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Research Article

THE IMPORTANCE OF NATURE OF PROBOSCIS IN BUTTERFLIES OF FAMILY: HESPERIIDAE FROM MAYURESHWAR WILDLIFE SANCTUARY, SUPE, BARAMATI DISTRICT, PUNE, INDIA

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ABSTRACT

Butterflies are depending on the plant juice in the form of nectar for their food material. They 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 the mouth in butterflies appear to be the most significant feature for their life. Most of the butterflies use to feed on floral nectar. Butterflies therefore may have a role as efficient pollinators for respective host plants. Development of long proboscis as modified mouth parts in butterflies is to be regarded as an example of a co-evolutionary line in the animal kingdom. The Hesperiidae butterflies of Mayureshwar Wildlife sanctuary 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 help to take up nectar food from the flowers with long or deep as well as short tube of the corolla. The hesperiidae butterflies with extremely long proboscis in present attempt were observed to obtain the nectar from their preferred host plants. The Calathea species are well known as nectar host plants for the Hesperiidae butterflies of Mayureshwar Wildlife sanctuary. Species of skipper butterflies (family: Hesperiidae) with long proboscis could potentially utilize the flowers with short as well as long corolla tube. 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) attract many different flower-visiting insects. The flowers of *Lantana camera* (L) (Family: Verbenaceae) and *Stachytarpheta frantzii* (L) (Family: Verbenaceae) are easily accessible. The skipper butterflies (family: Hesperiidae) with long-proboscis are recorded crowding around the host plant flowers with long tubed corolla.

Keywords: Mayureshwar Wildlife Sanctuarym, Siphoning, Corolla Tube, Proboscis, Mouth parts.

INTRODUCTION

The butterflies are the most successful animals on earth. The siphoning and sucking type of mouthparts is the significant feature of butterflies and moths. The siphoning and sucking type of mouthparts is 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 is greatly elongated semi-tube like structures. When these two galeae are applied and locked together along the length, they form a long

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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 high pressure of hemolymph. This pressure is generated in the stipes which is 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 nectarines of the flower. The muscles of cibarium and pharynx muscles serving a lot of proceed for sucking action in butterflies.

The reports on "Pondering over the evolutionary processes of long proboscis of flower-visiting butterflies" through earlier researchers, including Darwin is not new (Darwin, 1877; Johnson, 1997; Johnson & Anderson, 2010; Muchhala & Thomson, 2009; Nilsson, 1998; Pauw *et al*., 2009; Rodríguez-Gironés & Llandres, 2008; Rodríguez-Gironés & Santamaría, 2007; Wasserthal, 1997;Wasserthal, 1998; Whittall & Hodges, 2007). The evolution of proboscis in butterflies is supposed to be related with evolution of nectar spurs in angiosperm plant species. (Darwin, 1877; Nilsson *et al*., 1985). Earlier studies by Courtney *et al*., (1982); Krenn, (2010); Wiklund *et al*., (1979 and 1982), mentioned doubtfulness regarding some of the butterflies as efficient pollinators. There is a rare report on "Mutual relation for co-evolution between species of butterflies and the species of preferred nectar host plants" (Grant & Grant, 1965 and 1983; Levin & Berube, 1972). According to some researchers like (Stefanescu & 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 (Dennis & Whiteley, 1992; Stefanescu & Traveset, 2009; Tudor *et al*., 2004). The influence of length of butterfly proboscis for visiting common plant or a special plant is supposed to remain contradictory. Here, in the present attempt tried it's best to study the Hesperiidae butterflies of Mayureshwar Wildlife Sanctuary with a wide range of length of proboscis. Provision of long proboscis as a mouth parts making the hesperiidae butterflies most efficient for visiting a wide variety of flowers regardless of nectar spur length in an opportunistic way. The present attempt deals with studies on the importance of nature of proboscis in butterflies of family: Hesperiidae from Mayureshwar Wildlife Sanctuary, Supe Baramati Dist. Pune (India).

MATERIALS AND METHODS

Region of Study; Plant Species and Butterfly Species for the Study

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

Figure 1. Mayureshwar Wildlife Sanctuary Site.

