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# PATTERNS OF DIVERSITY AND DISTRIBUTION OF BUTTERFLIES IN HETEROGENEOUS LANDSCAPES OF THE WESTERN GHATS, INDIA

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## Abstract

Eight localities in various parts of the Western Ghats were surveyed for pattern of butterfly diversity, distribution and abundance. Each site had heterogeneous habitat matrices, which varied from natural habitats to modified habitats like plantations and agricultural fields. The sampling was done by the belt transects approximately 500m in length with 5 m on either side traversed in one hour in each habitat type. A total of 169 species were recorded in 8 localities. The diversity of butterfly species was high in natural habitats than the modified ones. Further analysis on commonness and rarity of butterfly species showed the rare butterflies were recorded only in natural habitats. The presence of natural habitats in the heterogeneous matrix influenced the species encountered in modified habitats. The data presented here is entirely collected by undergraduate students and teachers in Western Ghats Biodiversity Monitoring programme.

**Key words: Butterfly diversity, distribution, heterogeneous landscapes, Western Ghats**

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## Introduction

Butterflies (Order Lepidoptera) are sensitive biota which gets severely affected by the environmental variations and changes in the forest structure as they are closely dependent on plants (Pollard 1991 and Blair, 1999). They also react quickly to any kind of disturbance and changes in the habitat quality making a good indicator to study changes in the habitat and landscape structure variations (Blair 1999). Here an attempt made to understand how the distribution and variation in butterfly diversity changes in heterogeneous habitats in various sites in the Western Ghats. The data was collected by undergraduate teachers and students in Biodiversity Monitoring Network. As part of the Western Ghats Biodiversity Monitoring programme a network of experts, undergraduate students, teachers, NGO's and local people is being developed since 1994. Fifteen study sites along the Western Ghats covering major landscape features and vegetation types were mapped and important flora and fauna documented. The available data was analyzed with following objectives to see if

1. There is variation in the butterfly community across various sites.
2. Buttefly diversity changes in heterogeneous landscapes.
3. Seasonal variations in the butterfly diversity.
4. Changes in the butterfly diversity in natural, semi-natural and man-made ecosystem.

## Materials and Methods

The sampling and monitoring of butterflies was carried out localities along the Western Ghats tract, mountain range 1600km long with 5-50km width running parallel to the West Coast of India. It is one of the 25 biodiversity hotspots in the world. The present work is based on butterflies communities sampled at 8 different localities in the Maharashtra, Karnataka, Kerala and Tamil Nadu states. (Table 1). Monitoring selected biological taxa involving teachers and students was initiated in 1994 by Prof. Madhav Gadgil. Where he formed a network of over 20 undergraduate colleges collaborating with ecologists at Centre for Ecological Sciences, Indian Institute of Science. The data analyzed here was collected entirely by students and teachers in the Biodiversity Monitoring Network.

## Study Sites and Sampling design

Following are the study sites located in various parts of Western Ghats along with LSE types sampled in the study sites.

1. ***Muvattpuzha:*** Semi-evergreen, moist deciduous, scrub, teak plantation, coconut, and mixed vegetation.
2. ***Alagarkoil:*** Riparian, mixed cultivation.
3. ***Dhoni:*** Evergreen, semi-evergreen, moist deciduous, dry deciduous, riparian, coconut, rubber, unknown1, disturbed semievergreen, unknown 2.
4. ***Sullia:*** Disturbed evergreen, moist deciduous, riparian, bamboo, areca, paddy, and human habitation.
5. ***Mala:*** Evergreen, semievergreen, scrub, riparian, human habitation, mixed areca coconut, rubber.
6. ***Sringeri:*** Evergreen, Ticket, Grassland, paddy, orchards, and plantations.
7. ***Kumta:*** Semi-evergreen, scrub, acacia, teak, paddy and orchards.
8. ***Nasik:*** moist deciduous, dry deciduous
9. ***Tamini:*** Mixed mosaic.

A standard methodology was given by CES team to all participating group, which involved sampling a LSE type in a line transect approximately 600m length with 5 m on either side covered in an hour walking at a constant pace. All the butterflies on the line as well as 5 m on either side were recorded with time, number of individuals seen. Other parameters such as weather condition, habitat mosaic, LSE type within a site was recorded. Few of the initial samplings were done along with CES team until participants were familiar with the methodology and identification of some common butterflies. All the identification was done in the field without collecting the specimens. Some of the field guides were referred for identification. Most of the sampling was done between 8-30 to 11-00 when butterflies were active.

## Data Analyses

**Comparison of sampling done by Teachers and students with data collected by experts:** The data on butterfly diversity in various states published by Harish Gaonkar (1996) was used to compare the butterfly diversity by college teachers and students. The data in various sites belonging to 4 different states i.e. Kerala, Karnataka, Tamil Nadu and Maharastra were pooled together and each species was assigned to the family and comparison was done. Percentage of butterflies recorded under each family was calculated in comparison with data collected by experts.

**Variations in butterfly community across habitats in Western Ghats:** The transects data of each habitat (irrespective of what site it is from) were pooled to and rarefaction models or expected number of species for minimum sample size was done to construct rarefaction curve for all LSE types and find out which habitat supported more number butterfly species. A distributional pattern of butterfly species and analysis of rare and common butterfly was done using the abundance and frequency of occurrence data.

The number of habitats a species was found and its abundance was used to analyze the status of each species. The butterfly species recorded on all LSE types were ranked in ascending order based on the number of habitats it was recorded. These were transformed into an index of 1-5. Butterflies recorded in 1-6 habitats were ranked 1 (6 habitats constitutes the 25% of the number of habitats identified). Then 7-12 rank 2, 13-18 ranks 3 19-24 rank 4 and more than 24 rank 5 Then based on abundance each species was ranked from least abundant to most abundant species. Species with less then 10 sightings were given a value of 0,10-50 sightings a rank 1,51-100 a rank of 2 101-150 rank of 3 151-200 rank of 4 and 200+ rank of 5. Then each species was assigned to families. (Davidar *et.al* 1996)

**Butterfly diversity and heterogeneous landscape:** The transect data from various LSE types of within the site was used to calculate rarefied species richness using minimum common sample size (i.e. minimum number of individuals in each LSE type). Cluster analysis was done using Jaccard's dissimilarity index for each site containing various LSE types, and dendrogram was plotted for each site.

The data on various sites were analyzed for butterfly diversity, evenness, uniqueness, and rarity, endemic species to identify the LSE type important for butterfly species.

**Seasonality variations in butterfly in heterogeneous landscapes**

The data from each sites was classified into premonsoon, monsoon and postmonsoon (irrespective of which LSE type it is from) based on the month of sampling. Sampling in February-May was considered as Pre-monsoon, June-September as Monsoon, and October-January as post monsoon. Rarefaction was done using minimum number of individuals recorded in particular season.

**Endemictiy across LSE types in various sites:** Endemic butterflies were noted in each LSE types and percentage of endemic species found in each was calculated in comparison with the total endemic in Western Ghats and Srilanka.

**Butterfly diversity in natural, semi-natural and man-made ecosystem:** Each LSE types were assigned into natural (like evergreen, semievergreen, deciduous etc.) Semi-natural (scrub, thicket, grassland, woodland) and man-made or human impacted ecosystems (like plantations, human habitations etc.) diversity and average abundance in each of these categories was tested for difference.

## Results and Discussion

This study recorded a total of 8860 individuals of 172 butterfly species belonging to five families recorded during 6392 detection and 226 hours of sampling in 8 sites of Western Ghats.

**Comparison of sampling done by Teachers and students with data collected by experts:**

This study recorded 51% of butterflies, which were known to occur in Western Ghats. All Papilonids and 73% of Nymphalids, 75% of Pieridae were recorded whereas Family Lycaenidae and Hesperidae had lower recording with only 31% and 28% respectively. (See Fig.1, 2, 3, 4 and 5). The reason for good recording of butterflies species in Family Papiliondae can attributed to the size and conspicuous butterflies in this family which was comparatively easier for identification than butterfly species in Family Hesperidae and Lycaenidae therefore had poor recording as investigators tend to miss out due to its small size and also difficulty in identification without collection. The reason for low recording in Tamil Nadu was due to presence of only one study site and comparatively small data set (Alagarkoil), which represent only 8% of the total number of species. All the Papilionids, which are known to occur in Western Ghats, are recorded in the study.

It is a commendable effort by teachers and students involved in the monitoring project without any prior experience in natural history of butterflies to record 51% of butterflies. It is important to note that these study sites were mostly between 50-750 m altitude (whereas here the comparison is done with whole Western Ghats butterfly pool which also includes the higher altitudes) and moreover, the sampling done here without collecting the specimens.

**Butterfly Diversity and heterogeneous landscape:**

All the study sites had various habitats from natural forests to agricultural lands and plantation the butterfly diversity varied in all these habitats, the patterns of this variation was different in these 8 sites, in some the human impacted LSE types has similar species

composition as natural LSE types. The species richness (observed and rarefied), diversity indices, evenness, number endemic and unique species for various LSE types in all study sites are listed in Table 3,4,5,6,7, 8 9 and 10. Species accumulation curve for various sites sampled given in Figure 14. There were no adequate sampling efforts in some sites. Family wise classification of butterfly recorded for various sites given in Figure 15.The Family Nymphalidae was dominant among the butterflies recorded in all the area, followed by Family Papilionidae some and Pieridae in other sites.

1. **Nasik:** Dry deciduous and moist deciduous forests are two sampled LSE types, and a total of 42 species are recorded in this site. Shannon's and Simpson's diversity indices showed higher value in dry deciduous forest. There was 3 endemic and 21 unique species recorded in dry deciduous forest whereas in moist deciduous there was 4 unique species and no endemic species recorded. (Table 3.).
2. **Kumta:** Semi evergreen forests and scrubs showed higher Shannon and Simpson indices values. A total of 45 species was recorded in this site. There was no unique species to any LSE type in this site. The overlap of species between the LSE types was about 10%. Semi evergreen forest and scrub had 6 endemic species, lowest being in Paddy fields (3) and Acacia plantation (4). See table 4 and figure 8.
3. **Alagarkoil:** Riparian and Mixed plantation is the two LSE types sampled in this site. Riparian forests had higher Shannon and Simpson's value. Riparian forests had 8 unique species whereas mixed plantations had 4.A total of 27 species recorded in this site. The data set in this site was small. See table 5.
4. **Sringeri:** A total of 74 species are recorded in 6 LSE type. The species overlap between the LSE types is 45%. Highest number of unique species recorded in grassland (7) and evergreen forests (6). The species were evenly distributed in all the habitats. The Shannon and Simpson diversity indices showed somewhat similar values for all the LSE types. See table 6 and figure 9.
5. **Mala:** A total of 85 species recorded in 12 LSE type. The species overlap between the LSE types if 68%. Semi-evergreen, evergreen forests, scrub, had high Shannon and Simpson's diversity values. Semi evergreen forests had 8 endemic and 4 unique species whereas plantations had comparatively low diversity indices. See table 7. and figure 10
6. **Sullia:** The species overlap between the LSE types was 83%, even the species richness (observed and rarefied) did not vary much in LSE types. See table 8. and figure 11. A total of 86 species was recorded in the site.

