



## Pollination ecology of *Blepharis maderaspatensis* (L.) B. heyne ex roth. (Acanthaceae)

K Rohini Latha, Y R K V Tirupati Rao

Department of Botany and Microbiology, Acharya Nagarjuna University, Nagarjuna Nagar, Guntur, Andhra Pradesh, India

### Abstract

*Blepharis maderaspatensis* is a suffrutescent seasonal procumbent herb. The flowers are bi-lipped, bisexual and offer nectar and pollen as floral rewards to foragers. They are foraged by bees for pollen and nectar and butterflies for only nectar but only bees act as principal pollinators. Fruits mature by the onset of dry season. They display explosive dehiscence for seed dispersal indicating the function of autochory which is quite effective during dry season. Further, seed dispersal occurs through rain water indicating that the plant is also hydrochorous. Seeds germinate only during wet season to produce new plants.

**Keywords:** *Blepharis maderaspatensis*, hermaphroditism, bees, butterflies, autochory, hydrochory

### Introduction

The genus *Blepharis* (Family Acanthaceae, subfamily Acanthoideae and tribe Acantheae) comprising about 129 species is distributed predominantly in hot, arid to semi-arid tropical and subtropical regions of the old world with the eastern and southern Africa as its center of species diversity<sup>[1]</sup>. This genus forms an important constituent of desert vegetation and is highly adapted to inhabit extreme desert conditions where rainfall is limited which occurs in winter and temperature and light intensity is high during summer season<sup>[2]</sup>. Its species are easily recognizable by their growth habit, false-whorled leaves and inflorescence structure. The inflorescence ranges from spikes to a solitary terminal flower and the leaves display pseudo-whorled phyllotaxy. Bracts are leathery with spiny margins or papery with bristly margins. Bracteoles are linear or lanceolate with entire margins. The stamens are dimorphic and represent anterior and posterior pairs. The anterior pair has laterally flattened filaments which are hairy toward the base and have an appendage distally near the anther. The posterior pair has slightly narrower linear filaments without any appendage distally. The pistil has a bilocular ovary, each locule with two ovules, glabrous filiform glabrous style and bifid stigma<sup>[1, 2]</sup>. The genus as a whole has not been investigated for any aspect of its sexual reproduction throughout its distribution extent.

*Blepharis maderaspatensis* is widely distributed in dry evergreen to dry deciduous forests of tropical Africa, West Indian Ocean, China, India, Srilanka and Myanmar<sup>[3]</sup>. It is traditionally used to treat swellings, eye and throat infections, asthma, snake bites, wounds, edema and gout<sup>[3, 4]</sup>. Despite its value in traditional medicine, it has not been investigated for its sexual reproduction to understand its pollination systems and seed dispersal modes in order to cultivate in suitable areas for its continued use in traditional medicine and also to evaluate its ecological values in eco-restoration programs. Therefore, the present study is an occasion to describe the floral biology, pollination and seed dispersal in *B. maderaspatensis*.

### Materials and Methods

A population of *Blepharis maderaspatensis* was selected for study during 2020-2021 in Visakhapatnam and its surroundings, Andhra Pradesh, India (17°42'N Latitude and 82°18'E Longitude). Vegetative growth, flowering and fruiting events were examined continually from the time of appearance of plants during wet season. Floral structural and functional aspects, flower foragers and their role in pollination, fruiting and seed dispersal events were critically observed and evaluated to understand the sexual reproduction in this plant.

### Results and Discussion

It is a suffrutescent seasonal procumbent herb found among rocky and gravelly soil in dry to arid habitats (Figure 1a). The stems root at the nodes depending on the soil conditions. Leaves are borne in pseudo-whorls of four at each node. They are petiolate, elliptic and sparsely hairy with distantly toothed margins. The plant shows vegetative growth during late rainy season during September-October; it is immediately followed by flowering and fruiting. Flowers are borne solitary and also in clusters consisting of 8-10 flowers (Figure 1b, c). Bracts are 4 pairs, pale green to yellowish brown with purple veins ending in a recurved bristle with 4-10 barbed bristles on each side of the margin. The flowers are bi-lipped with prominent calyx and corolla. The calyx has 4 sepals arranged in opposite pairs, the inner pair is smaller while one of outer pair is emarginate and 2-lobed. Corolla is white to cream with mauve colored veins with a short tube at the base; it is bi-lipped, the upper lip is poorly developed while the lower lip is elaborate, 3-lobed and slightly deflexed. The stamens are 4, didynamous with sparsely glandular, rarely hairy filaments; the anterior filaments are laterally flattened with a prominent distally positioned finger-like appendage near the anther while the posterior filaments are normal and narrower without any appendage. They are adnate at the throat, exerted. The anthers are 1-celled, 2-4 mm long, apiculate and margins densely bearded. The ovary is oblong, glabrous and bilocular with 2 ovules in each locule; the style is linear, 10 mm long style tipped with a shortly bi-fid stigma. Mature buds open during early morning hours and remain in place

