



World Scientific News

An International Scientific Journal

WSN 126 (2019) 101-117

EISSN 2392-2192

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

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ABSTRACT

Modifications in the parts around mouth in butterflies appears 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 example of co-evolutionary line in animal kingdom. The Hesperidae butterflies of Mayureshwar Wildlife sanctuary shown variations in their length of proboscis. The hesperidae butterflies with longer proboscis visit plant species having flowers with long or deep-tube. Hesperidae butterfly proboscis help to take up nectar food from long or deep tubed as well as short tubed flowers. The hesperidae butterflies with extremely long proboscis in present attempt were observed to obtain the nectar from their preferred host plants. The Calathea species are reported as nectar host plants for the Hesperidae butterflies of Mayureshwar Wildlife sanctuary. The species of skipper butterflies (family: Hesperidae) 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: Hesperidae) would be greater than that of species skipper butterflies (Family: Hesperidae) with short proboscis. The data in present attempt support the hypothesis. The skipper butterflies (family: Hesperidae) 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: Hesperidae) with long-proboscis are crowded out to deep-tubed flowers.

Keywords: Hesperidae, Mayureshwar, Siphoning, Corolla Tube, Proboscis, Butterflies

1. INTRODUCTION

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 galeae 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 high pressure of haemolymph. This pressure is generated in the stipes which is associated with each galea. Coiling results from the elasticity of the cuticle of galeae together with the activity of the intrinsic muscles. The uncoiled-proboscis thrusts out into the nectaries of the flower. 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; Rodri'guez-Girone's and Llandres, 2008; Rodriguez-Girone's and Santamar'ia, 2007; Wasserthal, 1997, 1998; Whittall and Hodges, 2007). Extremely long proboscis in the butterflies is supposed to be related with 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 report 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 common plant or a special plant is supposed to remain contradictory. Here, in the present attempt tried it's best to study the Hesperidae butterflies of Mayureshwar Wildlife Sanctuary with a wide range of length of proboscis. Provision of long proboscis as a mouth parts making the hesperidae butterflies most efficient for visiting 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" is 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 (Coordinates: 18°20' 6" N, 74°22' 15" E) (Fig. 1). The higher density of host plants for hesperiidae butterflies in this region include: *Lantana camera* (L) (Verbenaceae); *Stachytarpheta frantzii* (L) (Verbenaceae); *Calathea 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.

