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# Diversity of butterfly communities at different altitudes of Menagesha-suba state forest, Ethiopia

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**Abstract**
Butterflies are having aesthetic value and great ecological significance as consumers and pollinators in the ecosystem. The objective of the study was to describe the diversity of butterfly communities in habitat types at Menagesha-Suba State Forest in Ethiopia. Five elevation sites at Menagesha-Suba State forestwere selected for the study. Five families comprising 423 individuals were collected. The significant difference in diversity of butterflies among the altitudes as indicated by the values of Shannon Weiner-index H', value at 2200-2500m and the lowest at above 3300 m altitude. The species richness was relatively highest at 2200- 2500m and lowest at 3100-3300 m altitude. The Jaccard's Similarity Index indicated that the butterfly communities similarity was highest between altitudes of 3100-3300m and above 3300m, while the lowest value was noted at altitudes between 2200-2500m and 3100-3300m, 2200-2500m and above 3300m, and 2500-2800m and above 3300m. Among the five families, Nymphalidae dominated the butterfly community at all of the altitudinal sites.

**Keywords:** Altitudes, butterflies, diversity, diversity indices, menagesha-suba state forest

## 1. Introduction
Analyses of altitudinal changes can provide important information on diversity, abundance, and species composition of organisms as those aspects of the environment limiting the distribution of organisms. These are factors influencing the structure of communities. The altitude of their habitat [1] affects butterfly diversity [2] showed that the species composition of butterflies differed between different altitudes as well as habitats. Several studies have concluded that a decrease in species richness with elevation is a typical characteristic of many animals, including insects, with the exception of bees [3] and tropical psocids [4, 5] indicated that species richness peaks at middle elevations, rather than at lowerones.
Menagesha-Suba State Forest is one of the few mountainous forests left in Central Ethiopia. Because of rapid land development activities for agriculture and forest succession in the surrounding area, it is hypothesized that they would be a changing in butterfly diversity of this mountainous forest now and in the future. This study was aimed to investigate the change of thebutterfly community at different altitudes of Menagesha-Suba State forest showing an altitudinal difference. Butterflies are suitable taxonomical group to assess this matter because they are conspicuous animals. The results of this study are expected to provide baseline data for future study and monitoring of butterfly community changes in terms of altitude in this mountainous habitat.

## 2. Materials and Methods
### 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 in the Oromia National Regional State. 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 montaneforest [6, 7]. The vegetation of the area varied with altitude, from high forest on the lower slopes to sub-afro-alpine vegetation at higher altitudes [8].
It has an altitude ranging from 2200 to 3385meter above sea level. It has a bimodal rainfall pattern.

### 2.2 Sampling Site
Five elevations were selected. These were 2200 – 2500 (Site I), 2500 – 2800(Site II), 2800 – 3100 (Site III), 3100 – 3300 (Site IV), and above 3300 meter above sea level (Site V). There were some differences in terms of sign of illegal logging activities, land surface characters, tree height and percent canopy cover, dominant plants present and as well as the thickness of dead leaves on the ground among these elevations. Three sampling points or plots (300m apart, 150 x 150m$^2$ per sampling point) were selected per altitude. Ten transect lines were established across the plot parallel to each other at 15m apart.

### 2.3 Sampling method, butterfly collection and identification
The line transect method was used for survey of butterflies. Sampling was done once in a month for about 4-5 days. All transects were sampled within every hour between 10:00 and 14:00 daily. Butterfly samples were collected with asweep net. These specimens were killed by pinching their thorax by taking proper care or by killing the small specimens using ethyl acetate and finally placed in paper envelop.
The collected butterflies were identified using identification keys at the species level with the help of available literatures. Besides, books, different drawings of butterflies, datasheet, specimens of butterflies in Addis Ababa University museums were used as a means of identifications tools. Identification of butterflies also followed [9, 10]. Morphological characteristics were used to identify butterfly species.

