



## Floral diversity and seasonal availability to butterflies (Order: Lepidoptera) at various agro-climatic landscapes of Mysore district, Karnataka, India

Bhagya U, S Basavarajappa\*

Department of Studies in Zoology, University of Mysore, Manasagangotri, Mysore, Karnataka, India

### Abstract

Persistence of herbivorous insects like butterflies completely depended on good floral source in the areas where they live and complete their life cycle. Different species, larvae and adult butterflies serve as major components of various food-chain and food-web at different agro-climatic landscapes. Several butterfly species behave like generalists or specialists based on the habitat where they live and flourish. Further, they exhibit species specific habitat requirements which should provide congenial temperature, humidity, source of good food plants for larvae and adults. Further, imago staged butterflies longevity, energy for flight and fecundity is depended on nectar (only source of carbohydrate). Hence, realizing the importance of floral source to butterfly fauna, present investigation was conducted at various distinct agro-climatic landscapes of Mysore district during 2022-2023 by following all out search, visual count and other standard methods. Total 171 host plant species and 73 nectar plant species were extended the food source to 100 different butterfly species at eight distinct agro-climatic areas during rainy, winter and summer seasons. Per cent occurrence of herbs, shrubs, trees, creepers, climbers, palm and liana was uneven and varied significantly during different seasons. Analysis of variance between different plant species and distinct landscapes revealed a significant variation existed during different seasons. Accordingly, this plant species diversity and distribution varied considerably at Mysore district. At certain landscapes, butterfly species are facing difficulty to get good food resource and travel to longer distances in search of suitable nest host plants and nectar plants during winter and summer seasons. This affected the reproductive success of butterflies by enhancing the energy investment in search of food and egg laying sites. Therefore, during the present investigation, importance of adequate requirement of host plants to complete the lifecycle of butterflies was observed. It is an important tool in the success and effective conservation management of butterflies. Thus, floral source availability is necessary during larval stage for normal growth and development, acquisition and assimilation for the future build-up of adult somatic and reproductive organs. As, butterflies are habitat specific, depended on different plant species to complete their lifecycle, maintaining distinct habitats which harbor different plant species during different seasons is essential to protect and conserve locally existing butterfly fauna. Further, butterfly species are facing severe threat due to inclement weather conditions, non-availability of required number of host plant and nectar plant species both during larval and imago stages, disturbances during breeding by various anthropogenic activities at different agro-climatic landscapes. Hence, it is high time to take appropriate mitigation measures to protect locally existed butterfly species. Further, suitable eco-friendly measures should be adopted by the farmers during cropping seasons to safeguard the nest host and nectar plant species midst different agro-climatic landscapes.

**Keywords:** Order, Lepidoptera, agro-climatic, butterflies

### Introduction

Butterflies are important plant pollinators at every local environment, which aids in the pollination of more than 50 economically important food crops (Reddy and Ravikanthachari, 2013) [2]. Butterfly larvae and adults serve as a major component of biological food chain and food web (Payra *et al.*, 2017) [1] at various agro-climatic landscapes. Persistence of herbivorous insects are completely dependent on locally available flora, where they complete life cycle on various host plants are present (Dexheimer and Despland, 2023) [3]. Floral source availability during larval development, its acquisition and assimilation is necessary for the future buildup of adult somatic and reproductive organs (Mukherjee *et al.*, 2020) [4, 17]. Hence, butterflies exhibit strong preference to specific plant species for oviposition in order to ensure prospective larval food resources (Mukherjee *et al.*, 2020) [4, 17] in the future. Thus, choice of host plant by female butterflies is moulded by elite selection to maximize the opportunities of survival, growth and development of offsprings (Strausz *et al.*, 2012) [5]. However, butterflies can be generalists or specialists (Sharma and Sharma, 2013) [6], their diet consists

of nectar, and thus become phytophagous (Subedi *et al.*, 2021) [7, 35]. The longevity, flight energetics and fecundity of butterflies is dependent on nectar from flowers which is the only source of carbohydrate for adult butterflies (Deepika *et al.*, 2014) [8]. Man-made habitats with good vegetation cover have potential to maintain butterfly diversity. Habitat types such as gardens, parks, abandoned lands and residual forests serves as good foraging habitats for butterflies in urban areas (Han *et al.*, 2022) [9]. Similarly, cultivated lands which contain several agrestals with main crop attract butterflies for their various activities (Dwari and Mondal, 2015) [10]. Knowledge of host plant requirements and life history of butterflies is an important tool in the effective protection of butterfly fauna successfully and to take appropriate conservation measures (Arju *et al.*, 2015) [11]. There are gaps in the knowledge on host plants of butterflies which is obvious from the recent publications on newly discovered host plants of various butterfly species (Baidya *et al.*, 2021) [12]; Banerjee *et al.*, 2023) [13]. Hence, the present study was undertaken with the aim of recording the seasonal availability of host plants and nectar plants to butterflies at distinct agro-climatic landscapes of Mysore district.

