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The Importance of Nature (Length) of Proboscis in Hesperiidae Butterflies

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ABSTRACT

Different insects have adapted themselves to different modes of ingestion of food. The feeding in butterflies is analogous to inserting a straw into a drink to withdraw fluid. Modifications in the parts around mouth in butterflies appear to be the most significant feature in their life. Most of the butterflies feed on floral nectars. Butterflies, therefore may have a role as efficient pollinators for respective host plants. Development of long proboscis as modified mouth parts in butterflies has been regarded as an example of co-evolutionary line in animal kingdom. The Hesperiidae butterflies of Mayureshwar Wildlife sanctuary have shown variations in their length of proboscis. The hesperiidae butterflies with longer proboscis visit plant species having flowers with long or deep-tube. Hesperiidae butterfly proboscis helps to take up nectar food from long or deep tubed as well as short tubed flowers. The hesperiidae butterflies with extremely long proboscis in present attempt were observed to obtain the nectar from their preferred host plants. The Calathea species have been reported as nectar host plants for the Hesperiidae butterflies of Mayureshwar Wildlife sanctuary. The Hesperiidae butterflies of Mayureshwar Wildlife sanctuary have shown not to be contributed for pollination. Species of skipper butterflies (family: Hesperiidae) with long proboscis could potentially utilize short flowers in addition to long flowers. It was expected that, the number of flowering species visited by skipper butterflies (family: Hesperiidae) would be greater than that of species skipper butterflies (family: Hesperiidae) with short proboscis. The data in the present attempt supported the hypothesis. The skipper butterflies (family: Hesperiidae) with extremely long-proboscis, generally did not visit flowers with short nectar spurs. Both Lantana camera (L) (Family: Verbenaceae) and Stachytarpheta frantzii (L) (Family: Verbenaceae) attracted many different flower-visiting insects. This was because, the flowers of Lantana camera (L) (Family: Verbenaceae) and Stachytarpheta frantzii (L) (Family: Verbenaceae) were easily accessible. These flowers have been continuously exploited by a great variety of butterfly species possessing rather short proboscis. The skipper butterflies (family: Hesperiidae) with long-proboscis were crowded out to deep-tubed flowers.

Keywords: *Hesperiidae; Mayureshwar; Siphoning; Corolla Tube; Proboscis.*

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1. INTRODUCTION

The presence of siphoning and sucking type of mouthparts is the significant feature of butterflies and moths. The siphoning and sucking type of mouthparts are best suited to draw nectar from the flowers. Siphoning and sucking type of mouthparts are mostly present in the adult butterflies and moths (Order Lepidoptera). Larval instars of butterflies and moths are with chewing type mouthparts. The labium in siphoning and sucking type of mouthparts is reduced to a triangular plate bearing labial palps. The mandibles and hypopharynx are absent in siphoning and sucking type of mouthparts. Maxillary palps and labial palps are present in a reduced condition. The only well-developed structures are galea of the first maxillae. The galea are greatly elongated semi-tube like structures. When these two galeae are applied and locked together along the length, they form a long tubular proboscis. The locking of galeae is done with the help of pegs and sockets. When not in use, the proboscis is coiled like a watch spring. The feeding in butterflies is analogous to inserting a straw into a drink to withdraw fluid food material. At the time of feeding, the proboscis is straightened up due to the high pressure of haemolymph. This pressure is generated in the stipes which are associated with each galea. Coiling results from the elasticity of the cuticle of galea together with the activity of the intrinsic muscles. The uncoiled-proboscis thrusts out into the nectaries of the flowers. Due to the sucking action of cibarium muscles and pharyngeal muscles, the nectar is sucked up.

