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Butterfly diversity associated with seasonality at menagesha-suba state forest, Central Ethiopia

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Abstract
Butterfly diversity at Menagesha-Suba State forest was investigated by the use of sweep nets along transects to study the ecology of butterflies with a view to establish the effect of seasonality on their diversity parameters. The data were analyzed using diversity indexes. Autumn had maximum abundance with 54 species and 32.5% butterflies followed by spring with the same number of species and 27.14% of butterflies. Summer showed the least species and abundance diversity, with 41 species and 18.5% butterflies and followed by winter. Across families, Nymphalidae constituted the highest number of species during autumn and spring. Papilionidae had the highest number of species in spring and autumn while Pieridae had in autumn and spring. Hesperidae had the least species composition in all of the seasons. There was a significance difference among seasons as ($p < 0.05$, $F= 5.529$ and $df =3$). Shannon diversity index showed higher diversity in autumn, followed by spring, winter and lastly summer. Comparison of Shannon diversity index among families showed Nymphalidae has high value and Hesperiidae had least diversity index in all seasons. Hesperids prefers autumn season and Papilionidae had high index in winter. Lycaenidae had high value in autumn while Pieridae during spring. The dominance indices indicated that Nymphalidae is the dominant family in all of the seasons followed by Peiridae. Conservation of their habitats at landscape level is important for conservation of butterfly fauna of the study area.

Keywords: butterflies, diversity, diversity indices, menagesha-suba state forest, season

1. Introduction
Butterflies offer good opportunities for studies on population and community ecology (Pollard, 1991). Many species of butterflies are strictly seasonal, preferring only a particular set of habitats. In spite of this, butterflies have been generally neglected and there are very few studies available on their community structures, population dynamics and the eco-climatic factors which affect them. Being good indicators of climatic conditions as well as seasonal and ecological changes, butterflies can serve in formulating strategies for conservation purpose [1]. However, they have largely been ignored. The study was started with a view to examine the dynamics of butterfly population across seasons. Therefore, this study emphasized the seasonal and monthly variation of butterflies diversity and abundance at Menagesha-Suba State Forest. This research also highlighted the studies on the seasonality of each butterflies species and butterflies dry and wet season preference. With quantitative data on butterfly populations gathered from a variety of habitats, the questions became more apparent. Seasonal fluctuations in population abundance and species richness of various butterfly population in the Menagesha-Suba State Forest were studied and discussed in this study. Despite its limitations, this study did attempt, perhaps for the first time, butterfly monitoring in the area.

2. Materials and Methods
According to the Ethiopian calendar, for convenience of data interpretation, the year was divided into four seasons (i) winter – December, January and February (ii) summer- June, July and August (iii) Autumn- September, October and November (iv) Spring- March, April and May. For assessing population fluctuations across seasons, species were arranged in a definite order and then a simple matrix with species in rows and seasons in columns was made for each site.

2.1 Study site
The study was carried out at Menagesha-Suba State Forest, found at the coordinates of 38°33'59 E and 9°03'00 N, Central Ethiopia. It is one of the few remaining highland forest blocks in the Central plateau of Ethiopia, dominated by *Juniperus procera.* The structural diversity of the forest is minimal, and is described as undifferentiated evergreen montane forest [2, 3]. The vegetation of the area varied with altitude, from high forest on the lower slopes to sub-afro-alpine vegetation at higher altitudes [4]. It has an altitude ranging from 2200 to 3385meter above sea level. It has a bimodal rainfall pattern.

2.2 Selection of Sampling Site
Sampling sites were systematically selected. The study area were divided into different sections based on the transect line. These techniques involved dividing the study site in to different habitat [5, 6].
The study area at Menagesha-Suba State Forest was divided in to ten transects, each of 0.1 km lengths with ten quadrates on each of them were marked through different habitats in the study area. The forest study area was divided into the following habitat types: natural forest, artificial forest and grassland. Each quadrate in the forest, having a size of 10m

x 10 m in ten transects line were sampled.