## Materials and methods Study area

Mysore District lies at 12°18' latitude and 76°12' longitude with an altitude of 770 meters above MSL (Gowda and Sridhara, 2014) <sup>[14]</sup>. The district experiences tropical monsoon type of climate. The average minimum and maximum temperature range from 21.4 – 34°C in April to 16.4 – 28.5°C in January. Average annual rainfall is 850mm. Mysore district is spread across seven taluks namely: Mysore, Hunsur, Piriapatna, Tirumakudal Narsipur, Nanjangud, Krishnarajanagara and Heggadadevankote (Kamath, 2011) <sup>[11]</sup>. The study was conducted across human-modified and managed habitats of rural and urban areas of these taluks of Mysore district, Karnataka. Fifteen sites were chosen randomly from each taluk of Mysore district for conducting the study during August 2022 to July 2023 (Figure 1).

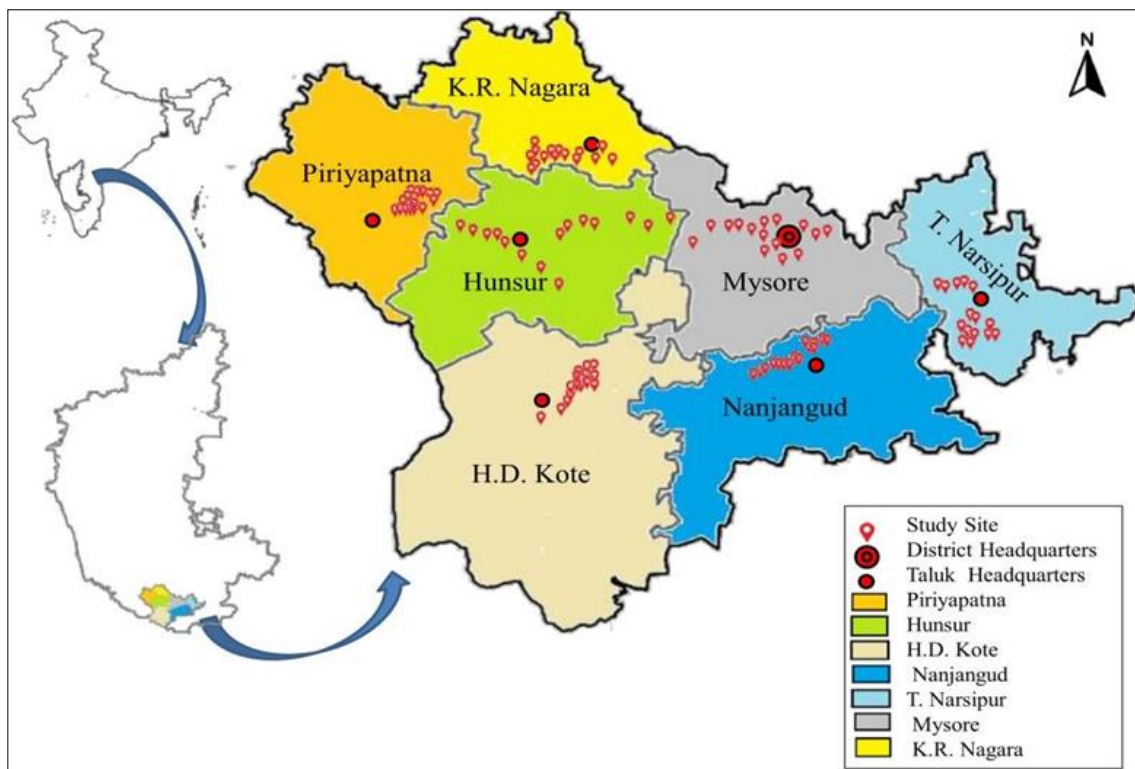
## Methodology

Observations of butterflies and associated flora were conducted across three seasons namely: rainy (June to September), winter (October to January) and summer (February to May) as per the methods of Padhye *et al.* (2006) <sup>[16]</sup>, Mukherjee and Mondal (2020) <sup>[4, 17]</sup>. Field survey

