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Short communications

Foraging efficiency and food bait standardization in stingless bee, *Tetragonula travancorica* Shanas and Faseeh (Hymenoptera: Apidae: Meliponinae)

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Abstract

Stingless bees, *Tetragonula travancorica* (Hymenoptera: Apidae: Meliponinae) are small to medium-sized eusocial bees predominantly found in tropical and subtropical regions. They have been domesticated for centuries, primarily for crop pollination. The study mainly focused on standardizing food bait and calculating the foraging distance of *T. travancorica,* a widely distributed stingless bee species in peninsular India. The standardization of food bait was carried out using an artificial feeder technique and the various food baits were evaluated including sugar, honey, and jaggery solutions of 35, 50, and 75 per cent concentrations, among them, 35 per cent sugar solution was found to be the most effective food bait in attracting *T. travancorica*. The average foraging distance of stingless was 378 m with a minimum foraging distance of 100 m and a maximum of 400 m. The number of bees attracted to the food bait decreased with the increases in the foraging distance. The study emphasizes the importance of bait concentration, strategic placement of stingless bee colonies for enhancing pollination efficiency and provides insights for advancing meliponiculture and pollination strategies.

Keywords: Attractants, Food bait, Foraging distance, Stingless bees, *Tetragonula travancorica*

Introduction

Stingless bees are small to medium-sized eusocial bees (Hymenoptera: Apidae: Meliponinae), found in the tropical and subtropical parts of the world. Unlike other eusocial bees, stingless bees do not have sting and defend their colonies with their strong mandibles. Stingless bees have been domesticated for centuries in Latin America (Cortopassi-Laurino et al., 2006) and have been used as important pollinators in crop pollination (Wallace and Trueman, 1995).The advancement in meliponiculture has led to the development of standard hive boxes for rearing stingless bees. These hive boxes are easy to manage and are widely used in commercial pollination, including crops like cucumbers. Understanding the foraging distance of stingless bees is crutial, as it influences the sexual reproduction of flowering plants and shapes the genetic and spatial dynamics of plant communities (Waser et al., 1996; Gomez et al., 2007). The foraging efficiency of stingless bees is affected by various factors including climatic conditions, species type, and the availability of natural vegetation (Cartwright and Collett, 1983; Plowright and Galen, 1985). For instance, Smith et al. (2017) reported that stingless bees could travel distances ranging from 333 m to 712 m. Similarly, *Melipona eburnea* Friese was observed to forage across a radius of approximately 908 ha, with a maximum distance of 1.7 km from its hive (Silva et al., 2017). The availability of artificial nectar sources also influences foraging behaviour. Basari et al. (2018) found that bees were more attracted to feeders placed 1 m away than at 10 m.

The foraging distance of stingless bees has been primarily estimated using two major techniques *viz.,* artificial feeder techniques (Zurbuchen et al., 2010) and capture-recapture methods (Roubik and Aluja, 1983; Gathmann and Tscharntke, 2002). Artificial feeder techniques are generally preferred for behavioural, foraging and communication studies due to their precision, controlled conditions and minimal invasiveness (Bukhari et al., 2019). Baiting is an effective method to attract stingless bees with pre-mix bait being a commonly accepted technique (Boontop et al., 2008; Hannah et al., 2012). The baits used in the estimation of foraging distance in the stingless bee includes honey solution 50 per cent (v/v) (Boontop et al., 2008; Jongjitvimol and Petchsri,

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2015), urine bait (Kumara et al., 2016), non-floral sources such as water, honeydew, seed, rotten fruit, and resin (Lorenzon and Matrangolo, 2005), sugar solution of 35 and 50 per cent concentration (Basari et al., 2018). Based on these attractants the present study focuses on standardizing food bait and evaluating the foraging efficiency of *T. travancorica,* the most widespread stingless bee species in peninsular India.

Materials and methods

Optimization of Attractants for Stingless bee, Tetragonula travancorica

The standardization of food bait for stingless bees was conducted using the artificial feeder technique described by Zurbuchen et al. (2010). The experiment was conducted from Nov 2019 to March 2020 in the playground of the College of Agriculture, Vellayani (8.4316° N, 76.9860° E) Kerala, India using a stingless bee hive with limited resources to attract the bees to different food bait. The baits used in the study included 35, 50 and 75 per cent sugar, jaggery and honey solutions with water as control. The stingless bee, *T. travancorica* colony was positioned at the centre of the experimental setup, and three feeder stands were placed 10 meters away from the hive in the south, west, and east directions. The height of the feeder stands was kept consistent with the height of the hive and the experiment was conducted on sunny days under normal temperatures (27° C - 35° C). All 10 treatments were placed on the feeder stands, allowing the stingless bees to feed on the various food baits (Plate 1). The number of bees attracted to the different bait was recorded and analyzed. The experiment was replicated thrice to standardize the food bait.

Foraging Distance of Stingless bee, Tetragonula travancorica

The foraging distance of the stingless bees was estimated using the artificial feeder technique described by Zurbuchen et al. (2010). The preferred food bait by the stingless bee, *T. travancorica* from the above study was used to estimate the foraging distance of the stingless bee. The preferred food bait was kept on feeder stands at varying distances from 100 m to 300 m from the stingless bee hive. After 300 m, food bait was progressively moved from 10 to 15 meters, up to 500 m and the number of bees attracted to food bait and the distance travelled was recorded. The experiment was repeated three times and calculated the foraging distance for the *T. travancorica.*

Statistical analysis

The data collected during the study were analyzed using descriptive statistics and graphical representations to summarize the data. Hypothesis testing such as ANOVA was performed to determine significant differences in bee behavior. The statistical method used was a completely randomized design and analysis were performed using WASP 2.0 software.

