*Asian Journal of Conservation Biology*, July 2023. Vol. 12 No. 1, pp. 10–26 AJCB: FP0206/73590
ISSN 2278-7666 ©TCRP Foundation 2023 https://doi.org/10.53562/ajcb.73590

***Research Article***

# Diversity of butterflies across three land use types of Chebera Churchura National Park and its surroundings, Southwestern Ethiopia

**Gebreegziabher Hailay[1*], Emana Getu[2]**

[1]*Animal Biodiversity Directorate, Ethiopian Biodiversity Institute, Addis Ababa, Ethiopia, P.O. Box 30726, Addis Ababa, Ethiopia.*
[2]*Department of Zoological Sciences, College of Natural and Computational Sciences; Addis Ababa University, Addis Ababa, Ethiopia.*

(Received: February 27, 2022; Revised: November 13, 2022; Accepted: January 05, 2023)

## ABSTRACT

Understanding and identifying butterfly species in various land uses serves a crucial eco-logical function in protecting biodiversity and improving environmental policy decisions. However, such a study on the diversity of butterflies from different land use types in and around Chebera Churchura Na-tional Park, southwestern Ethiopia, is extremely lacking. Thus, the present study aimed to quantify the species richness and abundance of butterflies in the Chebera Churchura National Park and its surroundings, which are prioritized for their conservation. Data was collected from January 2021 to June 2021 following the line transect method in the three habitat types using a standard insect net. In total, 2118 individuals representing 79 species and 38 genera belonging to five families were recorded. The Nymphalidae were the most dominant butterfly family, accounting for 45 species (57%) of the total butterflies observed, while the Heaspariidae contributed the least. Among the 79 species, 9 were very common, 32 were common, 37 were rare, and 1 was very rare. Based on butterfly species richness and composition, riverine forest had the greatest diversity and abundance with 65 species and 1028 individuals, and the least species composition was recorded in mosaic habitat with 26 species and 350 individuals, and the difference in diversity was significant. The study region was generally found to be rich in the diversity and abundance of butterflies in all three forms of land use. However, the study area is currently becoming an investment hub, and many road development projects are being planned. Ongoing human activities will devastate and harm the richness, abundance, and diversity of butterfly species. As a result, such human-induced activities need to be carefully studied to protect biodiversity.

**Key words**: Mosaic habitat, Nymphalidae, riverine forest, wooded grassland

## INTRODUCTION

Land use change and habitat fragmentation affect biodiversity through an increasing level of disturbance caused by the destruction of natural habitats (Broadbent *et al*., 2012b) and result in decreased population sizes and reduced genetic diversity within a species (Hansen *et al*., 2012). Globally, estimated that land use change reduced average species richness by 13.6%, total abundance by 10.7%, and rarefaction-based richness by 8.1%, so understanding how land use change affects biodiversity and what measurements may reduce the significant effects is critical for conservation (Newbold *et al*., 2015). Protected areas, mainly national parks, are a cornerstone of biodiversity conservation (Muhumuza & Balkwill, 2013). However, various factors affect the conservation of biodiversity in national parks. Intensive agriculture, human settlements, population increase, illegal use of forest resources, and mining inside national parks are the main causes (Kintz *et al*., 2006; Mucova *et al*., 2018). For example, researchers investigated whether changes in national park buffer zones have a significant impact on biodiversity within the parks. Butterflies (Lepidoptera: Papilionoidea) are the most studied, well-known, and successful insects, found in all parts and habitats of the world (Kiristensen, 2013). Butterflies are excellent indicators of changes in environmental impacts on biodiversity (Rakosy & Schmitt, 2011). Most of the species are dependent on specific plant types, and they are extremely sensitive to different climatic changes and types of vegetation, such that the absence of specific plant species is directly related to the presence or absence of butterfly species. The change in temperature and rainfall is also strongly related to the diversity and richness of butterflies.

Butterfly populations are important components of the ecosystem (Rakosy & Schmitt, 2011; Ghazanfar *et al*., 2016; Sharma *et al*., 2020). They play a significant role in natural and agricultural pollination (Jennersten, 1984; Reddi & Bai, 1984; Thakur & Mattu, 2010) and indicate the presence of other invertebrates due to their role in the food chain and food web (Fleishman & Murphy 2009; Gerlach *et al*., 2013; Sharma & Sharma, 2017; Watt & Boggs, 2019), which are food sources for birds, bats, and other invertebrates.

[*]*Corresponding Author's E-mail: gere31280@gmail.com*

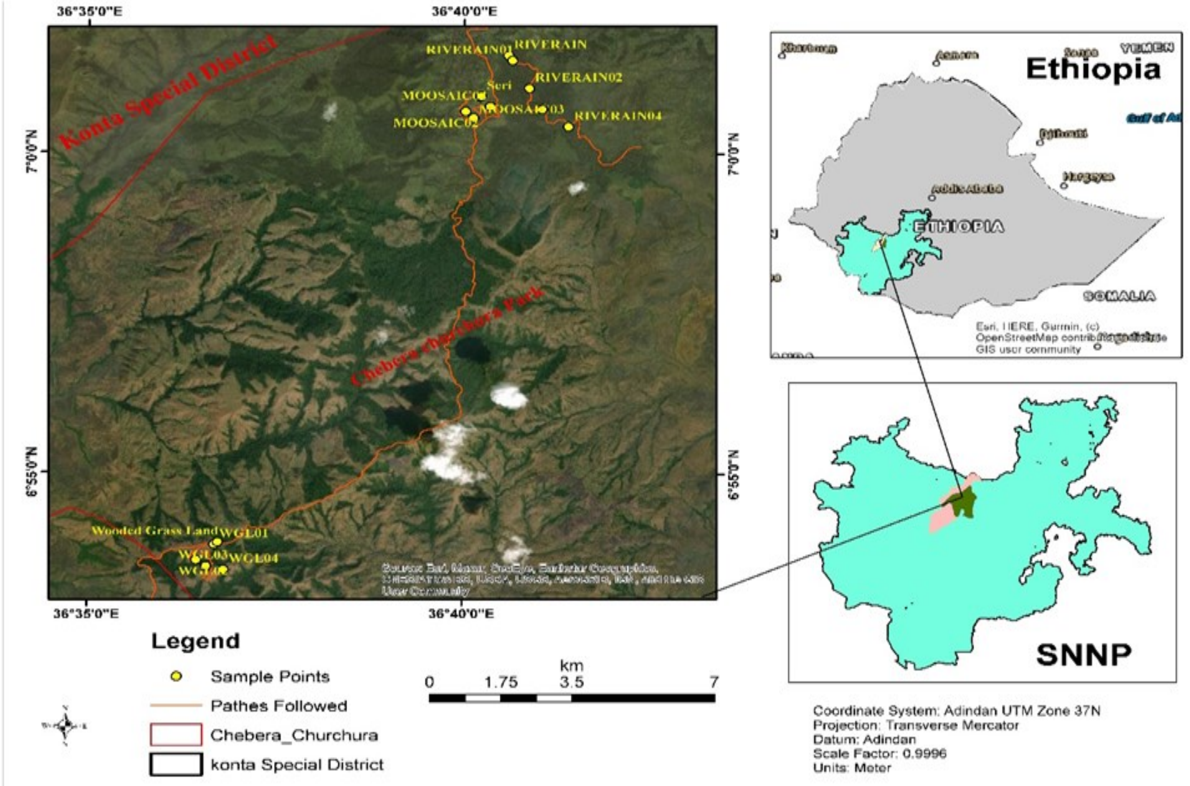


**Figure 1**. Map of Chebera Churchura National park.

Nevertheless, of the above functions, insects' biodiversity is decreasing at a speedy rate, butterflies are at the frontline of decline, and the most common causes of species decline are habitat loss, degradation, and fragmentation (Rodriguez-Echeverry *et al*., 2018; Sanchez-Bayo & Wyckhuys 2019; Daskalova *et al*., 2020). Thus, studding butterflies diversity in different land use types with an aim of understanding their diversity, ecology, and impact of their declining on land use type and biodiversity conservation is very important for their conservation strategies (Sharma *et al*., 2020).

Published data on butterfly fauna from the Chebera Churchura National Park is entirely lacking. Butterflies, due to their extreme ecological and scientific significance, have been documented from various habitat types in Ethiopia (Gorbunov, 2017; Norfolk *et al*., 2017; Jemal & Getu 2018; De Beenhouwer *et al*., 2019; Jenber & Getu, 2020). However, such a study on the diversity of butterflies from different land use types in and around Chebera Churchura National Park, southwestern Ethiopia, is extremely lacking. Given the lack of sufficient information on taxonomic composition and diversity of butterflies, the present study aimed to quantify the species richness and abundance of butterflies in the Chebera Churchura National Park and its surroundings, which are prioritized for their conservation. In addition, the purpose of this study was to highlight the importance of national parks and their surrounding habitat in sustaining butterfly diversity, which should be preserved effectively and managed scientifically in the current face of biome and biodiversity crises.

## MATERIALS AND METHODS

### *Study area description*

Chebera Churchura is found in the afro tropical region forest. It is a new national park situated between Konta Woreda and Dawro Zone. The study area was situated at 6° 53′ 14″N and 36° 38′ 11″E, and it is 480 km from Addis Ababa (Figure 1). The park's elevation ranges from 700 to 2450 meters above sea level, with an average yearly temperature of 10 to 29 degrees Celsius. Land use types generally in the study rea includes forestry areas, conservation areas, grazing area, hydropower area, and cropping area. The annual rainfall averages between 1200 and 2300 mm. The park covers an area of 1119 km2 and has four vegetation zones, namely wooded grassland, riverine forest, mountain woodland, and woodland. The wet season is from March to September, and the dry season extends from December to February (Alemayehu & Mathewo, 2015).