2.3 Sampling methods, butterfly collection and identification

All sampling were done once in a month for about 4-5 days in each study areas. All quadrates were sampled within every hour between 10:00 and 14:00 daily. According to [7, 8] this is the period within which most butterfly species are probably active.

Samples were taken from one of the quadrant of each transect line in each vegetation type in every month from the study areas. Butterflies samples were collected with 0.38 diameter sweep net constructed of muslin with fin mesh net at the tip. Each sweep represents a horizontal swing with an arc of approximately 135^0 and height between 0.5-2.00 meters above the ground. These specimens were killed by pinching their thorax by taking proper care or by killing the small specimen using ethyl acetate and finally placed in paper envelop.

The collected butterflies were identified using binocular microscope and identification key at the species level with the help of available literatures such as [9, 10, and 11]. Besides, books, different drawings of butterflies, datasheet, specimens of butterflies in Addis Ababa University museums were used as a means of identifications tools. When identifying and describing butterfly taxon, morphological characteristics were used to separate species.

2.4 Data analysis

2.4.1 Measurement of diversity

The type of diversity used is α- diversity, which is the diversity of species within a community or habitat. The diversity index was calculated by using the Shannon – Wiener diversity index [12].

Diversity index = H = – ∑ Pi In Pi

Where Pi = S / N

S = number of individuals of one species

N = total number of all individuals in the sample

In = logarithm to base e

Simpson's Index (D)

It measures the probability that two individuals randomly selected from a sample will belong to the same species or some category other than species. Simpson Index [13] was computed for each of the sites.

Simpson's Index is expressed as:

$$D = \Sigma = \frac{ni\,(ni-1)}{N\,(N-1)}$$

Where

N = total number of individuals encountered

ni = number of individuals of i^{th} species

The value of D ranges between zero and one. With this index, zero represents infinite diversity while, one represents no diversity. That is, the bigger the value of D, the lower the diversity. This is neither intuitive nor logical, so to get over this problem, D is subtracted from 1 to give: Simpson's Index of Diversity 1 – D. The value of this index also ranges between zero and one, but now, the greater the value, the greater the sample diversity. This makes more sense. In this case, the index represents the probability that two individuals randomly selected from a sample will belong to different species.

2.4.2 Measurement of species richness

In the ecological literature the number of species at a site, in a region or in a collection is called species richness, which is the simplest and most useful measure of species diversity. In this study, the total number of butterfly species collected in each habitat was considered as species richness.

Margalef's index was used as a simple measure of species richness [14].

Margalef's index R = (S – 1) / In N

S = total number of species

N = total number of individuals in the sample

In = natural logarithm

2.4.3 Measurement of evenness

For calculating the evenness of species, the Pielou's Evenness Index (e) was used [15].

e = H / In S

H = Shannon – Wiener diversity index

S = total number of species in the sample

2.4.4 Dominance index

Patterns of relative abundance of species determine the dominance component of diversity. In this study, the relative dominance of each butterfly family in a habitat was determined by calculating the dominance index using the following formula:

$$\textbf{Relative dominance} = ni \times \frac{100}{N}$$

Where ni = number of butterflies in the 'i' th family, and

N = the total number of butterflies in all the families collected in each season.

3. Results

3.1 Seasonal changes in the total number of butterflies

The species encountered in the various seasons are shown in Tables 1, 2, 3 and 4, for autumn, winter, spring and summer, respectively. The maximum species richness was recorded in the autumn and spring seasons particularly in the month of September and April and the minimum species richness was recorded in the summer during the month of July. Autumn showed the highest species and abundance diversity which contained 54 species and 304 individuals of butterflies (32.5%) followed by spring with the same number of species 54 and 254 individuals of butterflies (27.14%). Summer showed the least species and abundance diversity, which composed of 41 species and 173 individuals of, butterflies (18.5%) and then followed by winter with 48 species and 254 individuals of butterflies. The species list and their abundance across seasons are presented in Table 5.

Maximum abundance was noted in two seasons, autumn (September - November) and spring (March - April) with the peak in October 114 individuals and March 95 individuals, respectively. Minimum abundance was recorded in the month of July with 56 individuals during the summer season (Figure 1).