Results and Discussion

Optimization of Attractants for Stingless bee, Tetragonula travancorica

Standardization of food bait for stingless bee, *T. travancorica* revealed that a significant number of bees were attracted to the different food baits with 35 per cent sugar concentration being the most attractive food bait with an average number of 18 bees, followed by 35 per cent honey solution with 14 bees, and 50 per cent sugar concentration with 12.6 bees. In

Plate 1. Standardization of food bait for stingless bee, *Tetragonula travancorica* **a.** Different food bait for stingless bee **b.** Stingless bee colony with limited resources. **C.** Lay out for an experiment.

contrast, control (water) attracted the least number of bees and there was a decline in the number of bees visiting as the concentration of the attractants increased (Fig 1). The 35 per cent sugar concentration was the most attractive food bait for *T. travancorica*. This finding was supported by Kumara et al. (2016), who observed that eight species of stingless bees were attracted to pre-mixed sugar bait. Similarly, Basari et al. (2018) also reported that higher sugar concentrations of 35 per cent and 50 per cent were more attractive to stingless bees than lower concentrations of 15 per cent. Bees typically select and exploit the most rewarding food sources (Schmidt et al., 2006) and have optimal nectar concentration preferences according to their body sizes (Roubik et al., 1995; Kuhn-Neto et al., 2009). Larger bees prefer higher nectar concentrations, while smaller bees prefer lower concentrations (Kuhn-Neto et al., 2009). For instance, *Trigona muzoensis,* which is 6 mm in size prefers nectar with a sugar concentration of 30-60 per cent, whereas *Melipona beechei,* which is 9 mm in size has an optimal preference for a 65 per cent concentration. The size of the *T. travancorica* was 3 to 4 mm, which preferred a 35 per cent sugar concentration.

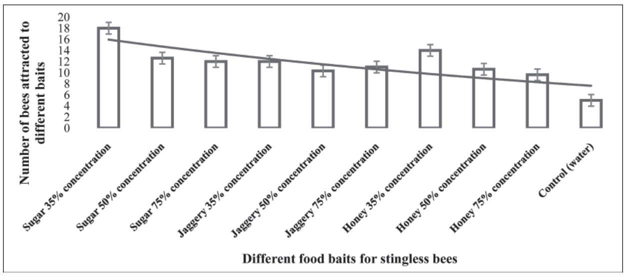

Figure 1. Preference of food baits by stingless bees

Foraging efficiency of stingless bee, Tetragonula travancorica

The foraging distance of stingless bees was assessed using a standardized 35% sugar solution as bait. The distances varied from a minimum of 100 meters to a maximum of 400 meters, with an average distance of 378 meters. The number of bees observed at the food bait varied with distance. The highest number of bees (28) was recorded at a distance of 100m, followed by 26 bees at 200 m and the lowest number of bees (19) was recorded at a 400 m distance (Fig. 2). This indicates that the number of bees decreases with the increase in the foraging distance. The average foraging distance travelled by stingless bees was 387 m with a maximum foraging distance of 400m and a minimum of 100m. These results align with the findings of Roubik et al. (1983) where, the stingless bee *Trigona* had foraging distances ranging from 155 to 505 m. The foraging activities of bees can be influenced by many factors such as temperature, food source availability, body sizeand colony condition. Different-sized bees have varying abilities to travel from their nests (Heard, 2016). The body size of *T. travancorica* favours exploiting

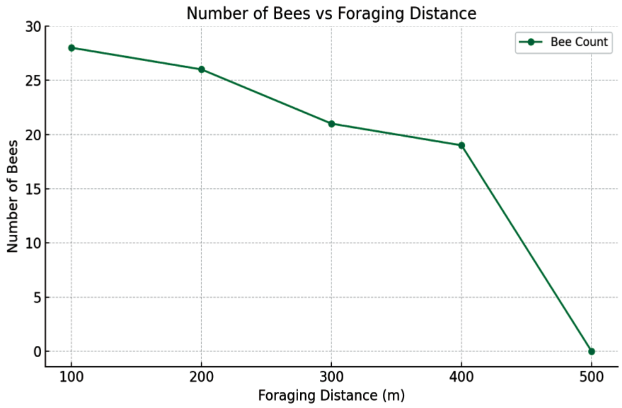

Figure 2. Foraging efficiency of stingless bees

nearby food resources over distant ones. A significant number of bees were attracted to the bait at 100 m rather than 400 m. Similarly, Basari et al. (2018) found that feeder stands at 1m distance had more numbers of bees compared to feeders kept at 10 m. This behavior likely stems from the bees' tendency to favour nearby resources to optimize their energy when food is readily available close to the hive (Seeley, 1997).

Conclusion

The standardization of food bait for stingless bees, *T. travancorica* highlights the importance of food concentration in shaping the foraging behaviour of stingless bees. This insight can assist agriculturists and stingless beekeepers in effectively positioning beehives and food sources in the crop fields and aids in improving pollination management and beekeeping practices.

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