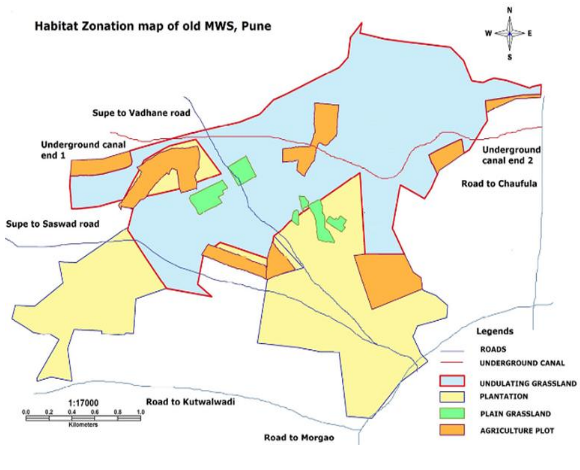


Figure 2. Habitat Zonation of Mayureshwar Wildlife Sanctuary.

The host plant species, *Lantana camera* (L) (Verbenaceae); *Stachytarpheta frantzii* (L) (Verbenaceae); *Calatheca lutea* (L) (Marantaceae) and *Calathea crotalifera* (L) (Marantaceae) were observed in a flowering condition in the study area during the whole tenure of the study attempt. These plant species were in the seminatural garden of Mayureshwar Wildlife Sanctuary of Supe, which borders on natural forest habitats. One more feature of these plant species were growing in close proximity and within reach of the butterfly species foraging in this area. Mayureshwar Wildlife Sanctuary of Supe, the study area, avails the rich supply of nectar throughout the year. This is system making on the study area highly attractive for varied number and variety of butterflies. The butterflies use the system for colonizing the surrounding natural forest and semi-natural habitats (the habitats modified by human influence but retaining many *natural* features) Khyade *et al*., (2019). The four studied flowering plant species *Lantana camera* (L) (Verbenaceae) ;*Stachytarpheta frantzii* (L) (Verbenaceae); *Calatheca lutea* (L) (Marantaceae) and *Calathea crotalifera* (L) (Marantaceae) make different demands on their butterfly visitors. The butterflies utilize the available system (corolla length, of butterflies with varying proboscis lengths) efficiently for their foraging activity. Collection of skipper butterflies was carried out soon after their landing on flowers and subsequently uncoiled the proboscis. Collection of butterflies was carried with the hand nets. The collected skipper butterfly specimens were stored in seventy percent ethanol.

(B). Butterfly Proboscis Length Measurement

The hesperiidae butterflies were collected, identified and preserved in seventy percent ethanol. The 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. Micrographs of the proboscis were taken using a Nikon SMZ 1500 stereomicroscope (Nikon, Tokyo, Japan) equipped with an Optocam-I digital camera (Nikon, Tokyo, Japan). Micrographs were imported to Image J (Savitribai Phule Pune University, Pune India), and proboscis length was measured with the aid of the segmented line tool. The permanent slides of proboscis of respective butterfly were prepared.

(C). Biology of the Flowers

Lantana camera (L) (Verbenaceae); *Stachytarpheta frantzii* (L) (Verbenaceae); *Calatheca lutea* (L) (Marantaceae) and *Calathea crotalifera* (L) (Marantaceae) were selected for the attempt. The host plant flowers, for example, *Lantana camera* (L) (Family: Verbenaceae) are small and mostly yellow or orange in colour changing to red or scarlet with age. The lantana flowers form a slightly curved corolla tube. Lantana flowers are arranged in hemispheric inflorescences, measuring up to 3 cm wide, that can be used by butterflies as a landing platform (Woodson *et al*., 1973). The flowers of Stachytarpheta *frantzii* (L) (Family: Verbenaceae); are larger than that of *Lantana camara* (L). The colour of flowers of Stachytarpheta *frantzii* (L) (Family: Verbenaceae) is purple. The petals of flowers in *Stachytarpheta frantzii* (L) (Family: Verbenaceae) are and forming a slender cylindrical tube. It is semi-immersed in the rachis of spikes. The flowers are arranged in terminal inflorescences (Woodson *et al*., 1973). The flowers of *Calathea crotalifera* (L) (Family: Marantaceae) and *Calathea lutea* (L) (Family: Marantaceae) are with a yellow tube and hooded staminode, that holds the style under tension. These flowers exhibit unique feature helping for the mechanism of pollination mechanism (Bauder *et al*., 2011). The pollination occurs only when the skipper butterfly touches a trigger like the appendage of the hooded staminode, which holds the style under tension. The style in the flower then springs forward, scrapes off any pollen grain from the insect. Simultaneously, it places its pollen onto the flower visitor (Pischtschan *et al*., 2008). The triggered movement of the style deserves "Irreversible Nature". Therefore, there is only one opportunity for the flower for pollination. The position of the style after replacement prevents any pollen from subsequently entering the stigma (Kennedy, 2000). Since the movement of style is easily visible and flowers can be inspected after visitation, the present attempt was able to determine whether skippers released the trigger and thus potentially act as efficient pollinators. For the purpose of measuring the length of the corolla, flowers from the individual plant of the concerned group at different locations of the study area. Freshly collected flowers were used for the estimation length of corolla. With the help of dissecting needles, the curved corolla, each flower was made straight. Digital caliper was used for measurement of the length of the corolla. Tip of petal and the point of origin of ovary were considered for the length of corolla of individual flower. Measurement of curvature of corolla was also considered in the attempt.