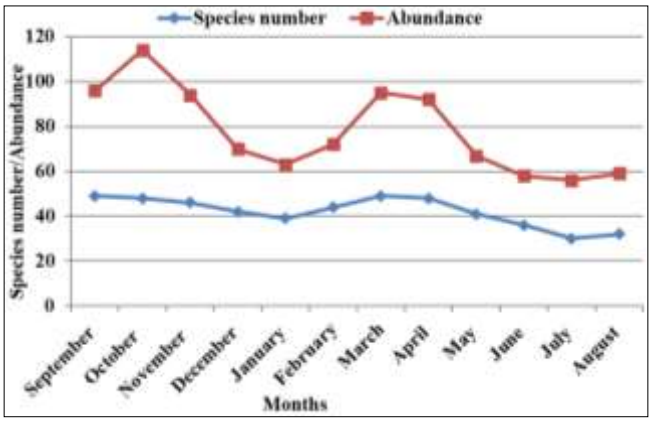

Fig 1: Butterfly species number and abundance across months at Menagesha-Suba State Forest during the year 2012 to 2014

Table 1: Butterfly species found in autumn season at Menagesha - Suba State Forest during the year 2012 to 2014

Species	Family
Papilio nireus	Papilionidae
Papilio rex	Papilionidae
Papilio dardanus	Papilionidae
Papilio constantinus	Papilionidae
Papilio echerioides	Papilionidae
Graphium leonidas	Papilionidae
Graphium antheus	Papilionidae
Graphium colonna	Papilionidae
Colotis agoye	Pieridae
Colias electo	Pieridae
Colotis danae	Pieridae
Appias epaphia	Pieridae
Appias sabina	Pieridae
Belenois raffrayi	Pieridae
Mylothris agathina	Pieridae
Mylothris yulei	Pieridae
Mylothris sagala	Pieridae
Mylothris rueppellii	Pieridae
Dixeia orbona	Pieridae
Leptomyrina boschi	Lycaenidae
Deudorix dinochares	Lycaenidae
Uranothauma antinorii	Lycaenidae
Uranothauma nubifer	Lycaenidae
Cupidopsis jobates	Lycaenidae
Cacyreus tespis	Lycaenidae
Eicochrysops messapus	Lycaenidae
Acraea bonasia	Nymphalidae
Acraea insignis	Nymphalidae
Acraea johnstoni	Nymphalidae
Acraea necoda	Nymphalidae
Acraea pharsalus	Nymphalidae
Acraea safie	Nymphalidae
Eurytela hiarbas	Nymphalidae
Hypolimnas misippus	Nymphalidae
Hypolimnas salmacis	Nymphalidae
Precis coelestina	Nymphalidae
Charaxes etesipe	Nymphalidae
Charaxes castor	Nymphalidae
Charaxes varanes	Nymphalidae
Charaxes etheocles	Nymphalidae
Charaxes phoebus	Nymphalidae
Bicyclus vulgaris	Nymphalidae
Bicyclus anynana	Nymphalidae
Bicyclus sandace	Nymphalidae
Ypthima pupillaris	Nymphalidae
Ypthima yatta	Nymphalidae
Ypthima simplicia	Nymphalidae
Amauris niavius	Nymphalidae
Phalanta phalantha	Nymphalidae

Coeliades keithloa	Hespeiridae
Eagris nottoana	Hespeiridae
Sarangesa motozi	Hespeiridae
Coeliades anchises	Hespeiridae
Eretis mixta	Hespeiridae

Table 2: Butterfly species found in winter season at Menagesha - Suba State Forest during the year 2012 to 2014