The study site were only focused on habitat types not on elevation. Thus, three land-use types, namely wooded grassland, riverine forest, and mosaic habitat, were selected based on information from literature and the accessibility of the habitats. The geographical coordinates of all the sampling sites measured with a GPS device. Each of the land use types described below as follows. Riverine forest (RF): It was located at 36$^{O}$ 41'' 00.60'' E and 07$^{O}$ 00' 36''N and at 1176 m.a.s. a. The main plant species main plant species were *Cordia africana*, *Terminalia laxiflora*, *Combretum collinum*, *Clerodendrum alatum*, *Satureja montana*, *Ficus sycomorus*, *Syzygium guineense*, *Sida rhombifolia*, and *Grewia mollis*.

Wooded grassland habitat (WGL): It was positioned at 36$^{O}$ 37'' 47.88''E and 06$^{O}$ 54' 00'' N and 1587m.a.s.l. and covers 62% of the park is an area covered by herbaceous plants with less tree and herb coverage such as *Acanthus mollis*, *Eseveria abyssinica*, *Crinum ornatum*, *Ocimum gratissimum*, and *Clerodendrum alatum*. Mosaic environment (MO): It was found at 36$^{O}$ 40''17.04''E and 07$^{O}$ 01' 12''N and elevation 1444 mal found in Seri kebele outside of the national park. It was mainly its high level of interaction with wildlife, and lepidopterans do not appear to be immune to the effects of human interaction *Mangifera indica*, *Colocasia esculenta*, *Terminalia loxifelera*, *Combretum mole, Combretum collinum, Entada Africana, Prunus africana* and *Harrisonia abyssinica* were some representatives.

***Butterfly collection and identification***

Data was collected from January 2021 to June 2021 following the line transect method in the three habitat types based using standard insect net (Pollared, 1982). Three transect lines were produced, one for each habitat, and each habitat was sampled every month for six months. Each transect line was 3 kilometers long. Sampling of butterflies was done considering environmental factors (temperature, sunlight, and rainfall), and all collected specimens were sorted, identified to family level, and transported to the Ethiopian Bio-diversity Institute for further identifications. Identification of the species was conducted based on photographs of specimens after spreading and mounting in the laboratory. Because there is no modern identification guide for Ethiopian butterflies, the African Butterfly Database species list was used (Safian & Siklosi, 2022).

***Data analysis***

The program PAST 4.10 was used to calculate the diversity measures Shannon's diversity index (Hs), Simpson's dominance index (D), Simpson's diversity index (1-D), and Pielou's equitability index (J). Using the PAST version 4.10 program, a cluster analysis was carried out on a Bray-Curtis similarity matrix of grouped butterfly sample samples to determine how butterfly populations arrange across the investigated habitat categories. For each habitat, individual-based rarefaction curves with 95% confidence intervals were built. PAST version 4.10 was used als to create a dendrogram to show how the butterfly composition varied among the research area's various habitats.

Because the data was not normally distributed, the nonparametric Kurskual-Wallis test was used to determine whether there were significant differences in butterfly communities collected from the surveyed habitat type. The total counts of each species in relation to the total number of individuals counted throughout the study period were used to compute the relative abundance (RA) of each particular species as a percentage. The results of this analysis were divided into four categories: "very common" (RA > 2.0%), "common" (RA < 2.0 - > 1.0%), "rare" (RA < 1.0 - > 0.30%), and "very rare" (RA < 0.30%) to study the local status of the butterflies. Analysis was done using Microsoft Excel 2016 by taking the climate data for the five years from 2013-2017 from the world climate database (Stackhouse, 2022).

## RESULTS

***Composition of total butterfly species***

In total, 2118 individuals representing 79 species and 38 genera belonging to five families were recorded in the study area (Tables 1& 2; File 1). The Nymphalids were the most dominant butterfly family, accounting for 45 species (57%) of the total butterflies observed, while the Heaspariidae contributed the least (Table 1; Fig 2 ). The family Nymphalidae had the highest percentage of butterflies collected from the entire study area, with 51% (n = 1028), followed by Pieridae with 28% (n = 596), Lycanidae with 11% (n = 224), Papilonidae with 7% (n = 139), and Hespariidae with 3% (n = 75) (Table 1; Figure 3).

**Table 1.** Butterfly's abundance in the study area

| Family name | Number of genera | Number of species | Number of individuals |
|---|---|---|---|
| Nymphalidae | 18 | 45 | 1084 |
| Pieridae | 7 | 16 | 596 |
| Lycanidae | 8 | 10 | 224 |
| Papillonidae | 2 | 5 | 139 |
| Hespariidae | 3 | 3 | 75 |
| **Total** | **38** | **79** | **2118** |

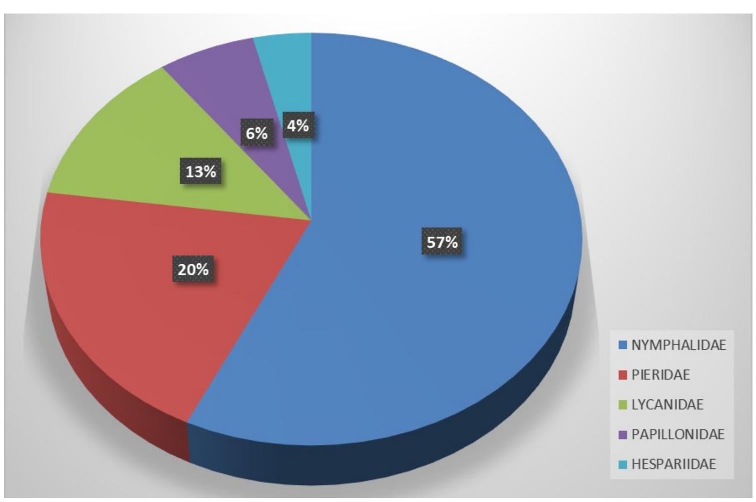


**Figure 2.** Butterfly species Percentage composition across families

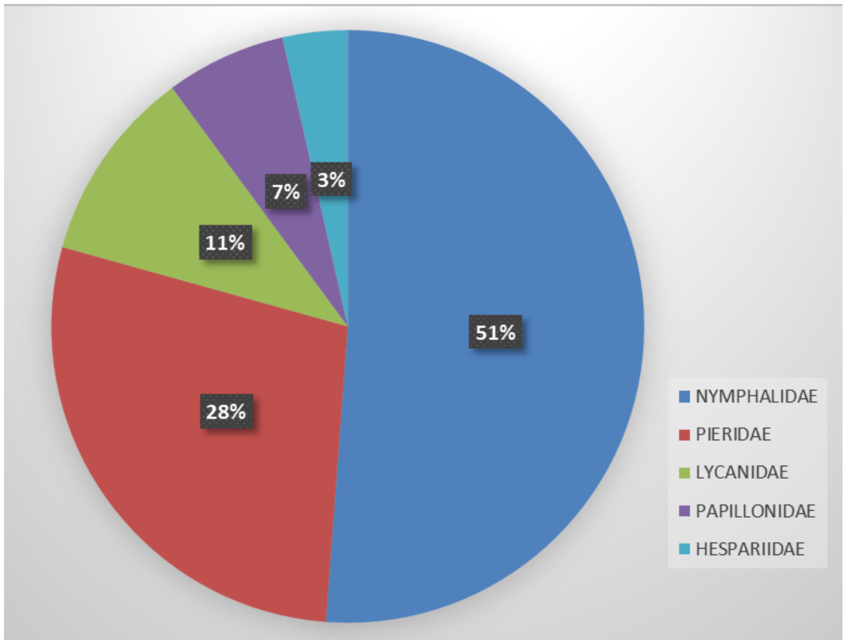


**Figure 3.** Butterfly abundance percentage composition across families

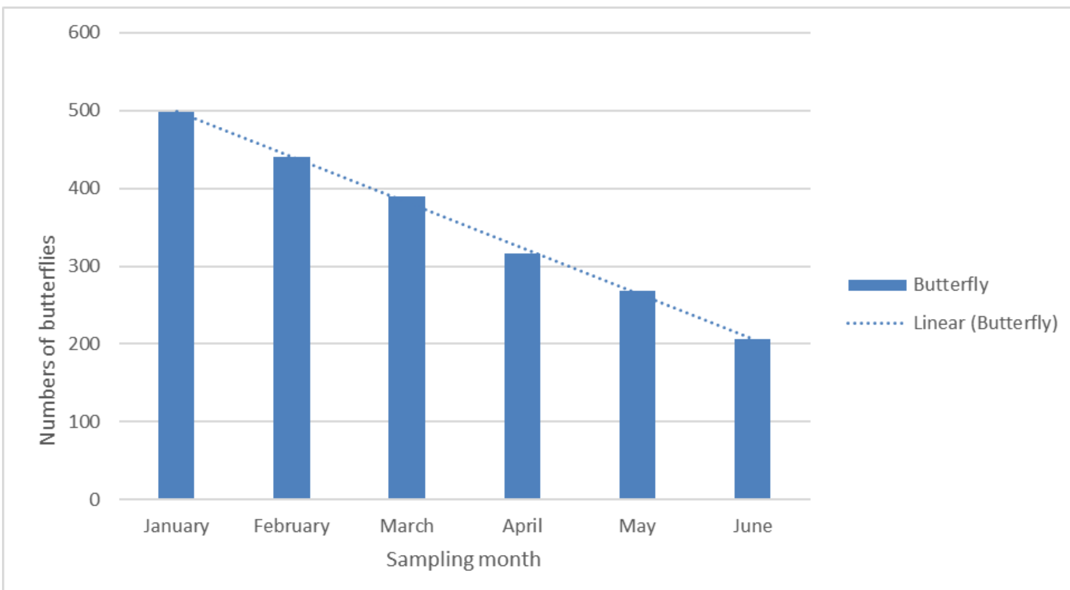


**Figure 4.** Total number of butterflies collected monthly in the study area during the entire study period

Figure 4 shows the total number of butterflies collected monthly, which is a measure that provides a better understanding of the temporal changes in the butterfly abundance in the study area. The number of butterflies was highest in the month of January and then followed a declining pattern until the end of June.

