

Wasp-pollination in *Premna integrifolia* L. (Lamiaceae)

Suvarna Raju P¹, Solomon Raju AJ^{2*}

ABSTRACT

Premna integrifolia displays phenological events of leaf shedding, leaf flushing and flowering events in succession from winter season to wet season. The flowers are bisexual, weakly protandrous, and obligately vector-dependent for pollination. It is pollinated by wasps only despite the presence of other insects in the biotope of this plant. This plant has the ability to propagate by seed as well as stem cuttings. The function of these dual modes of propagation ensures the plant species to invade and establishment its population in both deciduous and wet habitats.

Keywords: *Premna integrifolia*, hermaphroditic, wasp pollination.

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Author Affiliation:

¹Department of Health, Safety and Environmental Management, International College of Engineering and Management, Muscat, Sultanate of Oman, Oman

²Department of Environmental Sciences, Andhra University, Visakhapatnam 530 003, India

*Corresponding author:

A.J. Solomon Raju,
Department of Environmental Sciences, Andhra University,
Visakhapatnam 530 003, India
Email: solomonraju@gmail.com

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1. INTRODUCTION

The genus *Premna* has been assigned with about 200 species which are mainly distributed in the tropical and subtropical parts of Asia, Africa, Australia (Harley et al. 2004; Kadareit 2004). The number of species of this genus is reported differently by different authors in India – 25 by Santapau and Henry (1973), 31 with 11 varieties by Moldenke (1980) and 31 with 6 varieties by Rajendran and Daniel (2002). Later, a new species, *P. rajendranii* is reported from the Western Ghats of Kerala by Prabhu Kumar et al. (2013). Most species in this genus are small trees or shrubs and rarely lianas (de Kok 2013). This genus is characterized by its 4- or 5-lobed calyx and corolla, dilated corolla tube above the calyx, shortly exerted stamens and style beyond corolla lobes and 4-locular drupe (Munir 1989). *P. foetida* is reported to be an important source of forage for bee-flies in Pakistan (Bodlah et al. 2016). *P. latifolia* is pollinated by the wasp, *Ropalidia spatulata* (Subba Reddi 1990). *P. latifolia* and *P. tomentosa* are dichogamous, herkogamous and facultatively xenogamous; both species are pollinated by wasps and butterflies and the latter species is also pollinated by flies and bees. In *P. latifolia*, nectar robbery by *Camponotus* ants by removing the corolla with or without the sex organs is also reported (Dileepu Kumar et al. 2018). The information on the reproductive biology of all other *Premna* species is totally lacking. With this backdrop, the present study is made to describe floral biology and pollination in *Premna integrifolia* and discuss the same in the light of pertinent information.

2. MATERIALS AND METHODS

Fifteen small trees of *Premna integrifolia* with scattered occurrence in at Srikalahasti Reserve Forest in Ramapuram area in Tirupati District, Andhra

Pradesh, India, were used for the study during April 2021 to November 2021. The habitat conditions, leaf shedding, leaf flushing and flowering periods were documented. Floral traits, nectar section and flower-opening schedule were also recorded as they were considered to be important in pollination process. The anther dehiscence time and flower retention time were also noted. The flower-visitors consisted of only wasps. The wasps visiting the flowers were recorded. Their foraging schedule, flower-probing behavior and forage sought were carefully observed to evaluate their role in effecting both self- and cross-pollination. Casual observations vegetative mode were also made to note whether this plant species spreads by this mode or not. All field observations made on the plant events and wasp activity on the flowers were carefully evaluated to document the floral biology and pollination aspects in *P. integrifolia*.

3. RESULTS

It is an erect shrub with thorny trunk and large spreading branches in semi-deciduous habitats but it grows as a small tree in wet habitats (Figure 1a). The leaves are borne opposite to each other. They are petiolate, broadly elliptic with dentate margins and acuminate apex. Leaf shedding occurs during early December-late February, leaf flushing during late March-late May and flowering during late June-late September. Individual plants display flowering about three weeks only. The flowers are sessile, small, greenish- white, slightly fragrant, bisexual and borne in terminal flat-topped dense paniculate corymbose cymes (Figure 1b,c). The calyx is campanulate, 4-lobed but rarely 5-lobed. The corolla is greenish-white, tubular, hairy inside and 4- or 5-lobed distally. The stamens are 4, didynamous, inserted at the middle portion of the corolla tube; the filaments are creamy white, exerted and hairy at the base of filaments. The anthers are ovate, bi-ocular and display versatile fixation. The ovary is glabrous, 2-carpelled, each carpel with 2 locules and each locule with a single erect ovule. The style is glabrous, linear and the stigma is bifid with two equal divaricate lobes. Fruit is a succulent drupe with pear-shaped seeds and seated on the persistent calyx.