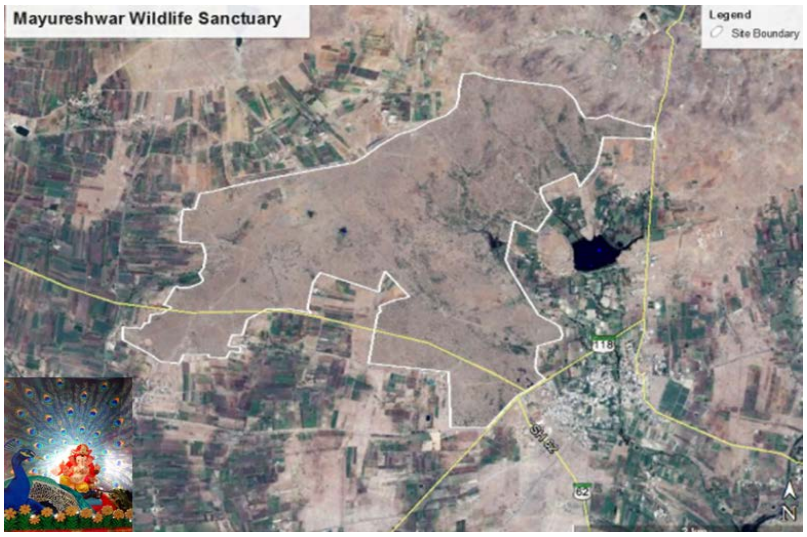
Many researchers, including Darwin have pondered over the evolutionary processes of long proboscis of flower visiting butterflies (Charles Darwin, 1862; Johnson, 1997; Johnson and Anderson, 2010; Muchhala and Thomson, 2009; Nilsson, 1988, 1998; Pauw *et al*., 2009; Rodrı´guez-Girone´s and Llandres, 2008; Rodrı´guez-Girone´s and Santamarı´a, 2007; Wasserthal, 1997, 1998; Whittall and Hodges, 2007). Extremely long proboscis in the butterflies has been supposed to be related with the evolution of long nectar spurs in angiosperm plant species (Darwin 1862; Nilsson 1998). Earlier studies by Krenn (2010); Courtney, et al (1982); Wiklund, *et al* (1979) and Wiklund (1981), mentioned "Doubtfulness regarding some of the butterflies as efficient pollinators". There are very few reports on "Mutual relation for co-evolution between species of butterflies and the species of preferred nectar host plants" (Gilbert, 1972, 1975; Grant and Grant, 1965; Levin and Berube, 1972). According to some researchers like Stefanescu and Traveset (2009) and others, butterflies are the flower visitors of "Opportunistic Category" and they are using the available natural resources in the form of plant flower – nectar as they become available during the season (Shreeve, 1992; Stefanescu

and Traveset, 2009; Tudor *et al.*, 2004). The influence of length of butterfly proboscis for visiting a common plant or a special plant has been supposed to remain contradictory. Here, in the present attempt, it was tried to best study the Hesperiidae butterflies of Mayureshwar Wildlife Sanctuary with a wide range of length of proboscis. Provision of long proboscis as a mouth part has made the hesperiidae butterflies the most efficient for visiting a wide variety of flowers regardless of nectar spur length in an opportunistic way. "To test the hypothesis on extremely long proboscis mouth parts specialized for visiting the flowers with deep nectar spurs" was the prime aim of the present attempt.

2. MATERIALS AND METHODS

(A) Study Area; Plant Species and Butterfly Species For the Study:

The study area for the present attempt was "Mayureshwar Wildlife Sanctuary" belonging to Deccan Plateau. It is located in Supe Tal. Baramati Dist. Pune Maharashtra India (Co-ordinates: 18^0 20' 6" N 74^0 22' 15" E) (Fig. 1 and 2). The higher density of host plants for hesperiidae butterflies in this region included: *Lantana camera* (L) (Verbenaceae) ; *Stachytarpheta frantzii* (L) (Verbenaceae); *Calatheca lutea* (L) (Marantaceae) and *Calathea crotalifera* (L) (Marantaceae). Therefore, these flowering plant species were selected for recording hesperiidae butterflies visitation. The study was carried during September, October, 2017 and January, February, 2018.



https://www.researchgate.net/figure/Mayureshwar-Wildlife-Sanctuary-site_1_316084100

Fig.1: Mayureshwar Wildlife Sanctuary Site.