was carried out from 08:00am to 17:00pm to record butterflies during their active period. The walk census method (WCM) was adopted to observe host plants which contain eggs and larvae as per Choudhury and Agarwala (2013) <sup>[18]</sup>, Liu *et al.* (2006) <sup>[19]</sup>. More emphasize was given on direct sighting to record using photograph as per evidences (Das *et al.*, 2012) <sup>[20]</sup>. Nectar plants of butterflies were recorded by employing visual count method and all-out search method as per Raghunandan and Basavarajappa (2014) <sup>[21]</sup>, Santhosh and Basavarajappa (2016) <sup>[22]</sup>. Photographic documentation of butterflies and plants were made using Canon SX430 IS camera. Further, identification of butterflies using field guides as per Gunathilagaraj *et al.* (1998) <sup>[23]</sup> and Kehimkar (2016) <sup>[24]</sup>. Plants were identified with the help of published research papers, herbarium JCB (<http://flora-peninsula-indica.ces.iisc.ac.in>) and Butterflies of India website (<http://www.ifoundbutterflies.org>).

## Data analysis

Collected data was compiled systematically and analyzed using analysis of variance as per Saha (2009) and Maguran (2004) <sup>[26]</sup>.



**Fig 1:** Map showing study sites in Mysore district

## Results and discussion

Total 171 host plant species and 73 nectar plant species supported variously to butterflies at different agro-climatic landscapes of Mysore district. Herbs were available as nectar plants throughout the year compared to shrubs, under shrubs, climbing shrubs, trees, creepers and climbers (Table 1). Herbs (34%), trees (32.6%), shrubs (13%), under shrubs (7.5%), palms (4.2%) and climbers (4.1%), lianas (2%), climbing shrubs (2%), and creeper (0.7%) have supported butterfly fauna (Figure 2) during different seasons. Among the nectar plant species, herbs predominated more (67.1%) and it was followed by shrubs (13.7%), under shrubs (11%), trees (2.7%), creepers (2.7%), climbers (1.4%) and climbing

shrubs (1.4%) (Figure 3). Few species of trees hosted butterfly fauna throughout the year compared to herbs, shrubs, under shrubs, palms, climbers, climbing shrubs, creepers and lianas (Table 2). Nectar plant species availability was high during rainy season and it was followed by winter and summer seasons (Table 1). Host plant availability was almost same during all the seasons except for slight reduction in summer season (Table 2). Total number of host plants across different agro-climatic landscapes were 145 trees, 143 herbs, 48 shrubs, 33 under shrubs, 13 palms, 12 climbers, 5 climbing shrubs, 4 lianas and 1 creeper (Table 3). Trees and herbs were predominant host plants across all the agro-climatic landscapes and

creepers were least in their occurrence (Table 3). Total number of nectar plants across different landscapes were represented by 181 herbs, 36 under shrubs, 26 shrubs, 10 trees, 3 creepers, 1 climber and 1 climbing shrubs (Table 4). Herbs were dominant nectar plants in all landscapes and climbers and creepers were very few in their occurrence (Table 4). Analysis of variance revealed that there was no significant difference between host plants ( $F=0.0078$ ;  $P<0.05$ ) and nectar plants ( $F=0.175$ ;  $P<0.05$ ) availability during different seasons. Analysis of variance revealed that there was no significant difference between host plants ( $F=0.102$ ;  $P<0.05$ ) and nectar plants ( $F=0.273$ ;  $P<0.05$ ) availability between different landscapes. Thus, host plants and nectar plants found adequately during different seasons to locally existing butterfly fauna.

Vegetation cover is a potential driver which influence butterfly species richness, abundance and pattern of distribution (Mukherjee *et al.* 2019; Dar *et al.* 2022) [28] at different landscapes. Several authors have witnessed that host plants and nectar plants availability influence the butterflies at different habitats (Nimbalkar *et al.* 2011 [29]; Hantzon and Baz, 2013; Nacua *et al.* 2014 [31]; Dwari and Mondal, 2015 [10]; Chettri *et al.* 2018 [32]; Mukherjee *et al.* 2019; Biswas *et al.* 2022 [33]; Banerjee *et al.* 2023) [13]. Herbs and trees species are commonly selected and depended by butterflies as their host plants at different habitats of Mysore district. Similar type of observations made by Mukherjee *et al.* (2019). Many herbs provided good nectar source to butterflies (Santhosh and Basavarajappa, 2016; Ashwin *et al.* 2020 [34]; Subedi *et al.* 2021) [7, 35], as species of herbs bloom throughout the year (Santhosh and Basavarajappa, 2016) [22] amidst waste landscapes, provide source of food to butterflies. During rainy season, vegetation diversity and density increases, thus provides a greater number of floral sources to butterflies for their feeding, oviposition and protection at Mysore district. Similar type of observation was made by Jaramillo *et al.* (2019) and others.

