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SPECIES DIVERSITY AND DISTRIBUTION OF BUTTERFLIES IN KUDREMUKH NATIONAL PARK AND MOOKAMBIKA AND SOMESHWARA WILDLIFE SANCTUARIES IN CENTRAL WESTERN GHATS OF KARNATAKA

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KEY WORDS

Butterfly conservation
Diversity
Distribution
Seasonal fluctuations

ABSTRACT: A survey of butterfly fauna was conducted in the study area comprising of Kudremukh National Park and Mookambika and Someshwara Wildlife Sanctuaries in Central Western Ghats of Karnataka. The study on the distribution and relative abundance of butterflies occurring in these areas was conducted through random sampling. Butterfly sample plots were laid in five different forest types, namely, evergreen, semi-evergreen, shola forests, open forest, and misc. plantation. Sampling was done by Blair and Launer (1997) method. Sample plots were of size 100 m×200 m. Transects were traversed on a monthly basis for counting of butterflies for a period of 2 years. The numbers of butterflies sighted in each sample plot were recorded separately for each family. The total number of butterflies sighted in each month was calculated. Out of the reported 149 species of butterflies in the region, a total of 142 species belonging to the five families were sighted during the study. For comparing the trends in the butterfly population, Shannon diversity index (H') and Margalef's richness index were calculated. Density of butterfly species in each sample plot was calculated. The values of H' were then grouped according to the three different seasons. Of the five families of butterflies in the study area, Nymphalidae were found to be dominating in all the seasons. Species belonging to Hesperidae were found in least number. The population of all butterfly families peaked during the month of September in both the years. However, in the year 2003-2004 in semi-evergreen forest, the peak was observed in the month of August. In the year 2004-2005, evergreen and miscellaneous plantation plots recorded the highest numbers in the month of October. There was a second peak during March/April. The lowest population was reported during spring, i.e. February/March. The increase in

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number of butterflies is due to the favorable conditions for breeding in the post-monsoon months when plenty of fresh flush of leaves are available. This is followed by flowering season of several plants which provide a nectar source for adult butterflies. Similar conditions prevail in the months of March/April too favoring a second peak. Significant fluctuations in butterfly population with change of seasons across forest types were observed.

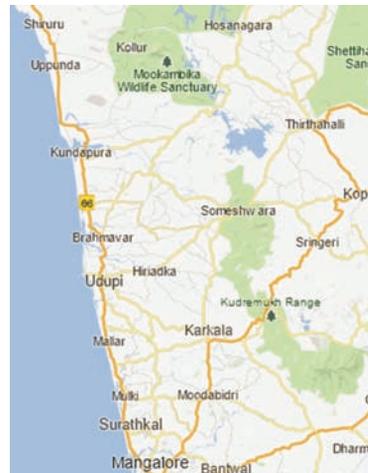
INTRODUCTION

The coastal districts, Dakshina Kannada and Udupi in Karnataka, are rich in forests and wildlife. Out of a total geographic area of 8441 sq. km, forest area occupies 5182.30 sq.km. covering 61.52% of the land area. It is the second highest in forest cover after Uttara Kannada district, which is with 80.57% of land area under forests. The Western Ghats which extend all along the coastal districts are home for rich and diverse flora and fauna and are a biodiversity hot spot. These districts spread from the Western Ghats in the east toward the Arabian Sea in the west. These districts lie between coordinates 12°57'00" and 13°50'17" N and 74°01'00" and 75°50'17"E. The coastal districts are bounded by Goa State in the north and Kerala in the south. Climate in the study area, the whole of which is of hilly terrain, is very pleasant and cool for most part of the year. In general, temperature is within agreeable and pleasant limits. The highest day temperature in summer hardly crosses 37°C while the lowest winter temperature is around 10°C. Humidity is rarely below 80%. The study area spreads across Udupi and Chikmagalur districts and consists of:

1. Kudremukh National Park (KNP) with an area of 600.32 sq. km.
2. Mookambika Wildlife Sanctuary (MWLS) with an area of 247 sq.km. and
3. Someshwara Wildlife Sanctuary (SWLS) with an area of 88.4 sq. km.