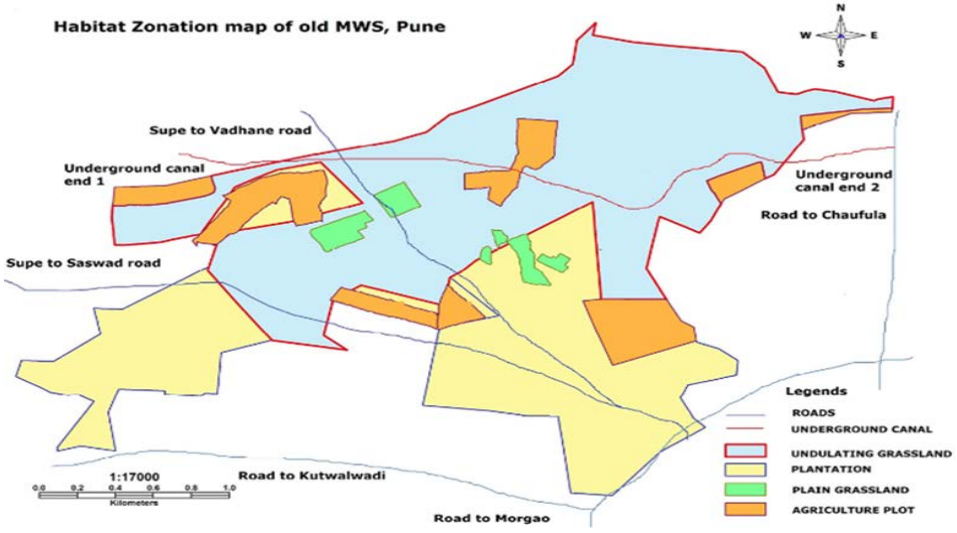


Fig.2: Habitat Zonation of Mayureshwar Wildlife Sanctuary.

The plant species *Lantana camera* (L) (Verbenaceae) ; *Stachytarpheta frantzii* (L) (Verbenaceae); *Calatheca lutea* (L) (Marantaceae) and *Calathea crotalifera* (L) (Marantaceae) were observed in flowering condition in the study area during the whole tenure of the study attempt. These plant species were in seminatural garden of Mayureshwar Wildlife Sanctuary of Supe, which borders on natural forest habitats. One more feature of these plant species was growing in a close proximity to each other, and within the reach of the butterfly species foraging in this area. Mayureshwar Wildlife Sanctuary of Supe, the study area availed the richest supply of nectar throughout the year. This system made the study area thighly attractive for its varied number and the variety of butterflies. The butterflies use the system for colonizing the surrounding natural and seminatural habitats (Vitthalrao B Khyade and Sharad G Jagtap, 2017). The four studied flowering plant species *Lantana camera* (L) (Verbenaceae); *Stachytarpheta frantzii* (L) (Verbenaceae); *Calatheca lutea* (L) (Marantaceae) and *Calathea crotalifera* (L) (Marantaceae) made different demands on their butterfly visitors. This might be due to varying corolla lengths of four studied flowering plant species *Lantana camera* (L) (Verbenaceae); *Stachytarpheta frantzii* (L) (Verbenaceae); *Calatheca lutea* (L) (Marantaceae) and *Calathea crotalifera* (L) (Marantaceae). Warren *et al*. (2009) reported that, the observation of butterflies visiting these flowers allowed for the conclusions on the flower morphology preferences, i.e., corolla length, of butterflies with varying proboscis lengths.

The collection of skipper butterflies was carried out soon after their landing on flowers, and subsequently uncoiled the proboscis. Hand nets were used for collection. The collected skipper butterfly specimens were stored in seventy percent ethanol. The classification of taxa followed the recent phylogeny of Hesperiidae (Warren *et al.* 2009).

(B) Measurement of Length of the Proboscis of Skipper Butterflies:

Proboscis length of skipper butterfly specimens (preserved in seventy percent ethanol) was measured. The proboscis of each skipper butterfly specimen was separated from the head at its base. It was then uncoiled and fixed on a foam mat using insect pins. Nikon SMZ 1500 stereomicroscope was utilized for microphotography of proboscis. Micrographs were imported to the proboscis length which was measured with the aid of the segmented line tool. The proboscis lengths of skippers caught in September, October, 2017 and January, February, 2018 were measured.

(C) Floral Biology and Length of Corolla:

The flowers of *Lantana camera* (L) (Family: Verbenaceae) were small and mostly yellow or orange in color, changing to red or scarlet with age. The lantana flowers formed a slightly curved corolla tube. Lantana flowers were arranged in hemispheric inflorescences, measuring up to 3 cm wide, that could be used by butterflies as a landing platform (Woodson *et al.* , 1973). The flowers of *Stachytarpheta frantzii* (L) (Family: Verbenaceae); were larger than that of *Lantana camara* (L). The color of flowers of *Stachytarpheta frantzii* (L) (Family: Verbenaceae) was purple. The corolla flowers of *Stachytarpheta frantzii* (L) (Family: Verbenaceae) were fused to a slender cylindrical tube. It is semi-immersed in the rachis of spikes. The flowers were arranged in terminal inflorescences (Woodson *et al*. 1973).