attracting flower foragers for two consecutive days. The flowers are nectariferous and provide easy access to both nectar as well as pollen as the anthers are well placed at the position of poorly developed upper corolla lip. The flower foragers included bees and butterflies, the former category represented by *Megachile* sp. (Figure 1d) and *Xylocopa latipes* (Figure 1e) while the latter category by *Papilio demoleus* (Figure 1f,g), *P. crino* (Figure 1h,i), *P. polytes* (Figure 1j) (Papilionidae) and *Junonia lemonias* (Figure 1k,l) (Nymphalidae). The flowers were foraged throughout the day with a maximum number of foraging visits during forenoon hours; the bees gathered both pollen and nectar while the butterflies collected only nectar. The white to cream coloured corolla serves as an attractant to the foragers from a distance and upon landing at the flower, the mauve-coloured veins on the ventral side of the corolla guide them to the place of nectar which is located at the corolla base. The bees and butterflies probe the flowers from the front, insert tongue/proboscis with great ease to collect the nectar. In this foraging act, the tongue/proboscis contacts the stigma and stamens ending up in pollination. The bees display backward or u-turn movement to collect pollen and in this act also, they effect pollination. Pollen deposition occurs in a particular position, i.e. dorsal head-thorax portion in case of bees characterizing the occurrence of specialized nototribic pollination but pollen is deposited all over the proboscis and forehead portion in case of butterflies characterizing the generalized pollination. Nototribic pollination also called as “dorsal pollination” is known for precision and economy in pollen transfer by pollinating bees. Because, pollen deposition occurs in a precise location and pollen grooming from the location by bees is difficult

and as a result it drastically reduces pollen loss to foraging bees. This pollination mode is beneficial for the plant to maximize pollination rate by pollinating bees<sup>[5, 6]</sup>.

The Papilionid butterflies being large-bodied usually visit the flowers of tree species and occasionally, woody shrubs which grow to the height of small trees for nectar collection because it is not economical or energetically profitable for them to descend to the ground level to collect nectar from the flowers of herbaceous flora. In this study, interestingly, Papilionid butterflies utilize *B. maderaspatensis* flowers consistently until they disappear. The flower fidelity displayed by these butterflies could be attributable to the dry rocky and gravelly soil habitats, prolific growth of the plant and nectar taste by quality and quantity.

In *B. maderaspatensis*, the fruit initiation occurs immediately and matures by the onset of early dry season in late February. Fruits are ellipsoid lignified and compressed 2-4 valved capsules consisting of 2-4 flat, discoid and echinate seeds covered with hygroscopic trichomes borne on hook-like retinacula structures<sup>[1, 2]</sup>. Mature and dry fruits dehisce explosively shedding seeds indicating the function of autochory which is quite effective during dry season. Aerial parts wither away totally after seed dispersal but the underground rootstock sprouts back to life soon after the fall of first rains to start its life cycle. But, seeds germinate during after 3-4 weeks of the onset of wet season to produce new plants. The same habitat is usually colonized by the parental and offspring plants for several years. However, rainwater is also instrumental in the dispersal of seeds which migrate and settle in new habitats. Therefore, autochory and hydrochory are the modes of seed dispersal in this plant.



**Fig 1:** *Blepharis maderaspatensis*: a. Habit, b. & c. Flowers, d. *Megachile* sp., e. *Xylocopa latipes*, f-j. Papilionid butterflies - f. & g. *Papilio demoleus*, h. & i. *Papilio crino*, j. *Papilio polytes*, k. & l. Nymphalid butterfly, *Junonia lemonias*.

## Conclusions

*Blepharis maderaspatensis* is a suffrutescent seasonal procumbent herb. The vegetative growth, flowering and fruiting events occur in quick succession. The flowers are bisexual, nectariferous, and attract bees and butterflies of which only bees act as principal pollinators. Fruits mature rapidly and become ready for dispersal by the onset of dry season. Autochory and hydrochory are the modes of seed dispersal, the former mode facilitates the production of new plants in the vicinity of parental sites while the latter mode facilitates the migration of seeds and production of new plants in new sites. Therefore, this herb with dual modes of seed dispersal is successful to produce populations continuously in the same sites and to colonize new sites in order to expand their distribution range.

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