Floral Biology and Carpenter Bee Pollination in Calotropis Gigantea at Amravati (M.S.)

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***Abstract*—The floral biology of *Calotropis gigantea* and its pollination by carpenter bees were investigated in Amravati (M.S.) from June 2024 to March 2025. Observations on flowering phenology, flower morphology, and floral rewards revealed adaptations likely facilitating carpenter bee pollination. Anthesis occurred throughout the day, with peak foraging activity of *Xylocopa latipes* observed around noon. These carpenter bees acted as efficient and effective primary pollinators, while other insect visitors appeared to be supplementary. This study suggests a mutualistic relationship between *C. gigantea* and X. latipes, benefiting both.**

***Index Terms*—Calotropis gigantea, Xylocopa latipes, Foragers, Mutualistic**

I. INTRODUCTION

Pollination, the transfer of pollen from the male to the female reproductive organs of plants, is a crucial ecological process underpinning plant reproduction and the maintenance of biodiversity (Ollerton et al., 2011). This process is often mediated by animal pollinators, with insects playing a particularly vital role in the reproduction of many angiosperm species (Proctor et al., 1996). Understanding the intricate relationships between floral traits and the behavior of their pollinators is fundamental to comprehending plant reproductive success and ecosystem stability.

Calotropis gigantea (L.) Dryand. ex W.T.Aiton, commonly known as Giant Milkweed or Crown Flower, is a prominent shrub or small tree belonging to the family Apocynaceae. This species is recognized for its medicinal properties and is also used for garlanding and offering flowers to Lord Hanuman (also known as Bajrangbali). Furthermore, it holds ecological significance in various tropical and subtropical regions, including India. The flowers of *C. gigantea* exhibit a complex morphology, suggesting specialized pollination mechanisms.

Large carpenter bees (genus Xylocopa) are wood-nesting generalist pollinators of broad geographical distribution that exhibit varying levels of sociality. Their foraging is characterized by a wide range of food plants, long season of activity, tolerance of high temperatures, and activity under low illumination levels. (Keasar T., 2010). While some studies have explored the pollination biology of *Calotropis* species, detailed investigations focusing on the specific interactions with carpenter bees within particular geographical regions, such as Amravati (Maharashtra, India), remain limited.

Given the ecological and medicinal importance of *C. gigantea* and the potential role of carpenter bees in its reproduction within the Amravati region, this study was undertaken from June 2024 to March 2025. The primary objectives were to: (1) characterize the floral biology of *C. gigantea*, including its flowering phenology, flower morphology, and floral reward types; and (2) investigate the foraging behavior and pollination effectiveness of carpenter bees (*Xylocopa latipes*) visiting these flowers. Understanding this specific plant-pollinator interaction will contribute to a broader understanding of reproductive ecology in the region and may have implications for conservation and sustainable utilization of this

valuable plant species.

II. MATERIALS AND METHODS

The study was conducted in in different open fields, road side area within Amravati city, Maharashtra, where substantial populations of *Calotropis gigantea* were observed. Observations on floral morphology, floral biology, and floral rewards were conducted on randomly selected *C. gigantea* plants within the identified study sites. Anthesis schedule for selected flowers was accurately determined by repeated observations (3-4 times) on different days following the initial marking of ten mature buds on different *C. gigantea* plants in the field. Following the recording of anthesis, the same marked flowers were monitored to determine the time of anther dehiscence. The pollen presentation pattern was investigated by observing the mode of anther dehiscence (e.g., longitudinal slits, pores) and the subsequent presentation of pollen. These observations were confirmed using a 10x hand lens. While general flower visitor surveys were conducted, detailed behavioral observations focused specifically on the foraging activity of carpenter bees Xylocopa species. Flower visitor dynamics were assessed by conducting censuses and recording the activity of floral visitors, including their visit timings, at different study sites throughout the flowering period of *C. gigantea*. During the initial, peak, and final phases of the *C. gigantea* blooming period, the types and timings of flower visitors were recorded to assess potential temporal variations in pollinator assemblages. Insect activity and flower visits were primarily observed on days with favorable weather conditions to ensure representative pollinator behavior. Flower visitors were identified in the field whenever possible, and further identification of some collected specimens was carried out at the Department of Zoology, Narayanrao Kale Smruti Model College, Karanja Gh., Dist. Wardha where voucher specimens were deposited. Photographs were taken with a digital mobile camera to document flower visitors and their interactions with *C. gigantea* flowers.

III. RESULTS

This study investigated the floral biology and carpenter bee pollination of *C. gigantea* in Amravati (M.S.) during the period of June 2024 to March 2025. The following key findings were observed:

Flowering Season and Flower Morphology:

Calotropis gigantea exhibited flowering throughout the year, with seasonal variations in intensity. The flowers were medium-sized, odourless, bisexual, and actinomorphic, produced in fascicled or umbellate cymes. Key floral features included inconspicuous calyxes, a salver-shaped corolla with basally united petals forming a cup-like structure, five stamens arising from the corolla base alternating with its lobes and possessing fleshy dorsal processes forming the staminal corona. Each stamen formed two waxy pollinial masses, with a translator consisting of a corpusculum and two retinacula connecting adjacent pollinia. Five such translators were present. The ovary comprised two free carpels with numerous ovules, two styles uniting into a common five-sided discoid stigmatic head forming the gynostegium with the stamens (pollinaria).