Among the 79 species, 9 were very common, 32 were common, 37 were rare, and 1were very rare (Table 2). *Belenois aurota* was the dominant with 92 individuals followed by *Mylothris agathina, Catopsilia florella* and *Libythea labdaca* with 64, 62 and 60 individuals in order where as *Lycaena phlaeas* the least abundant with 5 individuals (Table 2).

***Butterfly species comparisons among habitats***

Based on butterfly species richness and composition riverine forest had the greatest diversity and abundance with 65 species and 1028 individuals, and the least species composition was recorded in mosaic habitat with 26 species and 350 individuals (Tables 2 & 3). According to the diversity indices (both Shannon and Simpson indices), results demonstrated that the riverine forest has the highest species diversity followed by wooded grassland and the least diverse was the Moosic habitat (Tables 2 & 3).

Butterfly abundance was on average different in all three habitat types (Tables 2 &3 and Figure 5) and showed significance difference ($\chi2$ = 38.24, df = 2, p =1.31E-09; Figure 5). The individual rarefaction curves were asymptotic, showing sufficient sampling efforts to differentiate butterfly assemblages each habitat types (Figure 5).

**Table 2.** Checklist of butterflies identified from the study area ((Rf = riverine forest, WGL=Wooded grassland and Mo= mosaic habitat. Tot= total).

| Family name | Species name | Common name | Rf | WGL | Mo | TOT | Rf | Ls |
|---|---|---|---|---|---|---|---|---|
| **Nymphalidae** | *Acraea aganice* Hewitson, [1852] | Dark Wanderer | 25 | 15 | 0 | 40 | 1.9 | **C** |
| | *Acraea caecilia* (Fabricius, 1781) | Pink Acraea | 12 | 20 | 0 | 32 | 1.5 | **C** |
| | Acraea egina (Cramer, [1775]) | Elegant Acraea | 24 | 12 | 0 | 36 | 1.7 | **C** |
| | *Acraea encedon* (Linnaeus, 1758) | white-barred Acraea | 21 | 15 | 0 | 36 | 1.7 | **C** |
| | *Acraea oncaea* Hopffer, 1855 | Window Acraea | 0 | 15 | 10 | 25 | 1.2 | **C** |
| | *Acraea poggei* Dewitz, 1879 | Great Wanderer | 14 | 0 | 0 | 14 | 0.7 | **R** |
| | *Acraea sotikensis* Sharpe, 1891 | Sotik acraea | 0 | 0 | 10 | 10 | 0.5 | **R** |
| | *Acraea zetes* (Linnaeus, 1758) | Large Spotted Acraea | 12 | 15 | 8 | 35 | 1.65 | **C** |
| | *Amauris albimaculata* Butler, 1875 | Layman | 14 | 0 | 0 | 14 | 0.7 | **R** |
| | *Amauris echeria* (Stoll, [1790]) | Chief | 24 | 0 | 0 | 24 | 1.1 | **C** |
| | *Amauris niavius* (Linnaeus, 1758) | Friar | 16 | 0 | 0 | 16 | 0.8 | **R** |
| | *Bicyclus angulosa* (Butler, 1868) | Startled Bush Brown | 10 | 12 | 0 | 22 | 1 | **R** |
| | *Bicyclus anynana* (Butler, 1879) | Squinting Bush Brown | 11 | 0 | 0 | 11 | 0.5 | **R** |
| | *Bicyclus safitza* (Westwood, [1850])* | Black-haired Bush Brown | 20 | 25 | 0 | 45 | 2 | **C** |
| | *Byblia anvatara* (Boisduval, 1833) | African Joker | 18 | 12 | 10 | 40 | 1.9 | **C** |
| | *Byblia ilithyia* (Drury, 1773) | Spotted Joker | 15 | 0 | 0 | 15 | 0.7 | **R** |
| | *Charaxes candiope* (Godart, [1824]) | Green-veined Charaxes | 11 | 0 | 0 | 11 | 0.5 | **R** |
| | *Charaxes castor* (Cramer, 1775) | Giant Charaxes | 8 | 0 | 0 | 8 | 0.4 | **R** |
| | *Charaxes galawadiwosi* Plantrou & Rougeot, 1979 | Ethiopian Charaxes | 20 | 0 | 0 | 20 | 0.9 | **R** |
| | *Charaxes numenes* (Hewitson, [1859]) | Lesser Blue Charaxes | 12 | 0 | 0 | 12 | 0.57 | **R** |
| | *Charaxes tiridates* (Cramer, 1777) | Common Blue Charaxes | 10 | 0 | 0 | 10 | 0.5 | **R** |
| | *Charaxes jahlusa* (Trimen, 1862) | Pearl-spotted Charaxes | 0 | 17 | 0 | 17 | 0.8 | **R** |
| | *Cyrestis camillus* (Fabricius, 1781) | African Porcelain | 12 | 0 | 0 | 12 | 0.57 | **R** |
| | *Euphaedra medon* (Linnaeus, 1763) | Widespread Forester | 8 | 0 | 0 | 8 | 0.4 | **R** |
| | *Eurytela dryope* (Cramer, 1775) | Golden Piper | 9 | 8 | 0 | 17 | 0.8 | **R** |
| | *Hamanumida daedalus* (Fabricius, 1775) | Guinea fowl Butterfly | 16 | 20 | 8 | 44 | 2.1 | **VC** |
| | *Hypolimnas anthedon* (Doubleday, 1845) | Variable Diadem | 24 | 12 | 0 | 36 | 1.7 | **C** |
| | *Hypolimnas misippus* (Linnaeus, 1764) | Common Diadem | 18 | 8 | 0 | 26 | 1.2 | **C** |
| | *Junonia ansorgei* (Rothschild, 1899) | Ansorge's Leaf Pansy | 8 | 0 | 0 | 8 | 0.4 | **R** |

*Table 2 continued in next page*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *Junonia chorimene* (Guérin-Méneville, 1844) | Golden Pansy | 8 | 6 | 0 | 14 | 0.7 | **R** |
| | *Junonia hierta* (Fabricius, 1798) | Yellow Pansy | 9 | 12 | 14 | 35 | 1.65 | **C** |
| | *Junonia oenone* (Linnaeus, 1758) | Blue Pansy | 0 | 16 | 20 | 36 | 1.7 | **C** |
| | *Junonia orithya* (Linnaeus, 1758) | Eyed Pansy | 0 | 13 | 12 | 25 | 1.2 | **C** |
| | *Junonia sophia* (Fabricius, 1793) | Little Pansy | 19 | 13 | 0 | 32 | 1.5 | **C** |
| | *Junonia terea* (Drury, 1773) | Soldier Pansy | 17 | 20 | 0 | 37 | 1.7 | **C** |
| | *Libythea labdaca* Westwood, [1851] | Northern African Snout | 30 | 30 | 0 | 60 | 2.8 | **VC** |
| | *Neptis serena* Overlaet, 1955 | Notched Pied Sailer | 0 | 30 | 0 | 30 | 1.4 | **C** |
| | *Phalanta eurytis* (Doubleday, [1847]) | Forest Leopard | 30 | 12 | 0 | 42 | 2 | **C** |
| | *Protogoniomorpha anacardii* (Linnaeus, 1758) | Clouded Mother-of-pearl | 6 | 8 | 0 | 14 | 0.7 | **R** |
| | *Protogoniomorpha parhassus* (Drury, 1782) | Mother-of-pearl | 10 | 0 | 0 | 10 | 0.5 | **R** |
| | *Pseudacraea lucretia* (Cramer, [1775]) | False Chief | 12 | 0 | 0 | 12 | 0.57 | **R** |
| | *Sevenia garega* (Karsch, 1892) | Montane Tree Nymph | 0 | 13 | 0 | 13 | 0.6 | **R** |
| | *Sevenia umbrina* (Karsch, 1892) | Ochreous Tree Nymph | 0 | 14 | 0 | 14 | 0.7 | **R** |
| | *Tirumala formosa* (Godman, 1880) | Beautiful Monarch | 12 | 10 | 12 | 34 | 1.6 | **C** |
| | *Tirumala petiverana* (Doubleday, [1847]) | Blue Monarch | 10 | 14 | 8 | 32 | 1.5 | **C** |
| **Pieridae** | *Belenois aurota* (Fabricius, 1793) | Brown-veined White | 60 | 20 | 12 | 92 | 4.3 | **VC** |
| | *Belenois raffrayi* (Oberthür, 1878) | Raffray's White | 12 | 0 | 0 | 12 | 0.57 | **R** |
| | *Belenois zochalia* (Boisduval, 1836) | Forest White | 0 | 12 | 10 | 22 | 1 | **R** |
| | *Catopsilia florella* (Fabricius, 1775) | African Migrant | 24 | 18 | 20 | 62 | 3 | **VC** |
| | *Colotis antevippe* (Lucas, 1852) | Abyssinian Red Tip | 0 | 19 | 12 | 31 | 1.5 | **C** |
| | *Colotis chrysonome* (Klug, [1829]) | Golden Arab Tip | 14 | 9 | 13 | 36 | 1.7 | **C** |
| | *Colotis evenina* (Wallengren, 1857) | Orange Tip | 12 | 18 | 24 | 54 | 2.5 | **VC** |
| | *Colotis ione* (Godart, [1819]) | Bushveld Purple Tip | 0 | 18 | 0 | 18 | 0.85 | **R** |
| | *Colotis protomedia* (Klug, [1829]) | Yellow Splendor Tip | 0 | 12 | 20 | 32 | 1.5 | **C** |
| | *Colotis venosa* (Staudinger, [1885]) | No Patch Tip | 12 | 0 | 0 | 12 | 0.57 | **R** |
| | *Eurema brigitta* (Stoll, [1780]) | Broad-bordered Grass Yellow | 12 | 14 | 30 | 56 | 2.6 | **VC** |
| | *Eurema senegalensis* (Boisduval, 1836) | Forest Grass Yellow | 24 | 12 | 10 | 46 | 2.2 | **VC** |
| | *Leptosia alcesta* (Stoll, [1782]) | African Wood White | 16 | 0 | 0 | 16 | 0.76 | **R** |
| | *Mylothris agathina* (Cramer, [1779]) | Eastern Dotted Border | 12 | 24 | 28 | 64 | 3 | **VC** |
| | *Mylothris rueppellii* (Koch, 1865) | Twin Dotted Border | 0 | 21 | 0 | 21 | 1 | **R** |
| | *Pontia daplidice* (Linnaeus, 1758) | Bath Dappled White | 22 | 0 | 0 | 22 | 1 | **R** |