7. **Dhoni:** A total of 111 species were recorded in this site. The species overlap between LSE types being 64 %. Like in other sites the natural habitats Evergreen forests supported maximum number of species than other LSE types.The highest being in natural habitats and lower in plantations. See table 9 and figure 12
8. **Muvattpuzha:** A total of 79 species recorded in 6 LSE types, about 48% of species shared in these LSE types. Teak plantation had 15 unique species and 7 unique species. See table 10. and figure 13.

**Variations in butterfly community across habitats in Western Ghats:**

From the results it is evident that natural habitat supported more number of species (fig A). On the whole semievergreen forests, scrub, evergreen forests had higher butterfly species diversity than those of the semi-natural, monoculture plantation area. The results of this can be compared to the study done by Kunte (1999) shows similar results, with high diversity in natural habitats compared to human impacted areas in Western Ghats areas.

The ranking results showed that species with broad distributional range (regional) are also most abundant. About 57% butterflies were in rare category, which was recorded in 1 to 6 habitats, which also had low abundance, and only 8% of butterflies were distributed in more than 19-27 habitats. When abundance is considered about 38% species were recorded in less than 10 individuals and 7% of butterfly species were recorded being more than 200 individuals. Papilionidae and Pieridae were found almost in all habitats with even distributions. (See Table Hesperidae and Lycaenidae had restricted distributions they were recorded in 18 LSE types (total number of LSE types in this study was 27). Of the 7% butterflies present in rank 5 category of the abundance which included species like Common Indian Crow, Common Emigrant, Rustic, Chocolate Pansy etc. Species turn over or beta diversity across LSE types analyzed by jaccard's index. The dendrogram plotted by clustering the jaccard's similarity shows distinctly grouping of the natural habitat, from human impacted and plantations. Overall there was 42% species were common to all the LSE types.

**Seasonality variation in number butterfly species in various sites:** There was a fluctuation in number of butterfly species in various seasons. The changes in number of butterfly species varied for different sites (figure 7). In Nasik, Kumta, Mala, Dhoni, there was more number of species in premonsoon season than monsoon and postmonsoon. The study by Kunte (1997) in Northern Western Ghats showed the butterfly population starts building up in early monsoon and showed two peaks first in late monsoon and second in winter. Here

only the number of species is considered in each site which shows, the peak was in premonsoon in most of the study sites. However, it is not possible have a concrete idea of population fluctuations of butterflies from this study as, in some sites data was not available for comparison in various seasons and moreover; rarefaction test was done taking minimum number of individuals, as the sampling was not uniform in all localities.

## Conclusions

It appears from the results of the study, the heterogeneous habitats with various LSE types tend to share more species, in this particular study there were 26 LSE types (from all sites), which shared 42% of butterfly species. (See figure 6). The species found are not specialized to any particular habitats. The natural habitats supported more number of species than human impacted and plantations. When LSE types within a single site is considered same trend can be observed, there was overlap in the species in LSE types, ranging from 48% to 86% and natural habitats showed more number of species. It is important to note that the study was done by undergraduate teachers and students without much expertise in butterfly taxonomy, also without any collection of butterfly species for identification purposes. There was poor recording in butterfly of the family Lycaenidae and Hesperidae but the results of this study efficient in showing natural habitats in mosaic landscape within a locality had more butterfly species compared to human impacted or plantations, which is good enough in planning of conservation of the LSE types in a given locality.

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**Table-1. Study sites in the Western Ghats**

| State/Site | Latitude | Longitude | Altitude (m) | Rainfall (mm) |
|---|---|---|---|---|
| Kerala | | | | |
| **Muvattpuzha** | **10° 07' to 10°09'** | **76°40' to 76°45'** | **50-200** | **2500** |
| **Dhoni** | **10°51'38"** | **76°34'22"** | **200-450** | **2090** |
| Karnataka | | | | |
| **Sullia** | **13°9'** | **75°4'** | **90-850** | |
| **Mala** | **13°9'** | **75°4'** | **90-1200** | **5500** |
| **Sringeri** | **13°23'38"** | **75°8'58"** | **700-750** | **5500** |
| **Kumta** | | | | |
| Tamil Nadu | | | | |
| **Alagarkoil** | **10°20'53"** | **78°12'40"** | **350-450** | **810** |
| Maharastra | | | | |
| **Nasik** | **19°58'47"** | **73°25'9"** | **750** | **3000** |
| **Tamini** | **18°45'96"** | **73°44'14"** | **608** | **3500** |

**Table-2. Distribution of transects across vegetation types in various localities in the Western Ghats.**

| *Sites/habitats* | *1* | *2* | *3* | *4* | *5* | *6* | *8* | *10* | *11* | *12* | *13* | *14* | *16* | *17* | *18* | *19* | *20* | *22* | *24* | *26* | *27* | *28* | *29* | *31* | *32* | *33* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nasik | 0 | 0 | 0 | 3 | 8 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 11 |
| Kumta | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 10 |
| Sringeri | 11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 48 |
| Mala | 2 | 0 | 6 | 0 | 0 | 2 | 0 | 6 | 6 | 0 | 0 | 1 | 4 | 0 | 3 | 0 | 3 | 0 | 3 | 1 | 0 | 0 | 0 | 0 | 0 | 3 | 40 |
| Sullia | 0 | 6 | 0 | 2 | 0 | 6 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 20 |
| Dhoni | 11 | 0 | 5 | 12 | 2 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 | 1 | 0 | 4 | 0 | 0 | 3 | 2 | 2 | 0 | 0 | 0 | 53 |
| Alagarkoil | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 |
| Muvattpuzha | 0 | 0 | 5 | 2 | 0 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 18 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 41 |
| **Total** | 24 | 6 | 19 | 19 | 10 | 15 | 1 | 13 | 19 | 7 | 1 | 1 | 4 | 24 | 5 | 4 | 3 | 4 | 18 | 3 | 3 | 2 | 2 | 3 | 3 | 13 | 226 |

1-Evergreen, 2- Evergreen disturbed, 3-Semi-evergreen, 4-Moist Deciduous, 5-Dry Deciduous, 6-Riparian, 8- Bamboo, 10-Scrub, 11-Thicket, 12-Grassland, 13-Acacia, 14-Casurina, 17-Teak, 18-Areca, 19-Coconut, 20-Cashew, 22-Rubber, 24-Paddy, 26-Human habitation, 27-Unknwon 1, 28-Disturbed semievergreen, 29-Unknown2, 31-Orchards 32 plantation, 33-mixed.

Natural- 1,3,4,5, and 6
Semi-natural-2,8,10,11, 12 and 28
Plantation, cultivation and human habitation-13,14,17,18,19,20,22,24,26,27,29,31 and 33

**Table -3 Nasik**

| Habitat | Dry deciduous | Moist deciduous |
|---|---|---|
| **Species richness (observed)** | **39** | **22** |
| **Rarefied species richness at 119** | **31** | **21** |
| **Endemic species** | **3** | **0** |
| **Unique species** | **21** | **4** |
| **Simpson's index** | **0.91** | **0.88** |
| **Shannon's index** | **2.92** | **2.41** |
| **Hill's N1** | **18.53** | **11.16** |
| **Hill's N2** | **11.29** | **8.11** |
| **Evenness** | **0.59** | **0.70** |

**Table-4 Kumta**

| Habitat | Semi Evergreen | Scrub | Teak | Orchards | Paddy | Acacia |
|---|---|---|---|---|---|---|
| **Species richness (observed)** | **44** | **45** | **24** | **37** | **24** | **35** |
| **Rarefied species richness at 63** | **35** | **34** | **23** | **30** | **22** | **30** |
| **Endemic species** | **6** | **6** | **5** | **5** | **3** | **4** |
| **Unique species** | **0** | **0** | **0** | **0** | **0** | **0** |
| **Simpson's index** | **0.97** | **0.97** | **0.96** | **0.97** | **0.94** | **0.97** |
| **Shannon's index** | **3.61** | **3.55** | **3.05** | **3.41** | **2.84** | **3.41** |
| **Hill N1** | **37.08** | **34.92** | **21.12** | **30.28** | **17.17** | **30.38** |
| **Hill's N2** | **35.53** | **30.15** | **23.52** | **30.52** | **15.38** | **35.92** |
| **Evenness** | **0.96** | **0.86** | **1.12** | **1.01** | **0.89** | **1.19** |

**Table-5. Alagarkoil**

| Habitat | Riparian | Mixed |
|---|---|---|
| **Species richness** | **16** | **14** |
| **Rarefied species richness** | **15** | **13** |
| **Endemic species** | **0** | **0** |
| **Unique species** | **21** | **4** |
| **Simpson's index** | **0.91** | **0.88** |
| **Shannon's index** | **2.92** | **2.41** |
| **Hill's N1** | **18.53** | **11.16** |
| **Hill's N2** | **11.29** | **8.11** |
| **Evenness** | **0.59** | **0.70** |

**Table-6 Sringeri**

| Habitat | Evergreen | Thicket | Grassland | Paddy | Orchards | Plantation |
|---|---|---|---|---|---|---|
| **Species richness (Observed)** | **46** | **54** | **36** | **44** | **9** | **20** |
| **Rarefied species richness at 16** | **14** | **13** | **12** | **13** | **9** | **10** |
| **Endemic species** | **5** | **7** | **2** | **3** | **1** | **2** |
| **Unique species** | **6** | **3** | **7** | **5** | **0** | **1** |
| **Simpson's index** | **0.93** | **0.91** | **0.89** | **0.93** | **0.91** | **0.82** |
| **Shannon's index** | **3.15** | **2.97** | **2.73** | **3.04** | **2.05** | **2.19** |
| **Hill's N1** | **23.32** | **19.56** | **15.35** | **20.98** | **7.74** | **8.92** |
| **Hill's N2** | **13.39** | **10.85** | **9.30** | **14.37** | **10.91** | **5.56** |
| **Evenness** | **0.56** | **0.53** | **0.58** | **0.67** | **1.47** | **0.58** |