### 2.4 Data Analysis
In this study species richness considered as the total number of species recorded and species abundance as anumber of individual butterflies counted during sampling. Exclusive species were considered as the species recorded from only one particular altitude.
The diversity of butterfly species across different altitudinal belts was calculated using Shannon index of diversity given by the equation: $H' = \Sigma pi(Inpi)$, where, pi = ni/ N;
ni is the number of individuals of $i^{th}$ species and $N = \Sigma ni$.
Margalef's species richness was used to compare the species richness across different altitudes. This index was calculated using equation: $R = (S-1)$ In N, where S is the number of species andN is the number of individuals [11]. The variation in butterfly species richness and species diversity across the five-altitudinal belts was represented graphically.
For calculating the evenness of species, the Pielou's Evenness Index (e) was used [12].
e = H / In S
H = Shannon – Wiener diversity index and S = total number of species in the sample.
The relative abundance (RA) of all the butterflies among sites were calculated with the formula: RA = n *100/N, where, ni = number of i Individuals of $i^{th}$ species
N = total number of individuals of all species.
Range of each butterfly species was estimated as the difference between the lowest and highest altitude at which the species was observed during the study. The species are assumed to be present at all intermediate altitudes between lowest and highest altitude [13]. The number of species was estimated at range size of every 300 m interval.

### 2.5 Butterfly species similarity
Jaccard's coefficient index was used to measure butterfly species similarity between altitudes. The similarities of species between altitudes were measured using the following formula.
Jaccard's index (C j) = j / (a +b-j) Where, j = the number of species present in both sites
a = the number of species present in site A
b = the number of species present in site B.
The Jaccard's Index is equal to zero for two sites that are completely different, and is equal to one for two sites that are completely similar.

## 3. Results
### 3.1 Species richness and abundance
A total of 46 species, belonging to five families comprising 423 individuals were collected from all altitudes of Menagesha- Suba State Forest. Among the total species, 16 species were exclusives species.

**Table 1:** Species richness, abundance and exclusive species of butterflies in different altitudes of Menagesha- Suba State Forest during the year 2012 to 2014

| Altitudes (m) | Species richness | Species abundance | Exclusive species |
|---|---|---|---|
| 2200-2500 | 35 | 194 | 11 |
| 2500-2800 | 30 | 139 | 4 |
| 2800-3100 | 16 | 67 | 1 |
| 3100-3300 | 5 | 19 | 0 |
| Above 3300 | 3 | 4 | 0 |
| Total | 46 | 423 | 16 |

Butterfly species richness and abundance were highest in low elevation (site I) and lowest at a high altitudinal region (site IV and V). The trend of exclusive species is also coherent with the species richness (Table 1).
At elevation of 2200-2500masl (Site I) appears to support the greater number of species and individuals. The most abundant species along this altitudinal sites were *Papilio constantinus, Graphium leonidas, Graphium antheus, Graphium colonna, Colotisagoye, Deudorix dinochares* and *Phalanta phalantha.* They make up 36.6% of all individuals found in the altitudinal site.
The most abundant species at altitude of 2500-2800masl (site II) were *Appiasepaphia, Charaxes varanes, Mylothrissagala, Uranothaumaantinorii, Tirumala Formosa* and *Uranothauma antinorii.* They make up 32.4% of all individuals found in this altitude. At altitude of 2800-3100masl (site III) the dominant species were *Papilio dardanus, Colias electo, Eicochrysops messapus, Acraea necoda,* and *Coeliades keithloa.* They make up 46.3% of all individuals found in the altitude.
Site IV, at altitude of 3100-3300masl shows the least species diversity and abundance. The most abundant species in this altitudinal site were *Precis Octavia* and *Colias electo.* These two species composed about 52.64% of all individuals recorded in the altitude. The total number of species encountered in this site was only five species. The last altitudinal region, above 3300masl with three species and four individuals could not be feasible to compare among themselves to pick out the dominant species.

### 3.2 Family-wise pattern
The recorded butterflies at different altitude represent five families namely, Papilionidae, Pieridae, Lycaenidae, Nymphalidae and Hesperiidae. Among these families, Nymphalidae was the most dominant comprising maximum species (48%) and abundance (44%) (Figure 1 A and 1B). Nymphalidae had the highest species and abundance followed byPapilinionidae, Peridae and Lycaenidae. This indicated that Nymphalidae dominated with highest species and abundances

in all altitudes of the study area. Hesperidae were the least in species richness (4.35%) as well as abundance (4%). All of the families showed decline in species as well as abundance with altitude but Pieridae peaked a little bit at site II (Figure 2 A and 2B).