*Table 2 continued in next page*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Lycaenidae** | *Actizera stellata* (Trimen, 1883) | Red-clover Rayed Blue | 25 | 0 | 12 | 37 | 1.7 | **C** |
| | *Anthene definita* (Butler, 1899) | Common Hair tail | 12 | 10 | 0 | 22 | 1 | **R** |
| | *Anthene larydas* (Cramer, 1780) | Forest Hair tail | 15 | 10 | 0 | 25 | 1.2 | **C** |
| | *Azanus jesous* (Guérin-Méneville, 1849) | Topaz Babul Blue | 6 | 8 | 0 | 14 | 0.7 | **R** |
| | *Azanus natalensis* (Trimen, 1887) | Natal Babul Blue | 12 | 0 | 0 | 12 | 0.57 | **R** |
| | *Deudorix antalus* (Hopffer, 1855) oy | Brown Playb | 18 | 8 | 0 | 26 | 1.2 | **C** |
| | *Lepidochysops abyssiniensis* (Strand, 1911) | Abyssinian Giant Cupid | 15 | 16 | 9 | 40 | 1.9 | **C** |
| | *Lycaena phlaeas* (Linnaeus, 1760) | Small Sorrel Copper | 5 | 0 | 0 | 5 | 0.24 | **VR** |
| | *Tarucus rosacea* (Austaut, 1885) | Mediterranean Pierrot | 13 | 0 | 0 | 13 | 0.6 | **R** |
| | *Uranothauma antinorii* (Oberthür, 1883) | Blue Heart | 13 | 10 | 7 | 30 | 1.4 | **C** |
| **Papilonidae** | *Graphium angolanus* (Goeze, 1779) | White Lady | 14 | 0 | 0 | 14 | 0.7 | **R** |
| | *Papilio dardanus* Brown, 1776 | Flying Handkerchief | 16 | 0 | 0 | 16 | 0.76 | **R** |
| | *Papilio demodocus* Esper, [1798] | Citrus Gazer | 13 | 12 | 13 | 38 | 1.8 | **C** |
| | *Papilio echerioides* Trimen, 1868 | White-banded Sash | 35 | 9 | 0 | 44 | 2.1 | **VC** |
| | *Papilio nireus* Linnaeus, 1758 | Green-banded Malachite | 18 | 9 | 0 | 27 | 1.3 | **C** |
| **Hespariidae** | *Afrogegenes letterstedti* (Wallengren, 1857) | Yellow Hottentot | 10 | 10 | 12 | 32 | 1.5 | **C** |
| | *Apallaga menageshae* Libert, 2014 | | 0 | 12 | 0 | 12 | 0.57 | **R** |
| | *Coeliades forestan* (Stoll, [1782]) | Striped Policeman | 13 | 12 | 6 | 31 | 1.5 | **C** |
| **Total** | | | **1028** | **740** | **350** | **2118** | **100** | |

**Table 3.** Butterfly species richness and composition across the three habitat types

| **Diversity indices** | **Rf** | **WGL** | **Mo** |
|---|---|---|---|
| Taxa_S | 65 | 52 | 26 |
| Individuals | 1028 | 740 | 350 |
| Simpson_1-D | 0.9814 | 0.9794 | 0.9561 |
| Shannon_H | 4.095 | 3.921 | 3.199 |
| Evenness_e^H/S | 0.9235 | 0.9702 | 0.9427 |
| Margalef | 9.228 | 7.719 | 4.268 |
| Equitability_J | 0.9809 | 0.9923 | 0.9819 |


**Photo plate 1.** Species list and abundance of butterflies in different habitats: *1. Acraea aganice 2. Acraea caecilia 3. Acraea egina 4. Acraea encedon 5. Acraea oncaea6. Acraea poggei 7. Acraea sotikensis 8. Acraea zetes 9. Amauris albimaculata 10. Amauris echeria11. Amauris niavius 12. Bicyclus angulosa 13. Bicyclus anynana 14. Bicyclus 15. Byblia anvatara.*

Butterfly species composition in riverine forest and wooded grassland resembled each other, while mosaic habitat showed unique composition (Figures 5 & 6). Mosaic habitat with human settlements showed high dissimilarity of butterfly composition in the study area. According to plot of dendrogram habitat type the highest similarity was found between wooded grassland and mosaic habitats, followed by riverine forest and wooded grassland, and the least was between riverine forest and mosaic habitat (Figure 6).

Figure 7 showed that up to a sampling effort of 600 individuals, in woody grassland up to 450 individuals, and in mosaic habitat up to 150 individuals, the number of butterfly species had recovered new species.

Out of 1028 butterflies recorded from the riverine forest, 244 butterflies (highest) was recorded in January and the least recorded in June 96. Wooded grassland had about 740 butterflies with 176 (highest) butterflies in January and the least was 70 in June. From the 350 butterflies recorded in mosaic habitat, the highest abundance was recorded in January with 78 butterflies and the less abundant month was in June with 40 individuals (Figure 8). Similarly, the average monthly rainfall showed increasing trend and decreasing trend of maximum and minimum temperature from January to June (Fig 8).


**Photo plate 2.** Species list and abundance of butterflies in different habitats: *16. Byblia ilithyia17. Charaxes candiope18. Charaxes castor 19. Charaxes galawadiwosi 20. Charaxes numenes 21. Charaxes tiridates 22. Charaxes jahlusa 23. Cyrestis camillus 24. Euphaedra medon25. Eurytela dryope 26. Hamanumida daedalus 27. Hypolimnas anthedon 28. Hypolimnas misippus 29. Junonia ansorgei 30. Junonia chorimene.*

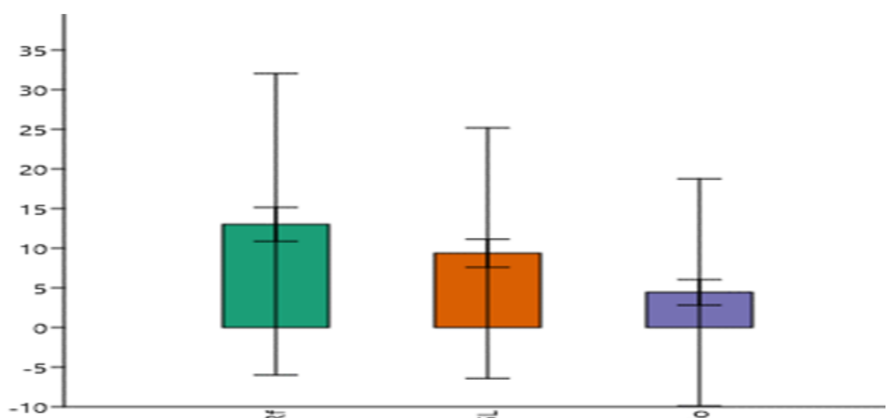


**Figure 5.** Pattern of butterfly richness across the three habitat types in and around Chebra Churchura (Rf = riverine forest, WGL=Wooded grassland and Mo= mosaic habitat).