Species	Family
Papilio nireus	Papilionidae
Papilio rex	Papilinidae
Papilio dardanus	Papilinidae
Papilio constantinus	Papilinidae
Papilio microps	Papilinidae
Papilio echerioides	Papilinidae
Graphium leonidas	Papilinidae
Graphium antheus	Papilinidae
Graphium colonna	Papilinidae
Colotis agoye	Pieridae
Colias electo	Pieridae
Colotis danae	Pieridae
Appias epaphia	Pieridae
Appias sylvia	Pieridae
Belenois raffrayi	Pieridae
Mylothris agathina	Pieridae
Mylothris yulei	Pieridae
Mylothris sagala	Pieridae
Mylothris rueppellii	Pieridae
Leptomyrina boschi	Lycaenidae
Cupidopsis jobates	Lycaenidae
Cacyreus tespis	Lycaenidae
Eicochrysops messapus	Lycaenidae
Acraea bonasia	Nymphalidae
Acraea insignis	Nymphalidae
Acraea necoda	Nymphalidae
Acraea safie	Nymphalidae
Eurytela hiarbas	Nymphalidae
Hypolimnas salmacis	Nymphalidae
Precis coelestina	Nymphalidae
Vanessa abyssinica	Nymphalidae
Vanessa *dimorphica*	Nymphalidae
Charaxes castor	Nymphalidae
Charaxes varanes	Nymphalidae
Charaxes etheocles	Nymphalidae
Charaxes phoebus	Nymphalidae
Bicyclus vulgaris	Nymphalidae
Bicyclus anynana	Nymphalidae
Bicyclus sandace	Nymphalidae
Ypthima yatta	Nymphalidae
Ypthima simplicia	Nymphalidae
Amauris niavius	Nymphalidae
Tirumala formosa	Nymphalidae
Phalanta phalantha	Nymphalidae
Coeliades keithloa	Hespeiridae
Eagris nottoana	Hespeiridae
Sarangesa motozi	Hespeiridae
Coeliades anchises	Hespeiridae

Table 3: Butterfly species found in spring season at Menagesha-Suba State Forest during the year 2012 to 2014

Species	Family
Papilio nireus	Papilionidae
Papilio rex	Papilionidae
Papilio dardanus	Papilionidae
Papilio constantinus	Papilionidae
Papilio microps	Papilionidae
Papilio echerioides	Papilionidae
Graphium leonidas	Papilionidae
Graphium antheus	Papilionidae

Graphium colonna	Papilionidae
Colotis agoye	Pieridae
Colias electo	Pieridae
Colotis danae	Pieridae
Appias epaphia	Pieridae
Appias sabina	Pieridae
Appias sylvia	Pieridae
Belenois raffrayi	Pieridae
Mylothris agathina	Pieridae
Mylothris yulei	Pieridae
Mylothris sagala	Pieridae
Mylothris rueppellii	Pieridae
Leptomyrina boschi	Lycaenidae
Deudorix dinochares	Lycaenidae
Uranothauma nubifer	Lycaenidae
Cupidopsis jobates	Lycaenidae
Cacyreus tespis	Lycaenidae
Eicochrysops messapus	Lycaenidae
Acraea johnstoni	Nymphalidae
Acraea necoda	Nymphalidae
Acraea safie	Nymphalidae
Eurytela hiarbas	Nymphalidae
Hypolimnas misippus	Nymphalidae
Hypolimnas salmacis	Nymphalidae
Precis coelestina	Nymphalidae
Vanessa abyssinica	Nymphalidae
Vanessa *dimorphica*	Nymphalidae
Charaxes etesipe	Nymphalidae
Charaxes castor	Nymphalidae
Charaxes varanes	Nymphalidae
Charaxes etheocles	Nymphalidae
Charaxes phoebus	Nymphalidae
Bicyclus vulgaris	Nymphalidae
Bicyclus anynana	Nymphalidae
Bicyclus sandace	Nymphalidae
Ypthima pupillaris	Nymphalidae
Ypthima yatta	Nymphalidae
Ypthima simplicia	Nymphalidae
Amauris niavius	Nymphalidae
Tirumala formosa	Nymphalidae
Phalanta phalantha	Nymphalidae
Coeliades keithloa	Hespeiridae
Eagris nottoana	Hespeiridae
Sarangesa motozi	Hespeiridae
Coeliades anchises	Hespeiridae
Eretis mixta	Hespeiridae

Table 4: Butterfly species found in summer season at Menagesha-Suba State Forest during the year 2012 to 2014

