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A Comparative Study of Ant Tunnelling and Foraging Behaviour in *Camponotus Albosparsus* and *Solenopsis Geminata*

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ABSTRACT

As one of the most varied and essential insect groups for the environment, ants display a wide range of behaviours vital to the survival of their colonies and the environment. Despite the ecological importance of ants, limited knowledge exists regarding how different species' behaviours contribute to ecosystem dynamics, hindering effective conservation and management strategies. The objective of this experiment is to compare the structural aspect of tunnel constructed and examine the foraging strategies employed by *Camponotus alboparsus* (Carpenter ant) and *Solenopsis geminata* (Fire ant). These species are classified into separate genera and occupy diverse ecological niches; fire ants are known for their aggressive foraging and stinging behaviour, whereas carpenter ants typically nest in wood-based buildings. The experiment took place in a formicarium for five days. Both *C. alboparsus* and *S. geminata* were provided with a soil-based set-up and anti-escape measures. The tunnels' structural aspects, construction methods, and architectural intricacies were thoroughly examined and compared across both species. The foraging behaviour was also investigated by monitoring the recruitment and foraging activities. The response of both ant species to food sources, foraging efficiency, and their food distribution are examined. The result revealed a significant difference between *C. alboparsus* and *S. geminata* tunnelling and foraging behaviour. *C. alboparsus* exhibited a more detailed, shorter, and larger radius tunnel, while *S. geminata* exhibited a more extensive tunnel, longer and smaller in radius. In conclusion, this research enhances our understanding of nature and helps in developing efficient algorithms for tasks like route planning and excavation.

Keyword: ant behaviour; tunnelling; foraging; *Camponotus alboparsus*; *Solenopsis geminate.*

1. INTRODUCTION

Ant species exhibit a wide range of behaviors and ecological roles that are crucial for understanding their impact on ecosystems. *S. geminata* (Fire ant) is known for its aggressive foraging behaviour and significant impact in natural and urban environments. This species is highly adaptable and efficient in resource acquisition, often outcompeting native ant species and affecting local biodiversity (Wetterer, 2020). On the other hand, *C. alboparsus* (Carpenter ant) is recognized for its complex tunnelling behaviors and preference for nesting in wood. *C. alboparsus* plays a vital role in in forest ecosystem by aiding in the decomposition process and nutrient cycling (Hölldobler & Wilson, 1990). The selection of these two ant species for comparison is significant due to their distinct ecological niches and behaviors. *S. geminata* is an invasive species that poses ecological and economic challenges in many regions (Vinson &

Sorenson, 2022). Its rapid colonization and aggressive nature make it a critical subject for studying competitive interactions and resource exploitation. Conversely, *C. alboparsus* is less aggressive but exhibits sophisticated nesting and foraging behaviors that contribute to forest health. Understanding the differences in their behaviors can provide insights into how they influence their environments and interact with other species. Despite the extensive research on the individual behaviors of these ant species, there is a limited comparative analysis of their foraging and tunnelling strategies. Understanding these differences is essential for comprehending their ecological impacts and interactions with other species. Previous studies have highlighted the importance of foraging and tunnelling behaviors for colony survival and resource acquisition (Lanan, 2014). However, a direct comparison between the foraging strategies and tunneling structures of *S. geminata* and *C. albosparsus* remains underexplored. This study aims to compare the tunnelling and foraging behaviours of *C. albosparsus*(Carpenter ant) and *S. geminata* (Fire ant) to enhance understanding of their ecological roles. The objective of the experiment is to investigate their tunnelling behavior, construction methods, foraging strategies, and responses to food sources. Observational and experimental methods were employed in controlled settings, involving the setup of formicariums with soil-based substrates to meticulously observe ant behaviors over a specified period.

2. METHODOLOGY

Two-meter wooden sticks were cut using a hand saw into 30.0cm lengths and glued at both edges and between acrylic sheets. Subsequently, an A3 clear acrylic sheet was glued to the base of the assembly. Ensuring there were no gaps or holes between the wood and acrylic, organic soil was added to the formicarium until it reached a depth of 15.0cm. The soil was then moistened by applying water using a dropper. Following this, the anti-escape solution was applied to the lid of the formicarium, approximately 10.0cm from its edge, and left to dry for 5 to 10 minutes. Replicating these steps, another formicarium was produced, labelled as formicarium A, and formicarium B. After that, each ant colony was delicately placed into its respective formicarium, with formicarium A housing the *C. albosparsus* colony and formicarium B accommodating the *S. geminata* colony. Food was provided daily for each colony on designated food trays, comprising a water-sugar solution and mealworms for both formicariums. The length and the radius of the tunnel constructed by both ant species within the formicarium were measured using a thread and a ruler. To investigate the foraging strategies of both ant species, food baits (sugar and protein) were placed at equal distances from the nests. The foraging behavior was monitored by observing the recruitment and foraging activities of the ants. A camera was used to continuously record the foraging activities, and the footage was analysed to determine patterns such as tunnelling behaviour, responses to the food source and optimal foraging period.

