Foraging Behavior of Field Populations of the Big-Headed Ant, *Pheidole megacephala* (Hymenoptera: Formicidae)

by

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ABSTRACT

Studies on foraging behavior of field populations of a tropical pest ant, the big-headed ant, *Pheidole megacephala* (Fabricius) were conducted in dormitory pantries of a university in Penang Island, Malaysia. A total of 19 field populations were observed for their preference for different types of food (peanut butter, 30% sucrose solution, fine castor sugar, peanut oil and freshly-killed cockroaches) over a period of 30 weeks. Results indicated that this species preferred protein-rich food (peanut butter and dead cockroaches) to those which contained solely sugar or lipid. There appeared to be some changes in their preference between peanut butter and dead cockroaches. Foraging activities were affected by the presence of other ant species such as *Monomorium pharaonis*, *Paratrechina longicornis* and *Tapinoma melanocephalum*. Foraging studies using mark-recapture technique on field *P. megacephala* in this study demonstrated a foraging distance and territory of 1.82 – 3.34 m and 2.75 – 4.84 m^2, respectively.

Keywords: Big-headed ant, *Pheidole megacephala*, food preference, foraging distance, foraging territory, territoriality

INTRODUCTION

Among more than 1000 species of *Pheidole* ants that have been identified (Hedges 1998), the big-headed ant (also known as Coastal Brown ant in Australia), *Pheidole megacephala* is an important structure-invading pest in both tropical and semi-tropical habitats (Lee *et al.* 2003). This polygynous species has been associated with agricultural damage in Hawaii for more than 100 years (Smith 1879). They are known to share a close relationship with the common sap-sucking Homopteran (mainly mealy bugs or scale insects) pests of pineapple, coffee and sugar cane plantations (Reimer & Beardsley 1990, Reimer *et al.* 1990), facilitating the transmission of plant pathogens, and interfering with gardening, cultivation and harvesting operations. In addition, it has been implicated as a major cause for the disappearance of many

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native invertebrates in lowland ecosystems in Hawaii (Perkins 1913).

In Malaysia, *P. megacephala* is one of the most dominant species of household ants in urban and suburban structures and buildings (Na & Lee 2001, Lee *et al.* 2002). It has two distinct sizes of workers (major and minor) and nests primarily outdoors, but invades structures for food ranging from sugar to meat products (Lee 2002). When nesting within the perimeter of the structure, this species usually feeds on other live or dead insects.

Despite its importance in the tropics, there has been a dearth of information on this species, particularly with regards to its biology and behavior. It was reported at 26 – 27°C, its queens will deposit eggs in groups of 2 – 82 on random days, averaging 6 eggs per queen per day, and the eggs generally took 6 – 11 days to hatch. Larvae underwent development for 9 – 21 days before they matured, and pupae took another 7 – 11 days to complete the cycle to become minor workers (Chang 1985, Smith 1996). Cornelius and Grace (1997) studied the influence of brood on the nutritional preference of this species and reported that its foraging rate for proteins and carbohydrates depended upon the type of protein, but was not affected by the presence of brood.

This study examined several aspects of foraging behavior of *P. megacephala* such as food preference, foraging distance and territory and effects of presence of other ant species on foraging activity.

MATERIALS AND METHODS

A total of 19 dormitory pantries in Universiti Sains Malaysia campus on Penang Island, Malaysia with *P. megacephala* infestations were chosen for this study. The pantries are generally used for the purpose of food preparation, dish washing and garbage disposal, and the sanitary condition varied among different dormitories, but were generally moderate to poor.

For the food preference studies, five food types from three main food classes; carbohydrate, protein and lipid were subjected to the choice test at the respective sites. These were: 0.5 g peanut butter (Delicia ®, Pacific Impact Industries Sdn. Bhd.), 1.5 ml of 30.0 % sucrose solution (Prai, Malayan Sugar Mfg. Co. Bhd.), 0.5 g fine castor sugar (crystal size 400 mm diameter; Malayan Sugar Manufacturing Co. Bhd.), 1.0 cm x 1.0 µm filter paper soaked with peanut oil (Lam Soon Malaysia Pte. Ltd.) and freshly-killed adult lobster cockroaches, (*Nauphoeta cinerea*). Filter paper was used to deliver the oil to the ants. The foods were randomly placed in separate round disposable plastic dishes (diameter 3.5 cm) with holes bored along the sides. These plastic dishes were stuck onto a piece of 35.0 cm x 4.5 cm cardboard in a straight row and

were left along detected ant trails at the sites for an hour. The species of ants found feeding on each food were identified according to the description by Na & Lee (2001), and their numbers were estimated. The sampling was done weekly for up to a period of 30 weeks and all 19 sites with *P. megacephala* infestations.

