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SHORT NOTE

A Unique Foraging Behavior of Honey Bees on the Fallen Flowers of an Indian Beech Tree (*Millettia pinnata* L.)

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Abstract

Millettia pinnata, a potential biodiesel plant, bears copious pink and white flowers from February to April, and there are plenty of pollen and nectar rewards for the flower visitors. Four species of bees, Indian rockbee, *Apis dorsata*, Indian honeybee, *A. cerana indica*, little bee, *A. florea,* and stingless bee, *Tetragonula iridipennis,* visited the fallen flowers of *M. pinnata* for the collection of rewards in the flowers. In the current study, *A. cerana indica* showed the highest frequency of foraging on fallen flowers (6.40 ± 1.67 bees/5 minutes), followed by *T. iridipennis*(4.20 ± 0.84 bees/5 minutes). The bees handled 3.01 ± 1.00 fallen white flowers and 2.20 ± 0.84 pink flowers in 5 minutes. The bees spent 4.40 ± 0.55 seconds and 4.20 ± 0.84 seconds on the fallen pink and white flowers, respectively. The study reported a unique foraging behavior of bees in the fallen flowers of *M. pinnata*, requiring caution in refraining from the inter-cultivation operations below the trees during the bloom period to enable floral rewards to the bees from the fallen flowers.

Introduction

Millettia pinnata, commonly called the Indian beech tree, is an annual dry-season flowering tree with papilionaceous flowers that provide copious amounts of nectar and pollen to flower visitors. This plant flourishes from March to May, attracting several bee species that aid in pollination. The plant belongs to the family Fabaceae, which bears papilionaceous flowers that require tripping behavior by the bees to collect the pollen and nectar rewards. In *M. pinnata*, floral reward collection and pollination occur through 'flower tripping' behavior. Tripping involves the release of the sexual column, exposing the stigma to pollen carried by the bee from other flowers or plants, resulting in cross-pollination (Murphy et al., 2012; Solomon Raju & Subba Reddi, 1995). During the anthesis period, honeybees actively forage for the nectar and pollen in the open flowers, which aids in successful pollination.

The plant has several flower visitors belonging to the orders Hymenoptera, Thysanoptera, and Lepidoptera, out of which honeybees were reported to be the dominant floral visitors (Siddanna et al., 2022). Several species of bees, viz., *Apis dorsata*, *A. cerana indica*, *Amegilla* sp., *Megachile* sp., *Xylocopa latipes,* and *X. pubescens* were reported to be the pollinators of *M. pinnata* (Soloman Raju & Punrachandra Rao, 2006). The longevity of the flowers lasts for a single day, marked by the gradual movement of the standard petals to close the wing and keel petals. The authors observed a considerable decline in the number of unopened flowers of *M. pinnata* at the ICAR-National Bureau of Agricultural

Insect Resources, Yelahanka campus, Bengaluru, Karnataka, India, from February to April 2024. Dry weather and water stress conditions produce smaller, fewer, or shorter-lived flowers (Gallagher & Campbell, 2017). The authors observed an interesting behavior of foraging of the bees on the fallen flowers of *M. pinnata*. In this study, we documented an interesting foraging activity of bees in the fallen flowers of *M. pinnata*.

Materials and Methods

The study was conducted at the ICAR-National Bureau of Agricultural Insect Resources, Yelahanka campus, Bengaluru, Karnataka, India. At the study site, twenty *M. pinnata* trees were planted in the avenue. The trees were in full bloom from February to April 2024. The different species of bees foraging on the pink and white types of flowers of *M. pinnata* (Fig 1) were recorded at two-hour intervals from 0900 to 1800 hours. The number of bees foraging on the fallen flowers/15 minutes and the number of fallen flowers handled by the bees/5 minutes were recorded. The time spent by the bee per flower was recorded in both the fallen white and pink flowers of *M. pinnata*. The reward collected by the bees was also recorded on 25 samples.

Analysis of variance (GLM in SAS 9.3; SAS Institute, Cary, NC) was used to compare the number of different species of bees visiting the fallen flowers of *M. pinnata* per five minutes and the number of flowers handled by each species of bee. Where a significant difference was detected, Tukey's HSD Test (5%) was used to separate treatment means.