**Table-7 Mala**

| Habitat | Evergreen | Semi evergreen | Riparian | Scrub | Thicket | Casurina | Hopea | Areca | Cashew | Paddy | Human habitation | Mixed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species richness | **35** | **49** | **31** | **31** | **41** | **14** | **31** | **22** | **31** | **31** | **14** | **31** |
| Rarefied species richness 30 | **19** | **19** | **17** | **19** | **19** | **13** | **20** | **15** | **18** | **18** | **13** | **19** |
| Endemic species | **4** | **8** | **4** | **3** | **5** | **2** | **4** | **2** | **5** | **4** | **2** | **3** |
| Unique species | **1** | **4** | **3** | **1** | **1** | **0** | **0** | **1** | **0** | **0** | **0** | **0** |
| Simpson's index | **0.94** | **0.92** | **0.91** | **0.94** | **0.92** | **0.91** | **0.95** | **0.91** | **0.92** | **0.91** | **0.86** | **0.94** |
| Shannon's index | **3.06** | **3.08** | **2.81** | **2.99** | **3.02** | **2.37** | **3.10** | **2.56** | **2.90** | **2.83** | **2.20** | **3.01** |
| Hill N1 | **21.23** | **21.68** | **16.55** | **19.91** | **20.41** | **10.72** | **22.28** | **12.91** | **18.09** | **16.97** | **9.02** | **20.32** |
| Hill's N2 | **16.23** | **13.05** | **11.28** | **15.76** | **12.60** | **11.45** | **20.00** | **10.62** | **12.98** | **11.06** | **7.26** | **16.71** |
| Evenness | **0.75** | **0.58** | **0.66** | **0.78** | **0.60** | **1.07** | **0.89** | **0.81** | **0.70** | **0.63** | **0.78** | **0.81** |

**Table-8 Sullia**

| Habitat | Evergreen disturbed | Riparian | Moist deciduous | Bamboo | Areca | Paddy | Human habitation | Unknown1 |
|---|---|---|---|---|---|---|---|---|
| **Species richness** | **20** | **48** | **34** | **29** | **28** | **29** | **24** | **48** |
| **Rarefied at 110** | **20** | **31** | **30** | **22** | **26** | **26** | **23** | **35** |
| **Endemic species** | **2** | **4** | **2** | **5** | **6** | **2** | **1** | **5** |
| **Unique species** | **0** | **4** | **2** | **2** | **3** | **1** | **1** | **2** |
| **Simpson's index** | **0.93** | **0.92** | **0.92** | **0.69** | **0.93** | **0.86** | **0.91** | **0.92** |
| **Shannon's index** | **2.74** | **3.00** | **2.95** | **1.93** | **2.87** | **2.57** | **2.71** | **3.04** |
| **Hill's N1** | **15.52** | **20.06** | **19.12** | **6.86** | **17.66** | **13.02** | **15.02** | **20.98** |
| **Hill's N2** | **14.36** | **12.53** | **12.39** | **3.24** | **14.19** | **7.09** | **10.62** | **12.18** |
| **Evenness** | **0.92** | **0.61** | **0.63** | **0.38** | **0.79** | **0.51** | **0.69** | **0.56** |

**Tabl- 9 Dhoni**

| Habitat | Evergreen | Semi-evergreen | Moist deciduous | Dry deciduous | Riparian | Teak | Coconut | Rubber | Unknown1 | Unknown2 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Species richness** | **81** | **52** | **50** | **24** | **49** | **42** | **15** | **31** | **23** | **13** |
| **Rarefied at 56** | **33** | **27** | **28** | **22** | **28** | **29** | **15** | **21** | **19** | **13** |
| **Endemic species** | **12** | **7** | **7** | **4** | **8** | **5** | **0** | **5** | **6** | **1** |
| **Unique species** | **6** | **2** | **0** | **2** | **0** | **1** | **0** | **2** | **0** | **0** |
| **Simpson's index** | **0.95** | **0.95** | **0.94** | **0.90** | **0.96** | **0.95** | **0.92** | **0.87** | **0.92** | **0.94** |
| **Shannon's index** | **3.43** | **3.23** | **3.11** | **2.75** | **3.27** | **3.12** | **2.69** | **2.51** | **2.58** | **3.08** |
| **Hill's N1** | **30.89** | **25.30** | **22.41** | **15.70** | **26.39** | **22.68** | **14.80** | **12.26** | **13.25** | **21.85** |
| **Hill's N2** | **19.61** | **18.94** | **15.79** | **10.43** | **22.22** | **21.54** | **12.08** | **7.41** | **12.18** | **17.05** |
| **Evenness** | **0.62** | **0.74** | **0.69** | **0.64** | **0.84** | **0.95** | **0.80** | **0.57** | **0.91** | **0.77** |

**Table 10. Muvattpuzha**

| Habitat | Semi evergreen | Moist deciduous | Scrub | Teak | Coconut | Mixed |
|---|---|---|---|---|---|---|
| **Species richness** | **41** | **24** | **23** | **62** | **9** | **46** |
| **Rarefied at 41** | **22** | **16** | **19** | **26** | **9** | **24** |
| **Endemic species** | **7** | **4** | **4** | **7** | **1** | **5** |
| **Unique species** | **1** | **1** | **1** | **15** | **0** | **7** |
| **Simpson's index** | **0.92** | **0.85** | **0.91** | **0.95** | **0.85** | **0.94** |
| **Shannon's index** | **3.00** | **2.37** | **2.67** | **3.44** | **1.95** | **3.21** |
| **Hill's N1** | **20.13** | **10.68** | **14.51** | **31.31** | **7.04** | **24.85** |
| **Hill's N2** | **12.06** | **6.80** | **11.34** | **19.96** | **6.51** | **17.09** |
| **Evenness** | **0.58** | **0.60** | **0.77** | **0.63** | **0.91** | **0.67** |

**Table-11. Distributional patterns and abundance of Western Ghats Butterfly species in various families**

| Family | | Number of habitats | | | | | Abundance | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Rank** | | 1 | 2 | 3 | 4 | 5 | 0 | 1 | 2 | 3 | 4 | 5 |
| | | 1-6 | 7-12 | 13-18 | 19-24 | >24 | <10 | 10-50 | 51-100 | 101-150 | 151-200 | 200+ |
| **Hesperidae** | 23 | 18 | 5 | 0 | 0 | 0 | 14 | 8 | 1 | 0 | 0 | 0 |
| **Lycaenidae** | 31 | 21 | 5 | 4 | 1 | 0 | 14 | 10 | 4 | 2 | 0 | 1 |
| **Nymphalidae** | 71 | 35 | 16 | 11 | 8 | 1 | 22 | 25 | 9 | 4 | 4 | 7 |
| **Papilionidae** | 19 | 9 | 2 | 7 | 1 | 0 | 6 | 4 | 2 | 3 | 2 | 2 |
| **Pieridae** | 24 | 12 | 8 | 2 | 2 | 0 | 8 | 8 | 3 | 2 | 0 | 3 |
| **Total** | 168 | 95 | 36 | 24 | 12 | 1 | 64 | 55 | 19 | 11 | 6 | 13 |