**Photo plate 3.** Species list and abundance of butterflies in different habitats: *31. Junonia hierta 32. Junonia oenone 33. Junonia orithya 34. Junonia sophia 35. Junonia terea 36. Libythea labdaca 37. Neptis serena 38. Phalanta eurytis 39. Protogoniomorpha anacardii 40. Protogoniomorpha parhassus 41. Pseudacraea lucretia*

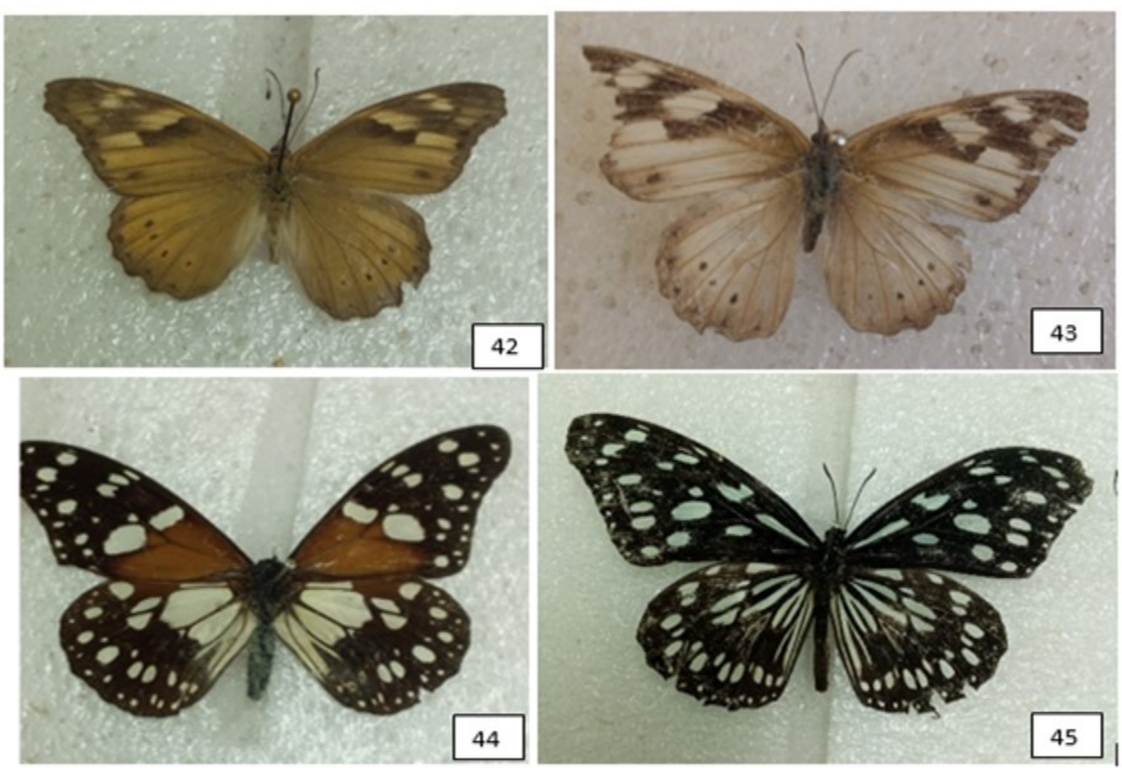


**Photo plate 4.** (Species list and abundance of butterflies in different habitats: *42. Sevenia garega 43. Sevenia umbrina 44. Tirumala formosa 45. Tirumala petiverana.*

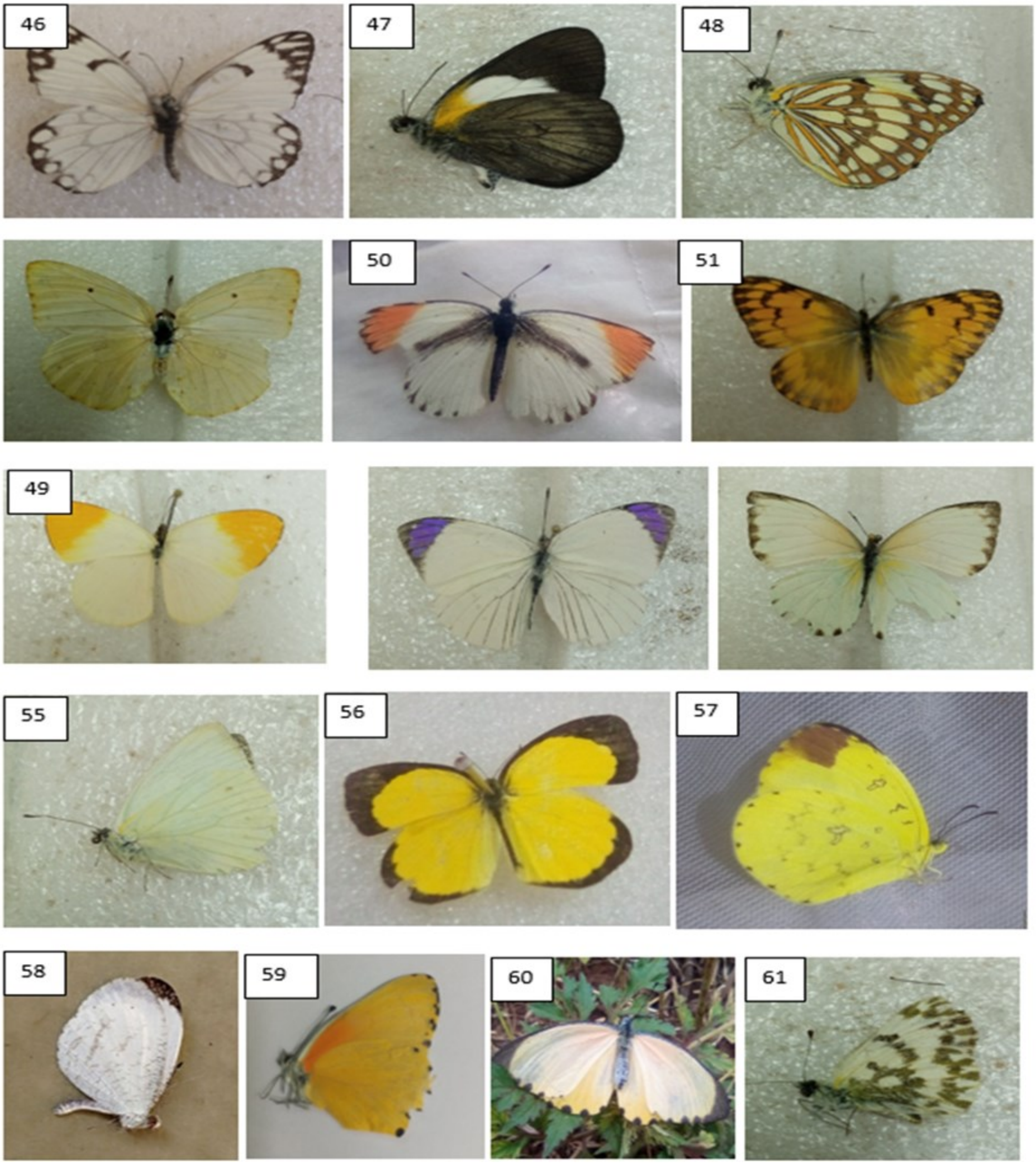


**Photo plate 5.** Species list and abundance of butterflies in different habitats: *46. Belenois aurota 47. Belenois raffrayi 48. Belenois zochalia 49. Catopsilia florella50. Colotis antevippe 51. Colotis chrysonome52. Colotis evenina 53. Colotis ione 54. Colotis protomedia 55. Colotis venosa 56. Eurema brigitta 57. Eurema senegalensis 58. Leptosia alcesta 59. Mylothris agathina 60. Mylothris rueppellii 61. Pontia daplidice).*

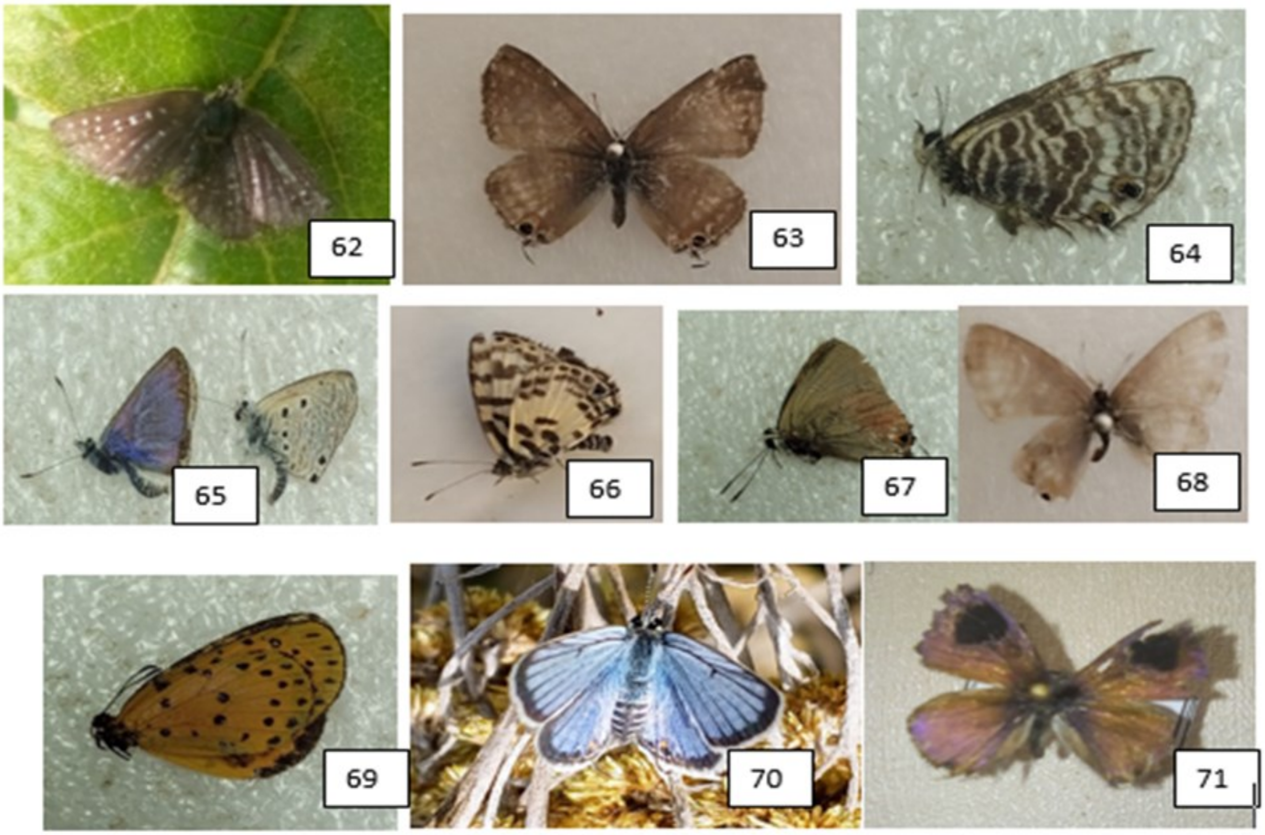


**Photo plate 6.** Species list and abundance of butterflies in different habitats:. *62. Actizera stellata 63. Anthene definita 64. Anthene larydas 65. Azanus jesous 66. Azanus natalensis 67. Deudorix antalus 68. Lepidochysops abyssiniensis 69. Lycaena phlaeas 70. Tarucus rosacea 71. Uranothauma antinorii.*