Fig 1. Fallen flowers of *Milletia pinnata* on the ground.

Results

There was a significant difference in the number of bees visited per fifteen minutes in the fallen flowers of *M. pinnata* (F value = 20.93; $P < 0.001$). Four different species of bees, *Apis dorsata* (1.40 ± 0.55 bees/15 minutes), *A. florea* (3.01 ± 1.00 bees/15 minutes), *A. cerana indica* (6.40 ± 1.67 bees/15 minutes) (Fig 2), and *Tetragonula iridipennis* (4.20 ± 0.84 bees/15 minutes), were observed to forage on the fallen flowers of *M. pinnata* (Fig 3). There was a significant difference in the number of pink (F value = 17.48; $P < 0.001$) and white (F value = 19.42; $P < 0.001$) flowers handled per five minutes between the five different species of bees (Fig 5). The mean number of pink flowers handled by *Apis cerana indica* (3.00±0.63 flowers/5 minutes), *A. dorsata* (1.50 ± 0.55 flowers/5 minutes), *A. florea* (1.16 ± 0.41 flowers/5 minutes), and *Tetragonula iridipennis* (3.16 ± 0.75 flowers/5 minutes). The mean number of white flowers handled by *Apis cerana indica* (2.83 ± 0.75 flowers/5 minutes), *A. dorsata* (1.00 ± 0.63 flowers/5 minutes), *A. florea* (1.50 ± 0.55 flowers/5 minutes), and *Tetragonula iridipennis* (3.00 ± 0.63 flowers/5 minutes).

Fig 2. Honeybee, *Apis cerana indica* foraging on the fallen flowers of *Millettia pinnata.*

The bees spent 4.40 ± 0.55 and 4.20 ± 0.84 seconds in the pink and white flowers (n = 25) during the foraging activity, respectively.

Discussion

This study presents the first report on the documentation of bees' foraging activity in fallen flowers. The authors came across a documentary video depicting a swarm of bees collecting pollen from the fallen flowers of palm trees (https://depositphotos.com/video/swarm-bees-ground-collecting-pollen-fallen-flowers-palm-trees). A closer examination of the fallen flowers of *M. pinnata* attended by the bees revealed that they were unopened flowers that had fallen to the ground. The bees approached the fallen flowers from the upward side and then attempted to open the standard petals, which provided access to the overlapping wing petals on the sides (Fig 4). The keel petals inside released the staminal column, enabling the bee to collect the pollen reward. The authors observed the bee visitors with pollen on their corbiculae as they left the fallen flowers.

Some bees were licking the petals, making brief, swift flights between the fallen flowers. The authors hypothesize that the bees made brief visits to the fallen flowers to consume the nectar droplets that might have spilled during the flower's fall, which caused it to stick to the petal surface. The innate ability of pollinators to detect minor changes in floral traits and adjust their behavior in floral handling and resource usage/intake has been well reported (Mothershead & Marquis, 2000; Dohzono et al., 2011). The activity of the bees was observed only in fresh, closed, fallen flowers with their intact rewards, as the bees