**Figure 1. Butterfly species richness recorded by teachers and students in comparison with the Western Ghat pool**

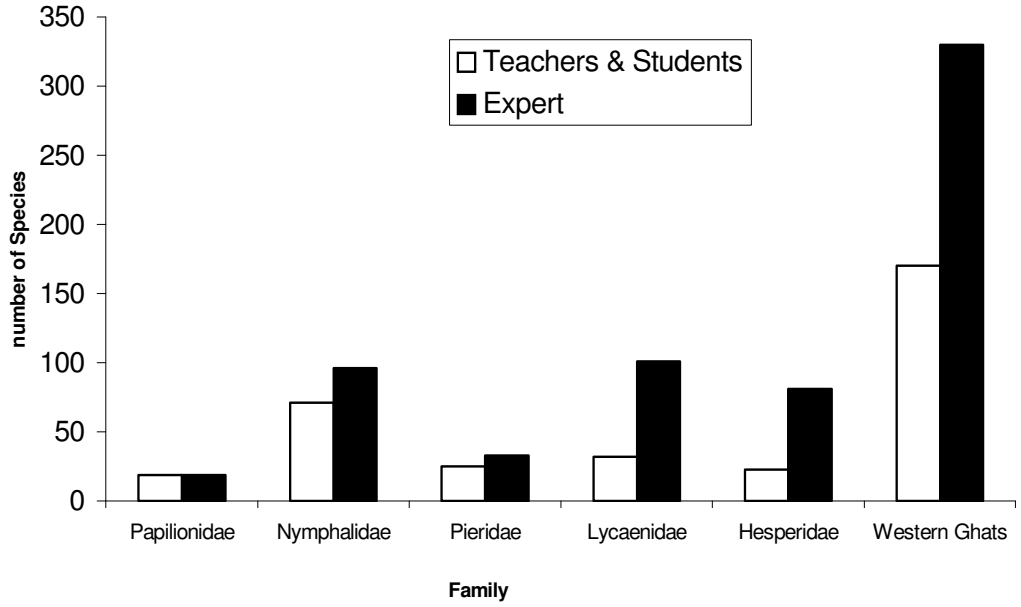



**Figure 2. A comparison of Butterflies species recorded by investigators in Kerala with total species pool**

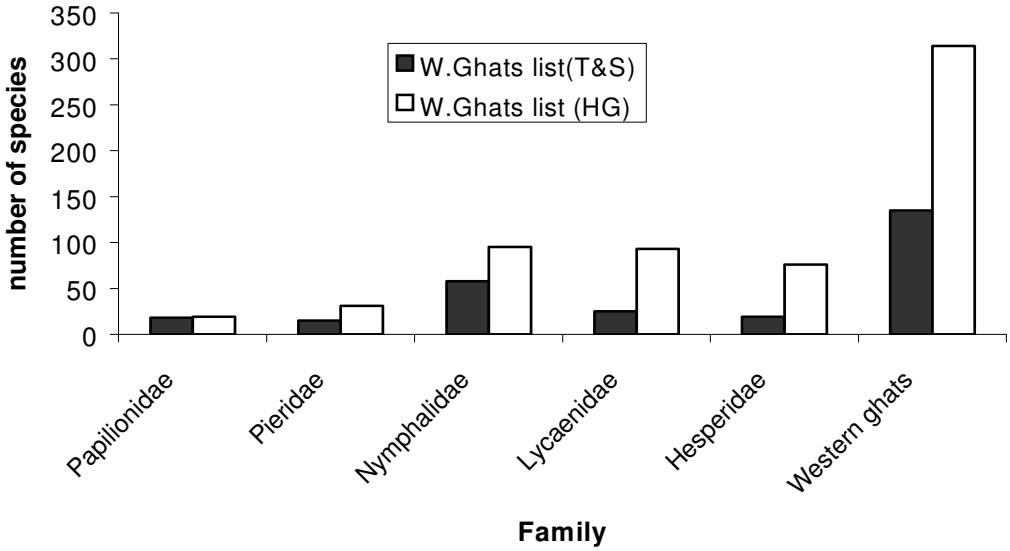


**Figure 3. A comparison of Butterfly species richness recorded by investigators in Karnataka with total species pool**

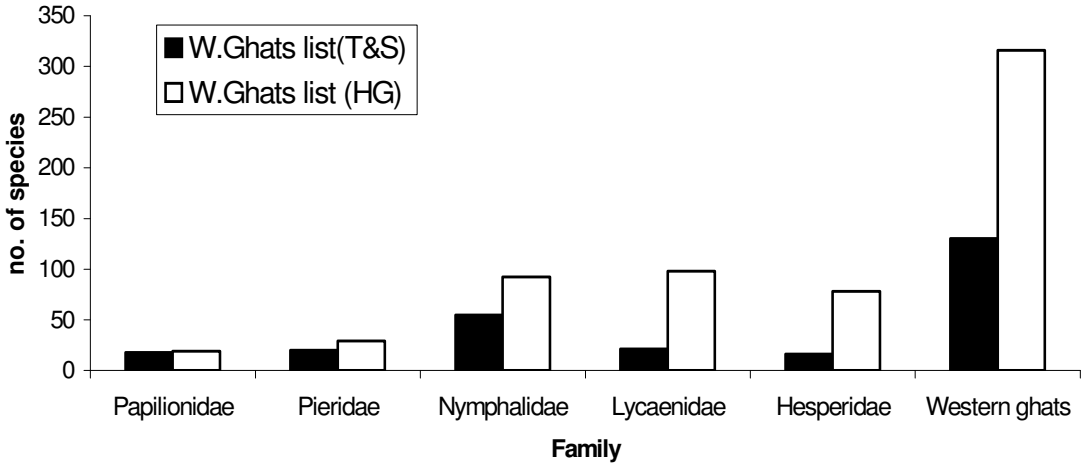



**Figure 4. A comparison of Butterfly speices richness recorded by investigators in Tamil Nadu with total species pool**

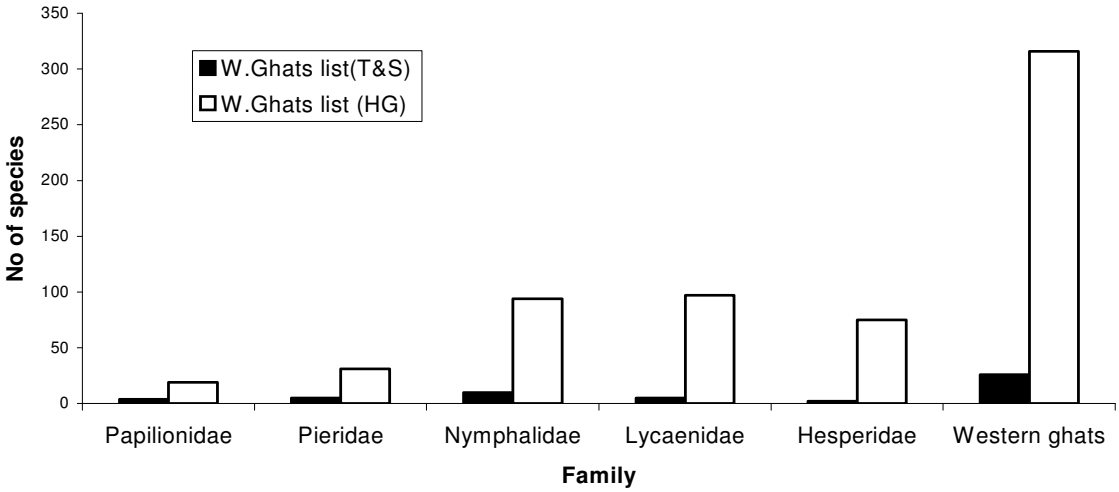
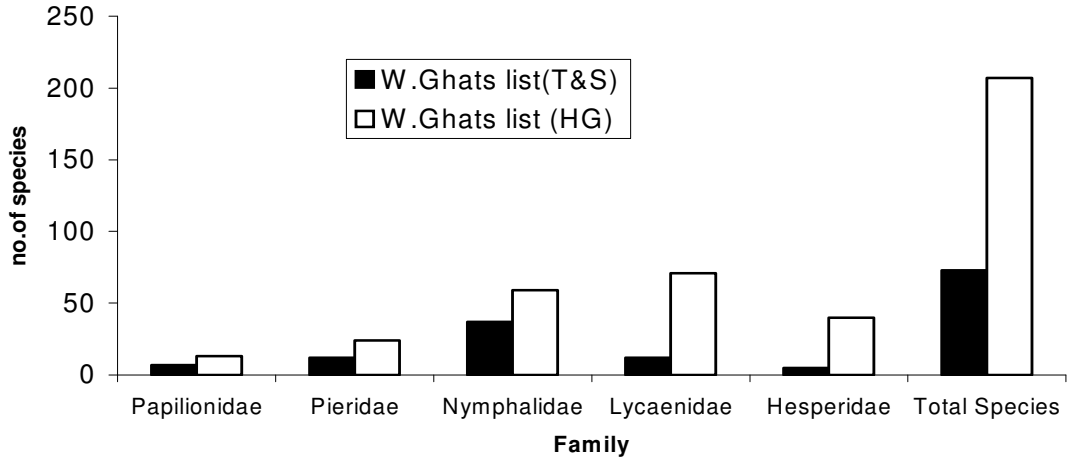


**Figure 5. A comparison of Butterfly species richness recorded by investigators in Maharashtra with total species pool**



Dendrogram showing similarity in butterfly composition across LSE types

Single Linkage

Jaccard's similarity

**Figure 6**

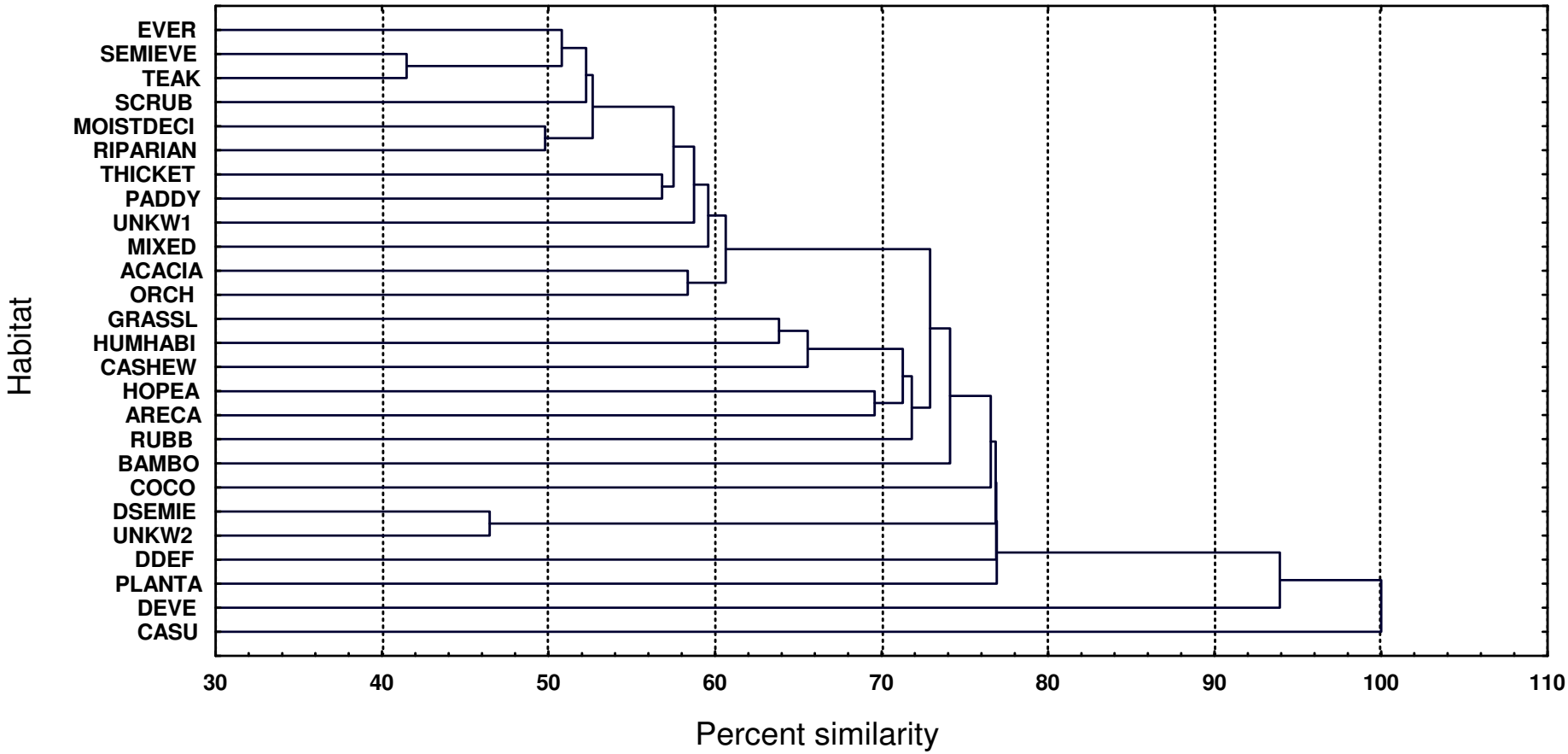
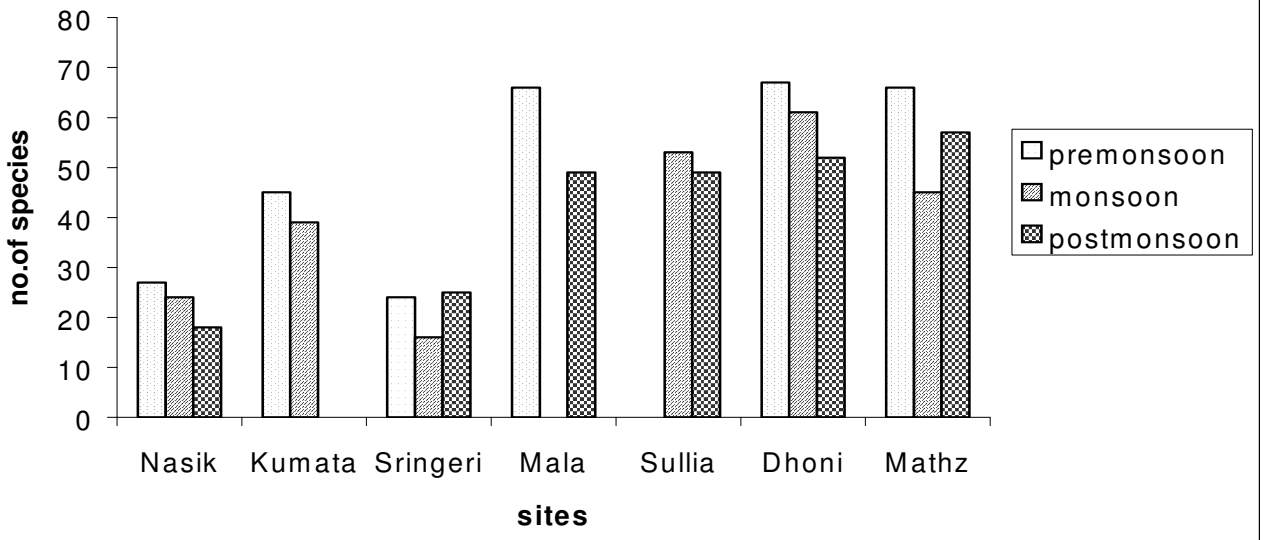
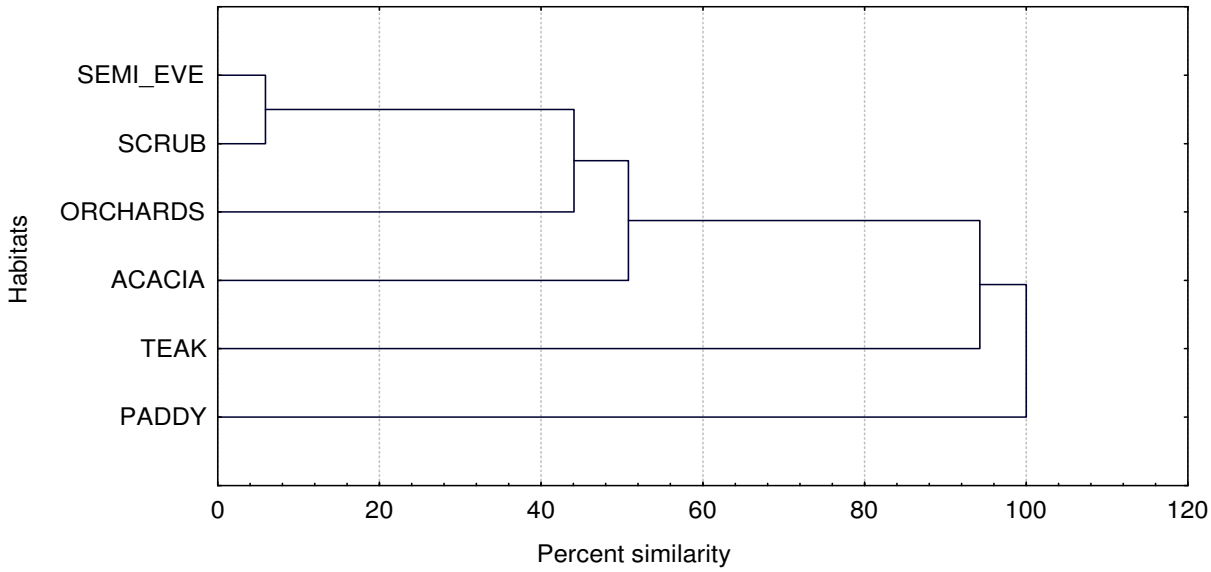


