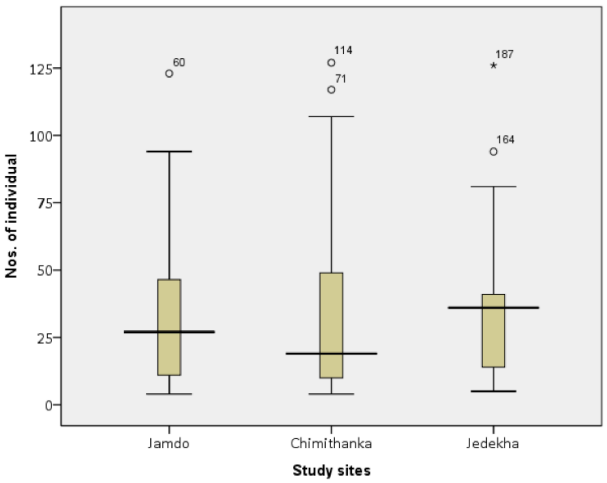


**Figure 6. The box plots showing the median of species abundance in three different study sites.**

## DISCUSSION

More than 12% of 732 butterfly species were recorded in Gidakom Forest. Observed species previously reported as rare in Bhutan (Singh 2016) included: White Banded Copper *Lycaena panava* (Lycaenidae), Pale Clouded Yellow *Colias fieldii* (Pieridae), Camberwell Beauty *Nymphalis antiopa*, Mountain Tortoiseshell *Aglais rizana*, and Scarce Labyrinth *Neope pulahina* (Nymphalidae), and Blue Peacock *Papilio arcturus* (Papilionidae).

Nymphalidae were found to be the dominant family, occupying a majority of habitat types and occurring throughout the year in Gidakom Forest. This is consistent with Nymphalidae being the largest butterfly family, accounting for one third of known species worldwide (Kumar & Sharma 2013). The dominance of Nymphalidae species may be attributed to their ability to feed on various kinds of food, and many species of this family are active fliers, thus having ecological advantages to forage larger areas.

Majority of the species were found in heterogeneous habitats: farmland, scrubland, forest edges and river banks. Many studies have reported a positive relationship between habitat heterogeneity and species diversity (Bazzaz 1975; Brooks 1997; Atauri & Lucio 2001; Tews et al. 2004). Possible reasons include increased availability and variety of host plants. The distribution and diversity of butterflies varies with the seasons. They are abundant in some months and rare or absent during others (Kunte 2000). In this study, we observed that species richness and relative abundance peaked during the monsoon (June–August). This has been reported in other studies (e.g. Qureshi et al. 2013), but it has also been reported that butterfly numbers and diversity peaked post-monsoon (e.g. Tiple et al. 2007; Tiple 2012). This dissimilarity in seasonal distribution of butterflies may be due to variation in geographical region with corresponding environmental factors. In mountain ecosystem, distribution of butterfly species is determined by its habitat and climatic stability (Stroch et al. 2003).

Species richness, abundance and diversity followed a declining trend along the elevation gradient, with only 37 species occurring above 2900m. Studies in Sikkim showed a similar distribution pattern (Acharya & Vijayan 2015). A strong link between altitude and changes in climate and vegetation was observed by Körner (2007), thus species assemblages can shift rapidly over relatively short distances (Bullock et al. 1995; van Ingen et al. 2008). The climate above 2900m is characterized by a prolonged winter with freezing temperatures and a relatively short growing season. According to McCain (2010), decreasing species diversity is mainly because of decreasing temperature, productivity, precipitation and plant species diversity along the elevation gradient. We observed a majority of butterfly species in areas below 2900m. The higher species richness, diversity, and abundance in lower altitudinal areas could be due to relatively high temperature, habitat heterogeneity and increased diversity of host and food plants. According to Sengupta et al. (2014) butterfly community is mostly determined by the larval host plants.


Image 1. Bhutan Blackvein


Image 2. Blue Admiral


Image 3. Blue Pansy


Image 4. Chestnut Tiger


Image 5. Lesser Brimstone


Image 6. Common Grassdart


Image 7. Hill Hedge Blue


Image 8. Common Flash


Image 9. Common Evening Brown


Image 10. Dubious Five-Ring


Image 11. Eastern Courtier


Image 12. Painted Lady


Image 13. Indian Purple Emperor


Image 16. Common Yellow Shallowtail


Image 19. Queen of Spain Fritillary


Image 22. Tailed Cupid


Image 14. Large Cabbage White


Image 17. Nepal Comma


Image 20. Spectacle Swallowtail


Image 23. Indian Fritillary


Image 15. Large Silverstripe


Image 18. Pale Clouded Yellow


Image 21. Straited Satyr

## REFERENCES


**Acharya, B.K. & L. Vijayan (2011).** Butterflies of Sikkim with reference to elevational gradient in species, abundance, composition, similarity and range size distribution pp. 207–220. In: Arawatia, M.L. & S. Tambe (eds.). *Biodiversity of Sikkim: Exploring and Conserving A Global Hotspot*. IPR Department, Government of Sikkim, Gangtok.