The flowers of *Calathea crotalifera* (L) (Family: Marantaceae) and *Calathea lutea* (L) (Family: Marantaceae) were with yellow tube and hooded staminode, that held the style under tension. These flowers exhibited unique features helping in mechanism of pollination mechanism (Bauder, *et al*. 2011). The pollination occurred only when the skipper butterfly touched a trigger like appendage of the hooded staminode, which held the style under tension. The style in the flower sprang forward, scraped off any pollen from the insect and simultaneously placed its pollen onto the flower visitor (Pischtschan and Claßen-Bockhoff, 2008). The triggered movement of the style deserved "Irreversible Nature". Therefore, there was only one opportunity for the flower for pollination. The position of the style after releasement prevented any pollen from subsequently entering the stigma (Kennedy 2000). Since the movement of style was easily visible and the flowers could be inspected after visitation, the present attempt was able to determine whether skippers released the trigger and thus potentially acted as efficient pollinators. For the purpose to measure the length of corolla, flowers from individual plants of concerned group at different locations of study area were collected. Freshly collected flowers were used for estimating the length of corolla. For the curved corolla, each flower was straightened with the aid of a dissection needle. Digital caliper was used for the measurement of the length of the corolla. The tips of the petals and the point of origin of ovary were considered for the length of corolla of the individual flower.

(D) Record (Video) of Visit of Skipper Butterflies to the flowers:

Skipper butterflies foraging on untriggered flowers of *Calathea crotalifera* (L) were recorded using a Sony HDR-XR550VE Handycam (Sony Corporation, Tokyo, Japan) in their natural environment (nine interactions), and in an outdoor cage equipped with freshly cut inflorescences (four interactions). Videos were checked for trigger releasement with the software PMB 5.0.02.11130 (Sony Corporation, Tokyo, Japan).

(E) Statistical Analysis of the data:

The whole attempt was repeated for three times. This repetition was for the purpose to obtain consistency in the results. The collected data was subjected for statistical analysis. The statistical package IBM SPSS Statistics 21.0 (IBM Corporation, New York, USA) was utilized for calculation. The Kruskal–Wallis ANOVA was used for analysis. Mann - Whitney U tests (Bonferroni-corrected significance level: $p = 0.008$) were used for the post hoc tests. The Sigma Plot 12.5 (Systat Software Incorporated, San Jose, California, USA), CorelDRAW X6 (Corel Corporation, Munich, Germany) and Adobe Photoshop CS4 Extended 11.0.2 (Adobe Systems Incorporated, San Jose, California, USA) were used for Graphical illustrations.

3. RESULTS AND DISCUSSION

The results on ecological significance of extremely long-proboscis in Hhesperiidae butterflies at Mayureshwar Wildlife Sanctuary have been summerised in the tables (1, 2 and 3) and Fig. (3, 4, 5 and 6). The total number of individual skipper butterflies visiting the flowers of *Lantana camera* (L) (Family:

Verbenaceae); *Stachytarpheta frantzii* (L) (Family: Verbenaceae); *Calathea crotalifera* (L) (Family: Marantaceae) and *Calathea lutea* (L) (Family: Marantaceae) was found to be 228. They bgelonged to 43 species and 30 genera (Table - 1). All the species of plants were found to be significantly different in corolla length (X^2 (3) = 121.5; p < 0.0001 (Table - 2). The *Calathea lutea* (L) (Family: Marantaceae) had the deepest nectar spurs measuring 31.6 (± 2.786) mm (N = 97), and those of *Calathea crotalifera* (L) (Family: Marantaceae) 26.011 (± 2.283) mm deep (N = 45). Nectar spurs of *Stachytarpheta frantzii* (L) (Family: Verbenaceae) were observed to be 16.228 (± 1.264) mm (N = 12). *Lantana camera* (L) (Family: Verbenaceae) was observed to have the shortest nectar spurs, measuring about 10.524 (± 1.712) mm (N = 12). Both, *Lantana camera* (L) (Family: Verbenaceae) and *Stachytarpheta frantzii* (L) (Family: Verbenace) were observed to receive frequent visits from butterflies of other families (Pieridae, Nymphalidae, Papilionidae and Lycaenidae). The *Calathea crotalifera* (L) (Family: Marantaceae) and *Calathea lutea* (L) (Family: Marantaceae) were reported to be visited by butterflies belonging exclusively to the family of Hesperiidae. This result was similar to that reported by Bauder, *et al* (2011). The length of proboscis of the skipper butterflies in the present study differed significantly according to the nectar host plants utilizing [X^2 (3) = 96.8, p\0.0001)]. The flowers of the *Lantana camera* (L) (Family: Verbenaceae) were with the shortest corolla length (among the flowers studied in the present attempt). Therefore, the flowers of the *Lantana camera* (L) (Family: Verbenaceae) in the present attempt had the skipper butterflies visitors with significantly shorter proboscis. This was in comparison with the skipper butterflies visitors of the other three nectar host plant species in the study [*Stachytarpheta frantzii* (L) (Family: Verbenaceae); *Calathea crotalifera* (L) (Family: Marantaceae) and *Calathea lutea* (L) (Family: Marantaceae)]. The skipper butterflies visitors of *Stachytarpheta frantzii* (L) (Family: Verbenaceae) in the present attempt were also observed significantly different from the other flower visitors with reference to the length of their proboscis (Table 3). The skipper butterflies visitors of *Stachytarpheta frantzii* (L) (Family: Verbenaceae) had longer proboscis in comparison with the skipper butterflies of *Lantana camera* (L) (Family: Verbenaceae). Furthermore, the skipper butterflies visitors of the flower visitors of *Calathea crotalifera* (L) (Family: Marantaceae) and *Calathea lutea* (L) (Family: Marantaceae) in the present attempt were reported with significantly longer proboscis than that of the skipper butterfly visitors of *Lantana camera* (L) (Family: Verbenaceae) and *Stachytarpheta frantzii* (L) (Family: Verbenaceae) (Table 3). The length of corolla of *Calathea crotalifera* (L) (Family: Marantaceae) and *Calathea lutea* (L) (Family: Marantaceae) in the present attempt was found to be significantly different from each other (Table -2). However, proboscis lengths of skipper butterfly visitors of these two Calathea species [*Calathea crotalifera* (L) (Family: Marantaceae) and *Calathea lutea* (L) (Family: Marantaceae)] in the present attempt appeared similar (Table 3).

The skipper butterflies (family: Hesperiidae) were with extremely long proboscis, measuring longer than 30 mm. Such butterflies visited flowers with deep nectar spurs. The skipper butterflies (family: Hesperiidae) with shorter proboscis used to visit flowers with shorter nectar spurs. The data of the present attempt indicated that, the skipper butterflies (family: Hesperiidae) with extremely long proboscis refrained from visiting short-tubed flowers, since the number of interactions with flowers of different nectar host plant species did not increase with increasing the proboscis length. Moreover, the pattern of interaction was compartmentalized indicating that skipper butterflies (family: Hesperiidae) with shorter proboscis were separated from the skippers with longer proboscis with reference to the preference of flowers. Each of the skipper butterflies (family: Hesperiidae) with shorter proboscis was using different sets of flowering plants as their source of nectar. The video recordings of visits of thirteen skipper butterflies (family: Hesperiidae) on un-triggered flowers of ***Calathea crotalifera* (L) (Family: Marantaceae)** reported that 92.4 % of the visited flowers, remained un-triggered after the skipper left the flower. During a single flower visit, the skipper butterfly (family: Hesperiidae) released the trigger mechanism with a leg through water droplet onto the style of flower.

The resources of food material was the force of driving to establish the coexistence among the living beings (Hespenheide, 1973;Inouye, 1980; Ranta and Lundberg, 1980 and Schoener, 1974). It was often the method of estimation of correlation through the use of morphological characters. These morphological characters included: the size differences between animals or the differences in mouthparts in relation to the size of food particles. The butterflies and the moths deserved a significant feature of development of siphoning type of mouth parts. The mandibles and labium in butterflies and moths reduced very much. The labrum was nearly a narrow transverse band, very long and deeply grooved medially. When applied together, the two galae enclosed fine food channel, and formed a prominent proboscis. They were the main siphoning tubes.

Table 1: The length of proboscis of Hesperiidae Butterflies Visited the Flowers of Selected Plant Species at Mayureshwar Wildlife Sanctuary of Baramati Tehsil of Pune (India).