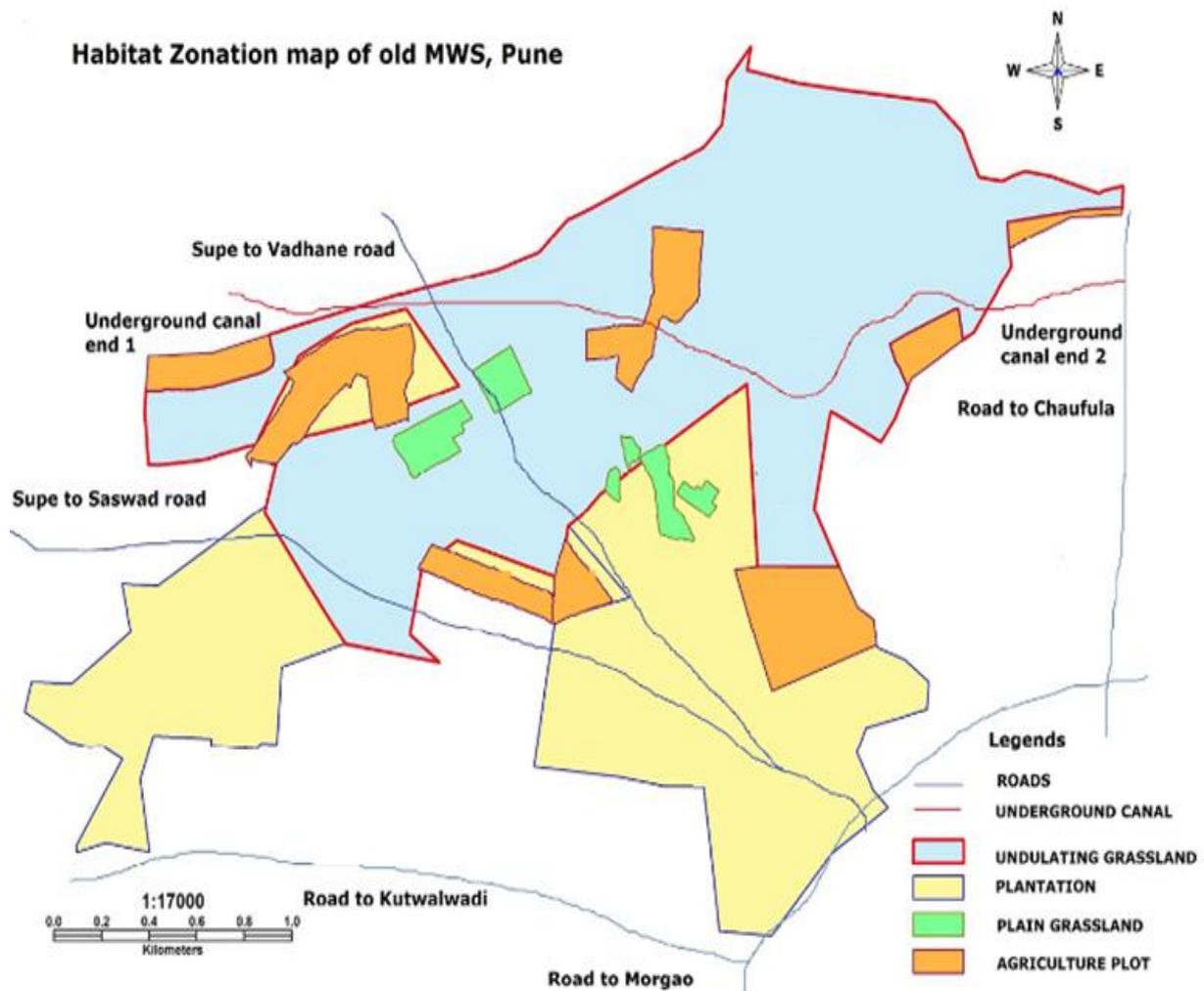


Figure 1. Habitat Zonation of Mayureshwar Wildlife Sanctuary

The plant species *Lantana camara* (L) (Verbenaceae); *Stachytarpheta frantzii* (L) (Verbenaceae); *Calathea lutea* (L) (Marantaceae) and *Calathea crotalifera* (L) (Marantaceae) were observed in flowering condition in study area during 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 close proximity to each other and within reach of the butterfly species foraging in this area. Mayureshwar Wildlife Sanctuary of Supe, the study area avails the richest supply of nectar throughout the year. This system making the study area highly attractive for varied number and 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 camara* (L) (Verbenaceae); *Stachytarpheta frantzii* (L) (Verbenaceae); *Calathea lutea* (L) (Marantaceae) and *Calathea crotalifera* (L) (Marantaceae) make different demands on their butterfly visitors. This may be due to varying corolla lengths of four studied flowering plant species *Lantana camara* (L) (Verbenaceae); *Stachytarpheta frantzii* (L) (Verbenaceae); *Calathea lutea* (L) (Marantaceae) and *Calathea crotalifera* (L) (Marantaceae). Warren *et al.* (2009) reported that, the observation of butterflies visiting these flowers allows for conclusions on the flower morphology preferences, i.e., corolla length, of butterflies with varying proboscis lengths.

Collection of skipper butterflies was carried out soon after their landing on flowers and subsequently uncoiled the proboscis. Hand net was used for collection. The collected skipper butterfly specimens were stored in seventy percent ethanol. Classification of taxa follows 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 proboscis length was measured with the aid of the segmented line tool. The proboscis lengths of skippers caught in September, October, 2017 and January, February, 2018.