**Acharya, B.K. & L. Vijayan (2015).** Butterfly diversity along the elevation gradient of Eastern Himalaya, India. *Ecological Research 30*(5): 909–919. https://doi.org/10.1007/s11284-015-1292

**Atauri, J.A. & J.V. Lucio (2001).** The role of landscape structure in species richness distribution of birds, amphibians, reptiles and lepidopterans in Mediterranean landscapes. *Landscape Ecology* 16: 147–159. https://doi.org/10.1023/A:1011115921050

**Bazzaz, F.A. (1975).** Plant species diversity in old-field successional ecosystems in southern Illinois. *Ecology* 56: 485–488.

**Bonebrake, T.C., L.C. Ponisio, C.L. Boggs & P.R. Erlich (2010).** More than just indicators: A review of tropical butterfly ecology and conservation. *Biological Conservation* 143: 1831–1841. https://doi.org/10.1016/j.biocon.2010.04.044

**Binghan, C.T. (1905)**. *The Fauna of British India including Ceylon and Burma.* Taylor and Francis Ltd., London, https://doi.org/10.5962/bhl.title.100738

**Brooks, D.M. (1997).** The influence of habitat structure upon diversity and evenness of abundance. *Texas Journal of Science* 49: 247–254.

**Bullock, S.H., H.A. Mooney & E. Medina (Eds.) (1995).** Seasonally Dry Tropical Forests. Cambridge University Press, Cambridge, UK, 439pp. https//doi.org/10.5822/978-1-61091-021-7

**Castro, A. & C.I. Espinosa (2015).** Seasonal diversity of butterflies and its relationship with woody-plant resources availability in an Ecuadorian tropical dry forest. *Tropical Conservation Science* 8(2): 333–351. https://doi.org/10.1177/194008291500800205

**Harada, M. (1987a).** Butterflies of Bhutan (I). The Lepidopterological Society of Janpan, 4-14pp.

**Harada, M. (1987b).** Butterflies of Bhutan (II). The Lepidopterological Society of Janpan, 23–24pp.

**Hill, J.K., C.D. Thomas, R. Fox, M.G. Telfer, S.G. Willis, J. Asher & B. Huntley (2002)**. Responses of butterflies to twentieth century climate warming: implications for future ranges. *Proceedings of the Royal Society of London, Series B, Biological Sciences* 269: 2163–2171. https://doi.org/10.1098/rspb.2002.2134

**Kocher, S.D. & E.H. Williams (2000)**. The diversity and abundance of North America butterflies, vary with habitat disturbance and geography. *Journal of Biogeography* 27(4): 785–794. https://doi.org/10.1046/j.1365-2699.2000.00454.x

**Körner, C. (2007). The use of 'altitude' in ecological research,** *Trends in Ecology & Evolution* 22 (11): 569–574. https://doi.org/10.1016/j.tree.2007.09.006

**Kunte, K. (2000).** *Butterflies of Peninsular India.* Universities Press (Hyderabad) and Indian Academy of Sciences (Bangalore), 254pp.

**McCain, C.M. (2010).** Elevational Gradients in Species Richness, pp. 1–10. In: *Encyclopedia of Life Sciences.* John Wiley & Sons, Ltd, Chichester. https://doi.org/10.1002/9780470015902.a0022548

**Phuntsho, Y. (2012).** *Forest Management Plan For Gidakom Forest Management Unit.* Forest Resources Management Division, Department of Forest and Park Services, Thimphu, 71pp.

**Pollard, E. & T.J. Yates (1993)**. *Monitoring Butterflies for Ecology and Conservation*. The British Butterfly Monitoring Scheme. Springer Netherlands, 174pp.

**Pollard, E., D.O. Elias, M.J. Skelton & J.A. Thomas (1975).** A method of assessing the abundance of butterflies in Monk's Wood National Nature Research in 1973. *Entomologist's Gazette* 26: 79–87.

**Qureshi, A.A., A.D. Rayees, I.T. Shaheen & R.C. Bhagat (2013).** Butterfly-fauna of Gulmarg, Kashmir, J&K State. *Journal of Agriculture and Veterinary Science* 2(5): 40–45.