**Figure 7. seasonality variations in butterfly species across various sites in Western Ghats**




Dendrogram showing similarity in species composition across LSE types in Kumta
Single Linkage
Jaccard's similarity

**Figure 8.**

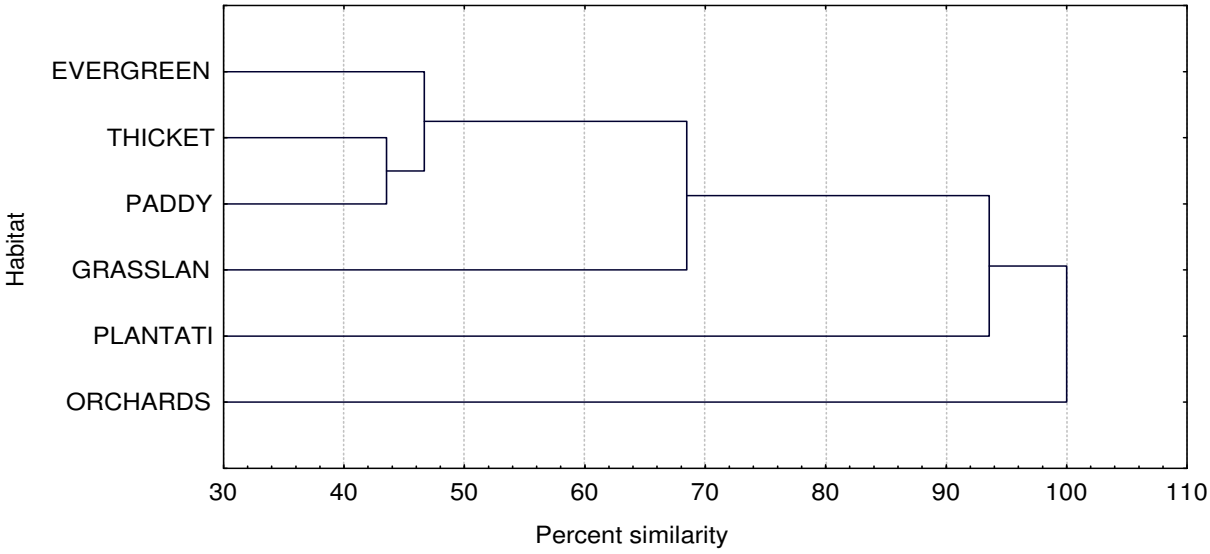


Dendrogram showing similarity in species composition across LSEtypes in Sringeri

Single Linkage

Jaccard's similarity

**Figure 9.**

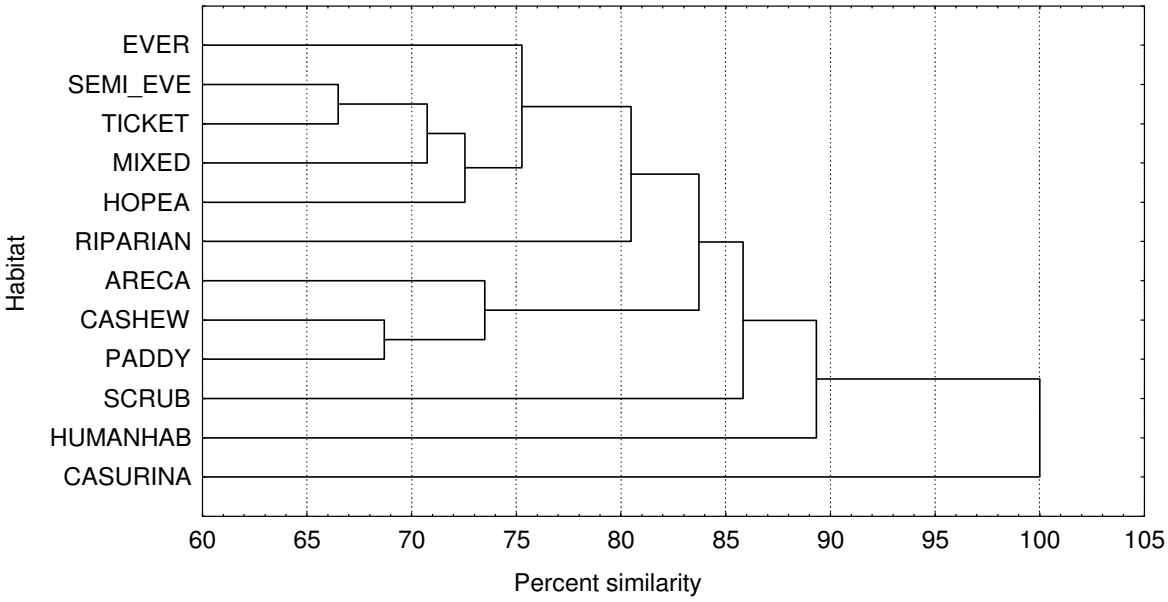



Dendrogram showing similarity in species composition across LSE types in Mala

Single Linkage

Jaccard's similarity

**Figure. 10**

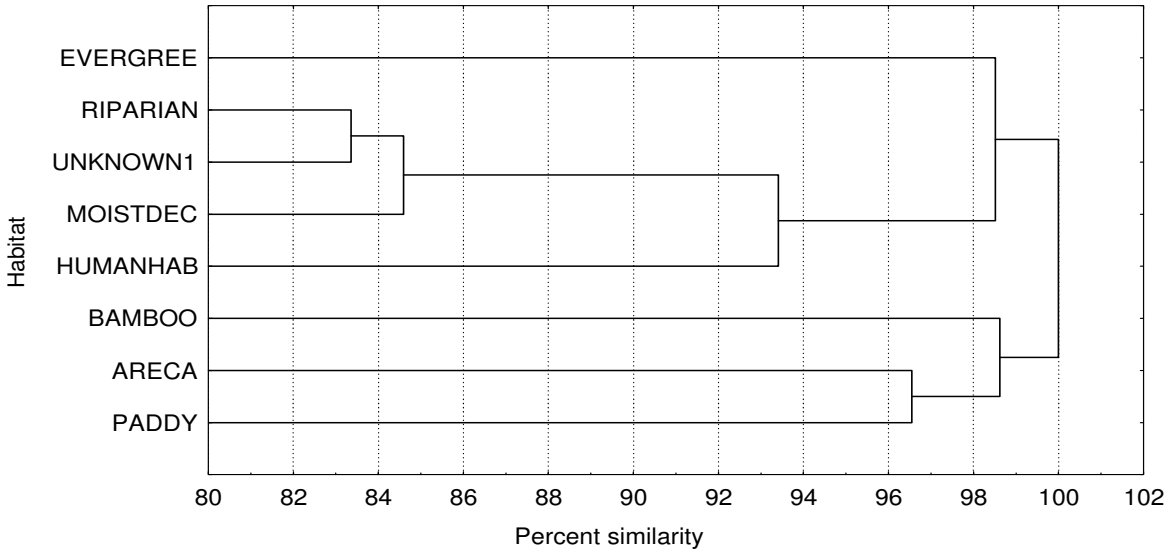


Dendrogram showing similarity in species composition across LSE types in Sullia

Single Linkage

Jaccard's similarity

**Figure. 11**

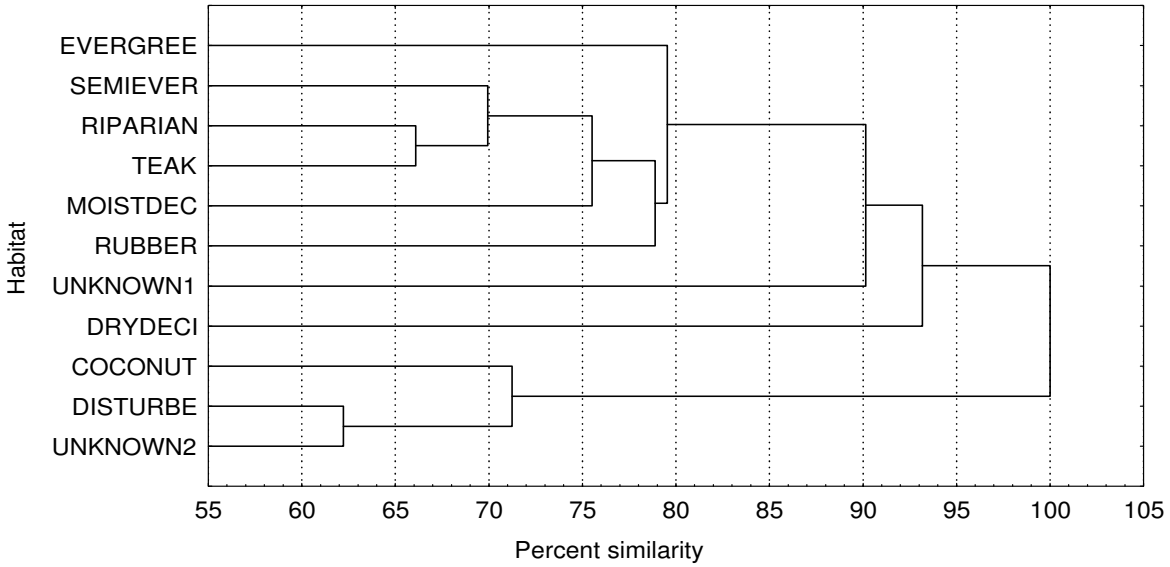



Dendrogram showing similarity in species composition acorss LSE types in Dhoni

Single Linkage

Jaccard's similarity

**Figure. 12**



Dendrogram showing similarity in species composition acorss LSE types in Muvattpuzha

Single Linkage

Jaccard's similarity

**Figure. 13**

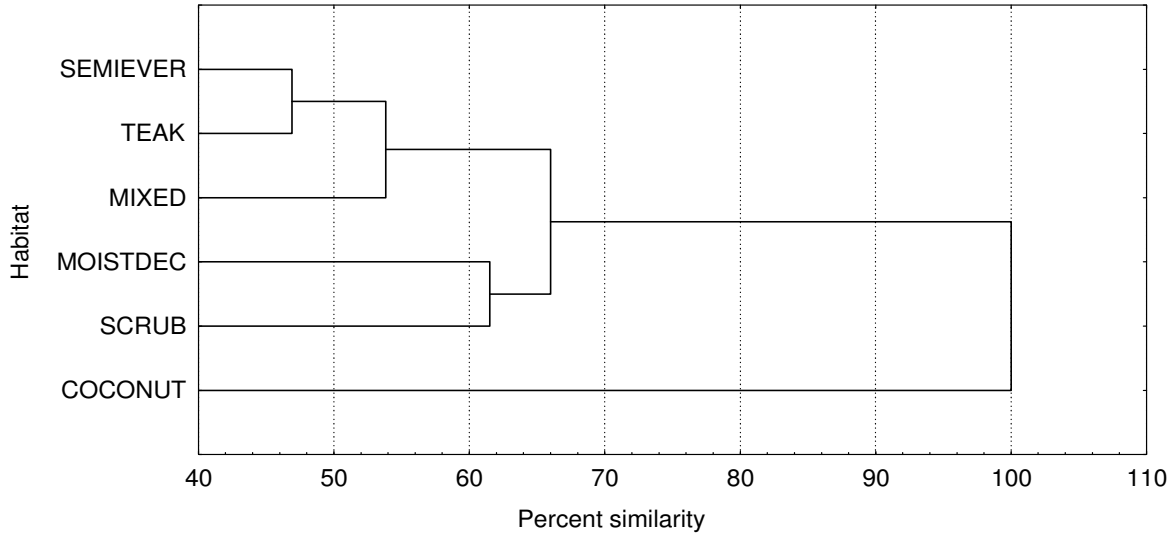



**Figure 14. Species accumulation curve for various sites in the Westren Ghats**

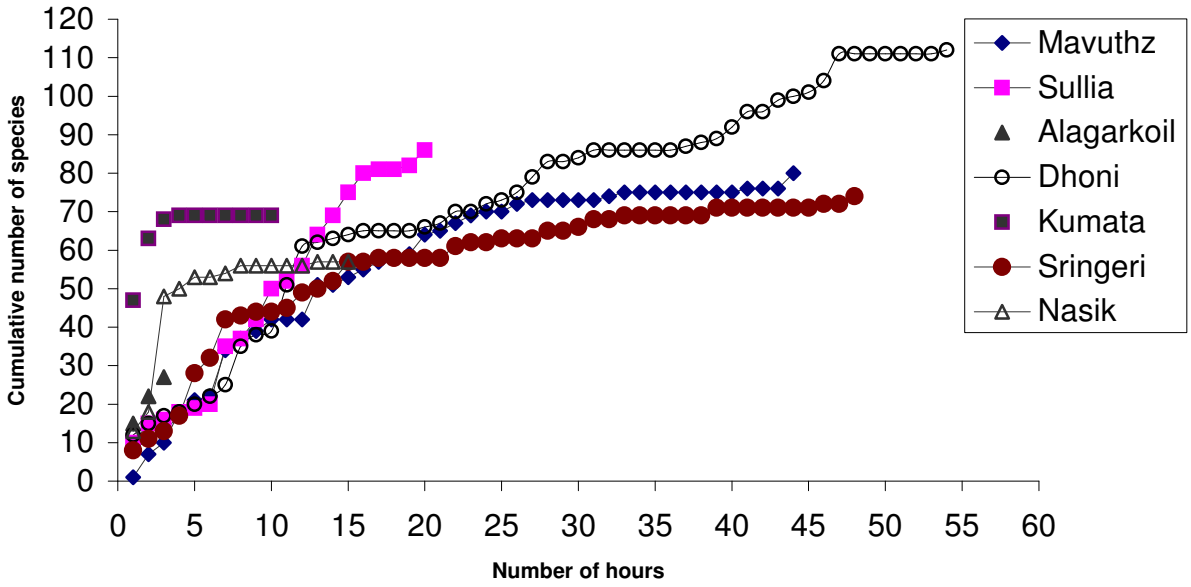
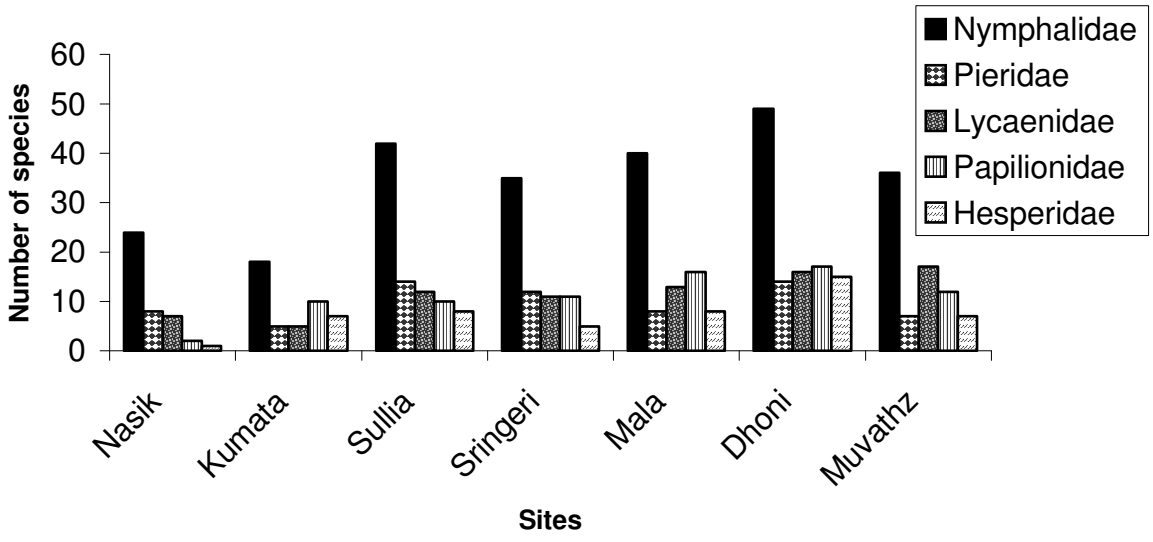