Four out of the 19 sites used earlier were randomly selected for studies on foraging distance and territory. Traps made from 9.0 cm diameter petri dishes (with holes along the side) were baited with 3.0 g peanut butter or a freshly-killed lobster cockroach. At each site, two traps were placed along the detected ant trails for two hours. The ants that were found foraging inside the traps were brought back to the laboratory for marking.

The captured worker ants were kept in 24.0 x 30.0 x 11.5 cm sandwich boxes and kept for two days without food and water. Subsequently, the ants were provided with 30.0 % sucrose solution stained with 5.0 % blue food dye (True Blue Color, Bush Bloake Allen, Sdn. Bhd., Malaysia) for three days. After the third day, 10 ants were randomly picked and crushed between two sheets of filter paper to detect the presence of dye in their bodies. This method had to be resorted since the dye was not visible on the insect's body due to the dark-colored gaster of this ant species. The ants were assumed to have been marked well when at least 8 out of 10 chosen ants were found to be dyed. The number of marked ants were then released back to their respective sites where they were originally collected. Upon release, these ants were left to mix freely with their original colonies for the following three days before similar traps were used to recapture them. This time, eight traps were placed by the sides of walls, at corners or any potential ant trails at the respective sites and two traps were placed in the pantries on adjacent floors above or below the sites chosen. This was to detect any possible vertical foraging. The distance of the traps from one another was also measured. After two hours, traps were collected in separate containers and the recaptured ants were crushed between two sheets of filter paper to determine the presence of the dye. Based on the traps with marked ants, the foraging distance and foraging territory size of the ants were estimated.

RESULTS & DISCUSSION

Results indicated throughout the study period that *P. megacephala* preferred the freshly-killed lobster cockroach (more than 40%), followed by peanut butter (15%), of the total foraging ants (Fig. 1). The findings agree with that of Lee (2002) who recorded the preference of *P. megacephala* for protein-rich food. In addition, there also appeared to

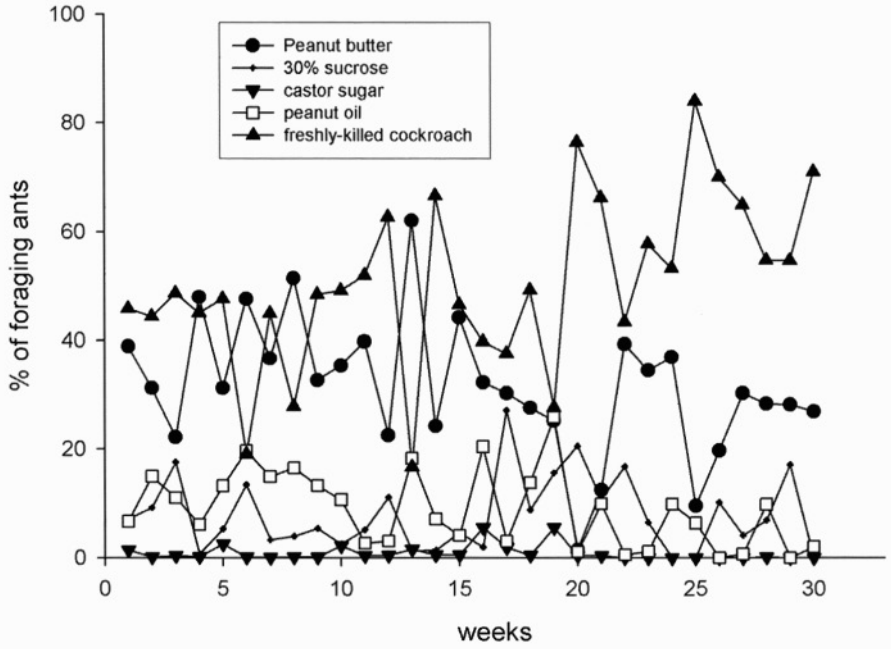

Fig. 1. Changes in food preference of 19 field populations of *Pheidole megacephala*.

be changes in food preference over the period of 30 weeks. For example, at week- 20 and 25, there were sharp decreases in preference for peanut butter, but a surge in preference for the freshly-killed lobster cockroaches. On the other hand, these ants were found to have relatively similar preference for both peanut oil and 30.0 % sucrose solution, which were always within the range of 5.0 % to 25.0 %. Lee (2002) reported changes in food preference of a *Monomorium pharaonis* population over an 18-month period and attributed that to changes in colony development (Erpenbeck 1981) and food satiation (Edwards & Abraham 1990). Nutrient intake is also regulated because different caste members often have different nutritional requirements (Chong *et al.* 2002).