The KNP lying on the tri-junction of Dakshina Kannada, Udupi, and Chikmagalur districts of Karnataka is known for its forests and wildlife. The park offers many scenic splendors. It is a mosaic of grasslands and dark green sholas held aloft by verdant evergreen rain forests. KNP is the principal catchment for three important

rivers, namely, Thunga, Bhadra, and Nethravathi, which support millions of human lives. The park offers endless pleasure to any visitor looking for nature at its best. Someshwara WLS is located to the west of Agumbe, best known as Cherrapunji of South India because it receives the highest rainfall in Peninsular India. The sanctuary is the best known for lion-tailed macaque and king cobra. Mookambika Wildlife Sanctuary has evergreen and semi-evergreen forests covering the steep slopes typical of the Western Ghats Mountains. The sanctuary shelters a rich variety of wildlife, with king cobra as the flagship species (Anonymous.2003).



Map showing location of the sanctuaries and Kudremukh National Park.

The KNP and Mookambika and Someshwara Wildlife Sanctuaries harbor a rich variety of butterflies. These butterflies are a major tourist attraction of the area. About 1500 species of butterflies belonging to five families, namely, Papilionidae, Nymphalidae, Pieridae, Lycaenidae, and Hesperidae are native to the Indian subcontinent. There are about 331 species

found in the Western Ghats region (Gaonkar, 1996). In the present investigation, a survey was conducted to study the distribution and relative abundance of different species of butterflies in these areas.

MATERIALS AND METHODS

Sample plots were laid out in various forest types as per Blair and Launer (1997) method for counting and observation of butterflies. Sample plots were laid out in the month of August 2003. Each sample plot measured 200 m × 100 m. Transects measuring 150 m long and 20 m wide were identified in each plot for counting of butterflies. Sampling was done for 2 years from September 2003 to August 2005. KNP, MWLS, and SWLS were selected for the study as these areas are rich in wildlife, particulars of the sample plots are given below:

KNP

1. Suthinagudda – In shola forests with adjoining grasslands.
2. Bhagavathi – In open forest along a stream.

MWLS

3. Anejari – In semi-evergreen forests near the nature camp.
4. Kollur – Inside the medicinal plants conservation area, covering evergreen forests.

SWLS

5. Seethanadi – Miscellaneous plantation and adjoining semi-evergreen forests.

Sampling of Butterflies

The vegetation types were identified using GIS data obtained from Karnataka Satellite Data Application Centre, Bangalore. Sample plots were laid out in various forest types as per Blair and Launer (1997) method. Area measuring 100 m by 200 m (2 Ha) was marked on the ground with stone pillars. Boundary trees were marked with green painted bands and flags were also tied wherever needed to clearly mark the boundaries. Transects measuring 150 m long

and 20 m wide were traversed for 30 min at monthly intervals for counting of butterflies. This study was conducted for 2 years, i.e., September 2003-August 2005. Regular observations were made on a monthly basis in the sample plots for studying the distribution and relative abundance of different butterfly species.

In the morning, the butterflies are generally less active and easy for observation and photography. Care was taken to see that each sample plot is visited alternatively in the forenoon and afternoon during the monthly intervals. Observations were made on the type of species of butterfly and the number of individuals of each species and were counted for calculating relative abundance. Different activities of butterflies like flight, perching on the trees, mud puddling or in courtship were observed. Feeding, foraging, daily rhythms and other characteristic activities of various species were also observed. Visual census of butterflies was made on either side of the transect line. Those butterflies which could not be identified were given a code number and after identification, were recorded in the respective data sheets. Butterfly species were identified with the help of Wynter-Blyth (1957) and other field guides and also discussed with the experts on the subject. Voucher specimens of several butterflies found in the study area were collected and preserved for future reference. The specimens were identified, given a number, labeled, and kept in insect boxes.