During the present investigation, man-made habitats like parks in urban areas, institutional campuses and cultivated land have recorded high diversity of host plants and nectar plants compared to other landscapes. Man-made habitats containing cultivated plants especially nectar rich flowering plants which have hosted several butterfly species and maintain high diversity of butterflies compared to the natural landscapes. Similar type of observations was made by Tiple *et al.* (2005) [35] at institutional campuses, where large open areas are with rich vegetation, provided good source of food (e.g. nectar) to butterflies. Cultivated lands with weeds growing along with crops offer important source of nectar to butterflies in agricultural areas (Kleiman and Koptur, 2023) [38]. Similar type of observations made by Antony *et al.* (2016) [39], Sobczyk *et al.* (2017) [40] at agricultural landscapes. Any disturbance to the flora of a different landscape due to anthropogenic activities would reduce butterfly species (Tiple, 2012 [41]; Mahata *et al.* 2019) [42]. Since host plants and nectar plants are fundamental for reproduction of butterflies, knowledge about the availability of flora for oviposition and feeding is a prerequisite for any butterflies survival and their conservation (Sharma *et al.* 2016) [43]. Therefore, inventorying locally available flora to butterfly fauna of agro-climatic landscapes is essential to protect local biodiversity. In this regard, our observations are on par with the observation of Tiple *et al.* (2005) [37], Nimbalkar *et al.* (2011) [29], Tiple (2012) [41], Hantzon and Baz (2013), Nacua *et al.* (2014) [31], Dwari and Mondal (2015) [10], Santhosh and Basavarajappa (2016) [22], Antony *et al.* (2016) [39], Sobczyk *et al.* (2017) [40], Chettri *et al.* (2018) [32], Mukherjee *et al.* (2019), Jaramillo *et al.* (2019), Mahata *et al.* (2019) [42], Ashwin *et al.* (2020) [34], Subedi *et al.* (2021) [7, 35], Biswas *et al.* (2022) [33], Dar *et al.* (2022) [28], Banerjee *et al.* (2023) [13], Kleiman and Koptur (2023) [38]. Thus, present study throws an insight on floral availability amidst different agroclimatic landscapes to butterfly fauna of Mysore district.

**Table 1:** Seasonal availability of nectar plants to butterflies

| Sl. No.   | Habit          | Seasonal availability |       |        |        |
|-----------|----------------|-----------------------|-------|--------|--------|
|           |                | Throughout year       | Rainy | Winter | Summer |
| 1         | Herb           | 20                    | 46    | 38     | 33     |
| 2         | Shrub          | 8                     | 8     | 8      | 9      |
| 3         | Undershrub     | 5                     | 7     | 6      | 7      |
| 4         | Climbing shrub | 1                     | -     | -      | 1      |
| 5         | Tree           | 1                     | 2     | 2      | 2      |
| 6         | Climber        | -                     | 1     | -      | -      |
| 7         | Creeper        | 1                     | 2     | 2      | 2      |
| Total     |                | 36                    | 66    | 56     | 54     |
| 'F' value |                | 0.175 NS              |       |        |        |

**Table 2:** Seasonal availability of host plants to butterflies

| Sl. No. | Habit          | Seasonal availability |       |        |        |
|---------|----------------|-----------------------|-------|--------|--------|
|         |                | Throughout year       | Rainy | Winter | Summer |
| 1       | Herb           | 34                    | 36    | 37     | 38     |
| 2       | Shrub          | 14                    | 18    | 17     | 14     |
| 3       | Undershrub     | 10                    | 10    | 11     | 11     |
| 4       | Climbing shrub | 3                     | 3     | 3      | 3      |
| 5       | Tree           | 46                    | 46    | 46     | 46     |
| 6       | Climber        | 4                     | 5     | 5      | 4      |
| 7       | Creeper        | 1                     | 1     | 1      | 1      |
| 8       | Liana          | 1                     | 2     | 3      | 2      |
| 9       | Palm           | 6                     | 6     | 6      | 6      |