(C) Floral Biology and Length of Corolla

The flowers of *Lantana camara* (L) (Family: Verbenaceae) are small and mostly yellow or orange in color, 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 color of flowers of *Stachytarpheta frantzii* (L) (Family: Verbenaceae) is purple. The corolla flowers of *Stachytarpheta frantzii* (L) (Family: Verbenaceae) is fused to 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 yellow tube and hooded staminode, that holds the style under tension. These flowers exhibit unique feature helping for mechanism of pollination mechanism (Bauder, *et al.* 2011). The pollination occurs only when the skipper butterfly touches a trigger

like appendage of the hooded staminode, which holds the style under tension. The style in the flower then springs forward, scrapes off any pollen from the insect and simultaneously places its pollen onto the flower visitor (Pischtschan and ClaßenBockhoff 2008). The triggered movement of the style deserve “Irreversible Nature”. Therefore, there is only one opportunity for the flower for pollination. The position of the style after releasement 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 to measure length of corolla, flowers from individual plant of concerned group at different locations of study area. Freshly collected flowers were used for the estimation length of corolla. For the curved corolla, each flower was straightened with the aid of a dissection needle. 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 length of corolla of individual flower.

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

Skippers 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), 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.

3. RESULT AND DISCUSSION

The results on ecological significance of extremely long-proboscis in Hhesperiidae butterflies at Mayureshwar Wildlife Sanctuary is summerised in the Tables (1, 2 and 3). 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 had the shortest nectar spurs, measuring about 10.524 (\pm 1.712) mm (N = 12). Both, *Lantana camera* (L) (Family: Verbenaceae) and *Stachytarpheta frantzii* (L) (Family: Verbenaceae) 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: Hesperiiidae. 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 appeared similar (Table 3).

The skipper butterflies (family: Hesperiiidae) are with extremely long proboscis, measures longer than 30 mm. Such butterflies visit flowers with deep nectar spurs. The skippers butterflies (family: Hesperiiidae) with shorter proboscis use to visit flowers with shorter nectar spurs. The data of present attempt indicate that, skipper butterflies (family: Hesperiiidae) 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: Hesperiiidae) with shorter proboscis are separated from skippers with longer proboscis with reference to preference of flowers. Each of skipper butterflies (family: Hesperiiidae) 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: Hesperiiidae) 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: Hesperiiidae) released the trigger mechanism with a leg through water droplet onto the style of flower.

The resources of food material is the force of driving to establish the coexistence among living beings (Hespenheide, 1973; Inouye, 1980; Ranta and Lundberg, 1980 and 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. At the time of feeding, the proboscis remain 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: Hesperidae) with extremely long-proboscis should specialize in visiting flowers that correspond to the length of their proboscis of mouth parts. The skipper butterflies (Family: Hesperidae) 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 and Janzen, 2005).

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

Serial No.	Hesperidae Butterfly Species	N	Proboscis Length (mm)	Flower Visited By Hesperidae Butterfly
1.	Eudaminae <i>Astrartes alardus latia</i> (Evans, 1952).	3	23.735 (± 2.436)	<i>Calathea lutea</i> (L) (Family: Marantaceae).
2.	Eudaminae <i>Astrartes anaphus anetta</i> (Evans, 1952).	3	19.700 (± 2.011)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae).
3.	Eudaminae <i>Autochton longipennis</i> (Plotz, 1882).	4	17.473 (± 1.786)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae).
4.	Eudaminae <i>Autochton zarex</i> (Hubner, 1818).	3	16.463 (± 1.513)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae).
5.	Eudaminae <i>Bungalotis quadratum quadratum</i> (Sepp, 1845)	3	28.129 (± 2.547)	<i>Calathea lutea</i> (L) (Family: Verbenaceae).
6.	Eudaminae <i>Cogia calchas</i> (Herrich-Schaffer, 1869).	3	12.669 (± 1.618)	<i>Lantana camera</i> (L) (Family: Verbenaceae) (N=3).