**Figure 15. Familywise classification of butterfly species recorded in various sites in Western Ghats**



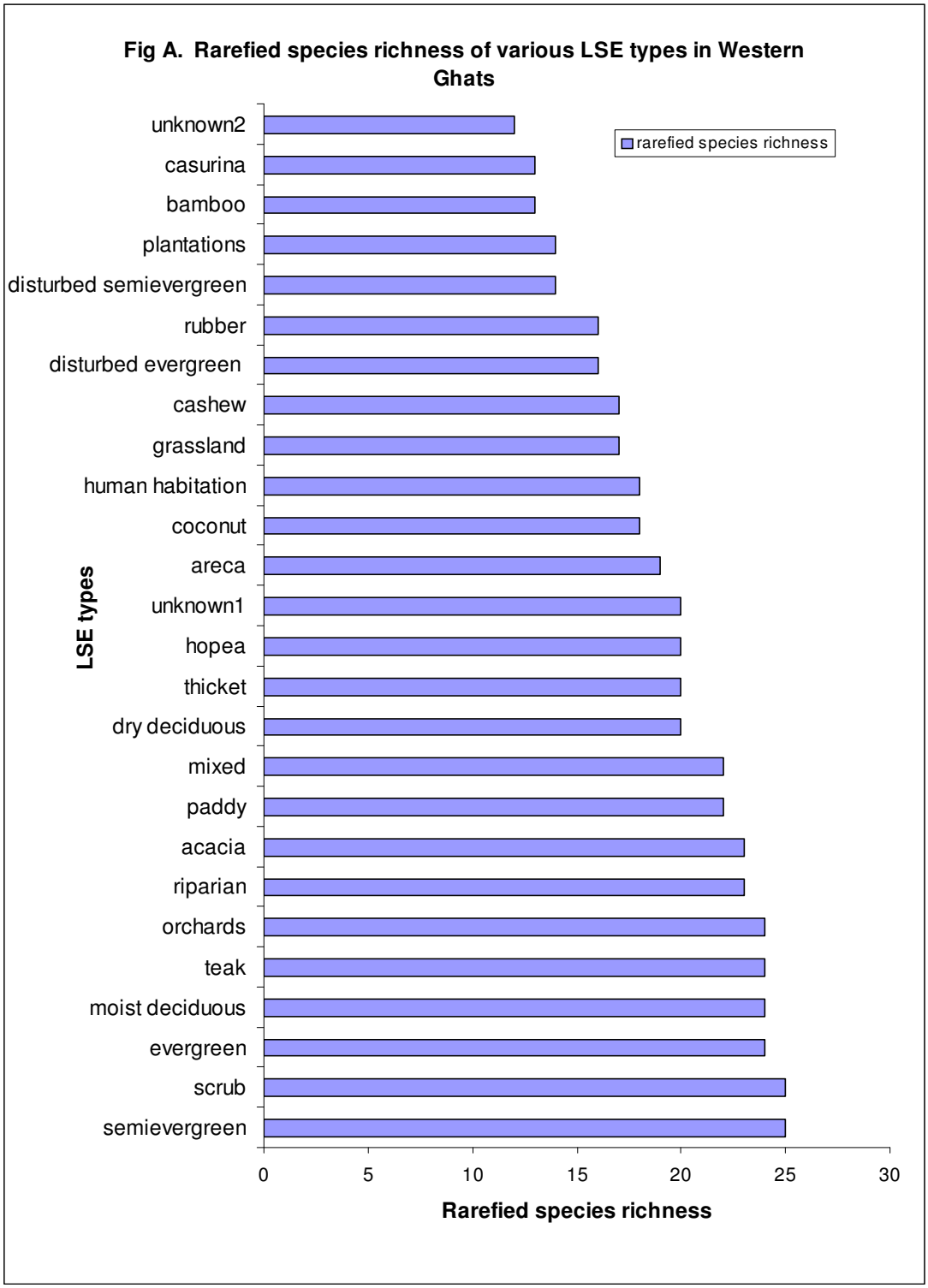


Fig A. Rarefied species richness of various LSE types in Western Ghats
rarefied species richness
unknown2
casurina
bamboo
plantations
disturbed semievergreen
rubber
disturbed evergreen
cashew
grassland
human habitation
coconut
areca
unknown1
hopea
thicket
dry deciduous
mixed
paddy
acacia
riparian
orchards
teak
moist deciduous
evergreen
scrub
semievergreen
LSE types
0
5
10
15
20
25
30
Rarefied species richness