RESULTS AND DISCUSSION

The data obtained were compared with the checklist of butterflies of the area obtained from secondary sources. Out of the reported 149 species of butterflies known from the region (Gaonkar, 1996), 142 species were sighted during the study. The butterfly species sighted during the study belonging to the five families were recorded and are shown in Table 1. The total number of butterflies sighted, familywise, is shown in Table 2. The Common Five-Ring (*Ypthima baldus*) of the family Nymphalidae is the only addition from the region during the study.



Table 1: List of butterflies sighted during the study.

S. No.	Family	Common name	Scientific name
1.	Papilionidae	Southern Birdwing	<i>Troides minos</i>
2.	Papilionidae	Malabar Rose	<i>Pachliopta pandiyana</i>
3.	Papilionidae	Common Rose	<i>Pachliopta aristolochiae</i>
4.	Papilionidae	Crimson Rose	<i>Pachliopta hector</i>
5.	Papilionidae	Common Bluebottle	<i>Graphium sarpedon</i>
6.	Papilionidae	Common Jay	<i>Graphium doson</i>
7.	Papilionidae	Tailed Jay	<i>Graphium agamemnon</i>
8.	Papilionidae	Spot Swordtail	<i>Graphium nomius</i>
9.	Papilionidae	Five-Bar Swordtail	<i>Graphium antiphates</i>
10.	Papilionidae	Common Mime	<i>Papilio clytia</i>
11.	Papilionidae	Lime	<i>Papilio demoleus</i>
12.	Papilionidae	Malabar Banded Swallowtail	<i>Papilio liomedon</i>
13.	Papilionidae	Malabar Raven	<i>Papilio dravidarum</i>
14.	Papilionidae	Red Helen	<i>Papilio helenus</i>
15.	Papilionidae	Common Mormon	<i>Papilio polytes</i>
16.	Papilionidae	Blue Mormon	<i>Papilio polymnestor</i>
17.	Papilionidae	Paris Peacock	<i>Papilio paris</i>
18.	Papilionidae	Malabar Banded Peacock	<i>Papilio Buddha</i>
19.	Papilionidae	Common Banded Peacock	<i>Papilio crino</i>
20.	Pieridae	Common Emigrant	<i>Catopsilia pomona</i>
21.	Pieridae	Mottled Emigrant	<i>Catopsilia pyranthe</i>
22.	Pieridae	Small Grass Yellow	<i>Eurema brigitta</i>
23.	Pieridae	Spotless Grass Yellow	<i>Eurema laeta</i>
24.	Pieridae	Common Grass Yellow	<i>Eurema hecabe</i>
25.	Pieridae	Three-Spot Grass Yellow	<i>Eurema blanda</i>
26.	Pieridae	Common Jezebel	<i>Delias eucharis</i>
27.	Pieridae	Psyche	<i>Leptosia nina</i>
28.	Pieridae	Painted Sawtooth	<i>Prioneris sita</i>
29.	Pieridae	Common Gull	<i>Cepora nerissa</i>
30.	Pieridae	Pioneer	<i>Anaphaeis aurota</i>
31.	Pieridae	Plain Puffin	<i>Appias indra</i>
32.	Pieridae	Chocolate Albatross	<i>Appias lycida</i>

(Contd...)

Table 1: (Continued).