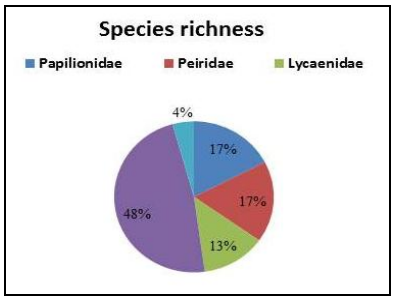


**Fig 1A:** Family-wise representation in species number of butterflies at Menagesh-Suba State Forest during the year 2012 to 2014.

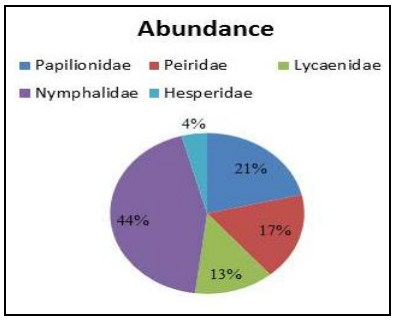


**Fig 1B:** Family-wise representation in abundances of butterflies at Menagesh-Suba State Forest during the year 2012 to 2014.

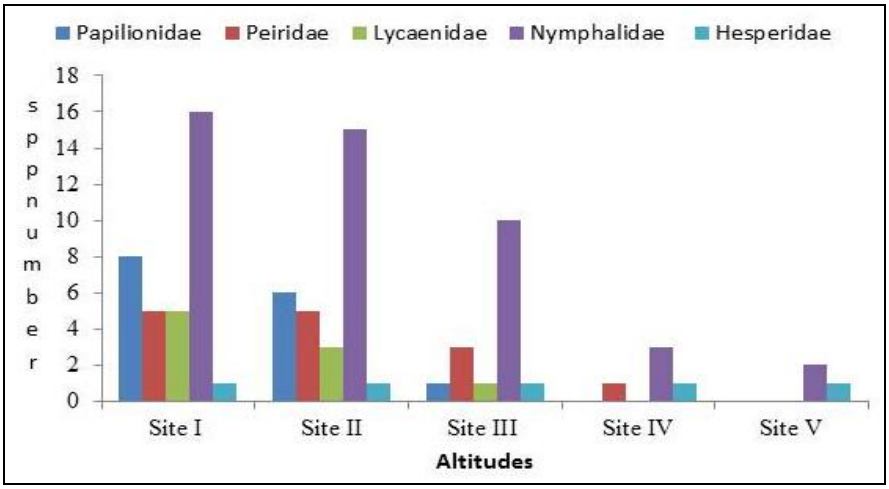


**Fig 2A:** Family-wise trend in species richness of butterflies in different elevation at Menagesh-Suba State Forest during the year 2012 to 2014.

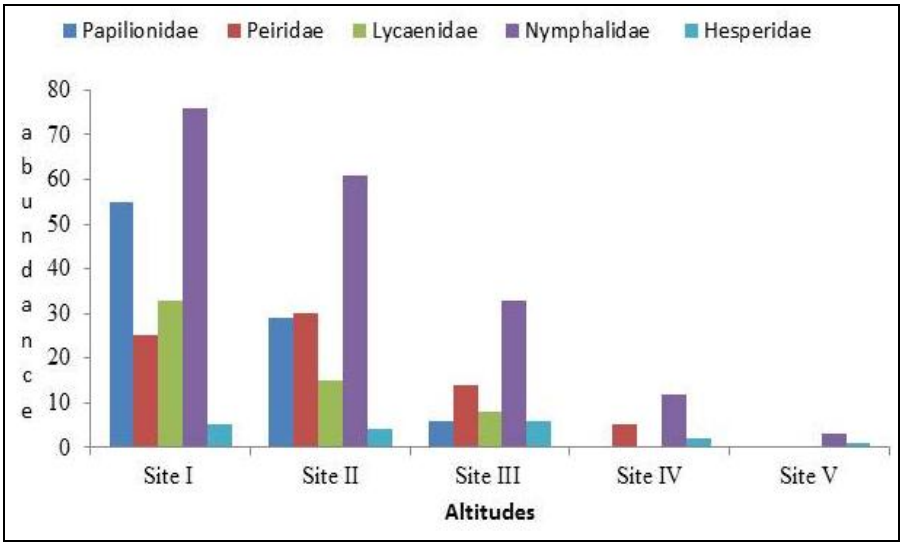


**Fig 2A:** Family-wise trend in abundances of butterflies in different elevation at Menagesh-Suba State Forest during the year 2012 to 2014

### 3.3 Butterfly diversity indices

The species diversity (H′) and species richness indices of butterflies across different altitudinal sites are shown in Table 2. Accordingly, the highest value of species diversity (3.438) and species richness (6.454) were noted at altitude of 2200-2500 masl. In contrast, the lowest values of species diversity (1.038) and species richness (1.442) were recorded at the highest altitudinal belt of above 3300 masl.