				<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae) (N=3).
7.	Eudaminae <i>Spathilepia clonius</i> (Cramer, 1775).	4	16.968 (± 1.413)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae).
8.	Eudaminae <i>Typhedanus undulates</i> (Hewitson, 1867).	3	12.524 (± 1.043)	<i>Lantana camera</i> (L) (Family: Verbenaceae)
9.	Eudaminae <i>Urbanus procne</i> (Plotz, 1881).	4	16.059 (± 1.833)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae)
10.	Eudaminae <i>Urbanus simplicius</i> (Stoll, 1790).	11	16.665 (± 1.413)	<i>Lantana camera</i> (L) (Family: Verbenaceae) (N=7). <i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae) (N=3).
11.	Eudaminae <i>Urbanus tanna</i> (Evans, 1952).	10	16.867 (± 0.856)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae) (N=7). <i>Lantana camera</i> (L) (Family: Verbenaceae) (N=3).
12.	Eudaminae <i>Urbanus teleus</i> (Hubner, 1821).	5	16.463 (± 1.736)	<i>Lantana camera</i> (L) (Family: Verbenaceae) (N=4). <i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae) (N=2)
13.	Eudaminae <i>Saliana sevens</i> (Mabille, 1895).	3	52.319 (± 3.786)	<i>Calathea crotalifera</i> (L) (Family: Marantaceae)
14.	Eudaminae <i>Saliana triangularis</i> (Kay, 1914).	7	41.915 (± 3.339)	<i>Calathea crotalifera</i> (L) (Family: Marantaceae) (N=6). <i>Calathea lutea</i> (L) (Family: Marantaceae) (N=3).

15.	Eudaminae <i>Talides hispa</i> (Evans, 1955).	3	45.955 (± 5.661)	<i>Calathea lutea</i> (L) (Family: Marantaceae).
16.	Eudaminae <i>Tracides phidon</i> (Cramer, 1779).	3	42.476 (± 5.233)	<i>Calathea lutea</i> (L) (Family: Marantaceae).
17.	Eudaminae <i>Tromba xanthura</i> (Godman, 1901).	3	48.682 (± 6.786)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae).
18.	Anthoptini <i>Corticera lysias lysias</i> (Plotz, 1883).	3	14.241 (± 1.853)	<i>Lantana camera</i> (L) (Family: Verbenaceae).
19.	Moncini <i>Arita arita</i> (Schaus, 1902).	3	28.337 (± 3.789)	<i>Calathea crotalifera</i> (L) (Family: Marantaceae).
20.	Moncini <i>Cymaenes alumna</i> (A. Butler, 1877).	3	16.665 (± 3.032)	<i>Lantana camera</i> (L) (Family: Verbenaceae).
21.	Moncini <i>Lerema ancillaries</i> (A. Butler, 1877).	3	20.705 (± 3.673)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae).
22.	Moncini <i>Moris geisa</i> (Moschler, 1879)	11	20.932 (± 1.978)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae) (N=10). <i>Lantana camera</i> (L) (Family: Verbenaceae) (N=3).
23.	Moncini <i>Moris miccythus</i> (Godman, 1900).	3	19.796 (± 1.392)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae) (N=3). <i>Lantana camera</i> (L) (Family: Verbenaceae) (N=3).
24.	Moncini <i>Papias phaeomelas</i> (Hubner, 1831).	12	17.473 (± 1.396)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae).
25.	Moncini <i>Papias phainis</i> (Godman, 1900).	3	16.362 (±3.379)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae).
26.	Moncini <i>Papias subcostulata</i> (Herrich-Schaffer, 1870).	18	27.453 (±3.014)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae) (N=12)