Other ant species such as *Paratrechina longicornis*, *M. pharaonis*, *Anoplolepis longipes*, *Monomorium floricola* and *Tapinoma melanocephalum* were also observed to forage on the foods tested. Some of these tramp ant species were seen to have affected the foraging activities of *P. megacephala* on certain food types, possibly indicating the more dominant former species. For example, at week-20, 24, 26 and 29, *Monomorium pharaonis* was found foraging on the peanut butter

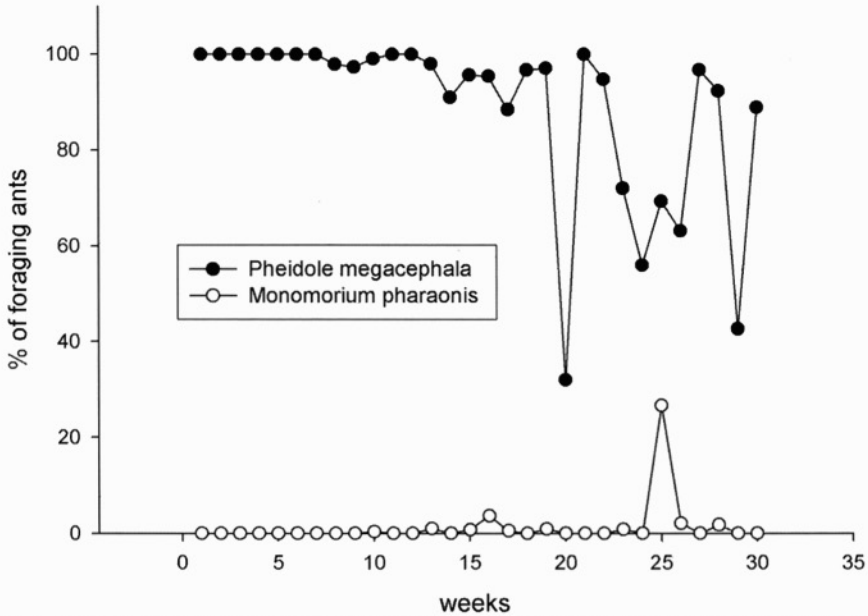

Fig. 2. Influence of *Monomorium pharaonis* presence on foraging activity of *Pheidole megacephala* to peanut butter.

and thus, causing a decrease in the number of foraging *P. megacephala* (Fig. 2). Figure 3 demonstrates the dominance of *Paratrechina longicornis* on the 30.0% sucrose solution, especially at week-13, 16, 19, 21, 23, 25 and 30. From our observation, this species also monopolized the castor sugar throughout the entire experimental period.

Foraging territories are well-defined results of intercolony or interspecies competition. In this study, the presence of other ant species affected the foraging behavior of *P. megacephala*. This may be caused by the trail pheromone of the other ant species which could have driven them away due to territorial competition in foraging behavior (Carroll & Janzen 1973). *P. megacephala* foragers were normally observed roaming near the food, but would not approach their usual food in the presence of other species.

It was also seen here that *P. megacephala* workers have a tendency to alternate between protein and carbohydrate (Sanders *et al.* 1992, Cornelius & Grace 1997), although a higher preference for protein food was observed. This suggests that a mixture of these two classes of food should be used as bait matrix to achieve more effective control of this species.