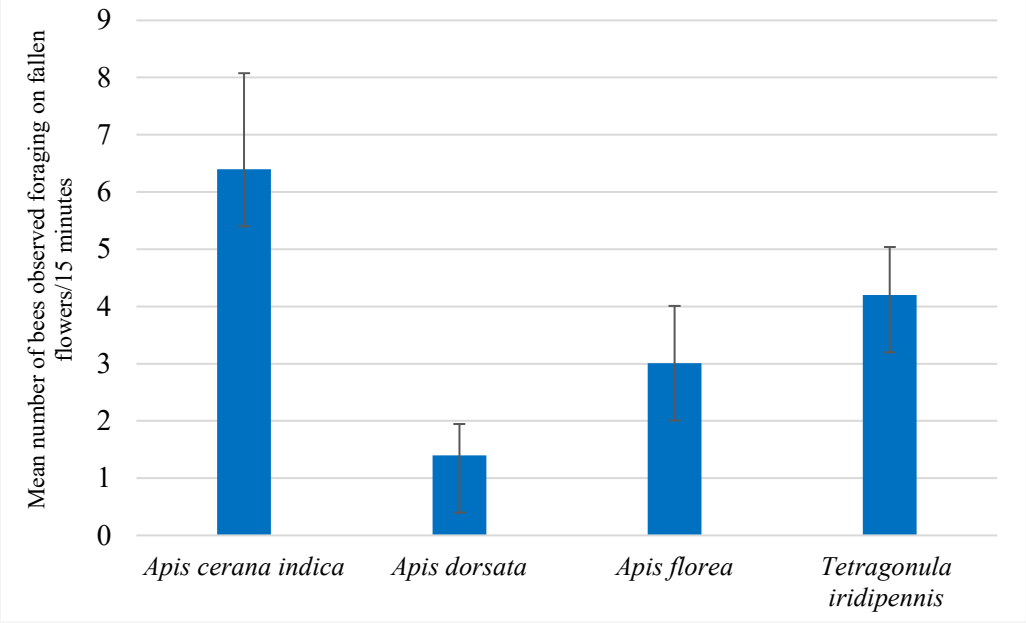

Fig 3. Bee foragers on the fallen flowers of *Millettia pinnata.*

Fig 4. Honeybee, *Apis cerana indica* opening the flowers of *Millettia pinnata* for reward collection.

neglected to visit the fallen, dried flowers. The bees foraged in the fallen flowers during the morning and evening, as flower drop was observed throughout the day. The bees equally preferred both pink and white fallen flowers for foraging.

Although the authors observed abundant foraging of bees in intact flowers on the tree, the bees were not sparing even the fallen flowers for reward collection, indicating the bees' opportunistic and vigorous resource-depleting behavior. The observations made in this study can be interpreted as an advisory to beekeepers to avoid cleaning/intercultivation operations below *M. pinnata* trees during bloom in their apiaries, thereby providing a pollen/nectar feast to the bees from the fallen flowers.

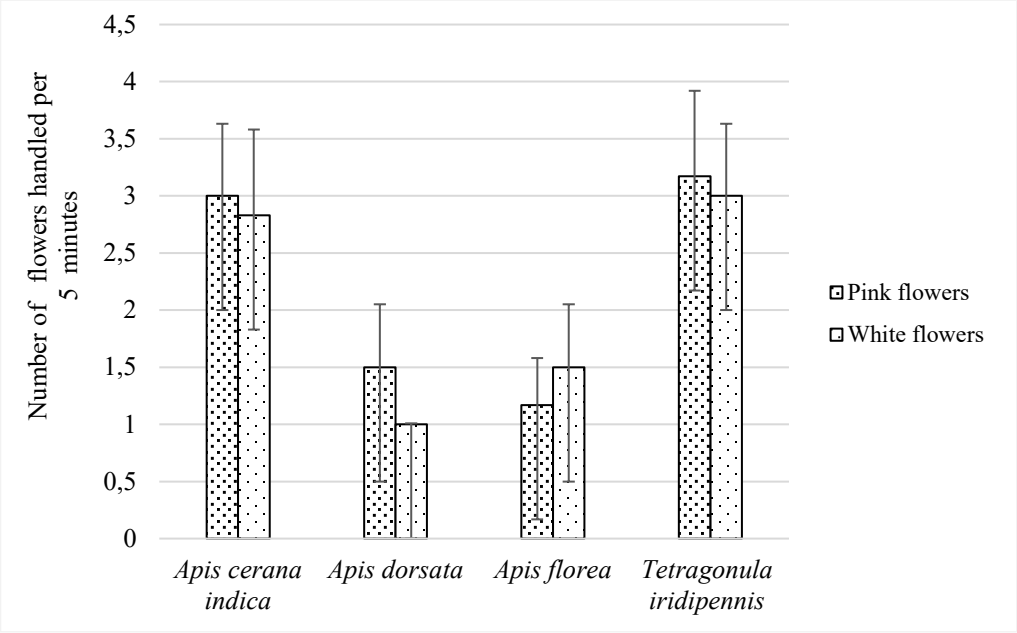

Fig 5. Handling time of bee foragers in the fallen flowers of *Millettia pinnata.*

Authors' Contributions

AU: Conceptualization, investigation, writing-original draft, review and editing.
VHS: Formal analysis.
TMS and ANS: Supervision, writing-review and editing.
KS and SNS: writing-review and editing.

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