Serial No.	Hesperiidae Butterfly Species	N	Proboscis Length (mm)	Flower Visited By Hesperiidae Butterfly
1.	Eudaminae *Astraptes alardus latia* (Evans, 1952).	3	23.735 (± 2.436)	*Calathea lutea* (L) (Family:Marantaceae).
2.	Eudaminae *Astraptes anaphus anetta* (Evans, 1952).	3	19.700 (± 2.011)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae).
3.	Eudaminae *Autochton longipennis* (Plotz, 1882).	4	17.473 (± 1.786)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae).
4.	Eudaminae *Autochton zarex* (Hubner, 1818).	3	16.463 (± 1.513)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae).
5.	Eudaminae *Bungalotis quadratum quadratum* (Sepp, 1845)	3	28.129 (± 2.547)	*Calathea lutea* (L) (Family: Verbenaceae).
6.	Eudaminae *Cogia calchas*	3	12.669 (± 1.618)	*Lantana camera* (L) (Family: Verbenaceae)

	(Herrich-Schaffer, 1869).			(N=3). *Stachytarpheta frantzii* (L) (Family: Verbenaceae) (N=3).
7.	Eudaminae *Spathilepia clonius* (Cramer, 1775).	4	16.968 (± 1.413)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae).
8.	Eudaminae *Typhedanus undulates* (Hewitson, 1867).	3	12.524 (± 1.043)	*Lantana camera* (L) (Family: Verbenaceae)
9.	Eudaminae *Urbanus procne* (Plotz, 1881).	4	16.059 (± 1.833)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae)
10.	Eudaminae *Urbanus simplicius* (Stoll, 1790).	11	16.665 (± 1.413)	*Lantana camera* (L) (Family: Verbenaceae) (N=7). *Stachytarpheta frantzii* (L) (Family: Verbenaceae) (N=3).
11.	Eudaminae *Urbanus tanna* (Evans, 1952).	10	16.867 (± 0.856)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae) (N=7). *Lantana camera* (L) (Family: Verbenaceae) (N=3).
12.	Eudaminae *Urbanus teleus* (Hubner, 1821).	5	16.463 (± 1.736)	*Lantana camera* (L) (Family: Verbenaceae) (N=4). *Stachytarpheta frantzii* (L) (Family: Verbenaceae) (N=2).
13.	Eudaminae *Saliana sevens* (Mabille, 1895).	3	52.319 (± 3.786)	*Calathea crotalifera* (L) (Family: Marantaceae)
14.	Eudaminae *Saliana triangularis* (Kay, 1914).	7	41.915 (± 3.339)	*Calathea crotalifera* (L) (Family: Marantaceae)(N=6). *Calathea lutea* (L) (Family: Marantaceae)(N=3).
15.	Eudaminae *Talides hispa* (Evans, 1955).	3	45.955 (± 5.661)	*Calathea lutea* (L) (Family: Marantaceae).
16.	Eudaminae Tracides phidon (Cramer, 1779).	3	42.476 (± 5.233)	*Calathea lutea* (L) (Family: Marantaceae).
17.	Eudaminae *Tromba xanthura* (Godman, 1901).	3	48.682 (± 6.786)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae).
18.	Anthoptini Corticera lysias lysias (Plotz, 1883).	3	14.241 (± 1.853)	*Lantana camera* (L) (Family: Verbenaceae).
19.	Moncini *Arita arita* (Schaus, 1902).	3	28.337 (± 3.789)	*Calathea crotalifera* (L) (Family: Marantaceae).
20.	Moncini	3	16.665	*Lantana camera* (L)
	Cymaenes alumna (A. Butler, 1877).		(± 3.032)	(Family: Verbenaceae).
21.	Moncini *Lerema ancillaries* (A. Butler, 1877).	3	20.705 (± 3.673)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae).
22.	Moncini *Moris geisa* (Moschler, 1879).	11	20.932 (± 1.978)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae) (N=10). *Lantana camera* (L) (Family: Verbenaceae) (N=3).
23.	Moncini *Moris micythus* (Godman, 1900).	3	19.796 (± 1.392)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae) (N=3). *Lantana camera* (L) (Family: Verbenaceae) (N=3).
24.	Moncini *Papias phaeomelas* (Hubner, 1831).	12	17.473 (± 1.396)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae).
25.	Moncini *Papias phainis* (Godman, 1900).	3	16.362 (±3.379)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae).
26.	Moncini *Papias subcostulata* (Herrich-Schaffer, 1870).	18	27.453 (±3.014)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae)(N=12) *Calathea lutea* (L) (Family: Marantaceae)(N=3)
27.	Moncini *Vehilius stictomenes illudens* (Mabille, 1891).	3	13.520 (±1.111)	*Lantana camera* (L) (Family: Verbenaceae)
28.	Hesperiini *Pompeius Pompeius* (Latreille, 1824).	6	15.254 (±3.173)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae)(N=5) *Lantana camera* (L) (Family: Verbenaceae) (N=3).
29.	Hesperiini *Quinta cannae* (Herrich-Schaffer, 1869).	9	21.917 (±3.966)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae)
30.	Pyrginae Pyrrhopygini Mysoria ambigua (Mabille and Boullet, 1908)	7	15.453 (±2.423)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae)
31.	Celaenorrhini *Celaenorrhinus darius* (Evans, 1952).	3	30.098 (±5.654)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae)
32.	Carcharodini *Nisoniades godma* (Evans, 1953).	3	11.819 (±3.538)	*Lantana camera* (L) (Family: Verbenaceae)
33.	Hesperiinae *Lycas godart*	3	47.071 (±14.091)	*Calathea lutea* (L) (Family:

	boisduvalii (Ehmann, 1909).			Marantaceae).
34.	Hesperiinae Perichares adela (Hewitson, 1867).	11	45.834 (±6.786)	*Calathea lutea* (L) (Family: Marantaceae)(N=8). *Calathea crotalifera* (L) (Family: Marantaceae)(N=3).
35.	Hesperiinae *Perichaeres lotus* (A. Butler, 1870).	3	49.948 (±5.896)	*Calathea lutea* (L) (Family: Marantaceae).
36.	Hesperiinae *Pyrrhopygopsis Socrates orasus* (H.Druce, 1876).	3	35.432 (±2.358)	*Calathea lutea* (L) (Family: Marantaceae).
37.	Calpodini *Aroma henricus henricus* (Staudinger, 1876).	3	30.906 (±2.786)	*Calathea crotalifera* (L) (Family: Marantaceae)
38.	Calpodini *Calpodes ethlius* (Stoll, 1782).	5	43.044 (±1.529)	*Calathea lutea* (L) (Family: Marantaceae)(N=4). *Calathea crotalifera* (L) (Family: Marantaceae) (N= 3).
39.	Calpodini *Carystoides escalantei* (H. Freeman, 1969).	6	33.163 (±1.498)	*Calathea lutea* (L) (Family: Marantaceae).
40.	Calpodini *Carystoides hondura* (Evans, 1955).	3	29.767 (±1.235)	*Calathea lutea* (L) (Family: Marantaceae)(N=3). *Calathea crotalifera* (L) (Family: Marantaceae) (N= 3).
41.	Calpodini *Damas clavus* (Herrich-Schaffer, 1869).	19	51.996 (±8.403)	*Calathea lutea* (L) (Family: Marantaceae)(N=10). *Calathea crotalifera* (L) (Family: Marantaceae) (N= 6).
42.	Calpodini *Damas immaculate* (Nicolay, 1973).	3	53.227 (±8.786)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae)
43.	Calpodini *Saliana esperi esperi* (Evans, 1955).	3	36.259 (±2.221)	*Calathea lutea* (L) (Family: Marantaceae)

-Each figure is the Mean of three replications.
-The figures in parentheses with ± are the standard deviations.
-When two or more plant species were visited by individual butterflies of one species, the number of observed flower visits to each plant species has been given in parentheses.

Table 2: Pair-wise post hoc tests (Mann–Whitney U tests, p \0.008; Bonferronicorrected).

Serial No.	Host Plant and Corolla length of flower (mm)	*Lantana camera* (L) (Family: Verbenaceae)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae)	*Calathea crotalifera* (L) (Family: Marantaceae)
1.	*Lantana camera* (L) (10.3; 8.5-11.7)	-	-	-
2.	*Stachytarpheta frantzii* (L) (15.8; 14.7-18.2)	$p < 0.0001^*$		-
3.	*Calathea crotalifera* (L) (25.3; 22.3 – 28.4)	$p < 0.0001^*$	$p < 0.0001^*$	-
4.	*Calathea lutea* (L) (31.3; 26.6 – 36.3)	$p < 0.0001^*$	$p < 0.0001^*$	$p < 0.0001^*$

-Median; Minimal and Maximal Coroll Length of Each Nectar Host Plant are given in bracket. -The "Pair-wise post hoc tests" showed that all nectar host plants differed significantly in corolla length.