S. No.	Family	Common name	Scientific name
33.	Pieridae	Common Albatross	<i>Appias albina</i>
34.	Pieridae	Yellow Orange Tip	<i>Ixias pyrene</i>
35.	Pieridae	Great Orange Tip	<i>Hebomoeta glaucippae</i>
36.	Pieridae	Common Wanderer	<i>Pareronia valeria</i>
37.	Pieridae	Dark Wanderer	<i>Pareronia ceylanica</i>
38.	Nymphalidae	Common Evening Brown	<i>Melanitis leda</i>
39.	Nymphalidae	Dark Evening Brown	<i>Melanitis phedima</i>
40.	Nymphalidae	Common Palm fly	<i>Elymnias hypermenstra</i>
41.	Nymphalidae	Bamboo Tree brown	<i>Lethe europa</i>
42.	Nymphalidae	Common Tree brown	<i>Lethe rohria</i>
43.	Nymphalidae	Bush brown	<i>Mycalesis sp.</i>
44.	Nymphalidae	Gladeye Bush brown	<i>Mycalesis patnia</i>
45.	Nymphalidae	Nigger	<i>Orsotrioena medus</i>
46.	Nymphalidae	White Four-Ring	<i>Ypthima ceylonica</i>
47.	Nymphalidae	Common Four-Ring	<i>Ypthima huebneri</i>
48.	Nymphalidae	Common Five-Ring	<i>Ypthima baldus</i>
49.	Nymphalidae	Common Nawab	<i>Polyura athamas</i>
50.	Nymphalidae	Tawny Rajah	<i>Charaxes bernardus</i>
51.	Nymphalidae	Tawny Coster	<i>Acraea violae</i>
52.	Nymphalidae	Tamil Lacewing	<i>Cethosia nietneri</i>
53.	Nymphalidae	Cruiser	<i>Vindula erota</i>
54.	Nymphalidae	Rustic	<i>Cupha erymanthis</i>
55.	Nymphalidae	Common Leopard	<i>Phalanta phalantha</i>
56.	Nymphalidae	Small Leopard	<i>Phalanta alcippe</i>
57.	Nymphalidae	Tamil Yeoman	<i>Cirrochroa thais</i>
58.	Nymphalidae	Chestnut-Streaked Sailor	<i>Neptis jumbah</i>
59.	Nymphalidae	Yellowjack Sailor	<i>Neptis viraja</i>
60.	Nymphalidae	Common Sailor	<i>Neptis hylas</i>
61.	Nymphalidae	Common Beak	<i>Libythea lepita</i>
62.	Nymphalidae	Common Lascar	<i>Pantoporia hordonia</i>
63.	Nymphalidae	Painted Lady	<i>Cynthia cardui</i>
64.	Nymphalidae	Common Sergeant	<i>Athyma perius</i>

(Contd...)



Table 1: (Continued).

S. No.	Family	Common name	Scientific name
65.	Nymphalidae	Commander	<i>Limenitis procris</i>
66.	Nymphalidae	Clipper	<i>Parthenos sylvia</i>
67.	Nymphalidae	Grey Count	<i>Tanaecia lepidea</i>
68.	Nymphalidae	Common Baron	<i>Euthalia aconthea</i>
69.	Nymphalidae	Red spot Duke	<i>Dolpha evelina</i>
70.	Nymphalidae	Angled Castor	<i>Ariadne ariadne</i>
71.	Nymphalidae	Common Castor	<i>Ariadne merione</i>
72.	Nymphalidae	Common Map	<i>Cyrestis thyodamas</i>
73.	Nymphalidae	Yellow Pansy	<i>Junonia hierta</i>
74.	Nymphalidae	Blue Pansy	<i>Junonia orithya</i>
75.	Nymphalidae	Lemon Pansy	<i>Junonia lemonias</i>
76.	Nymphalidae	Peacock Pansy	<i>Junonia almana</i>
77.	Nymphalidae	Grey Pansy	<i>Junonia atlites</i>
78.	Nymphalidae	Chocolate Pansy	<i>Junonia iphita</i>
79.	Nymphalidae	Blue Admiral	<i>Kaniska canace</i>
80.	Nymphalidae	Great Eggfly	<i>Hypolimnas bolina</i>
81.	Nymphalidae	Danaid Eggfly	<i>Hypolimnas misippus</i>
82.	Nymphalidae	Blue Oakleaf	<i>Kallima horsfieldi</i>
83.	Nymphalidae	Glassy Tiger	<i>Parantica aglea</i>
84.	Nymphalidae	Blue Tiger	<i>Tirumala limniace</i>
85.	Nymphalidae	Dark Blue Tiger	<i>Tirumala septentrionis</i>
86.	Nymphalidae	Plain Tiger	<i>Danaus chrysippus</i>
87.	Nymphalidae	Striped Tiger	<i>Danaus genutia</i>
88.	Nymphalidae	Common Indian Crow	<i>Euploea core</i>
89.	Nymphalidae	Double-Branded Crow	<i>Euploea sylvester</i>
90.	Nymphalidae	Malabar Tree Nymph	<i>Idea malabarica</i>
91.	Lycaenidae	Plum Judy	<i>Abisara echerius</i>
92.	Lycaenidae	Common Pierrot	<i>Castalius rosimon</i>
93.	Lycaenidae	Angled Pierrot	<i>Caleta caleta</i>
94.	Lycaenidae	Banded Blue Pierrot	<i>Discolampa ethion</i>
95.	Lycaenidae	Zebra Blue	<i>Leptotes plinius</i>
96.	Lycaenidae	Indian Cupid	<i>Everes lacturnus</i>