Species	**Family**
Papilio nireus	Papilionidae
Papilio dardanus	Papilionidae
Graphium leonidas	Papilionidae
Graphium antheus	Papilionidae
Graphium colonna	Papilionidae
Colotis agoye	Pieridae
Colias electo	Pieridae
Colotis danae	Pieridae
Appias epaphia	Pieridae
Appias sabina	Pieridae
Belenois raffrayi	Pieridae
Mylothris yulei	Pieridae
Mylothris sagala	Pieridae
Mylothris rueppellii	Pieridae
Dixeia orbona	Pieridae
Leptomyrina boschi	Lycaenidae
Deudorix dinochares	Lycaenidae
Uranothauma antinorii	Lycaenidae

Uranothauma nubifer	Lycaenidae
Cacyreus tespis	Lycaenidae
Acraea bonasia	Nymphalidae
Acraea insignis	Nymphalidae
Acraea johnstoni	Nymphalidae
Acraea pharsalus	Nymphalidae
Eurytela hiarbas	Nymphalidae
Hypolimnas misippus	Nymphalidae
Hypolimnas salmacis	Nymphalidae
Vanessa abyssinica	Nymphalidae
Vanessa *dimorphica*	Nymphalidae
Charaxes etesipe	Nymphalidae
Charaxes castor	Nymphalidae
Charaxes varanes	Nymphalidae
Bicyclus vulgaris	Nymphalidae
Bicyclus anynana	Nymphalidae
Ypthima pupillaris	Nymphalidae
Amauris niavius	Nymphalidae
Tirumala formosa	Nymphalidae
Phalanta phalantha	Nymphalidae
Coeliades keithloa	Hespeiridae
Eagris nottoana	Hespeiridae
Sarangesa motozi	Hespeiridae

Table 5: Butterfly species and their abundance at different seasons of Menagesha-Suba State Forest during the year 2012 to 2014

Species	**Seasons**			
	Autumn	**Winter**	**Spring**	**Summer**
Papilio nireus	6	7	3	1
Papilio rex	1	5	2	0
Papilio dardanus	4	8	6	3
Papilio constantinus	9	7	5	0
Papilio microps	0	3	2	0
Papilio echerioides	10	3	1	0
Graphium leonidas	10	3	6	4
Graphium antheus	7	6	3	3
Graphium colonna	9	5	7	3
Colotis agoye	5	1	8	6
Colias electo	2	2	6	8
Colotis danae	3	3	8	3
Appias epaphia	6	3	9	3
Appias sabina	3	0	6	6
Appias sylvia	0	6	6	0
Belenois raffrayi	2	6	5	1
Mylothris agathina	6	2	6	0
Mylothris yulei	6	1	6	6
Mylothris sagala	4	4	6	1
Mylothris rueppellii	6	5	4	2
Dixeia orbona	5	0	0	3
Leptomyrina boschi	5	7	5	3
Deudorix dinochares	7	0	9	1
Uranothauma antinorii	3	0	0	7
Uranothauma nubifer	2	0	4	7
Cupidopsis jobates	6	5	2	0
Cacyreus tespis	3	5	3	2
Eicochrysops messapus	5	4	2	0
Acraea bonasia	8	6	0	4
Acraea insignis	5	6	0	3
Acraea johnstoni	4	0	5	7
Acraea necoda	11	4	4	0
Acraea pharsalus	4	0	0	7
Acraea safie	8	3	5	0
Eurytela hiarbas	3	8	7	1
Hypolimnas misippus	2	0	4	11
Hypolimnas salmacis	1	4	4	8
Precis coelestina	8	6	2	0
Vanessa abyssinica	0	4	9	3
Vanessa *dimorphica*	0	5	6	1

Charaxes etesipe	4	0	6	4
Charaxes castor	11	4	3	5
Charaxes varanes	3	6	4	5
Charaxes etheocles	6	6	5	0
Charaxes phoebus	9	3	2	0
Bicyclus vulgaris	7	5	5	3
Bicyclus anynana	8	4	4	7
Bicyclus sandace	6	5	4	0
Ypthima pupillaris	3	0	4	2
Ypthima yatta	3	3	4	0
Ypthima simplicia	6	4	2	0
Amauris niavius	9	2	2	5
Tirumala formosa	0	2	12	1
Phalanta phalantha	7	5	8	1
Coeliades keithloa	8	2	1	4
Eagris nottoana	9	1	1	9
Sarangesa motozi	4	1	5	9
Coeliades anchises	8	5	4	0
Eretis mixta	4	0	2	0