				<i>Calathea lutea</i> (L) (Family: Marantaceae) (N=3)
27.	Moncini <i>Vehilius stictomenes illudens</i> (Mabille, 1891).	3	13.520 (±1.111)	<i>Lantana camera</i> (L) (Family: Verbenaceae)
28.	Hesperiini <i>Pompeius Pompeius</i> (Latreille, 1824).	6	15.254 (±3.173)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae) (N=5) <i>Lantana camera</i> (L) (Family: Verbenaceae) (N=3).
29.	Hesperiini <i>Quinta cannae</i> (Herrich-Schaffer, 1869).	9	21.917 (±3.966)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae)
30.	Pyrginae Pyrrhopygini <i>Mysoria ambigua</i> (Mabille and Boulet, 1908)	7	15.453 (±2.423)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae)
31.	Celaenorrhini <i>Celaenorrhinus darius</i> (Evans, 1952).	3	30.098 (±5.654)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae)
32.	Carcharodini <i>Nisoniades godma</i> (Evans, 1953).	3	11.819 (±3.538)	<i>Lantana camera</i> (L) (Family: Verbenaceae)
33.	Hesperiinae <i>Lycas godart boisduvalii</i> (Ehmann, 1909).	3	47.071 (±14.091)	<i>Calathea lutea</i> (L) (Family: Marantaceae).
34.	Hesperiinae <i>Perichares adela</i> (Hewitson, 1867).	11	45.834 (±6.786)	<i>Calathea lutea</i> (L) (Family: Marantaceae) (N=8). <i>Calathea crotalifera</i> (L) (Family: Marantaceae) (N=3).
35.	Hesperiinae <i>Perichaeres lotus</i> (A. Butler, 1870).	3	49.948 (±5.896)	<i>Calathea lutea</i> (L) (Family: Marantaceae).

36.	Hesperiinae <i>Pyrrhopygopsis</i> <i>Socrates orasus</i> (H.Druce, 1876).	3	35.432 (±2.358)	<i>Calathea lutea</i> (L) (Family: Marantaceae).
37.	Calpodini <i>Aroma henricus</i> <i>henricus</i> (Staudinger, 1876).	3	30.906 (±2.786)	<i>Calathea crotalifera</i> (L) (Family: Marantaceae)
38.	Calpodini <i>Calpodes ethlius</i> (Stoll, 1782).	5	43.044 (±1.529)	<i>Calathea lutea</i> (L) (Family: Marantaceae) (N=4). <i>Calathea crotalifera</i> (L) (Family: Marantaceae) (N= 3).
39.	Calpodini <i>Carystoides escalantei</i> (H. Freeman, 1969).	6	33.163 (±1.498)	<i>Calathea lutea</i> (L) (Family: Marantaceae).
40.	Calpodini <i>Carystoides hondura</i> (Evans, 1955).	3	29.767 (±1.235)	<i>Calathea lutea</i> (L) (Family: Marantaceae)(N=3). <i>Calathea crotalifera</i> (L) (Family: Marantaceae) (N= 3)
41.	Calpodini <i>Damas clavus</i> (Herrich-Schaffer, 1869).	19	51.996 (±8.403)	<i>Calathea lutea</i> (L) (Family: Marantaceae) (N=10). <i>Calathea crotalifera</i> (L) (Family: Marantaceae) (N= 6).
42.	Calpodini <i>Damas immaculate</i> (Nicolay, 1973).	3	53.227 (±8.786)	<i>Stachytarpheta frantzii</i> (L) (Family: Verbenaceae)
43.	Calpodini <i>Saliana esperi esperi</i> (Evans, 1955).	3	36.259 (±2.221)	<i>Calathea lutea</i> (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).

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

-Median; Minimal and Maximal Corolla Length of Each Nectar Host Plant are 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).

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

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

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.

4. CONCLUSIONS

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 appears 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 example of co-evolutionary line in 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 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 are reported as nectar host plants for the HesperIIDae butterflies of Mayureshwar Wildlife sanctuary.