**Ribeiro, D.B. & A.V. Freitas (2012).** The effect of reducedimpact logging on fruit-feeding butterflies in Central Amazon, Brazil. *Journal of Insect Conservation* 16(5): 733–744. https://doi.org/10.1007/s10841-012-9458-3

**Sbordoni, V., G.C. Bozano, K. Wangdi, S. Sherub, S. Marta, S. De Felici & D. Cesaroni (2015).** Towards a georeferenced checklist of the butterflies of Bhutan: a preliminary account (Insecta: Lepidoptera). pp.523–546, pl. I-VI. In: Hartmann, M. & J. Weipert. *Biodiversity and Natural Heritage of the Himalaya.* V, Verein der Freunde und Foerder des Naturkundemuseums Erfurt e.V. Erfurt, Germany.

**Sengupta, P., K.K. Banerjee & N. Ghorai (2014).** Seasonal diversity of butterflies and their larval food plants in the surroundings of upper Neora Valley National Park, a sub-tropical broad leaved hill forest in the eastern Himalayan landscape, West Bengal, India. *Journal of Threatened Taxa* 6(1): 5327–5342. https://doi.org/10.11609/JoTT.o3446.5327-42.

**Singh, A.P. (2016).** Moist temperate forest butterflies of western Bhutan. *Journal of Threatened Taxa* 8(3): 8596–8601. https://doi.org/10.11609/ jott.2297.8.3.8596-8601

**Singh, I.J., & M. Chib (2014).** A preliminary checklist of butterflies (Lepidoptera: Rhophalocera) of Mendrelgang, Tsirang District, Bhutan. *Journal of Threatened Taxa* 6(5): 5755–5768. https://doi.org/10.11609/JoTT.o3632.5755-68

**Singh, I.J & M.S. Chib (2015).** Checklist of Butterflies of Bhutan. *Journal of the Bhutan Ecological Society* 1(2): 22–58.

**Sondhi, S. & K. Kunte (2016**). Butterflies (Lepidoptera) of the Kameng Protected Area Complex, western Arunachal Pradesh, India. *Journal of Threatened Taxa* 8(8): 9053–912. https://doi.org/10.11609/jott.2984.8.8.9053-9124

**Storch, D., M. Konvicka, J. Benes, J. Martinkova & K.J. Gaston (2003**). Distribution patterns in butterflies and birds of the Czech Republic: separating effects of habitat and geographical position. *Journal of Biogeography* 30 (8): 1195–1205. https://doi.org/10.1046/j.1365-2699.2003.00917.x

**Tews, T., U. Brose, V. Grimm, K. Tielborger, M.C. Wichmann, M. Schwager & F. Jeltsch (2004).** Animal species diversity driven by habitat heterogeneity/diversity: the importance of keystone structures. *Journal of Biogeography* 31: 79–92. https://doi.org/10.1046/j.0305-0270.2003.00994.x.

**Tiple, A.D. (2012).** Butterfly species diversity, relative abundance and status in Tropical Forest Research Institute, Jabalpur, Madhya Pradesh, and central India. *Journal of Threatened Taxa* 4(7): 2713–2717. https://doi.org/10.11609/JoTT.o2656.2713-7

**Tiple, A.D., A.M. Khurad & R.L.H. Dennis (2007).** Butterfly diversity in relation to a human-impact gradient on an Indian university campus. *Nota lepidopterologica* 30(1):179–188.

**van der Poel & T. Wangchuk (2007).** *Butterflies of Bhutan. Mountains, hills and valleys between 800 and 3000m.* Royal Society for Protection of Nature (RSPN), Thimphu, Bhutan, 71pp.

**van-Ingen, L.T., R.I. Campos & A.N. Andersen (2008).** Ant community structure along an extended rain forest–savanna gradient in tropical Australia. *Journal of Tropical Ecology* 24 (4): 445–455. https://doi.org/10.1017/S0266467408005166

**Wangdi, K. & Sherub (2012a).** *Nature Guide Series. Nymphalids, Brush-footed Butterflies of Bhutan***.** Ugyen Wangchuk Institute for Conservation and Environment, Bumthang, Bhutan, 77pp.

**Wangdi, K. & Sherub (2012b).** *Field Guide for Swallowtails of Bhutan*. Ugyen Wangchuk Institute for Conservation and Environment, Bumthang, Bhutan, 130pp.

**Wangdi, K. & Sherub (2015).** Butterflies of Bhutan. UWICE Nature Guide Series: Pieridae (Whites and Yellows) & Lycaenidae (Blues). Ugyen Wangchuck Institute for Environment and Conservation. Bhumthang, Bhutan, 173pp.

Journal of Threatened Taxa

www.threatenedtaxa.org

PLATINUM OPEN ACCESS



**ISSN 0974-7907 (Online) | ISSN 0974-7893 (Print)**

**May 2020 | Vol. 12 | No. 8 | Pages: 15767–15966**
**Date of Publication: 26 May 2020 (Online & Print)**
**DOI: 10.11609/jott.2020.12.8.15767-15966**



Publisher & Host

WILD ZOOREACH Threatened Taxa

Member

FJN