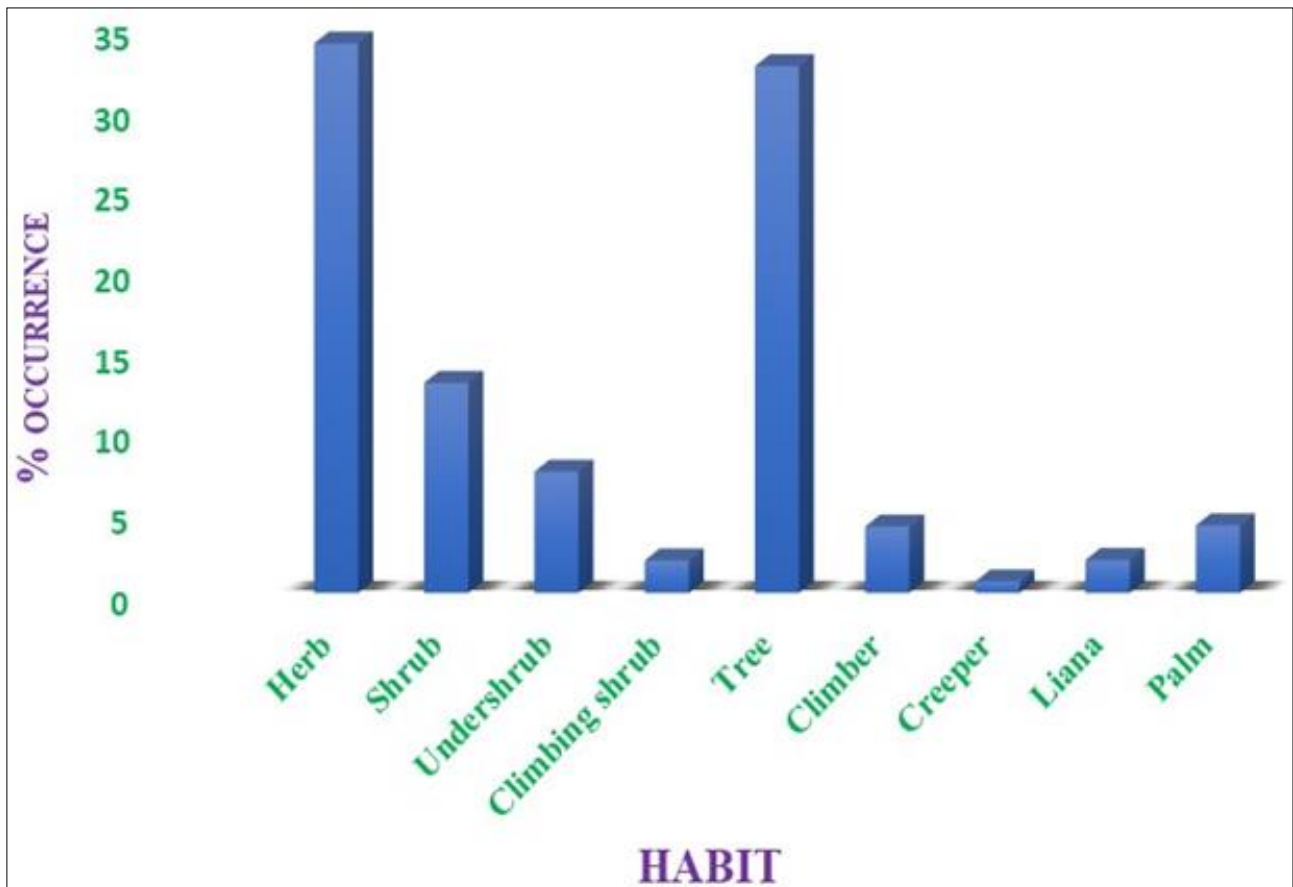
|           |  |           |     |     |     |
|-----------|--|-----------|-----|-----|-----|
| Total     |  | 119       | 127 | 129 | 124 |
| 'F' value |  | 0.0078 NS |     |     |     |