The HesperIIDae butterflies of Mayureshwar Wildlife sanctuary are not contributing for pollination. 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.

Acknowledgement

Author extend sincere thanks to Administrative Staff at the “Mayureshwar Wildlife Sanctuary” of Baramati Tehsil District Pune (India) for constant guidance and providing valuable information regarding the research project. Efforts of World Scientific News deserve appreciations and exert a grand salutary influence.

References

- [1] Agosta SJ, Janzen DH (2005) Body size distributions of large Costa Rican dry forest moths and the underlying relationship between plant and pollinator morphology. *Oikos* 108: 183–193. doi:10.1111/j.0030-1299.2005.13504.x
- [2] Alexandersson R, Johnson SD (2002) Pollinator-mediated selection on flower-tube length in a hawkmoth-pollinated *Gladiolus* (Iridaceae). *Proc R Soc Lond B* 269: 631–636. doi:10.1098/rspb.2001.1928
- [3] Bauder JAS, Lieskonig NR, Krenn HW (2011) The extremely longtongued Neotropical butterfly *Eurybia lycisca* (Riodinidae): proboscis morphology and flower handling. *Arthropod Struct Dev* 40: 122–127. doi:10.1016/j.asd.2010.11.002
- [4] Bauder JAS, Morawetz L, Warren AD, Krenn HW (2015) Functional constraints on the evolution of long butterfly proboscides: lessons from Neotropical skippers (Lepidoptera: HesperIIDae). *J Evol Biol* 28: 678–687. doi:10.1111/jeb.12601
- [5] Borrell BJ (2005) Long tongues and loose niches: evolution of euglossine bees and their nectar flowers. *Biotropica* 37: 664–669. doi:10.1111/j.1744-7429.2005.00084.x
- [6] Corbet SA (2000) Butterfly nectaring flowers: butterfly morphology and flower form. *Entomol Exp Appl* 96: 289–298. doi:10.1046/j.1570-7458.2000.00708.x
- [7] Courtney SP, Hill CJ, Westerman A (1982) Pollen carried for long periods by butterflies. *Oikos* 38: 260–263. doi:10.2307/3544030
- [8] Darwin C (1862). On the various contrivances by which British and foreign orchids are fertilised by insects and on the good effects of intercrossing. John Murray, London
- [9] DeVries PJ (1997). The butterflies of Costa Rica and their natural history - Volume II: Riodinidae. Princeton University Press, Chichester.
- [10] Garrison JSE, Gass CL (1999) Response of a traplining hummingbird to changes in nectar availability. *Behav Ecol* 10: 714–725. doi:10.1093/beheco/10.6.714
- [11] Gilbert LE (1972) Pollen feeding and reproductive biology of *Heliconius* butterflies. *PNAS* 69: 1403–1407. doi:10.1073/pnas.69.6.1403
- [12] Gilbert LE (1975) Ecological consequences of a coevolved mutualism between butterflies and plants. In: Gilbert LE, Raven PH (eds) *Coevolution of animals and plants*. University of Texas Press, Austin, pp 210–240
- [13] Grant V, Grant KA (1965) *Flower pollination in the Phlox family*. Columbia University Press, New York.
- [14] Grant V, Grant KA (1983) Hawk-moth pollination of *Mirabilis longiflora* (Nyctaginaceae). *PNAS* 80: 1298–1299. doi:10.1073/pnas.80.5.1298
- [15] Harder LD (1985) Morphology as a predictor of flower choice by bumble bees. *Ecology* 66:198–210. doi:10.2307/1941320 Hespeneide HA (1973) Ecological inferences from morphological data. *Annu Rev Ecol Evol Syst* 4: 213–229. doi:10.1146/annurev.es.04.110173.001241