3.2 Distribution of butterflies species and abundance among butterfly families in different seasons

Butterfly species distribution among butterfly families across seasons is shown in Figure 2. Family wise distribution of butterfly species revealed that Lycaenidae had similar number of species in all of the seasons with a slight peak in autumn and spring and the least being in winter.

Nymphalidae constituted the highest number of species during autumn and spring. Papilionidae had the highest number of species in spring and autumn while Pieridae had in autumn and spring. Hesperidae had the least species composition in all of the seasons.

The seasonal population trend of various families of butterfly abundance is presented in Figure 3. In terms of abundance, Nymphalidae contained the highest abundance of individuals in autumn followed by spring. Pieridae reaches its peak during spring and they were present in all seasons. Nymphalidae was present throughout the year. Papilionidae and Lycaenidae had the highest abundance of individuals during autumn. Even though the Nymphalids were most common and adapted, population count was low. The population of Hesperidae was very low. Hesperidae had the least abundance composition in all of the seasons when compared to other families except in summer in which case Papilionidae had the least number of individuals.

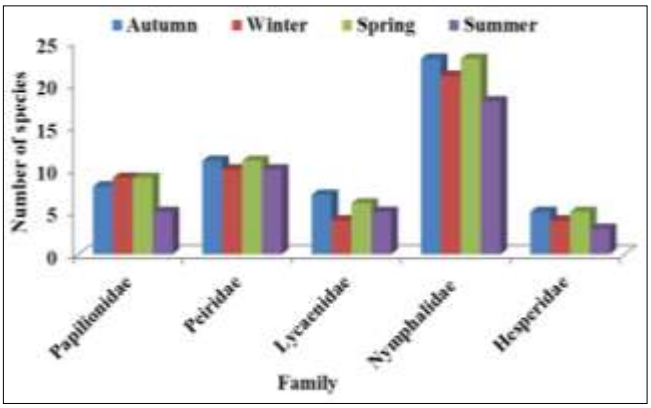

Fig 2: Family-wise trend in species richness of butterflies across seasons at Menagesha – Suba State Forest during the year 2012 to 2014

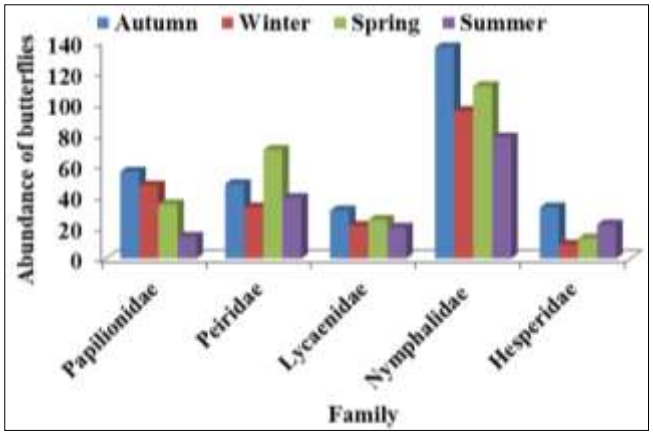

Fig 3: Overall population trend of various families of Butterflies across seasons at Menagesha – Suba State Forest during the year 2012 to 2014

3.3 Species richness and diversity indices

The diversity of butterflies during the four seasons was found to be significantly different from each other. Comparison of the Shannon diversity index showed higher diversity in autumn, followed by spring, winter and lastly summer. The evenness index of butterfly distribution is high and similar, the highest being in autumn followed by winter. Spring and summer have the same evenness index. Species richness was found to be higher in spring season followed by autumn and then winter and summer (Table 7).