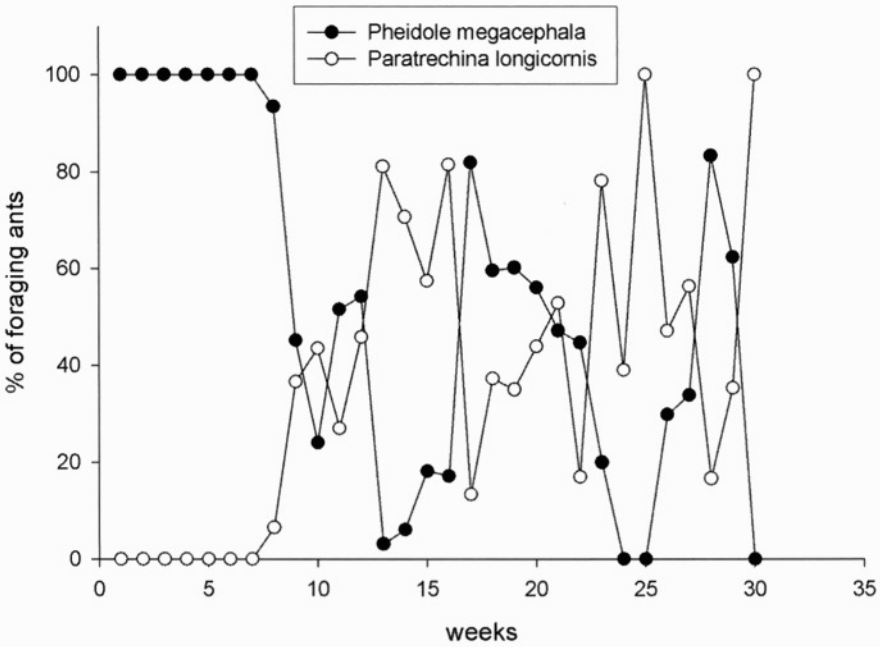

Fig. 3. Influence of *Paratrechina longicornis* presence on foraging activity of *Pheidole megacephala* to 30% sucrose solution.

Our results indicated that the foraging distance and territory of *P. megacephala* populations in this study were relatively limited. At site 1, only a small percentage (4.3 ± 1.6 %) of the total 543 ants collected were marked. The pantry measured approximately 7.0 m^2, but the foraging area of the ants were only 3.61 m^2. The foraging distance that was determined was 2.25 ± 0.54 m. The traps that were excluded from determining the foraging distance were invaded by other ant species such as *Prenolepis imparis* and *Monomorium destructor*. Ant population at site 2 also showed a relatively similar foraging distance and territory, *i.e.*, 3.34 ± 1.03 m and 4.84 m^2, respectively. On the other hand, ant population in site 3 recorded a foraging distance of 2.21 ± 0.69 m and a foraging territory of 2.75 m^2, while site 4 recorded a foraging distance of 1.82 ± 0.47 m and territory of 3.19 m^2.

Generally, our results and observations showed a relatively short distance and small territory where *P. megacephala* would forage. *P. megacephala* could have avoided the traps even though they were placed on their usual foraging trails simply because the ants generally avoid any territorial invasion in foraging as much as they could

(Traniello 1989). The effect of territoriality on ant foraging activities was reported earlier by Lee *et al.* (2003) when baiting *M. pharaonis*. They found that upon suppression of the Pharaoh's ant by methoprene baits, other species such as *P. longicornis* and *T. melanocephalum* (which were not attracted to feed on the bait) were found at higher numbers than earlier at pre-baiting sampling.

The foraging population could not be determined since the dye marker used could be transferred to other colony members through trophallaxis. Vail & Williams (1994) have stated that for field studies, colored baits which are used should have a short exposure period to ensure that only the foragers from the nearest colony could feed on it and be marked.

Many ants have a restricted range of prey and probably have orientations that confine their foraging to places where food is plentiful. Large colonies however, are often forced to search over large areas. The foraging area of ants may be as small as 2.32 m^2 in *Myrmica ruginodis* (Brian 1955), to 5,000 m^2 in *Formica nigricans* (Wellenstein 1952) to even as large as 2,000,000 m^2 in *Myrmecia gulosa* (Haskins & Haskins 1950). However, only a small part of this area is searched for food because ants are not able to form a panoramic view of their foraging range or utilize their sense of smell from long distance. Each ant finds food which lies within a short distance of its path through the foraging range. This path depends, firstly, on the availability of food which encourages the ant to return and secondly, on the communication among nestmates. Both factors confine the ants in some parts of their range whilst other less-productive parts are seldom explored unless they engage in occasional exploratory behavior (Wilson 1971).

In summary, it was demonstrated that the Big-headed ant, *P. megacephala* showed a higher preference for protein-rich food than those of lipid- or carbohydrate-based, and changes in food preference was also recorded during the 30-week study period. Its foraging activity was found to be affected by the presence of other ant species and this could have delimitated its foraging distance and territory as observed in this study. More research on these aspects are warranted before the current findings can be substantiated.

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