- [16] Horvitz CC, Turnbull C, Harvey DJ (1987) Biology of immature *Eurybia elvina* (Lepidoptera: Riodinidae), a myrmecophilous metalmark butterfly. *Entomol Soc Am* 80: 513–519
- [17] Inouye DW (1980) The effect of proboscis and corolla tube lengths on patterns and rates of flower visitation by bumblebees. *Oecologia* 45: 197–201. doi:10.1007/BF00346460
- [18] Janzen DH (1971) Euglossine bees as long-distance pollinators of tropical plants. *Science* 171: 203–205. doi:10.1126/science.171.3967.203
- [19] Janzen DH, Hallwachs W (2009) Dynamic database for an inventory of the macrocaterpillar fauna, and its food plants and parasitoids, of area de conservacion guanacaste (ACG), northwestern Costa Rica (nn-SRNP-nnnnn voucher codes). URL <http://janzen.sas.upenn.edu>
- [20] Johnson SD (1997) Pollination ecotypes of *Satyrium hallackii* (Orchidaceae) in South Africa. *Bot J Linn Soc* 123: 225–235. doi:10.1006/bojl.1996.0082
- [21] Johnson SD, Anderson B (2010) Coevolution between food-rewarding flowers and their pollinators. *Evol: Educ Outreach* 3: 32–39. doi:10.1007/s12052-009-0192-6
- [22] Johnson SD, Steiner KE (1997) Long-tongued fly pollination and evolution of floral spur length in the *Disa draconis* complex (Orchidaceae). *Evolution* 51: 45–53. doi:10.2307/2410959
- [23] Kennedy H (2000) Diversification in pollination mechanisms in the Marantaceae. In: Wilson K, Morrison D (eds) *Monocots: systematics and evolution*. CSIRO Publishing, Collingwood, pp 335–344
- [24] Krenn HW (2010) Feeding mechanisms of adult Lepidoptera: structure, function, and evolution of the mouthparts. *Annu Rev Entomol* 55: 307–327. doi:10.1146/annurev-ento-112408-085338
- [25] Krenn HW, Wiemers M, Maurer L, Pemmer V, Huber W, Weissenhofer A (2010) Butterflies of the Golfo Dulce region, Costa Rica. Verein zur Förderung der Tropenstation La Gamba, Vienna.
- [26] Levin DA, Berube DE (1972). Phlox and *Colias*: the efficiency of a pollination system. *Evolution* 26: 242–250. doi:10.2307/2407034
- [27] Muchhala N, Thomson JD (2009) Going to great lengths: selection for long corolla tubes in an extremely specialized bat - flower mutualism. *Proc R Soc B* 276: 2147–2152. doi:10.1098/rspb.2009.0102
- [28] Nilsson LA (1988) The evolution of flowers with deep corolla tubes. *Nature* 334: 147–149. doi:10.1038/334147a0
- [29] Nilsson LA (1998) Deep flower for long tongues. *Tree* 13: 259–260. doi: 10.1016/S0169-5347(98)01452-9
- [30] Nilsson LA, Jonsson L, Rason L, Randrianjohany E (1985) Monophily and pollination mechanisms in *Angraecum arachnites* Schltr. (Orchidaceae) in a guild of long-tongued hawkmoths (Sphingidae) in Madagascar. *Biol J Linn Soc* 26: 1–19. doi:10.1111/j.1095-8312.1985.tb01549.x