(D). Attempt on Video Record of Visit of Skipper Butterflies to the flowers

Visit of butterflies to individual flower of respective host plant flower was the concern of attempt. Sony HDR-XR550VE Handycam (Sony Corporation, Tokyo, Japan) was used for recording the foraging activity of the butterflies in their natural environment.One recording period was approximately 84 minutes due to the camera's memory capacity, and recording was carried out twice a day at each experimental site. Video was recorded at 15 frames per second at a spatial resolution of 320 × 240 pixels. The camera was located approximately 120 cm away at an upward angle from the flowers. Early morning (7 a.m. to 10 a.m.) was found suitable for video recording of visit of skipper butterflies to the host plant flowers.

(E). Analysis of the data through Statistical Methods

The whole attempt was repeated thrice. This *repetition of whole attempt was for 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), Corel DRAW 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. The computer was used for plotting the graph.

RESULTS AND DISCUSSION

The results on the attempt are summarized in the tables (1-3) and Fig. (3-5 and 6). The total number of individuals skipper butterflies visited 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 measured 228. They belong to 43 species and 30 genera (Table - 1). All the species of plants were found differed significantly 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 16.228 (± 1.264) mm (N = 12). *Lantana camera* (L) (Family: Verbenaceae) was observed with 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 the visit of butterflies belong exclusively to family: Hesperiidae. This result is similar to that reported by Bauder *et al*., (2011). The length of proboscis of the skipper butterflies in present study differed significantly according to the nectar host plants utilized [X^2 (3) = 96.8, p\0.0001)]. The flowers of the Lantana *camera* (L) (Family: Verbenaceae) are with the shortest corolla length (among the flowers studied in present attempt). Therefore, flowers of the Lantana *camera* (L) (Family: Verbenaceae) in present attempt had the skipper butterflies visitors with significantly shorter proboscis. This is 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 other flower visitors with reference to length of their proboscis (Table 3). The skipper butterflies visitors of *Stachytarpheta frantzii* (L) (Family: Verbenaceae) had longer proboscis in comparison with 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 are reported with significantly longer proboscis than that of skipper butterflies visitors of 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 differed significantly from each other (Table -2). However, proboscis lengths of skipper butterflies visitors of the flower visitors of these two Calathea species [*Calathea crotalifera* (L) (Family: Marantaceae) and *Calathea lutea* (L) (Family: Marantaceae)] in the present attempt were reported one and the same.

The hesperiidae butterflies are also recognized as skipper butterflies. They are with extremely long proboscis, measures longer than 30 mm. Such butterflies visit flowers with deep nectar spurs. The skippers butterflies (family: Hesperiidae) with shorter proboscis use to visit flowers with shorter nectar spurs. The data of present attempt indicate that, 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 proboscis length. Moreover, the pattern of interaction is compartmentalized and indicating that skipper butterflies (family: Hesperiidae) with shorter proboscis are separated from skippers with longer proboscis with reference to preference of flowers. Each of 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 of host plants.

The sources of food material are the force of driving to establish the coexistence among living beings (Inouye, 1980; Ranta & Lundberg, 1980; Schoener, 1974). It is often method of estimation of correlation through the use of morphological characters. These morphological characters include: size differences between animals or differences in mouthparts in relation to the size of food particles. The butterflies and the moths deserve significant feature of development of siphoning type of mouth parts. The mandibles and labium in butterflies and moths are very much reduced. The labrum is nearly a narrow transverse band, very long and deeply grooved medially. When applied together, the two galae use to enclose fine food channel and it forms a prominent proboscis. It is the main siphoning tube.

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

S. 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* (Herrich-Schaffer, 1869).	3	12.669 (± 1.618)	*Lantana camera* (L) (Family: Verbenaceae) (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 *Cymaenes alumna* (A. Butler, 1877).	3	16.665 (± 3.032)	*Lantana camera* (L) (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 &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 boisduvalii* (Ehmann, 1909).	3	47.071 (±14.091)	*Calathea lutea* (L) (Family: 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 is given in parentheses.