Table 3: Pairwise post hoc tests (Mann–Whitney *U* tests, $p < 0.008$; Bonferroni-corrected).

Serial No.	Host Plant and Corolla length of flower (mm)	*Lantana camera* (L) (Family: Verbenaceae)	*Stachytarpheta frantzii* (L) (Family: Verbenaceae)	*Calathea crotalifera* (L) (Family: Marantaceae)
1.	*Lantana camera* (L) (15.5; 10.8–49.4)	-	-	-
2.	*Stachytarpheta frantzii* (L) (17.7; 13.1-52.8)	$p < 0.0001^*$		-
3.	*Calathea crotalifera* (L) (42.2; 27.5–52.6)	$p < 0.0001^*$	$p < 0.0001^*$	-
4.	*Calathea lutea* (L) (43.0; 23.6–52.7)	$p < 0.0001^*$	$p < 0.0001^*$	$p = 0.85$

-Median; Minimal and Maximal Coroll Length of Each Nectar Host Plant have been given in brackets.

At the time of feeding, the proboscis remained uncoiled and was inserted in the flower. It was hypothesized that, the length of proboscis varied according to the length of corolla tube of the flowers selected by the butterflies for feeding. The skipper butterflies (family: Hesperiidae) with extremely long-proboscis should specialize in visiting flowers that corresponded to the length of their proboscis of mouth parts. The skipper butterflies (family: Hesperiidae) with extremely long-proboscis might avoid the flowers with short corolla tube. Many researchers (Corbet, 2000; Nilsson, 1988; Nilsson *et al*., 1985)

considered the butterflies as "Generalist Flower Visitors". The attempt of the butterflies was to visit the maximum number of flowers for the nectar. They visited the flowers of the number of plant species available for them. This was possible due to the presence of extremely long proboscis in the mouth parts of the butterflies (Agosta and Janzen, 2005).

Conclusively enough, the species of skipper butterflies (family: Hesperiidae) with long proboscis could potentially utilize short flowers in addition to long flowers. It was expected that, the number of flowering species visited by skipper butterflies (family: Hesperiidae) would be greater than that of species skipper butterflies (family: Hesperiidae) with short proboscis. The data in the present attempt supported the hypothesis. The skipper butterflies (family: Hesperiidae) with extremely long-proboscis, generally did not visit flowers with short nectar spurs. Both *Lantana camera* (L) (Family: Verbenaceae) and *Stachytarpheta frantzii* (L) (Family: Verbenaceae) attracted many different flower-visiting insects. This was because, the flowers of *Lantana camera* (L) (Family: Verbenaceae) and *Stachytarpheta frantzii* (L) (Family: Verbenaceae) were easily accessible. These flowers were continuously exploited by a great variety of butterfly species possessing rather short proboscis. The skipper butterflies (family: Hesperiidae) with long-proboscis were crowded out to deep-tubed flowers. Here, in these flowers, the skipper butterflies could benefit from a more exclusive access to nectar.

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Fig. 3: Corolla Tube of Individual Flower of *Lantana camera* (L) (Family: Verbenaceae) Mayureshwar Wildlife Sanctuary [Supe Tal. Baramati Dist. Pune Maharashtra India (Co-ordinates: 18⁰ 20′ 6″ N 74⁰ 22′ 15″ E)].

Fig. 4: Corolla Tube of Individual Flower of *Stachytarpheta frantzii* (L) (Family: Verbenaceae) Mayureshwar Wildlife Sanctuary [Supe Tal. Baramati Dist. Pune Maharashtra India (Co-ordinates: 18⁰ 20′ 6″ N 74⁰ 22′ 15″ E)].

Fig. 5: Corolla Tube of Individual Flower of *Calathea crotalifera* (L) (Family: Marantaceae) Mayureshwar Wildlife Sanctuary [Supe Tal. Baramati Dist. Pune Maharashtra India (Co-ordinates: 18⁰ 20′ 6″ N 74⁰ 22′ 15″ E)].

Fig. 6: Corolla Tube of Individual Flower of ***Calathea lutea*** **(L) (Family: Marantaceae)** Mayureshwar Wildlife Sanctuary [Supe Tal. Baramati Dist. Pune Maharashtra India (Co-ordinates: 18^0 20′ 6″ N 74^0 22′ 15″ E)].