The Shannon diversity index for the five families of butterflies is shown in Table 8. The comparison of Shannon diversity index among five different families showed Nymphalidae has high value and Hesperiidae had least diversity index in all seasons. Hesperids prefers autumn season and Papilionidae had high index in winter followed by autumn and the least index in spring. Lycaenidae had high value in autumn while Pieridae had high value during spring followed by summer. Both of them had the least index in winter.

Table 6: Butterfly diversity across seasons at Menagesha-Suba State Forest during the year 2012 to 2014

Family	Seasons			
	Autumn	Winter	Spring	Summer
Papilionidae	0.669	0.811	0.529	0.324
Pieridae	0.652	0.609	0.983	0.801
Lycaenidae	0.416	0.366	0.369	0.405
Nymphalidae	1.697	1.695	1.612	1.556
Hesperidae	0.405	0.172	0.214	0.392

Table 7: Margalef´s richness index of butterflies in various at Menagesha-Suba State Forest during the year 2012 to 2014

No	Seasons	Species richness index
1.	Autumn	9.27
2.	Winter	8.83
3.	Spring	9.57
4.	Summer	7.76

Table 8: Diversity indices (H') of various butterfly families across seasons at Menagesha-Suba State Forest during the year 2012 to 2014

	Species number	Individuals	Evenness index e	Diversity index H'
Autumn	54	304	0.96	3.84
Winter	48	205	0.94	3.65
Spring	54	254	0.93	3.71
Summer	41	173	0.93	3.47

Table 9: Dominance index Butterfly families in various seasons at Menagesha-Suba State Forest during the year 2012 to 2014

Family	Dominance index				
	Seasons				
	Autumn	Winter	Spring	Summer	Pooled value
Papilionidae	18.42	22.92	13.77	8.09	16.24
Pieridae	15.78	16.09	27.55	22.54	23.83
Lycaenidae	10.19	10.24	9.84	11.56	10.36
Nymphalidae	44.73	46.34	43.70	45.08	44.87
Hesperidae	10.85	11.68	5.11	12.71	8.22
Pooled value	32.47	21.90	27.13	18.48	

The dominance indices for various butterfly families across seasons at Menagesha-Suba State Forest are given in Table 9. The indices indicated that Nymphalidae is the dominant family in all of the seasons. Lycaenidae had similar index almost in all seasons with a slight dominant during summer. Peiridae was the dominant family in the spring followed by summer. Papilionidae had high dominance index in the winter followed by autumn. The pooled data indicated that in Menagesha-Suba State Forest, Nymphalidae was the most dominant family followed by Peiridae.

4. Discussions

The butterflies of Menagesha – Suba State Forest showed distinct seasonality and well-defined seasonal peaks and only the lesser proportion of the species being active throughout the year. Seasonal preferences of butterflies were also shows distinct variation of the proportional abundance in various months or seasons (Figure 1). These differences of butterfly abundances are due to well-defined dry and wet seasons.

Diversity pattern of butterflies differ significantly among seasons: Species diversity was consistently highest during autumn season (Table 6), primarily due to a greater abundance of species. The abundance of butterfly families was also usually highest during autumn season (Figure 3). Therefore, in both study areas, highest abundance was noted after the rainy season in autumn and this may be related to an increase in young vegetation, flowering of plants and the appropriate climatic conditions. Optimum light, temperature and rainfall usually increase the vegetation and thereby directly favour their abundance. Hence, there is a direct correlation between abundance of butterflies with flowering of plants, intensity of light and larval host plant [16, 17, and 18].

During winter season the declination of species diversity and abundance are associated with habitat dryness and differences in microhabitat conditions in various seasons. The butterfly population showed a gradual decline in numbers from December onwards with the onset of dry condition. This dry period was least favourable to many butterflies, probably due to the scarcity of water, nectar and fresh foliage.

In addition, at Menagesha - Suba State Forest the diversity and species richness indices were also high during spring and lowest during summer. It seems like seasonality was less in this study area. This might be due to it rains periodically. However, there were population peaks and troughs, because butterflies try to time the emergence of their larvae with their food plants having fresh young leaves. Therefore, this variation of butterfly diversity in different seasons indicated that, the abiotic factors such as rainfall, temperature and humidity played a vital role in influencing the distribution and abundance of butterflies [19, 20].