(Contd...)

Table 1: (Continued).

S. No.	Family	Common name	Scientific name
97.	Lycaenidae	Common Hedge Blue	<i>Actolepis puspa</i>
98.	Lycaenidae	Quaker	<i>Neopithecops zalmora</i>
99.	Lycaenidae	Malayan	<i>Magisba malaya</i>
100.	Lycaenidae	Pale Grass Blue	<i>Psuedozizeeria maha</i>
101.	Lycaenidae	Grass Jewel	<i>Freyeria trochylus</i>
102.	Lycaenidae	Gram Blue	<i>Euchrysops cnejus</i>
103.	Lycaenidae	Forget-Me-Not	<i>Catochrysops strabo</i>
104.	Lycaenidae	Pea Blue	<i>Lampides boeticus</i>
105.	Lycaenidae	Dark Cerulean	<i>Jamides bochus</i>
106.	Lycaenidae	Common Cerulean	<i>Jamides celeno</i>
107.	Lycaenidae	Line Blue	<i>Nacaduba sp.</i>
108.	Lycaenidae	Red Pierrot	<i>Talicauda nyseus</i>
109.	Lycaenidae	Large Oakblue	<i>Arhopala amantes</i>
110.	Lycaenidae	Many tailed Oakblue	<i>Thaduka multicaudata</i>
111.	Lycaenidae	Common Silverline	<i>Spindasis vulcanus</i>
112.	Lycaenidae	Yamfly	<i>Loxura atymnus</i>
113.	Lycaenidae	Common Imperial	<i>Cheritra freja</i>
114.	Lycaenidae	Monkey Puzzle	<i>Rathinda amor</i>
115.	Lycaenidae	Peacock Royal	<i>Tajuria cippus</i>
116.	Lycaenidae	Indian Red Flash	<i>Rapala iarbus</i>
117.	Lycaenidae	Slate Flash	<i>Rapala manea</i>
118.	Lycaenidae	Sunbeam	<i>Curetis spp.</i>
119.	Hesperiidae	Common Banded Awl	<i>Hasora chromus</i>
120.	Hesperiidae	White Banded Awl	<i>Hasora taminatus</i>
121.	Hesperiidae	Brown Awl	<i>Badamia exclamationis</i>
122.	Hesperiidae	Common Spotted Flat	<i>Celaenorrhinus leucocera</i>
123.	Hesperiidae	Malabar Spotted Flat	<i>Celaenorrhinus ambareesa</i>
124.	Hesperiidae	Common Snow Flat	<i>Tagiades jepetus</i>
125.	Hesperiidae	Water Snow Flat	<i>Tagiades litigiosa</i>
126.	Hesperiidae	Fulvous Pied Flat	<i>Psuedocoladenia dan</i>
127.	Hesperiidae	Tricolor Pied Flat	<i>Psuedocoladenia indrana</i>
128.	Hesperiidae	Common Small Flat	<i>Sarangesa dasahara</i>

(Contd...)



Table 1: (Continued).