Floral Biology and Floral Rewards:

Flowers opened throughout the day, predominantly during morning and evening hours. Nectar was produced from five nectarine chambers and accumulated in well-developed cuculli. Pollen was presented as paired pollinia held within grooves between the nectar chambers, requiring appropriately sized foragers for pickup. A high incidence of thrips and ants' infestation was observed, leading to nectar depletion in many flowers, potentially compelling foragers to make multiple visits.

Foraging Behavior and Activity of Flower Foragers:

Carpenter bees of the genus *Xylocopa*, specifically *Xylocopa latipes* (Plate-I Fig.-5), were common and exclusive nectar foragers on *C. gigantea*. Ants were also observed as resident nectar foragers. Carpenter bees (*X. latipes*) were frequently observed carrying pollinia on their legs, attached to the gynostegium, and inserting them into the stigmatic chamber of other flowers. Pollinia capture by other insect visitors was rare; these insects typically probed for nectar at the base of the flowers. Other occasional visitors were Indian Little Spider hunter bird (Plate-I Fig.-2), Indian Black Sunbird (Plate-I Fig.-3) for nector. Milkweed bug (Plate-I Fig.-6), oriental fruit fly (Plate-I Fig.-1) and Ants (Plate-I Fig.-4) was an occasional forager, while other insect visits were infrequent. From all forager the Carpenter bees

constituted 89% of the total foraging visits recorded for *C. gigantea*

All foragers were active during daylight hours (0700-1800 h), with carpenter bees and ants showing peak nectar collection activity around noon. Carpenter bees visit 10-15 flower per bout and reside 4 to 183 second on per flower and its visit very frequent. Indian Little Spider hunter bird visit 1-3 flower per bout and stay for 3 to 8 second on per flower, Indian Black Sunbird visit 1-3 flower per bout and stay for 3 to 12 second on per flower for nectar. Milkweed bug and ants stay for long time on a flower, oriental fruit fly visit 1-5 flower per bout and reside for 3 min to 1 hour per flower. Carpenter bees were identified as the primary and legitimate pollinators, while other insects were considered opportunistic foragers.

IV. DISCUSSION

This study in Amravati highlights a strong relationship between *Calotropis gigantea* and the carpenter bee *Xylocopa latipes*. The flower's characteristics, such as its shape, concealed nectar, and specialized pollen transfer mechanism (common in plants pollinated by large bees; Proctor *et al*., 1996), appear well-suited for pollination by these insects. The peak foraging activity of *X. latipes* around noon likely reflects the temporal availability of floral rewards (Ollerton et al., 2011). Foraging behaviour of carpenter bees, Genus Xylocopa: Xylocopidae: Hymenoptera and the pollination of some Indian plants (Solomon Raju, A.J. and Subba Reddi, C. 2000). A pattern also observed in male *Xylocopa aestuans* in Solapur, Maharashtra (Aland & Mamlayya, 2012), suggesting a common influence of resource availability on carpenter bee foraging schedules across species and regions. The aggregated flower display likely enhances the plant's attractiveness to efficient pollinators by increasing visual signals (Weberling, 1989). While other insects visit the flowers, *X. latipes* is the dominant forager and appears to be the primary pollinator, effectively transferring the unique pollinia characteristic of Calotropis. This close interaction underscores a mutualistic relationship where the bee gains nectar, and the plant achieves successful reproduction (Faegri & van der Pijl, 1979). The findings contribute to our understanding of plant-pollinator dynamics in the region, emphasizing the ecological importance of carpenter bees for *C. gigantea* and highlighting potential similarities in foraging patterns within the Xylocopa genus in Maharashtra

In conclusion, this study demonstrates that *Xylocopa latipes* is the primary and effective pollinator of *Calotropis gigantea* in the Amravati region. The floral biology of *C. gigantea*, including its morphology, rewards, and temporal patterns, appears well-adapted to attract and facilitate pollination by these carpenter bees, highlighting a significant mutualistic interaction within this ecosystem.

Photo Plate-I

Fig.1- Oriental fruit fly

Fig.2-Indian Little Spider hunter bird

Fig.3- Indian Black Sunbird

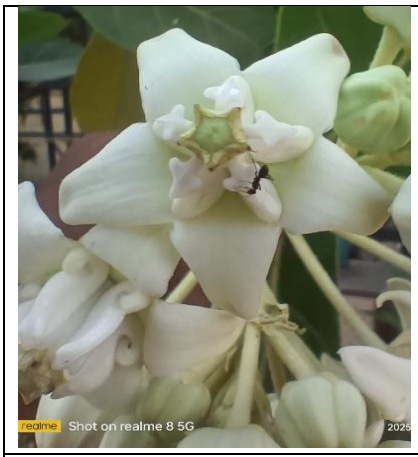

Fig.4- Ant visiting flower

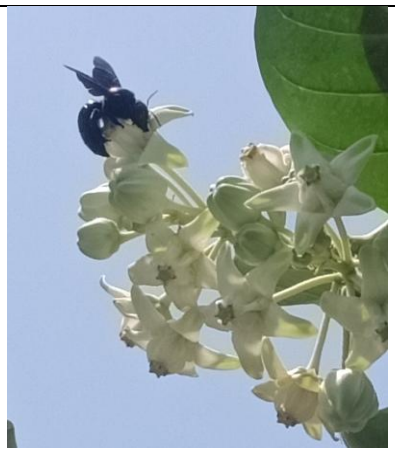

Fig.5- *Xylocopa latipes*

Fig.6- Milkweed Bug

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