3. RESULTS AND DISCUSSION

3.1 Figures and images

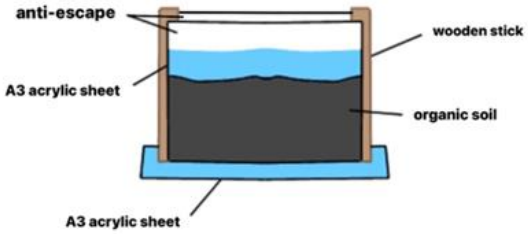

Figure 1. Day 1 of the experiment

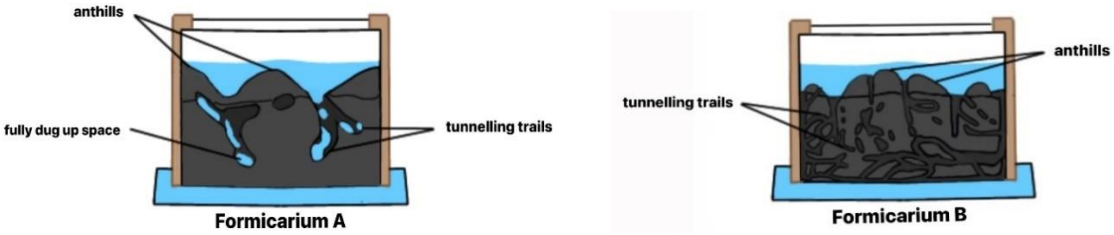

Figure 2. Day 5 of the experiment

3.2 Table

Table 1. Tunnelling and foraging strategies

	Formicarium A	**Formicarium B**
Tunnelling behaviour	*C. albosparsus* constructed detailed and intricate tunnels with a larger radius. Over the five days, *C. albosparsus* dug tunnels totalling 7.5 cm and a radius of 1 cm. There is 1 main tunnel dug by *C. albosparsus*. These tunnels were generally shorter but displayed a more complex architecture with few chambers and branching pathways. This species showed a methodical approach to excavation, with tunnels appearing well-organized and structurally robust.	*S. geminata* exhibited a more extensive tunnelling system with a smaller radius. Over the five days, *S. geminata* dug tunnels totalling 18 cm and a radius of 0.25 cm. There are 7 main tunnels dug by *S. geminata*. These tunnels were longer, often extending over a larger area with multiple branches and chambers compared to *C. albosparsus*. The excavation was rapid and less structured, resulting in simpler tunnel networks.
Response to the food sources	*C. alboparsus* preferred protein-based baits, showing higher recruitment and collection rates for mealworms compared to sugar solutions.	*S. geminata* showed a balanced preference for both sugar and mealworms, with quick discovery and high recruitment rates for all food types.

Foraging strategies	The ants use the tandem running strategy and pheromone to allocate food (Goy et al., 2021). Ants from the *C. albosparsus* colony exhibited a slower but more systematic foraging pattern. The recruitment process was gradual, with a steady increase in the number of foraging ants over time. Foraging efficiency was high, with ants making fewer trips but collecting larger quantities of food per trip	S. geminata ants rely on pheromone trails for quickly recruiting others to food sources. They detect these pheromones through their sensitive antennae (Chalissery et al., 2019). These ants demonstrate a swift and aggressive foraging strategy, recruiting a significant number of ants rapidly to food. Although they collect less food per trip, their overall collection rate is higher due to the larger number of foraging ants involved.
Optimal foraging period	*C. albosparsus* foraged primarily during the early morning and late afternoon	*S. geminata* was most active at midday

4. CONCLUSION

The study found distinct trailing and foraging behaviors in each colony of C. alboparsus and S. geminata. Future research should delve into the reasons for these differences and their ecological impacts. Insights gained can optimize route planning, excavation methods, and resource allocation across industries. Overall, our study highlights the commercial potential of understanding ant behavior.

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