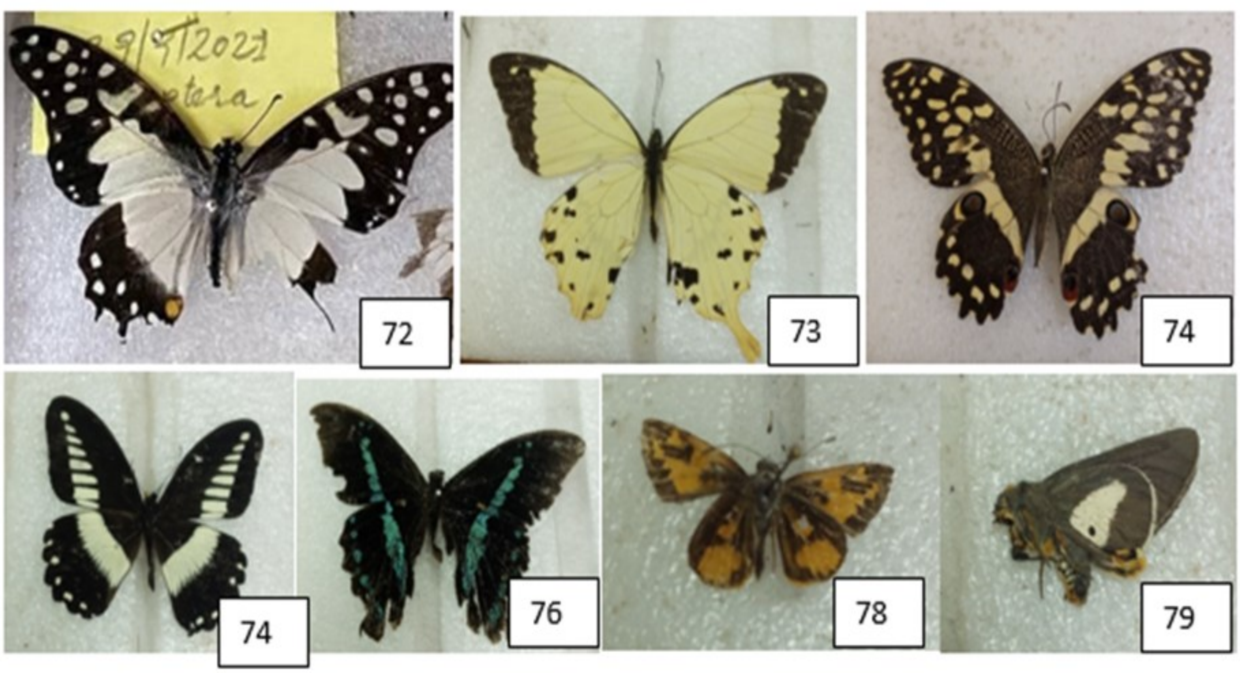


**Photo plate 7.** Species list and abundance of butterflies in different habitats: *72. Graphium angolanus 73. Papilio dardanus74. Papilio demodocus 75. Papilio echerioides 76. Papilio nireus 77. Afrogegenes letterstedti 78. Apallaga menageshae 79. Coeliades forestan*

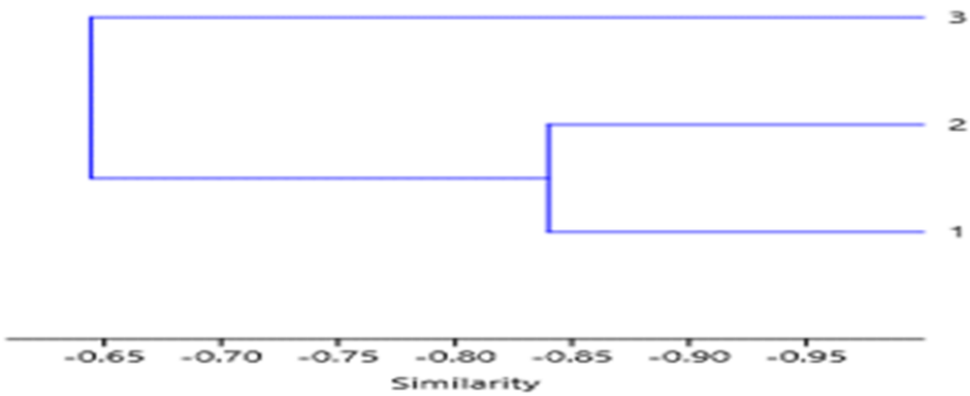


**Figure 6.** Dendrogram showing the similarity of habitats based on species richness ((1= riverine forest, 2= wooded grassland and 3= mosaic habitat).

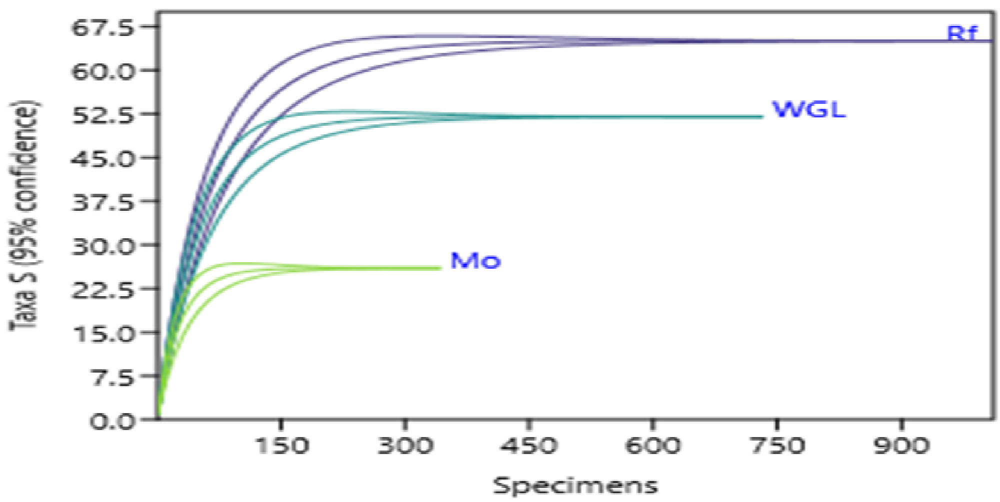


**Figure 7.** Individual butterfly Species richness based accumulation curve.

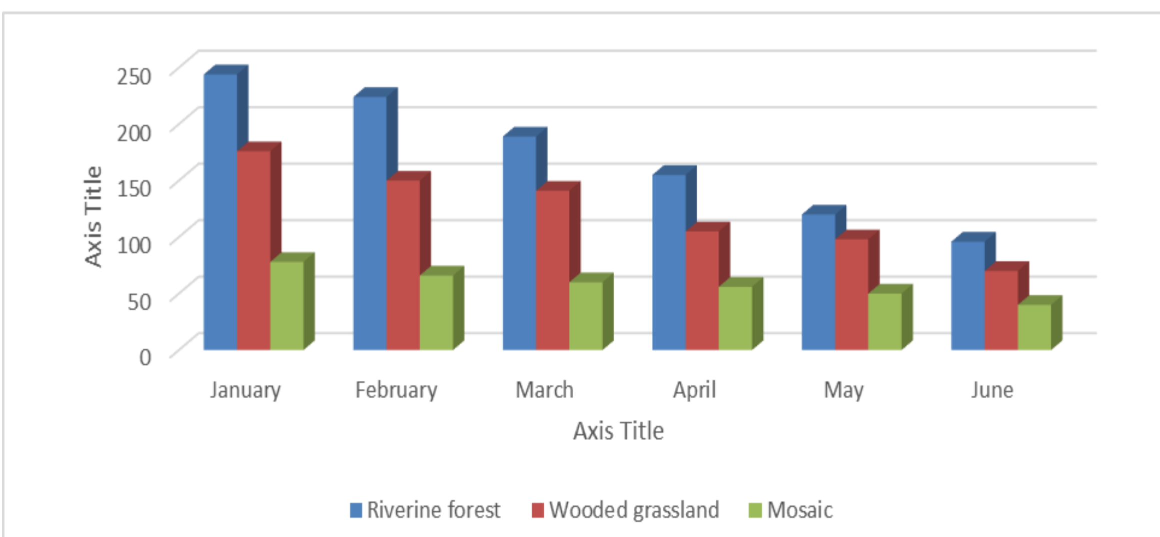


**Figure 8.** Monthly abundance of butterfly species across land use types

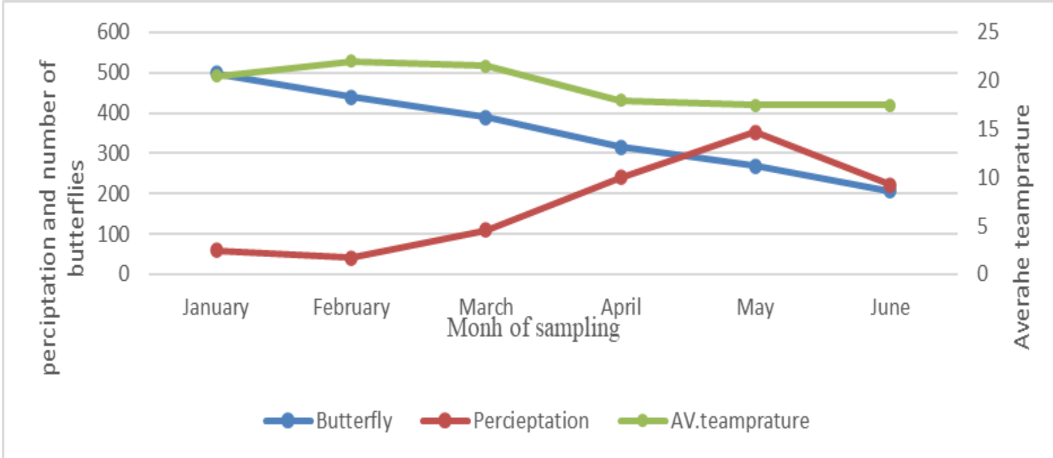


**Figure 9.** Trends of butterflies with climatic factors

Generally, the average monthly rainfall showed increasing trend and decreasing trend of maximum and minimum temperature from January to June (Figure 9).