**Table 2:** Butterfly diversity at different altitudes of Menagesha – Suba State Forest during the year 2012 to 2014

| Altitudes (m) | Species richness index, R | Evenness index, e | Diversity index, H′ |
|---|---|---|---|
| 2200-2500 | 6.454 | 0.966 | 3.438 |
| 2500-2800 | 5.877 | 0.977 | 3.324 |
| 2800-3100 | 3.567 | 0.973 | 2.698 |
| 3100-3300 | 1.358 | 0.967 | 1.557 |
| Above 3300 | 1.442 | 0.944 | 1.038 |

### 3.4 Range size distribution

Butterfly species showed narrow tolerance to elevation. Number of species declined with increasing range size. Most of the butterflies had narrow distribution range, about 34% species confined to a single site. Of the total, 16 species had less than 300 m range observed at the single elevation site. None of the butterfly species occurred all along the gradient (Figure 3).

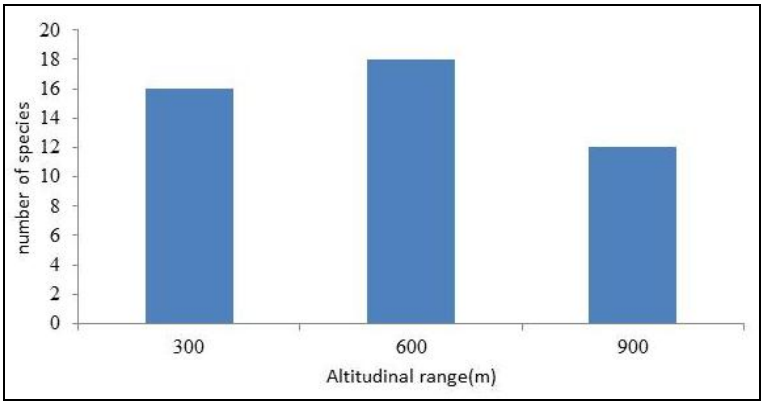


**Fig 3:** Altitudinal range size distribution of butterflies of Menagesh-Suba State Forest during the year 2012 to 2014.

### 3.5 Species similarity

The similarities in butterfly communities (Jaccard's coefficient index) are shown in Table 3. Butterfly species similarity results based on the Jaccard's coefficient index indicated that the butterfly species similarity was highest between altitudes of 3100-3300m and above 3300m (0.6), and between altitudes of 2200-2500m and 2500-2800m (0.585). This indicated that 60% of the butterfly species at 3100-3300m and above 3300m altitudes were similar and 58.5% of the butterfly species at 2200-2500m and 2500-2800m altitudes were similar. The lowest value of similarity index of butterfly species (0) was noted at altitudes of between 2200-2500m and 3100-3300m, 2200-2500m and above 3300m, and 2500-2800m and above 3300m. It indicated that the butterfly species at these altitudes were completely different.

**Table 3:** Similarity in butterfly communities (Jaccard's coefficient index) in different altitudes at Menagesha-Suba State Forest during the year 2012 to 2014

| Altitudes (m) | 2200-2500 | 2500-2800 | 2800-3100 | 3100-3300 | Above3300 |
|---|---|---|---|---|---|
| 2200-2500 | * | 0.585 | 0.243 | 0 | 0 |
| 2500-2800 | 0.585 | * | 0.352 | 0.029 | 0 |
| 2800-3100 | 0243. | 0.352 | * | 0.235 | 0.117 |
| 3100-3300 | 0 | 0.029 | 0.235 | * | 0.6 |
| Above 3300 | 0 | 0 | 0.117 | 0.6 | * |

## 4. Discussion

### 4.1 Species diversity and abundance

About 46 species of butterflies were recorded which are sub-set of the total butterfly fauna of the area and reflects the potential of the study area in retaining and conserving butterflies and contributing high diversity to the study area. The wide variation in elevation in the forest and habitat disturbances might have resulted in a variety of microhabitats and ecological niches for the existence of different species and enhancing diversity.