5. Conclusions

Butterfly exhibits seasonal variation in distribution of butterfly species in the study area. At autumn, the total number of species was more than spring, summer or winter seasons. The diversity of butterflies is also high in autumn. In general, the seasonality of butterflies becomes less extreme and it is related to rainfall and other factors. Conservation of their habitats at landscape level is important for conservation of butterfly fauna especially for the preservation of rich and unique butterfly species of the area.

6. Acknowledgements

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7. References

1. Pollard E, Yates TJ. Monitoring butterflies for ecology and conservation. Institute of Terrestrial Ecology and the Joint Nature Conservation Committee, Great Britain.1993; 30:85-88.
2. Breitenbach FV, Koukal J. Menagesha State Forest: description of the forest, its management and its future development including the National Park Project. Ethiop. Forest. Rev. 1962; 3(4):17-34.
3. Gilbert EF. Mount Wachacha: a botanical commentary. Walia. 1970; 2:3-12.
4. Demel Teketay. Deforestation, Wood Famine and Environmental Degradation in Ethiopia's Highland Ecosystems: Urgent Need for Action. Northeast African

Studies, (New Series). 2001; 8(1):53-76.
5. Tanka LK, Tanka SK. Rainfall and seasonal changes in arthropod abundance on tropical Oceanic Island. Biotropica.1982; 14:114-123.
6. Tayyab M, Suhail A, Shazia, Arshad M. Biodiversity of Lepidopterous insects in agro-forest area of Bahawalpur. Pak. Entoml. 2006; 28:5-10.
7. Holl KD. The effect of coal surface mine reclamation on diurnal lepidopteran conservation. J Appl. Ecol.33: 1996; 225-236.
8. Gardiner AJ, Reid RS, Kiema S. Impact of land use on butterflies in southwestern Burkina Faso. Afr. Entoml. 2005; 13(2):201-212.
9. Williams JG. A field guide to the butterflies of Africa. Collins, London, 1969.
10. Carcasson RH. The swallowtail butterflies of East Africa (Lepidoptera, Papilionidae). Faringdon, UK: EW Classey, 1975.
11. D'Abrera B. Butterflies of the Afrotropical Region, 2nd edition. Part I. Papilionidae, Pieridae, Acraeidae, Danaidae & Satyridae. Melbourne: Hill House, 1997.
12. Shannon CE, Weaver W. The mathematical theory of communication. University of Illinois Press, Illinois, 1949.
13. Simpson EH. Measurement of diversity. 1949; Nat.163: 688.
14. Magurran AE. Ecological Diversity and Its Measurements. University Press, Cambridge, 1988. http://dx.doi.org/10.1007/978-94-015-7358-0
15. Pielou E. An Introduction to Mathematical Ecology. Wiley-Interscience, New York, USA, 1969.
16. Kitahara M, Sei K, Fuji K. Patterns in the structure of grassland butterfly communities along a gradient of human disturbance: Further analysis based on the generalist/specialist concept. Pop. Ecol. 2000; 42:135-144.
17. Kunte KJ. Butterflies of peninsular India. Indian Academy of Sciences, Bangalore and University Press, Hyderabad, 2000.
18. Hussain KJ, Ramesh T, Satpathy KK, Selvanayagam. Seasonal dynamics of butterfly population in DAE campus, Kalpakkam, Tamil Nadu, India. J Threa. Taxa. 2011; 3(1):1401-1414.
19. Shubhalaxmi V, Chaturvedi N. Abundance and distribution of Moths of the Families Saturnidae and Sphingidae in Sanjay Gandhi National Park, Mumbai. J. Bombay Nat. Hist. Soc.1999; 96 (3):379-386.
20. Hill JK, Hamer KC, Dawood MM, Tangah J, Chey VK. "Rainfall but not selective logging affects changes in abundance of a tropical forest butterfly in Sabah, Borneo," J of Trop. Ecol. 2003; 19(1):35-42.