## DISCUSSION

Chebera Churchura National Park was established recently and has recently received conservation attention from government organizations and other conservation organizations and researchers. This primary investigation focused on how important the three different land-use types are for butterfly conservation. Butterfly species richness in and around Chebera Churchura National Park accounts for about 18.54% of the total known species (426 species) from Ethiopia so far (Tujuba et., 2019). Approximately 77% of the butterfly species at Chebera Churchura National Park and its surrounding. Moreover, the individual-based rarefaction curves provided an indication for the addition of more species with increased sampling in the study area.

Comparing with other studies on the diversity of butterflies, the current study was higher than some other studies. Norfolk *et al*. (2017) documented 64 butterfly species in the agricultural landscape of the Jimma Highlands of Ethiopia. Hailay *et al*. (2022) identified 44 butterfly species in Ethiopia's Gozamn wored Amhara regional state. Hailay (2022) and Jemal & Getu (2018) identified 21 and 43 butterfly species from the Ethiopian biodiversity compound in Addis Ababa, Ethiopia, and the Menagesha-Suba State Forest in Addis Ababa, Ethiopia, respectively. Jenber & Getu (2020) reported 46 butterfly species from Gullele Botanical Garden, Addis Ababa, Ethiopia. Wale & Abdella (2021) reported 11 butterfly species from the Middle Afromontane Area of Northwestern Ethiopia. The species richness of butterflies in the current study area was also lower as compared to that of records from different parts of Ethiopia such as Belete-Gera Forest, 87 species reported (De Beenhouwer *et al*., 2019).

Considering the taxonomic composition of butterfly species in and around Chebera Churchra national park comprising high species richness and abundance of the family Nymphalidae. In this context recorded from different parts of Ethiopia (Norfolk *et al*., 2017; Jemal & Pantharajan, 2018; De Beenhouwer *et al*., 2019; Jenber & Getu, 2020; Wale & Abdella, 2021; Hailay, 2022; Hailay *et al*., 2022) corroborated with the pattern that has reported from the current study. The highest abundance and diversity of nymphalid butterflies of the total recorded butterflies from the entire study area) could be due to their ability to inhibit variety of habitat types and ability and adaptation to feed on different plant species and Herspariidae recorded with lower due to most species have limited host plants (Koneri & Maabuat, 2016).

Among the sampled three habitats (riverine forest, wooded grassland, and mosaic habitat), based on butterfly diversity, the mosaic habitat recorded low species richness and high dissimilarity of butterfly species richness and abundance. Reduced vegetation cover, constant human interference, increased land use for raising agricultural and vegetable crops, and infrastructure development are the responsible factors for the observed low diversity and richness of butterflies in the mosaic habitat. High species diversity and similarity of butterfly species were recorded across riverine forest and wooded grassland habitats in the study area. These habitats shared many plants, which are important larval food resources for a number of butterflies common to both habitats. Moreover, riverine forest and wooded grassland were found inside the National Park that are relatively free of human and animal interaction and may contribute to the highest diversity and richness of butterflies in the study area. This shows that protected habitats support more diversity of butterfly species, while unprotected and degraded habitats support less diversity of butterflies (Koneri & Maabuat 2016).

The abundance of butterflies is dependent on climatic factors, as butterflies are ectothermic and their body functions are dependent on climatic factors (Roy *et al*., 2001). In the current study, the pattern of butterfly abundance was affected by the sampling month, such that the highest abundance was recorded in January and the least was recorded in June. When compared to other sampling months (March, April, May, and June), January and February have the highest abundance of butterflies. The highest rainfall was recorded in June and the least was recorded in January, and the temperature was vice versa. Possible causes include the fact that more butterflies are collected during the dry season than the wet season due to the high temperatures and relatively low amount of rainfall in the dry season compared to the wet season. Due to adult butterflies' diapause, which reduces the quantity of butterflies that are counted, butterflies may potentially be present in the research region during the wet season but go undetected. The survival of the juvenile stages, adult flight required for oviposition, and butterfly fecundity rate are all impacted by the weather (Wolda, 1988; Roy *et al*., 2001; Boggs & Freeman, 2005; Dooley *et al*., 2013; Bonelli *et al*., 2015).

In this case, the results of the current study agree with the above conclusions. However, the lowest abundance of individuals in June does not necessarily represent the whole population abundance of butterflies in the study area. The number of predators may contribute to the population difference in the study area. In general, the diversity of butterflies in and around Chebera Churchura National Park was found suitable for butterfly diversity. Disturbances in and around national parks affect butterfly species composition and diversity (Namu, 2004; Koh, 2007; Nidup *et al*., 2014). Overgrazing by cattle in grasslands and forests both within and outside national parks, logging of forest trees, construction of lodges and hotels that cause deforestation, contraction of roads, and hydropower dams are a few of the concerns that have been observed in the national park. These activities have a negative impact on the habitat quality and the food supplies available to butterflies, both of which have the potential to hasten the loss of taxonomic diversity in butterflies.

Finally, this study has painted the first ecological picture of butterfly species richness, abundance, and relative abundance in relation to different land use types in and around Chebera Churchura National Park. Since there is no reliable butterfly community monitoring method available to track changes in the butterfly communities residing in this national park, it is yet unknown how the risks currently present in the park have affected the butterfly species that were previously present. The current study, conducted for six months (January to June), provides a general picture of the diversity of butterflies in different habitat types. Thus, future studies looking at the rest of the months and the effect of changes in habitat types on the diversity of butterflies will be necessary for generating full information that will be useful in identifying species-specific needs for improving the conservation of the butterfly community in and around Chebera Churchura National Park.

## CONCLUSION

The current study focused on butterfly diversity across three different land uses. From the study, we can conclude that the area is rich and diverse in butterfly species. Considering the land use types, the highest was recorded in riverine forest, followed by wooded land and mosaic habitat. This is the first study of the butterfly diversity in Chebera Churchura National Park and the surrounding farmlands of southwestern Ethiopia. The present list of butterfly species is not an exhaustive sampling; it covers only six months (January to June) and is focused on three land use types. So further exploration of butterfly species should be continued to update this checklist for the rest of the unstamped months (July to December). Such research on butterflies should be expanded to include different altitude ranges, as it is currently lacking. The current study area is becoming an investment hub, and many road development projects are being planned. Ongoing human activities will devastate and harm the richness, abundance, and diversity of butterfly species. As a result, such human-induced activities need to be carefully studied to protect biodiversity loss in the current study area, and particular attention should be paid to the conservation of biodiversity in general.

## ACKNOWLEDGEMENTS

I would like to thank Dr.Tesfu Fekensa, Head of the Animal Biodiversity Department at the Ethiopian Biodiversity Institute (EBI) for his support and guidance and Dr.Tesfaye Awas for identifying plants collected from the park. I would like to extend my gratitude to Mr. Adane Tsegaye, Head of Chebera Chrchura National Park, for his permission to work in the park.

**Conflict of interest:** The authors declared that they have no conflict of interest.

## REFERENCES

Alemayehu A, Mathewos T. 2015. Approaches to human-wildlife conflict management in and around Chebera-Churchura National Park, Southern Ethiopia. Asian Journal of Conservation Biology 4(2):136-142.

Boggs, C. L., & Freeman, K. D. 2005. Larval food limitation in butterflies: effects on adult resource allocation and fitness. *Oecologia*, *144*(3), 353–361. https://doi.org/10.1007/s00442-005-0076-6

Bonelli, S., Barbero, F., Casacci, L. P., Cerrato, C., & Balletto, E. 2015. The butterfly fauna of the Italian Maritime Alps: results of the EDIT project. *Zoosystema*, *37*(1), 139–167. https://doi.org/10.5252/z2015n1a6

**Br**oadbent, E. N., Zambrano, A. M. A., Dirzo, R., Durham, W. H., Driscoll, L., Gallagher, P., Salters, R., Schultz, J., Colmenares, A., & Randolph, S. G. 2012. The effect of land use change and ecotourism on biodiversity: a case study of Manuel Antonio, Costa Rica, from 1985 to 2008. *Landscape Ecology*, *27*(5), 731–744. https://doi.org/10.1007/s10980-012-9722-7

Daskalova, G. N., Myers-Smith, I. H., Bjorkman, A. D., Blowes, S. A., Supp, S. R., Magurran, A. E., & Dornelas, M. 2020. Landscape-scale forest loss as a catalyst of population and biodiversity change. *Science*, *368*(6497), 1341–1347. https://doi.org/10.1126/science.aba1289

De Beenhouwer M, Foquet R, Kassie A. 2019. Express Biodiversity Survey in Gura-Ferda Forest, Ethiopia. BINCO Express Report 8. Biodiversity Inventory for Conservation. Glabbeek, 5-24.