S. No.	Family	Common name	Scientific name
129.	Hesperiidae	Banded Angle	<i>Odontoptilum angulata</i>
130.	Hesperiidae	Golden Angle	<i>Odontoptilum ransonnetti</i>
131.	Hesperiidae	Indian Skipper	<i>Spialia galba</i>
132.	Hesperiidae	Bush Hopper	<i>Ampittia dioscorides</i>
133.	Hesperiidae	Chestnut Bob	<i>lambrix salsala</i>
134.	Hesperiidae	Common Banded Demon	<i>Notocrypta paralysos</i>
135.	Hesperiidae	Restricted Demon	<i>Notocrypta curvifascia</i>
136.	Hesperiidae	Grass Demon	<i>Udaspes folus</i>
137.	Hesperiidae	Tree Flutter	<i>Hyarotis adrastus</i>
138.	Hesperiidae	Giant Redeye	<i>Gangara thyrasis</i>
139.	Hesperiidae	Common Redeye	<i>Matapa aria</i>
140.	Hesperiidae	Tamil Grass Dart	<i>Taractrocera ceramas</i>
141.	Hesperiidae	Dart	<i>Potanthus sp.</i>
142.	Hesperiidae	Dark Palm Dart	<i>Telicota ancilla</i>

Table 2: Butterfly species sighted familywise during the study.

Families	No. of species as per checklist	No. of species of butterflies sighted during the study
Papilionidae	19	19
Nymphalidae	52	53
Pieridae	18	18
Lycaenidae	33	28
Hesperiidae	27	24
Total	149	142

Density and Diversity of Butterfly Species

The density of butterflies found in the sites was calculated, taking the sample plot as representative of the area. The number of individuals of all five families recorded in different forest types was worked out and their densities studied with reference to each sample

plot. Fluctuations in butterfly population with the change of seasons worked out and plotted in the form of graphs. Various observations were recorded and the data were analyzed to study the distribution pattern, seasonal variations, etc. (Tables 3-7).

The number of butterflies sighted in each sample plot was recorded separately for each family. The total number of butterflies sighted in each month for the period of study (24 months – from September 2003 to August 2005) was calculated. For comparing the trends in the butterfly population, Shannon diversity index (H') and Margalef's richness index were calculated. Density of butterfly species in each sample plot was calculated. The study revealed that the population of all families was showing two peaks, in the months of September and October and later in April. This trend was seen in both the years. However, in the year 2003-2004 in semi-evergreen forest, the peak was observed in the month of August. In the year 2004-2005, evergreen

Table 3: Seasonal variations in the butterfly density (No./ha) Diversity H' and Margalef's index in plot 1 – Shola forest.

Family name	September 3-August 4			September 4-August 5		
	Monsoon	Winter	Summer	Monsoon	Winter	Summer
Papilionidae	7	5	5	11	8	5
Nymphalidae	28	13	15	36	19	22
Pieridae	16	9	6	12	15	5
Lycaenidae	12	10	6	10	8	4
Hesperiidae	10	9	5	10	7	3
Shannon diversity	1.488	1.571	1.486	1.442	1.526	1.269
Margalef's index	0.8049	0.8911	0.9415	0.7921	0.8446	0.9265

Table 4: Seasonal variations in the butterfly density (No./ha) diversity H' and Margalef's index in open forest.

Family name	September 3-August 4			September 4-August 5		
	Monsoon	Winter	Summer	Monsoon	Winter	Summer
Papilionidae	14	6	6	8	19	6
Nymphalidae	35	14	14	34	25	23
Pieridae	19	11	7	10	14	7
Lycaenidae	9	8	7	11	8	6
Hesperiidae	6	8	4	10	5	8
Shannon diversity	1.436	1.561	1.504	1.422	1.475	1.417
Margalef's index	0.7834	0.8825	0.9294	0.8037	0.8094	0.8744

and miscellaneous plantation plots recorded the highest numbers in the month of October. There was a second peak during March/April. The number of individuals was minimum in the month of February. The increase in number of butterflies is due to the favorable conditions for breeding in the post-monsoon months when plenty of fresh flush of leaves are available. This is followed by a flowering season of several plants which provide nectar source for adult butterflies. Similar conditions prevail in the months of March/April too, favoring a second peak.

Out of the five families of butterflies in the study area, Nymphalidae were found to be dominating in all the seasons. Species belonging to Hesperiidae were found in least numbers (Mohandas, 2010).