**Table 3:** Availability of host plants to butterflies across different agro-climatic landscapes

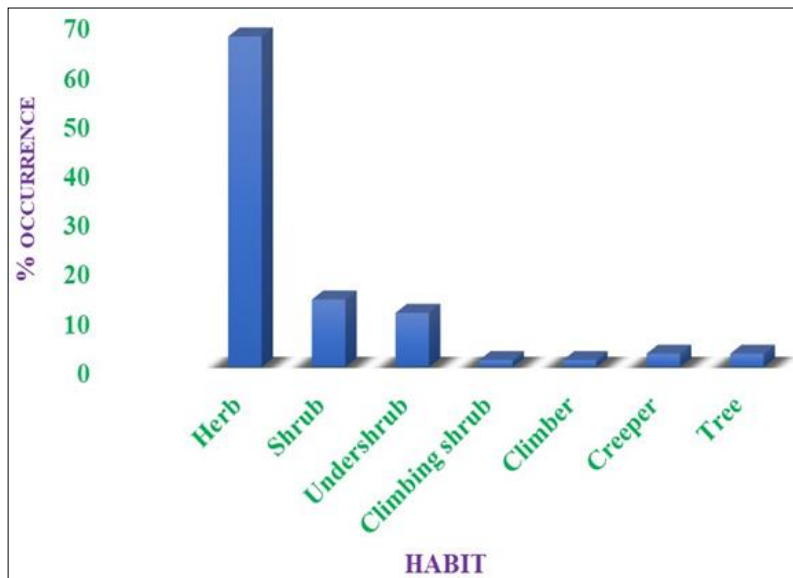
| Sl. No.   | Habit          | Type of landscape |      |                  |                      |         |            |                 |                 |
|-----------|----------------|-------------------|------|------------------|----------------------|---------|------------|-----------------|-----------------|
|           |                | Park              | Lake | Residential area | Institutional campus | Nursery | Road verge | Cultivated land | Weed vegetation |
| 1         | Herb           | 23                | 13   | 16               | 18                   | 16      | 17         | 23              | 17              |
| 2         | Shrub          | 8                 | 9    | 6                | 5                    | 4       | 7          | 4               | 5               |
| 3         | Undershrub     | 2                 | 5    | 6                | 3                    | -       | 7          | 5               | 5               |
| 4         | Climbing shrub | 1                 | -    | -                | 1                    | 1       | 1          | 1               | -               |
| 5         | Tree           | 19                | 23   | 9                | 30                   | 14      | 22         | 19              | 9               |
| 6         | Climber        | -                 | 1    | 4                | 1                    | -       | 1          | 4               | 1               |
| 7         | Creeper        | -                 | 1    | -                | -                    | -       | -          | -               | -               |
| 8         | Liana          | -                 | -    | -                | -                    | -       | 2          | 2               | -               |
| 9         | Palm           | 6                 | 1    | 1                | 1                    | 1       | 1          | 1               | 1               |
| Total     |                | 59                | 53   | 42               | 59                   | 36      | 58         | 59              | 38              |
| 'F' value |                | 0.102 NS          |      |                  |                      |         |            |                 |                 |

**Table 4:** Availability of nectar plants to butterflies across different agro-climatic landscapes

| Sl. No.   | Habit          | Type of landscape |      |                  |                      |         |            |                 |                 |
|-----------|----------------|-------------------|------|------------------|----------------------|---------|------------|-----------------|-----------------|
|           |                | Park              | Lake | Residential area | Institutional campus | Nursery | Road verge | Cultivated land | Weed vegetation |
| 1         | Herb           | 39                | 26   | 22               | 20                   | 17      | 18         | 24              | 15              |
| 2         | Shrub          | 7                 | 1    | 3                | 3                    | 4       | 2          | 4               | 2               |
| 3         | Undershrub     | 4                 | 6    | 4                | 3                    | 2       | 6          | 7               | 4               |
| 4         | Climbing shrub | -                 | -    | -                | -                    | -       | 1          | -               | -               |
| 5         | Tree           | 2                 | 1    | 1                | 1                    | 1       | 1          | 3               | -               |
| 6         | Climber        | -                 | 1    | -                | -                    | -       | -          | -               | -               |
| 7         | Creeper        | -                 | -    | -                | 1                    | -       | 1          | 1               | -               |
| Total     |                | 52                | 35   | 30               | 28                   | 24      | 29         | 39              | 21              |
| 'F' value |                | 0.273 NS          |      |                  |                      |         |            |                 |                 |



**Fig 2:** Per cent occurrence of host plant species available to butterflies



**Fig 3:** Per cent occurrence of nectar plant species available to butterflies



**Fig 4:** Few butterfly species nectarine on different plant species

## Conclusion

The different distinct landscapes supported locally existing butterfly fauna by providing necessary host plants and nectar plants in Mysore district. Finally, it can be concluded that vegetation prevailed in different landscapes during different seasons supported the locally existing butterfly fauna.

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## Conflict of interest

The authors declare no conflict of interests.

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