## CHECKLIST OF BUTTERFLY SPECIES RECORDED FROM VARIOUS SITES

| SlNo | FAMILY | NAME OF THE SPECIES/SITE | Scientific Name/SITE | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **I** | **PAPILIONIDAE** | | | | | | | | | | |
| 1 | | TAILED JAY | *Graphium agamemnon* | - | + | - | + | + | + | + | + |
| 2 | | FIVE-BAR SWORDTAIL | *Graphium antiphates* | - | - | - | + | + | + | - | + |
| 3 | | COMMON JAY | *Graphium doson* | + | - | - | + | - | - | - | + |
| 4 | | SPOT SWORDTAIL | *Graphium nomius* | - | - | + | - | - | - | + | - |
| 5 | | COMMON BLUEBOTTLE | *Graphium sarpedon* | - | + | - | + | + | + | + | + |
| 6 | | COMMON ROSE | *Pachliopta aristolochiae* | + | - | - | - | + | - | + | + |
| 7 | | CRIMSON ROSE | *Pachliopta hector* | - | + | - | - | + | + | + | + |
| 8 | | MALABAR OR CEYLON ROSE | *Pachliopta pandiyana* | - | + | - | + | + | - | + | + |
| 9 | | MALABAR BANDED PEACOCK | *Papilio budha* | - | - | - | + | + | + | + | - |
| 10 | | COMMON MIME | *Papilio clytia* | + | + | - | - | + | - | + | + |
| 11 | | COMMON BANDED PEACOCK | *Papilio crino* | - | - | + | - | + | + | + | - |
| 12 | | LIME | *Papilio demoleus* | - | + | + | + | + | + | + | - |
| 13 | | MALABAR RAVEN | *Papilio dravidarum* | - | - | - | - | + | - | - | - |
| 14 | | RED HELEN | *Papilio helenus* | - | + | - | + | + | + | + | + |
| 15 | | MALABAR BANDED SWALLOWTAIL | *Papilio liomedon* | - | - | - | - | - | - | - | + |
| 16 | | PARIS PEACOCK | *Papilio paris* | - | - | - | - | - | - | + | + |
| 17 | | BLUE MORMON | *Papilio polymnestor* | - | + | - | + | + | + | + | + |
| 18 | | COMMON MORMON | *Papilio polytes* | - | + | + | + | + | + | + | + |
| 19 | | SOUTHERN BIRDWING | *Troides minos* | - | + | - | + | + | + | + | + |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **II** | **PIERIDAE** | | | | | | | | | | |
| 20 | | PIONEER OR CAPER WHITE | *Anaphaeis aurota* | + | + | - | - | + | - | + | - |
| 21 | | COMMON ALBATROSS | *Appias albina* | - | - | - | - | + | + | + | - |
| 22 | | PLAIN PUFFIN | *Appias indra* | + | - | - | - | - | - | - | - |
| 23 | | CHOCOLATE ALBATROSS | *Appias lyncida* | - | - | - | - | - | + | + | - |
| 24 | | COMMON EMIGRANT | *Catopsilia pomona* | + | + | + | + | + | + | + | + |
| 25 | | MOTTLED EMIGRANT | *Catopsilia pyranthe* | - | - | - | - | + | + | + | + |
| 26 | | LESSER GULL | *Cepora nadina* | - | - | - | + | - | + | - | - |
| 27 | | COMMON GULL | *Cepora nerissa* | + | - | + | + | - | - | - | + |
| 28 | | NILGIRI CLOUDED YELLOW | *Colias nilgiriensis* | - | - | - | - | - | - | + | - |
| 29 | | CRIMSON TIP | *Colotis danae* | - | + | - | + | - | + | + | - |
| 30 | | SMALL ORANGE TIP | *Colotis etrida* | - | - | - | + | - | - | - | - |
| 31 | | PLAIN ORANGE TIP | *Colotis eucharis* | - | - | - | - | - | - | + | - |
| 32 | | COMMON JEZEBEL | *Delias eucharis* | - | - | - | + | + | + | + | + |
| 33 | | ONE-SPOT GRASS YELLOW | *Eurema andersoni* | - | - | - | + | - | - | - | - |
| 34 | | THREE-SPOT GRASS YELLOW | *Eurema blanda* | - | - | - | + | + | + | + | + |
| 35 | | SMALL GRASS YELLOW | *Eurema brigitta* | + | - | - | - | - | - | - | - |
| 36 | | COMMON GRASS YELLOW | *Eurema hecabe* | + | + | - | + | + | + | + | + |
| 37 | | SPOTLESS GRASS YELLOW | *Eurema laeta* | + | - | - | - | - | - | - | - |
| 38 | | GREAT ORANGE TIP | *Hebomoia glaucippe* | - | - | - | + | + | + | + | + |
| 39 | | WHITE ORANGE TIP | *Ixias marianne* | - | + | - | - | - | - | - | - |
| 40 | | YELLOW ORANGE TIP | *Ixias pyrene* | - | - | - | + | - | + | + | - |
| 41 | | PSYCHE | *Leptosia nina* | + | - | - | - | + | + | + | + |
| 42 | | COMMON WANDERER | *Pareronia valeria* | + | - | + | - | + | + | + | - |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 43 | **PIERIDAE** | PAINTED SAWTOOTH | *Prioneris sita* | - | - | - | - | - | + | - | - |
| **III** | **NYMPHALIDAE** | | | | | | | | | | |
| 44 | | TAWNY COSTER | *Acraea violae* | - | + | + | + | + | - | + | + |
| 45 | | INDIAN FRITILLARY | *Argyreus hyperbius* | - | + | - | - | - | - | - | - |
| 46 | | ANGLED CASTOR | *Ariadne ariadne* | - | - | - | - | - | + | - | + |
| 47 | | COMMON CASTOR | *Ariadne merione* | + | - | + | + | + | + | + | + |
| 48 | | COMMON SERGEANT | *Athyma perius* | + | + | - | - | - | + | + | + |
| 49 | | STAFF SERGEANT | *Athyma selenophora* | - | - | - | - | - | - | + | - |
| 50 | | JOKER | *Byblia ilithyia* | - | - | + | - | + | + | + | - |
| 51 | | TAMIL LACEWING | *Cethosia nietneri* | - | - | - | + | - | - | + | + |
| 52 | | TAWNY RAJAH | *Charaxes bernardus* | - | - | - | - | + | - | + | - |
| 53 | | BLACK RAJAH | *Charaxes solon* | + | - | - | - | - | - | - | - |
| 54 | | TAMIL YEOMAN | *Cirrochroa thais* | - | - | + | - | + | + | + | + |
| 55 | | RUSTIC | *Cupha erymanthis* | - | + | - | + | + | + | + | + |
| 56 | | PAINTED LADY | *Cynthia cardui* | + | - | - | - | - | + | + | - |
| 57 | | COMMON MAP | *Cyrestis thyodamas* | - | + | - | - | - | - | - | - |
| 58 | | PLAIN TIGER | *Danaus chrysippus* | + | + | - | + | + | + | + | - |
| 59 | | STRIPED OR COMMON TIGER | *Danaus genutia* | + | - | - | + | + | + | + | + |
| 60 | | REDSPOT DUKE | *Dolpha evelina* | - | - | - | - | - | - | + | - |
| 61 | | COMMON PALMFLY | *Elymnias hypermenstra* | + | - | - | + | + | + | - | + |
| 62 | | COMMON INDIAN CROW | *Euploea core* | + | + | - | + | + | + | + | + |
| 63 | | DOUBLE-BRANDED CROW | *Euploea sylvester* | - | + | - | + | + | - | - | - |
| 64 | | COMMON BARON | *Euthalia aconthea* | + | - | - | + | + | + | + | - |
| 65 | | GAUDY BARON | *Euthalia lubentina* | - | + | - | - | - | - | - | - |
| 66 | | BARONET OR RED BARON | *Euthalia nais* | + | + | - | - | - | + | - | - |
| 67 | | GREAT EGGFLY | *Hypolimnas bolina* | - | - | - | + | + | + | + | + |
| 68 | | DANAID EGGFLY | *Hypolimnas misippus* | - | + | - | - | + | + | + | + |
| 69 | | MALABAR TREE NYMPH | *Idea malabarica* | - | + | - | + | + | + | + | - |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 70 | **NYMPHALIDAE** | PEACOCK PANSY | *Junonia almana* | - | + | - | + | + | - | - | - |
| 71 | | GREY PANSY | *Junonia atlites* | - | + | - | + | + | + | + | + |
| 72 | | YELLOW PANSY | *Junonia hierta* | + | - | + | + | - | + | + | + |
| 73 | | CHOCOLATE PANSY | *Junonia iphita* | + | - | - | + | + | + | + | + |
| 74 | | LEMON PANSY | *Junonia lemonias* | + | - | - | + | + | + | + | + |
| 75 | | BLUE PANSY | *Junonia orithya* | + | + | - | + | + | - | + | - |
| 76 | | INDIAN BLUE OAKLEAF | *Kallima horsfieldi* | + | + | - | - | - | + | + | - |
| 77 | | BLUE ADMIRAL | *Kaniska canace* | - | + | - | - | - | - | + | - |
| 78 | | COMMON TREEBROWN | *Lethe rohria* | + | - | - | - | - | - | + | - |
| 79 | | COMMANDER | *Limenitis procris* | - | - | - | + | + | + | + | + |
| 80 | | COMMON EVENING BROWN | *Melanitis leda* | + | - | + | + | + | + | + | + |