Dooley, C. A., Bonsall, M. B., Brereton, T., & Oliver, T. 2013. Spatial variation in the magnitude and functional form of density-dependent processes on the large skipper butterflyOchlodes sylvanus. *Ecological Entomology*, *38*(6), 608–616. https://doi.org/10.1111/een.12055

Fleishman, E., & Murphy, D. D. 2009. A Realistic Assessment of the Indicator Potential of Butterflies and Other Charismatic Taxonomic Groups. *Conservation Biology*, *23*(5), 1109–1116. https://doi.org/10.1111/j.1523-1739.2009.01246.x

Gerlach, J., Samways, M., & Pryke, J. 2013. Terrestrial invertebrates as bioindicators: an overview of available taxonomic groups. *Journal of Insect Conservation*, *17*(4), 831–850. https://doi.org/10.1007/s10841-013-9565-9

Ghazanfar M, Malik MF, Hussain M, Iqbal R, Younas M.2016. Butterflies and their contribution in ecosystem: A review. Journal of Entomology and Zoology Studies 4(2): 115-118.

Gorbunov OG. 2017. On the Pieridae butterflies of the West Shewa Zone (Ethiopia) (Lepidoptera: Pieridae). Ethiopian Journal of Biological Sciences 16(1): 95-147.

Hailay G, Biru , Kassie A. 2022. Butterfly diversity and abundance at two different habitat types of Gozamen woreda, Amhara regional state, Ethiopia. *Arthropods*, 11(3): 153-163.

Hailay G. 2022. Checklist of butterflies from the Ethiopian Biodiversity Institute (EBI) premises, Addis Ababa, Ethiopia. Journal of Nature and Applied Research, 2(1), 8–17. https://doi.org/10.5281/zenodo.6547894

**Ha**nsen AJ, DeFries RS, Turner W. 2012. Land use change and biodiversity. In *Land, change science* (pp. 277-299). Springer, Dordrecht.

Jemal, A., & Getu, E. 2018. Diversity of butterfly communities at different altitudes of Menagesha-suba state forest, Ethiopia. *Journal of Entomology and Zoology Studies*, *6*(2), 2197-2202.

Jenber, A. J., & Getu, E. 2020. Studies on butterflies' diversity in relation to habitats and seasons at Gulele Botanical Garden in Central Ethiopia: implication of protected area for in-situ conservation of biological entity. *SINET: Ethiopian Journal of Science*, *43*(2), 64-76.

Jennersten, O. 1984. Flower visitation and pollination efficiency of some North European butterflies. *Oecologia*, *63*(1), 80–89. https://doi.org/10.1007/bf00379789

Kintz, D. B., Young, K. R., & Crews-Meyer, K. A. (2006). Implications of Land Use/Land Cover Change in the Buffer Zone of a National Park in the Tropical Andes. *Environmental Management*, *38*(2), 238–252. https://doi.org/10.1007/s00267-005-0147-9

Koh, L. P. 2007. Impacts of land use change on South-east Asian forest butterflies: a review. *Journal of Applied Ecology*, *44*(4), 703–713. https://doi.org/10.1111/j.1365-2664.2007.01324.x

Koneri, R., & Maabuat, P. V. 2016. Diversity of Butterflies (Lepidoptera) in Manembo-Nembo Wildlife Reserve, North Sulawesi, Indonesia. *Pakistan Journal of Biological Sciences*, *19*(5), 202–210. https://doi.org/10.3923/pjbs.2016.202.210

Kristensen P. 2013. Phylogeny of endopterygote insects, the most successful lineage of living organisms. *European Journal of Entomology*, *96*(3), 237–253.

Mucova SA, Filho WL, Azeiteiro UM, Pereira MJ.2018. Assessment of land use and land cover changes from 1979 to 2017 and biodiversity & land management approach in Quirimbas National Park, Northern Mozambique, and Africa. *Global Ecology and Conservation*, *16*, e00447. https://doi.org/10.1016/j.gecco.2018.e00447

Mucova, S. A. R., Filho, W. L., Azeiteiro, U. M., & Pereira, M. J. 2018. Assessment of land use and land cover changes from 1979 to 2017 and biodiversity & land management approach in Quirimbas National Park, Northern Mozambique, Africa. *Global Ecology and Conservation*, *16*, e00447. https://doi.org/10.1016/j.gecco.2018.e00447

Muhumuza, M., & Balkwill, K. 2013. Factors Affecting the Success of Conserving Biodiversity in National Parks: A Review of Case Studies from Africa. *International Journal of Biodiversity*, *2013*, 1–20. https://doi.org/10.1155/2013/798101

Namu FN. 2004. *Effects of forest disturbance on Butterfly diversity in Kakamega Forest National Reserve (KFNR), Western Kenya* (Doctoral dissertation, University of Nairobi).

Newbold, T., Hudson, L. N., Hill, S. L. L., Contu, S., Lysenko, I., Senior, R. A., Börger, L., Bennett, D. J., Choimes, A., Collen, B., Day, J., De Palma, A., Díaz, S., Echeverria-Londoño, S., Edgar, M. J., Feldman, A., Garon, M., Harrison, M. L. K., Alhusseini, T., Purvis, A. 2015. Global effects of land use on local terrestrial biodiversity. *Nature*, *520*(7545), 45–50. https://doi.org/10.1038/nature14324

Nidup T, Dorji T, Tshering U. 2014. Taxon diversity of butterflies in different habitat types in Royal Manas National Park. *Journal of Entomology and Zoology Studies*, *2*(6), 292-298.

Norfolk, O., Asale, A., Temesgen, T., Denu, D., Platts, P. J., Marchant, R., & Yewhalaw, D. 2017. Diversity and composition of tropical butterflies along an Afromontane agricultural gradient in the Jimma Highlands, Ethiopia. *Biotropica*, *49* (3), 346–354. https://doi.org/10.1111/btp.12421

Pollard, E. 1982. Monitoring butterfly abundance in relation to the management of a nature reserve. *Biological Conservation*, *24*(4), 317–328. https://doi.org/10.1016/0006-3207(82)90018-0

Rákosy, L., & Schmitt, T. 2011. Are butterflies and moths suitable ecological indicator systems for restoration measures of semi-natural calcareous grassland habitats? *Ecological Indicators*, *11* (5), 1040–1045. https://doi.org/10.1016/j.ecolind.2010.10.010

Reddi, C. S., & Bai, G. M. 1984. Butterflies and pollination biology. *Proceedings: Animal Sciences*, *93*(4), 391–396. https://doi.org/10.1007/bf03186258

Rodríguez-Echeverry, J., Echeverría, C., Oyarzún, C., & Morales, L. 2018. Impact of land-use change on biodiversity and ecosystem services in the Chilean temperate forests. *Landscape Ecology*, *33*(3), 439–453. https://doi.org/10.1007/s10980-018-0612-5

Roy, D. B., Rothery, P., Moss, D., Pollard, E., & Thomas, J. A. 2001. Butterfly numbers and weather: predicting historical trends in abundance and the future effects of climate change. *Journal of Animal Ecology*, *70*(2), 201–217. https://doi.org/10.1111/j.1365-2656.2001.00480.x

Sáfián Sz, Siklósi, A. 2022. *African Butterfly Database*. ABDB-Africa. Retrieved December 23, 2022, from https://abdb-africa.org/

Sanchez-Bayo F, Wyckhuys KA .2019. The global decline of entomo-fauna: An examination of the cause's Biological conservation 232: 8-27. 10.1016/J.BIOCON.2019.01.020

Sharma S, Dalip K, Mansotra JP. 2020. Role of butterflies in shaping an ecosystem: why to protect them. *Ecology and Biodivdersity*, *39*, 44.

Sharma, M., & Sharma, N. 2017. Suitability of Butterflies as Indicators of Ecosystem Condition: A Comparison of Butterfly Diversity across four habitats in Gir Wildlife Sanctuary. *International Journal of Advanced Research in Biological Sciences (IJARBS)*, *2*(3), 43–53. https://doi.org/10.22192/ijarbs.2017.04.03.005

Thakur MS, Mattu V K. 2010. The role of Butterfly as flower visitors and pollinators in Shiwalik hills of western Himalayas. *Asian Journal of Experimental Biological Sciences*, *4*, 822-825.

Tujuba, T. F., Sciarretta, A., Hausmann, A., & Atenafu Abate, G. 2019. Lepidopteran biodiversity of Ethiopia: current knowledge and future perspectives. *ZooKeys*, *882*, 87–125. https://doi.org/10.3897/zookeys.882.36634

Wale, M., & Abdella, S. 2021. Butterfly Diversity and Abundance in the Middle Afromontane Area of Northwestern Ethiopia. *Psyche: A Journal of Entomology*, *2021*, 1–14. https://doi.org/10.1155/2021/8805366

Watt WB, Boggs CL. 2019. Butterflies as Model Systems in Ecology and Evolution—Present and Future. In Butterflies (pp. 603-614). University of Chicago Press.

Wolda, H. 1988. INSECT SEASONALITY: WHY? *Annual Review of Ecology and Systematics*, *19* (1), 1–18. https://doi.org/10.1146/annurev.es.19.110188.000245

Stackhouse, P. 2022. *NASA POWER | Data Access Viewer*. NASA POWER | Data Access Viewer. Retrieved December 30, 2022, from https://power.larc.nasa.gov/data-access-viewer/