The species diversity of butterflies was calculated using Shannon-Weiner diversity index (H') which combines the number of species within a site with the relative abundance of each species. It varies from 0 for communities with only a single species to high values for communities with many species, each with few individuals.



Table 5: Seasonal variations in the butterfly density (No./ha) diversity H' and Margalef's index in semi-evergreen forest.

Family name	September 3-August 4			September 4-August 5		
	Monsoon	Winter	Summer	Monsoon	Winter	Summer
Papilionidae	6	6	4	6	5	6
Nymphalidae	28	15	15	30	17	23
Pieridae	9	14	8	10	11	5
Lycaenidae	6	9	6	8	7	6
Hesperiidae	6	5	4	7	6	6
Shannon diversity	1.367	1.523	1.446	1.382	1.491	1.352
Margalef's index	0.8543	0.8764	0.9384	0.8370	0.8911	0.8934

Table 6: Seasonal variations in butterfly density (No./ha) diversity H' and Margalef's index in evergreen forest.

Family name	September 3-August 4			September 4-August 5		
	Monsoon	Winter	Summer	Monsoon	Winter	Summer
Papilionidae	10	6	3	7	9	5
Nymphalidae	29	19	16	26	23	21
Pieridae	20	13	7	8	14	8
Lycaenidae	15	8	6	9	6	4
Hesperiidae	14	7	2	8	6	4
Shannon diversity	1.543	1.505	1.358	1.440	1.458	1.354
Margalef's index	0.7762	0.8630	0.9547	0.8446	0.8461	0.9052

Shannon Weiner diversity index (H') = $-\sum_i p_i \log(p_i)$

Where,

$$p_i = \frac{n_i}{n}$$

Another index calculated was Margalef's richness index:

Margalef's richness index: $(S-1)/\ln(n)$, where, S is the number of species and n is the number of individuals.

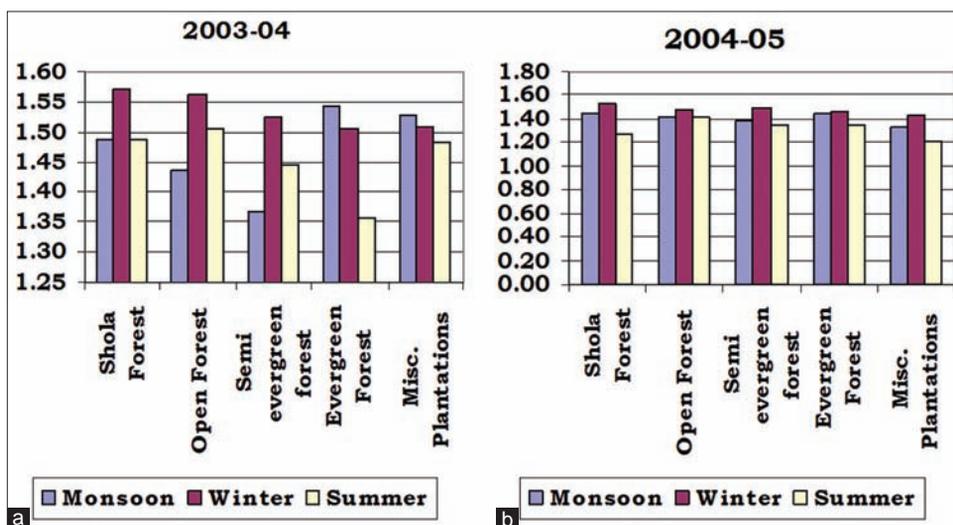
The values of H' were then grouped according to the three different seasons (Figures 1 and 2) These data

were then analyzed by analysis of variance to see if the seasonal changes in species diversity of butterflies varied significantly.

Comparison of Shannon diversity indices given in Figures 1 shows that during the year 2003-2004, diversity of butterflies (comprising five families) is higher in winter season for the shola forest, open forest, and semi-evergreen forest. In the case of evergreen forest and miscellaneous plantations, diversity is higher in monsoon season followed by winter season. During the year 2004-2005, diversity for all the seasons was

Table 7: Seasonal variations in the butterfly density (No./ha) diversity H' and Margalef's index in misc. plantations.