The data indicated that butterfly species richness, abundance and exclusive species decrease with altitude although the maximum value recorded at altitude below 2800 masl altitude (Sites I and II) with the abrupt decline above this altitude. The species richness and abundance of each of the five families of butterflies recorded at Menagesha-Suba State Forest also decreased with increased altitude. Negative correlation between butterflies species richness and elevation were reported from the Great Basin, USA [14] and Spain [15]. Uniyal [16] also made similar observation in a study in Himachal Pradesh, India. The declining trend might be due to decline in temperature and rainfall towards higher elevation. Mostly, the

rate of temperature decline reported as -0.62°C at every 100 m rise in elevation [17]. This rate changes above 2400 m as -1°C at every 100 m rise in elevation [18]. Butterfly needs certain level of temperature for their activity and hence unable to cope up with the extreme climatic conditions [14]. The continuous decrease in the number of species and abundance with increasing altitude might cause by the harshness of environmental conditions, area reduction and reduction in resource diversity.

There was also a significant difference in the diversity of butterfly among the altitudes of Menagesha-Suba State Forest as indicated by the values of Shannon Weiner-lndex (H') as well as species richness (R') (Table 2). The H' values 1.557 and 1.038 were significantly lower at altitude of 3100-3300m and above 3300m as compared to H' values at other altitudes. These two altitudes has also low E' and R' values that are the two important components in determining the value of diversity. It seems like that altitude 3100 may be the limit for butterfly diversity. The relatively low E' and R' of butterfly species at an altitude greater than 3100m may be associated with plants that is most abundant at this altitude. These plant groups may be able to serve as food or shelter to less number of butterfly species at 3100 m altitude as compared to plant groups at other altitudes.

The overall species diversity is higher at lower altitudes of Suba than at higher altitudes. This result corresponds with theory and practice since previous works indicated that the diversity of insects or butterflies decreases with increasing altitude [1, 19]. The differences in composition and patterns of abundance among assemblages suggest that, the butterfly community is shaped by various factors such as food, breeding habitat, competition among co-existing species, climate, vegetation and disturbance level [20, 21]. The type and quantity of resources as well as their distribution patterns, climatic conditions and disturbance levels are the major factors that determine the community structure of butterflies along an elevation gradient [22, 23]. All these factors support higher levels of species diversity of butterflies at low altitudes of Suba compared to higher altitudes.

### 4.2 Range size distribution

Narrow range size of most species reflects that butterflies are very sensitive to changes in environmental parameters caused by changes in elevation. The data showed that most of the species found at one elevation does not occur at other sites. There are reports that the butterfly ranges are affected by the global climate change and physiography [24, 22, 23]. The co-specificity of butterflies with climate and host plants for feeding and laying eggs make them unable to cope up with the changed habitats.

### 4.3 Species similarity

Butterfly species similarity was highest between altitudes of 3100-3300m and above 3300m (0.6) and, between altitudes of 2200-2500m and 2500-2800m (0.585). This species similarity was high between two nearest altitudinal sites. The similarity decreases and finally becomes completely different as the altitudes far apart. This butterfly species similarity among altitudes might be influenced by temperature, plant diversity, or by majority of the plant species present at each altitude.

## 5. Conclusion

The concept of biodiversity has grown with the perception of its loss due to the increasing human impact and mismanagement of the environment. The total number of collected specimens from the two different study sites was 29 genera comprising 59 species belonging to five families at Menagesha-Suba State Forest and 23 genera comprising 36 species belonging to five families from Gullele Botanical Garden. At Menagesha-Suba State Forest, A large number of specimens were collected from the natural forest and grassland habitats and least from the artificial forest habitat in both study areas. This is probably due to the destruction of host plant in the artificial forest and human disturbance. The species diversity at Menagesha-Suba State Forest area of each habitat type, which enjoys some level of protection, was higher than in each of the habitat types at Gullele Botanical Garden. This underlines the importance of site for butterfly species conservation and calls for better protection and management. However, the low species similarity between each pair of habitats indicates that habitat fragmentation and land use changes may increase biodiversity.