Figure 1. *Premna integrifolia*: a. Habit, b. & c. Flowering inflorescences, d. *Bembix melancholica*, e. & f. *Scolia* sp., g. *Ropalidia* sp.

The flowers are open at 0730-1030 h with peak anthesis during 0830-0900 h by the unfolding of corolla lobes. The petal lobes appear star-shaped when they complete the process of anthesis. Then, the stamens, style and stigma are exposed beyond the throat of the corolla tube. After anthesis, the stigma grows further and reaches the height of long stamens. But, the stigma never contacted with the anthers during flower life despite their close proximity to each other. The anther dehiscence occurs by longitudinal slits during flower-opening. The stamens and corolla fall off as a single unit by the end of the day while the style and stigma remain in place and wither away on 3rd or 4th day. The calyx remains in place throughout fruit development and until fruit fall. The flowers secrete $2.42 \pm 0.21 \mu\text{l}$ of nectar and it fills half of the corolla tube.

The flowers were foraged exclusively by wasp species, *Bembix melancholica* (Figure 1d), *Scolia* spp. (Figure 1e) and *Ropalidia* sp. (Figure 1f) during 0730-1630 h for nectar collection. Their visits were more during forenoon hours. They alighted in upright position on the corymbose cymes and probed the flowers one by one legitimately without any difficulty by inserting their sharp tongues into the corolla throat during which their head parts contacted with the sex organs facilitating the transfer of pollen from them to the stigma and from the anthers to them; this entire probing process resulted in the occurrence of pollination. The wasps foraged many flowers of the same inflorescence in a single visit by swiftly moving from flower to flower; they also swiftly moved between inflorescences of the same and different plants to collect the required levels of nectar and in this process they effected both self- and cross-pollination.

4. DISCUSSION

Dileepu Kumar et al. (2018) reported that *Premna latifolia* and *P. tomentosa* are semi-evergreen tree species. They show robust growth in habitats near streams and stunted growth in habitats with water stress conditions. In this study, it is found that *P. integrifolia* displays robust growth in wet habitats and non-robust growth in habitats with limited water content. Dileepu Kumar et al. (2018) reported that *P. latifolia* and *P. tomentosa* shed their leaves during winter season but leaf flushing occurs during dry season in *P. latifolia* and during wet season in *P. tomentosa*. Flowering occurs during wet season in *P. latifolia* and during dry season in *P. tomentosa*. In *P. integrifolia*, leaf shedding, leaf flushing and flowering events occur in succession from winter season to wet season. In this species, the flat-topped dense corymbose cymes with numerous flowers could attract only wasp species despite the presence of an array of insect species at the study site. The visiting wasp species used this floral source throughout the flowering season for nectar. Their probing behavior facilitated the occurrence of both self- and cross-pollination. Since the wasps are swift in visiting several flowers on the same or different inflorescences in a single visit on the same plant, they are able to effect pollination in many flowers. Further, the production of flowers in corymbose cymes is profitable for them to reduce flight and search time for rewarding flowers, and also energetically advantageous for them. The flowers do not resort to spontaneous self-pollination although the stamens and the stigma are placed close to each other and hence it indicates that *P. integrifolia* is obligately vector-dependent and it is exclusively wasp-pollinated. Dileepu Kumar et al. (2018) reported that *P. latifolia* and *P. tomentosa* are pollinated by wasps and butterflies. *P. tomentosa* is additionally pollinated by bees and flies. *Premna* species appear to be primarily adapted for wasp-pollination but at the same time they also use other insect visitors for pollination according to the habitat conditions. In *P. integrifolia*, fruit and seed production is dependent on wasp pollination. But, this plant species also has the ability to propagate by vegetative means. Mali (2015) documented that *P. integrifolia* propagates by stem cuttings. Therefore, *P. integrifolia* with dual modes of reproduction has the ability to invade and produce prominent populations in deciduous and wet habitats.

5. CONCLUSION

Premna integrifolia displays leaf shedding, leaf flushing and flowering events in gradual success from winter season to wet season. The flowers are bisexual, weakly dichogamous and obligately vector-dependent for pollination. It is pollinated by wasps only despite the presence of other insects in the biotope of this plant. This plant has dual modes of propagation, by seed through sexual reproduction and by stem cuttings by asexual reproduction. These modes of propagation ensure the plant species to invade and establishment its population in both deciduous and wet habitats.

Authors contributions:

Both authors contributed equally.

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Conflicts of interests

The authors declare that there are no conflicts of interests.

Data and materials availability

All data associated with this study are present in the paper.

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