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

S. 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 is given in bracket.

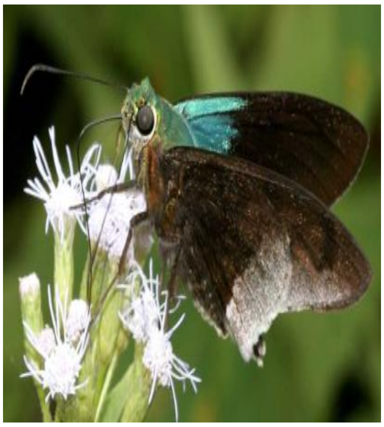
The “Pair-wise post hoc tests” showed that all nectar host plants differ significantly in corolla length.

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

S. 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

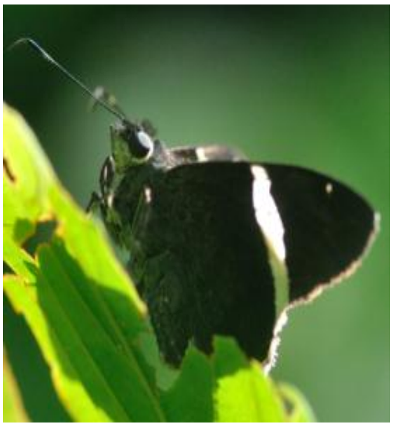
-Median; Minimal and Maximal Coroll Length of Each Nectar Host Plant is given in bracket.

Table 4. Siphon like mouth parts in the Hesperiidae Butterflies of Mayreshwar Wildlife Sanctuary, Supe Taluka - Baramati District - Pune (India).



Eudaminae *Astraptes alardus latia* (Evans, 1952).

Eudaminae *Astraptes anaphus anetta* (Evans, 1952).



Eudaminae *Autochton longipennis* (Plotz, 1882).

Eudaminae *Autochton zarex* (Hubner, 1818).

Eudaminae *Bungalotis quadratum quadratum* (Sepp, 1845)

Eudaminae *Cogia calchas* (Herrich-Schaffer, 1869).

Eudaminae *Spathilepia clonius* (Cramer, 1775).

Eudaminae *Typhedanus undulates* (Hewitson, 1867).

Eudaminae *Urbanus procne* (Plotz, 1881).

Eudaminae *Urbanus simplicius* (Stoll, 1790).

Eudaminae *Urbanus tanna* (Evans, 1952).

Eudaminae *Urbanus teleus* (Hubner, 1821).

Eudaminae *Saliana sevens* (Mabille, 1895).

Eudaminae *Saliana triangularis* (Kay, 1914).

Eudaminae *Talides hispa* (Evans, 1955).

Eudaminae Tracides phidon (Cramer, 1779).

Eudaminae *Tromba xanthura* (Godman, 1901).

Anthoptini Corticera lysias lysias (Plotz, 1883).

Moncini *Arita arita* (Schaus, 1902).

Moncini *Cymaenes alumna* (A. Butler, 1877).

Moncini *Lerema ancillaries* (A. Butler, 1877).

Moncini *Moris geisa* (Moschler, 1879).

Moncini *Moris micythus* (Godman, 1900).

Moncini *Papias phaeomelas* (Hubner, 1831).

Moncini *Papias phainis* (Godman, 1900).

Moncini *Papias subcostulata* (Herrich-Schaffer, 1870).

Moncini *Vehilius stictomenes illudens* (Mabille, 1891).

Hesperiini *Pompeius Pompeius* (Latreille, 1824).

Hesperiini *Quinta cannae* (Herrich-Schaffer, 1869).

Pyrginae Pyrrhopygini *Mysoria ambigua* (Mabille and Boullet, 1908)

Celaenorrhini *Celaenorrhinus darius* (Evans, 1952).

Carcharodini *Nisoniades godma* (Evans, 1953).

Hesperiinae *Lycas godart boisduvalii* (Ehmann, 1909).

Hesperiinae *Perichares adela* (Hewitson, 1867).

Hesperiinae *Perichaeres lotus (*A. Butler, 1870).

Hesperiinae *Pyrrhopygopsis Socrates orasus* (H.Druce, 1876).

Calpodini *Aroma henricus henricus* (Staudinger, 1876).

Calpodini *Calpodes ethlius* (Stoll, 1782).