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## 7. References

1. Price W. Pattern in communities along latitudinal gradients. In: Plant-animal interaction: Evolutionary ecology in tropical and temperate regions, (Price PW, Lewinsohn TM, Fernandes GW, Benson WW., eds). John and Wiley, New York. 1991, 51-69
2. Nelson SM, Wydoski R. Ripparian butterflies (Papilinionoidea and Hesperiodea) assemblages associated with *Tamarix*- dominated, native vegetation-dominated, and *Tamarix* removal sites along the Arkansas River, Colorado, USA. Restored Ecol. 2008; 16:168-179.
3. Gauld ID. Some factors affecting the composition of tropical ichneumonid faunas
4. Biological Journal of Linnaean Society. 1987; 30:299-312
5. Turner BD, Broadhead. E. Diversity and distribution of psocid populations on *Mangifera indica* L. in Jamaica and their relationships to altitude and microepiphyte diversity. J Anim. Ecol. 1974; 43:173-190.
6. Janzen, DH, Ataroff M, Farinas M, Reyes S, Rincon N, Soler A *et al*. Changes in the arthropod community along an elevation transect in the Venezuelan Andes. Biotropica. 1976; 8:193-203.
7. Breitenbach FV, Koukal J. Menagesha State Forest: description of the forest, its management and its future development including the National Park Project. Ethio. Forest Rev. 1962; 3(4):17-34.
8. Gilbert EF. Mount Wachacha: A botanical commentary. Walia. 1970; 2:3-12.
9. Demel Teketay. Deforestation, Wood Famine and Environmental Degradation in Ethiopia's Highland Ecosystems: Urgent Need for Action. Northeast Afr. Studies, (New Series). 2001; 8(1):53-76.
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. Magurran AE. Ecological Diversity and Its Measurements. University Press, Cambridge. Pielou, E. An Introduction to Mathematical Ecology. Wiley-Interscience, New York, USA, 1988, 1969.
13. Brehm G, Colwell RK, Kluge J. The role of environment and mid-domain effect on moth species richness along a tropical elevational gradient. Global Ecol. and Biogeog. 2007; 16:205-219
14. Fleishman E, Austin GT, Weiss AD. An empirical test of Rapoport's rule: elevational gradients in montane butterfly communities. Ecol. 1998; 79:2482-2493.
15. Sanchez-Rodriguez JF, Baz A. The effects of elevation on the butterflies communities of a Mediterranean Mountain, Sierra De Javalambre, Central Spain. J Lepidopterists' Soc. 1995; 49:192-207.
16. Uniyal VP. Butterflies in the Great Himalayan Conservation Landscape, Himachal Pradesh, Western Himalaya. Entomol. 2007; 32:119-127.
17. Acharya BK, Chettri B, Vijayan, L. Distribution pattern of trees along an elevation gradient of Eastern Himalaya, India. Acta Oecologica. 2011; 37:26-33.
18. Chettri B, Bhupathy S, Acharya BK. Distribution pattern of reptiles along an Eastern Himalayan elevation gradient, India. Acta Oecologica. 2010; 36:16-22.
19. Sparrow RH, Sisk DT, Ehrlich PR, Murphy DD. Techniques and Guidelines for monitoring Neotropical butterflies. Conser. Biol. 1994; 8:800-809.
20. Tokeshi M. Species coexistence: ecological and evolutionary perspectives. Blackwell Science Ltd, United Kingdom, 1999.
21. Willott SJ, Lim DC, Compton SG Sutton SL. Effects of selective logging on the butterflies of a Bornean rainforest. Conser. Biol. 2000; 14:1055-1065.
22. Foristera ML, McCallb AC, Sanders NJ, Fordycec JA, Thorned JH, Briend JO' *et al*. Compounded effects of climate change and habitat alteration shift patterns of butterfly diversity. PNAS. 2010; 107:2088- 2092.
23. Levanoni O, Levin N, Pe'er G, Turb A, Kark S. Can we predict butterfly diversity along an elevation gradient from space? Ecography, 2010; DOI: 10.1111/j.1600-0587.2010.06460.x.
24. Parmesan C, Ryrholm N, Stefanescu C, Hill JK, Thomas CD, Descimon H *et al*. Poleward shifts in geographical ranges of butterfly species associated with regional warming. Nat. 1999; 399:579-583.