- [31] Pauw A, Stofberg J, Waterman RJ (2009) Flies and flowers in Darwin's race. *Evolution* 63: 268–279. doi:10.1111/j.1558-5646.2008.00547.x0014-3820
- [32] Pischtschan E, Claßen-Bockhoff R (2008) Setting-up tension in the style of Marantaceae. *Plant Biol* 10: 441–450. doi:10.1111/j.1438-8677.2008.00051.x
- [33] Porter K, Steel CA, Thomas JA (1992) Butterflies and communities. In: Dennis RLH (ed) *The ecology of butterflies in Britain*. Oxford University Press, Oxford, pp 46–72
- [34] Ranta E, Lundberg H (1980) Resource partitioning in bumblebees: the significance of differences in proboscis length. *Oikos* 35: 298–302. doi:10.2307/3544643
- [35] Rodríguez-Girone's MA, Llandres AL (2008) Resource competition triggers the co-evolution of long tongues and deep corolla tubes. *PLoS ONE* 3: 1–8. doi:10.1371/journal.pone.0002992
- [36] Rodríguez-Girone's MA, Santamaría L (2007) Resource competition, character displacement, and the evolution of deep corolla tubes. *Am Nat* 170: 455–464. doi:10.1086/520121.
- [37] Ruppel A (2013) Morphologisch-systematische Untersuchungen der Blüten der Marantaceae im Piedras Blancas NP, Costa Rica. Diploma thesis, Justus-Liebig Universität Gießen
- [38] Schemske DW (1981) Floral convergence and pollinator sharing in two bee-pollinated tropical herbs. *Ecology* 62: 946–954. doi:10.2307/1936993
- [39] Schemske DW, Horvitz CC (1984) Variation among floral visitors in pollination ability: a precondition for mutualism specialization. *Science* 225: 519–521. doi:10.1126/science.225.4661.519
- [40] Schoener TW (1974) Resource partitioning in ecological communities. *Science* 185: 27–39. doi:10.1126/science.185.4145.27
- [41] Shreeve TG (1992) Adult behaviour. In: Dennis RLH (ed) *The ecology of butterflies in Britain*. Oxford University Press, Oxford, pp 22–45
- [42] Stefanescu C, Traveset A (2009) Factors influencing the degree of generalization in flower use by Mediterranean butterflies. *Oikos* 118:1109–1117. doi:10.1111/j.1600-0706.2009.17274.x
- [43] Tiple AD, Kuhrad AM, Dennis RLH (2009) Adult butterfly feeding– nectar flower associations: constraints of taxonomic affiliation, butterfly, and nectar flower morphology. *J Nat Hist* 43: 855–884. doi:10.1080/00222930802610568
- [44] Tudor O, Dennis RLH, Greatorex-Davies JN, Sparks TH (2004) Flower preferences of woodland butterflies in the UK: nectaring specialists are species of conservation concern. *Biol Conserv* 119: 397–403. doi:10.1016/j.biocon.2004.01.002
- [45] Warren AD, Ogawa JR, Brower AVZ (2009) Revised classification of the family HesperIIDae (Lepidoptera: Hesperioidea) based on combined molecular and morphological data. *Sys Entomol* 34: 467–523. doi:10.1111/j.1365-3113.2008.00463.x

- [46] Wasserthal LT (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. *Bot Acta* 110: 343–359. doi:10.1111/j.1438-8677.1997.tb00650.x
- [47] Wasserthal LT (1998) Deep flowers for long tongues. *Tree* 13: 459–460. doi:10.1016/S0169-5347(98)01481-5
- [48] Weber A, Huber W, Weissenhofer N, Zamora N, Zimmermann G (2001) An introductory field guide to the flowering plants of the Golfo Dulce rain forests, Costa Rica. Corcovado National Park and Piedras Blancas National Park („Regenwald der Österreicher“). *Stapfia* 78, Linz
- [49] Whittall JB, Hodges SA (2007) Pollinator shifts drive increasingly long nectar spurs in columbine flowers. *Nature* 447: 706–710. doi:10.1038/nature05857
- [50] Wiklund C (1981) On the pollination efficiency of butterflies: a reply to Courtney et al. *Oikos* 38:263. doi:10.2307/3544031
- [51] Wiklund C, Eriksson T, Lundberg H (1979) The wood white butterfly *Leptidea sinapis* and its nectar plants: a case of mutualism or parasitism? *Oikos* 33: 358–362. doi:10.2307/3544323
- [52] Woodson RE Jr, Schery RW, Moldenke HN (1973) Flora of Panama. Part IX. family 168. Verbenaceae. *Ann Mo Bot Gard* 60: 41–148. doi:10.2307/2394768