Family name	September 3-August 4			September 4-August 5		
	Monsoon	Winter	Summer	Monsoon	Winter	Summer
Papilionidae	10	4	5	9	9	4
Nymphalidae	30	14	15	38	40	25
Pieridae	15	10	8	9	21	6
Lycaenidae	15	8	6	10	13	4
Hesperiidae	13	6	4	7	10	3
Shannon diversity	1.528	1.510	1.484	1.341	1.437	1.200
Margalef's index	0.7862	0.9102	0.9353	0.8071	0.7670	0.9077

**Figure 1: (a and b) Comparison of seasonal variation in Shannon diversity indices in different vegetation in various seasons.**

almost equal and slightly higher diversity is seen in winter season for all vegetation studied.

Comparison of Margalef's index given in Figures 2 shows that in both the years, studied Margalef's index is higher in summer seasons. Margalef's index measures the richness of species. It indicates the increase in distribution of species in summer season. Although the number of individuals may be more in winter, the number of species is more in summer. According to Larsen (1987),

butterflies are good indicators for the general ecological impact assessments and in continued monitoring of ecological health. Butterflies would also be very suitable organisms for studying the effect of forest management. Extensive studies on butterflies of Western Ghats, South India, were carried out by Gaonkar (1996), which was the first study that took into account all the 331 species in 166 genera belonging to five families recorded from this mountain range and the adjacent areas.

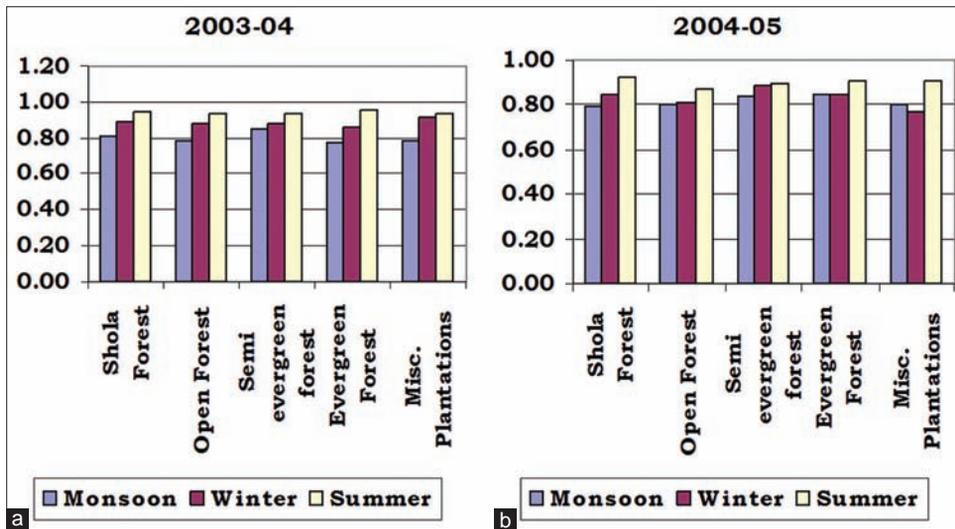


Figure 2: (a and b) Comparison of Margalef's index of butterfly species in different vegetation in various seasons.

Watson (1890) studied the diversity of butterflies in the Mysore region and listed the various butterflies found in the region. Mohandas (2004) studied the distribution of butterflies in monsoon season in the KNP and the present study conforms to the data on distribution of butterfly species during monsoon. Radhakrishnan and Palot (2007) evaluated the Fauna of KNP and list most of the butterfly species occurring in the park.

Larval host plants are well distributed in the area. The presence or absence of butterflies depends on the existence of host plants. The Western Ghats are rich in plant diversity. The evergreen and semi-evergreen forests in the region have a wide variety of host plants which support abundant butterfly population. The diverse assemblages of host plants in the coastal Western Ghats ensure survival of a diverse butterfly fauna in the region.

The present study shows that the protected areas in Central Western Ghats are having a diverse assemblage of butterfly species which need immediate measures for protection and conservation.

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Accepted: 24 February 2020