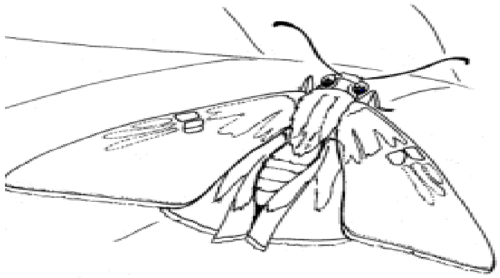
Calpodini *Carystoides escalantei* (H. Freeman, 1969).

Calpodini *Carystoides hondura* (Evans, 1955).

Calpodini Damas clavus (Herrich-Schaffer, 1869).

Calpodini *Damas immaculate* (Nicolay, 1973).

Calpodini *Saliana esperi esperi* (Evans, 1955).



Calpodini *Saliana esperi esperi* (Evans, 1955).

Figure 3. Corolla Tube of Individual Flower of *Lantana camera* (L) (Family: Verbenaceae) Mayureshwar Wildlife Sanctuary [Supe Tal. Baramati Dist. Pune Maharashtra India (Co-ordinates: 18^{0} 20' 6" N 74^{0} 22' 15" E)].

Figure 4. Corolla Tube of Individual Flower of *Stachytarpheta frantzii* (L) (Family: Verbenaceae) Mayureshwar Wildlife Sanctuary [Supe Tal. Baramati Dist. Pune Maharashtra India (Co-ordinates: 18^{0} 20' 6" N 74^{0} 22' 15" E)].

Figure 5. Corolla Tube of Individual Flower of *Calathea crotalifera* (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)].

Figure 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)].

At the time of feeding, the proboscis remains uncoiled and inserted in the flower. It is hypothesized, that, the length of proboscis vary 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 correspond to the length of their proboscis of mouth parts. The skipper butterflies (family: Hesperiidae) with extremely long-proboscis may avoid the flowers with short corolla tube. Many researchers (Corbet, 2000; Nilsson , 1988; Nilsson *et al.*, 1985) consider the butterflies as “Generalist Flower Visitors”. The attempt of the butterflies is to visit the maximum number of flowers for the nectar. They use to visit the flowers of the number of plant species available for them. This is possible due to the presence of extremely long proboscis in the mouth parts of the butterflies (Agosta & Janzen, 2005).

Conclusively enough, species of skipper butterflies (family: Hesperiidae) with long proboscis could potentially utilize short flowers in addition to long flowers. It would be 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 present attempt support 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) attract many different flower-visiting insects. This is because, the flowers of *Lantana camera* (L) (Family: Verbenaceae) and *Stachytarpheta frantzii* (L) (Family: Verbenaceae) are easily accessible. These flowers are continuously exploited by a great variety of butterfly species possessing rather short proboscis. The skipper butterflies (family: Hesperiidae) with long-proboscis are crowded out to deep-tubed flowers. Here, in these flowers, the skipper butterflies can benefit from a more exclusive access to nectar.

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REFERENCES

Agosta, S.J., & Janzen, D.H. (2005). Body size distributions of large Costa Rican dry forest moths and the underlying relationship between plant and pollinator morphology. *Oikos, 108*(1), 183-193.

Bauder, J.A., Lieskonig, N.R., & Krenn, H.W. (2011). The extremely long-tongued Neotropical butterfly *Eurybia lycisca* (Riodinidae): proboscis morphology and flower handling. *Arthropod Structure and Development, 40*(2), 122-127.

Corbet, S.A. (2000). Butterfly nectaring flowers: butterfly morphology and flower form. *Entomologia Experimentalis et Applicata, 96*(3), 289-298.

Courtney, S., Hill, C., & Westerman, A. (1982). Pollen carried for long periods by butterflies. *Oikos*, 260-263.

Darwin, C. (1877). On the various contrivances by which British and foreign orchids are fertilised by insects: John Murray.

Dennis, R.L., & Whiteley, D.A. (1992). *The ecology of butterflies in Britain*: Oxford University Press, Oxford, 1-368.

Grant, V., & Grant, K. A. (1965). Flower pollination in the Phlox family. 1-180.

Grant, V., & Grant, K. A. (1983). Hawkmoth pollination of *Mirabilis longiflora* (Nyctaginaceae). *Proceedings of the National Academy of Sciences, 80*(5), 1298-1299.

Inouye, D.W. (1980). The effect of proboscis and corolla tube lengths on patterns and rates of flower visitation by bumble bees. *Oecologia, 45*(2), 197-201.