| 81 | | DARK EVENING BROWN | *Melanitis pedima* | - | + | - | - | - | - | - | - |
| 82 | | WHITEBAR BUSHBROWN | *Mycalesis anaxias* | - | - | - | - | - | - | + | - |
| 83 | | DARK BRANDED BUSHBROWN | *Mycalesis mineus* | - | + | - | + | + | + | + | + |
| 84 | | RED-DISK BUSHBROWN | *Mycalesis occulus* | - | - | - | - | - | - | + | - |
| 85 | | GLADEYE BUSHBROWN | *Mycalesis patnia* | + | + | - | - | - | - | - | - |
| 86 | | COMMON BUSHBROWN | *Mycalesis perseus* | - | - | - | + | + | + | + | + |
| 87 | | TAMIL BUSHBROWN | *Mycalesis subdita* | - | - | - | - | - | + | + | - |
| 88 | | COMMON SAILOR | *Neptis hylas* | + | - | + | + | + | + | + | + |
| 89 | | YELLOW JACK SAILOR | *Neptis viraja* | - | - | - | - | - | - | - | + |
| 90 | | NIGGER | *Orsotrianea medus* | - | + | - | + | + | + | + | + |
| 91 | | COMMON LASCAR | *Pantoporia hordonia* | + | - | - | - | - | + | - | + |
| 92 | | GLASSY TIGER | *Parantica aglea* | + | + | - | + | + | + | + | + |
| 93 | | CLIPPER | *Parthenos sylvia* | - | + | - | + | + | + | + | + |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| 94 | **NYMPHALIDAE** | SMALL LEOPARD | *Phalanta alcippe* | - | - | - | - | + | + | + | - |
| 95 | | COMMON LEOPARD | *Phalanta phalantha* | + | + | - | + | + | + | - | + |
| 96 | | COMMON NAWAB | *Polyura athamas* | - | - | - | + | + | - | + | + |
| 97 | | GREY COUNT | *Tanaecia lepidea* | + | + | - | + | + | + | + | + |
| 98 | | BLUE TIGER | *Tirumala limniace* | + | + | + | + | + | + | + | + |
| 99 | | DARK BLUE TIGER | *Tirumala septentrionis* | + | + | + | + | + | + | + | + |
| 100 | | INDIAN RED ADMIRAL | *Vanessa indica* | - | + | - | - | - | - | + | - |
| 101 | | CRUISER | *Vindula erota* | + | - | - | + | + | + | + | - |
| 102 | | COMMON THREERING | *Ypthima asterope* | - | + | - | + | - | - | - | + |
| 103 | | COMMON FIVERING | *Ypthima baldus* | - | - | - | - | + | - | + | + |
| 104 | | WHITE OR CEYLON FOURRING | *Ypthima ceylonica* | - | - | - | + | - | + | - | - |
| 105 | | COMMON FOURRING | *Ypthima huebneri* | + | - | - | + | + | + | + | + |
| 106 | | BABY FIVERING | *Ypthima philomela* | - | - | - | - | + | - | - | - |
| 107 | | TAMIL CATSEYE | *Zipoetis saitis* | - | + | - | - | - | - | - | - |
| **IV** | **LYCAENIDAE** | | | | | | | | | | |
| 108 | | PLUM JUDY | *Abiasara echerius* | + | - | - | + | + | - | + | + |
| 109 | | HAMPSON'S HEDGE BLUE | *Actolepis lilacea* | - | - | - | - | - | + | - | - |
| 110 | | COMMON HEDGE BLUE | *Actolepis puspa* | - | - | - | + | + | + | + | - |
| 111 | | WESTERN CENTAUR OAKBLUE | *Arhopala pseudocentaurus* | - | - | - | - | - | - | + | - |
| 112 | | COMMON PIERROT | *Castalius rosimon* | + | - | - | + | + | + | + | + |
| 113 | | COMMON IMPERIAL | *Cheritra freja* | - | - | - | - | - | + | - | - |
| 114 | | LIME BLUE | *Chilades laius* | - | - | + | - | - | - | - | - |
| 115 | | INDIAN SUNBEAM | *Curetis thetis* | + | - | - | - | - | + | - | - |
| 116 | | GRAM BLUE | *Euchrysops cnejus* | - | - | + | - | - | - | - | + |
| 117 | | INDIAN CUPID | *Everes lacturnus* | - | + | + | + | - | + | + | - |
| 118 | | GRASS JEWEL | *Freyeria trochylus* | + | - | - | + | - | - | - | - |
| 119 | | METALLIC CERULEAN | *Jamides alecto* | - | - | - | - | - | - | + | - |
| 120 | | DARK CERULEAN | *Jamides bochus* | + | - | - | - | + | + | - | + |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 121 | **LYCAENIDAE** | ZEBRA BLUE | *Leptotes plinius* | - | - | - | - | + | - | + | - |
| 122 | | YAMFLY | *Loxura atymnus* | - | - | - | + | + | - | - | + |
| 123 | | MALAYAN | *Magisba malaya* | - | - | + | - | - | - | + | + |
| 124 | | QUAKER | *Neopithecops zalmora* | - | - | - | - | - | - | - | + |
| 125 | | COMMON LINE BLUE | *Prosotas nora* | - | - | - | + | + | - | + | - |
| 126 | | PALE GRASS BLUE | *Psuedozizeeria maha* | - | - | - | + | + | + | - | + |
| 127 | | MONKEY PUZZLE | *Rathinda amor* | - | + | - | - | - | - | + | - |
| 128 | | COMMON SILVERLINE | *Spindasis vulcanus* | - | + | - | + | - | - | + | + |
| 129 | | RED PIERROT | *Talicada nyseus* | - | + | - | + | + | + | + | - |
| 130 | | DARK PIERROT | *Tarucus ananda* | - | - | - | + | - | + | - | - |
| 131 | | MANY-TAILED OAK BLUE | *Thaduka multicaudata* | - | - | - | - | - | - | - | + |
| 132 | | FLUFFY TIT | *Zeltus amasa* | - | + | - | - | - | - | - | - |
| 133 | | TINY GRASS BLUE | *Zizula hylax* | - | - | - | - | - | - | + | - |
| **V** | **HESPERIIDAE** | | | | | | | | | | |
| 134 | | BUSH HOPPER | *Ampittia dioscorides* | - | + | - | - | - | + | + | - |
| 135 | | BROWN AWL | *Badamia exclamationis* | - | - | - | - | - | - | + | - |
| 136 | | BEVAN'S SWIFT | *Borbo bevani* | - | + | - | + | + | - | + | + |
| 137 | | RICE SWIFT | *Borbo cinnara* | - | - | - | - | - | - | + | - |
| 138 | | MALABAR SPOTTED FLAT | *Celaenorrhinus ambareesa* | - | - | - | - | - | - | + | - |
| 139 | | COMMON SPOTTED FLAT | *Celaenorrhinus leucocera* | - | - | - | + | - | - | - | - |
| 140 | | GIANT REDEYE | *Gangara thyrsis* | + | + | - | - | - | - | + | - |
| 141 | | COMMON BANDED AWL | *Hasora chromus* | - | - | - | - | - | + | + | - |
| 142 | | TREE FLITTER | *Hyarotis adrastus* | - | - | - | - | - | - | + | - |
| 143 | | CHESTNUT BOB | *Iambrix salsala* | - | - | - | - | + | + | + | + |
| 144 | | COMMON REDEYE | *Matapa aria* | - | - | - | - | + | - | - | - |
| 145 | | RESTRICTED DEMON | *Notocrypta curvifascia* | - | - | - | - | - | - | + | - |
| 146 | | CHESTNUT/BANDED ANGLE | *Odontoptilum angulata* | - | + | - | + | + | - | + | - |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 147 | **HESPERIIDAE** | GOLDEN ANGLE | *Odontoptilum ransonnetti* | - | - | - | - | - | - | - | + |
| 148 | | CONJOINED SWIFT OR GREAT SWIFT | *Pelopidas conjucta* | - | - | - | - | - | + | - | - |
| 149 | | SMALL BRANDED SWIFT | *Pelopidas mathias* | - | - | - | - | + | + | - | - |
| 150 | | COON | *Psolos fuligo* | + | - | + | - | + | + | + | - |
| 151 | | FULVOUS PIED FLAT | *Psuedocoladenia dan* | - | + | - | - | - | - | - | - |
| 152 | | COMMON SMALL FLAT | *Sarangesa dasahara* | - | - | - | + | - | - | - | - |
| 153 | | INDIAN SKIPPER | *Spialia galba* | - | + | - | - | + | + | + | + |
| 154 | | INDIAN PALM BOB | *Suastus gremius* | - | + | + | + | - | - | + | - |
| 155 | | SUFFUSED SNOW FLAT | *Tagiades gana* | - | - | - | - | - | + | - | - |
| 156 | | WATER SNOW FLAT | *Tagiades litigiosa* | - | - | - | - | - | - | - | + |
| 157 | | DARK PALM DART | *Telicota ancilla* | - | + | - | - | + | + | - | + |
| 158 | | GRASS DEMON | *Udaspes folus* | + | - | - | - | + | - | - | - |

**Site Code**
**1- NASIK**
**2- KUMTA**
**3- ALAGARKOIL**
**4- SRINGERI**
**5- MALA**
**6- SULLIA**
**7- DHONI**
**8- MUVATTPUZHA**

**Note:** 10 species used for the data analysis were identified only up genus (crow, flat, swift etc.). These species are not listed above.