Johnson, S. (1997). Pollination ecotypes of Satyrium hallackii (Orchidaceae) in South Africa. *Botanical Journal of the Linnean Society*, *123*(3), 225-235.

Johnson, S.D., & Anderson, B. (2010). Coevolution between food-rewarding flowers and their pollinators. *Evolution: Education and Outreach, 3*(1), 32.

Kennedy, H. (2000). Diversification in pollination mechanisms in the Marantaceae. *Monocots: Systematics and Evolution, 2*, 335-343.

Khyade, V.B., Dongare, S.K., & Shinde, M.R. (2019). The Indian Square for Enzyme Kinetics Through the Regular Form of Lineweaver-Burk Plot (Double Reciprocal Plot); It's Inverse Form and Other Additional Form of Plots (Equations).

Krenn, H.W. (2010). Feeding mechanisms of adult Lepidoptera: structure, function, and evolution of the mouthparts. *Annual Review of Entomology, 55*, 307-327.

Levin, D.A., & Berube, D.E. (1972). Phlox and Colias: the efficiency of a pollination system. *Evolution*, 242-250.

Muchhala, N., & Thomson, J.D. (2009). Going to great lengths: selection for long corolla tubes in an extremely specialized bat–flower mutualism. *Proceedings of the Royal Society B: Biological Sciences, 276*(1665), 2147-2152.

Nilsson, L.A. (1988). The evolution of flowers with deep corolla tubes. *Nature, 334*(6178), 147.

Nilsson, L.A. (1998). Deep flowers for long tongues. *Trends in Ecology & Evolution, 13*(7), 259-260.

Nilsson, L.A., Jonsson, L., Rason, L., & Randrianjohany, E. (1985). Monophily and pollination mechanisms in *Angraecum arachnites* Schltr.(Orchidaceae) in a guild of long-tongued hawk-moths (Sphingidae) in Madagascar. *Biological Journal of the Linnean Society, 26*(1), 1-19.

Pauw, A., Stofberg, J., & Waterman, R.J. (2009). Flies and flowers in Darwin's race. *Evolution: International Journal of Organic Evolution, 63*(1), 268-279.

Pischtschan, E., & Claßen-Bockhoff, R. (2008). Setting-up tension in the style of Marantaceae. *Plant Biology, 10*(4), 441-450.

Ranta, E., & Lundberg, H. (1980). Resource partitioning in bumblebees: the significance of differences in proboscis length. *Oikos*, 298-302.

Rodríguez-Gironés, M.A., & Llandres, A.L. (2008). Resource competition triggers the co-evolution of long tongues and deep corolla tubes. *PloS one*, *3*(8), e2992.

Rodríguez-Gironés, M.A., & Santamaría, L. (2007). Resource competition, character displacement, and the evolution of deep corolla tubes. *The American Naturalist, 170*(3), 455-464.

Schoener, T. W. (1974). Resource partitioning in ecological communities. *Science, 185*(4145), 27-39.

Stefanescu, C., & Traveset, A. (2009). Factors influencing the degree of generalization in flower use by Mediterranean butterflies. *Oikos, 118*(7), 1109-1117.

Tudor, O., Dennis, R., Greatorex-Davies, J., & Sparks, T. (2004). Flower preferences of woodland butterflies in the UK: nectaring specialists are species of conservation concern. *Biological Conservation, 119*(3), 397-403.

Wasserthal, L. (1997). The pollinators of the Malagasy star orchids Angraecum sesquipedale, *A. sororium* and *A. compactum* and the evolution of extremely long spurs by pollinator shift. *Botanica Acta, 110*(5), 343-359.

Wasserthal, L.T. (1998). Deep flowers for long tongues. *Trends in Ecology and Evolution, 13*(11), 459-460.

Whittall, J.B., & Hodges, S.A. (2007). Pollinator shifts drive increasingly long nectar spurs in columbine flowers. *Nature, 447*(7145), 706.

Wiklund, C., Eriksson, T., & Lundberg, H. (1979). The wood white butterfly *Leptidea sinapis* and its nectar plants: a case of mutualism or parasitism? *Oikos*, 358-362.

Wiklund, C., Eriksson, T., & Lundberg, H. (1982). On the pollination efficiency of butterflies: A reply to Courtney *et al*. *Oikos*, 263-263.

Woodson, R.E., Schery, R.W., & Moldenke, H.N. (1973). Flora of Panama. Part IX. Family 168. Verbenaceae. *Annals of the Missouri Botanical Garden, 60*(1), 41-148.