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## Attraction of Household Ants (Hymenoptera: Formicidae) to Various Food Sources in Different Seasons

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### ABSTRACT

A few species of ants form an important group of household pests that are a nuisance to mankind. An experiment was conducted to study the attraction of some common household ants viz., *Tapinoma melanocephalum*, *Solenopsis geminata*, *Paratrechina longicornis* and *Monomorium latinode* to various food sources in different (summer, rainy and winter) seasons in the urban region of Bengaluru, India. Ten different food sources of carbohydrates, proteins or lipids or in combinations were used in this study. *Tapinoma melanocephalum* and *P. longicornis* were more attracted to carbohydrates than other types of food in all the seasons. *Solenopsis geminata* and *M. latinode* showed more attraction to proteins and lipids during the summer and lipid-rich food during the rainy and winter seasons. The study indicates that the attraction that these household ants have to various food sources differs from one species to another and also showed slight changes in attraction to food sources in the different seasons of the year.

**Key words:** Household ants, formicidae, food attraction, seasons, *Tapinoma melanocephalum*, *Paratrechina longicornis*, *Solenopsis geminata*, *Monomorium latinode*

### INTRODUCTION

Ant colonies makes the most use of what the environment has to offer entirely by social networking via the worker caste. Among other functions the worker caste performs, access to rich food resources mainly occurs by communication amongst the workers, which helps in gathering information and transmitting the same to the other members of the colony. Scouts are sent into the field in search of rich food resources. When they come across such a food resource, they in turn communicate to the other workers waiting in the nest so that more recruitment to the food source occurs depending on the type and abundance of the food source (Holldobler and Wilson, 1990). Household ants (Hymenoptera: Formicidae) are an important group of insect pests in the urban habitat because of their close association with man (Holldobler and Wilson, 1990). The ghost ant *Tapinoma melanocephalum* (Fabricius) (Dolichoderinae), the tropical fire ant *Solenopsis geminata* (Fabricius), *Monomorium latinode* (Mayr) (Myrmicinae) and the crazy black ant *Paratrechina longicornis* (Latreille) (Formicinae) are common household ants in the urban Bengaluru region, India (Savitha *et al.*, 2008). These four species of ants are widespread in tropical regions (Bingham, 1903). But, *P. longicornis* also occurs in the temperate region (Wetterer, 2008). Workers of *S. geminata* build a large and externally visible mound. This aggressive species is a pest in home lawns, play areas and agricultural fields and attacks anything that disturbs their mounds or food sources (Byron and Hays, 1986). *Tapinoma melanocephalum* nests are usually found in

flower pots, soil and in rotten wood and leaves (Appel *et al.*, 2004). *Paratrechina longicornis* is considered as one of the most common 'tramp species' in urban habitats (Kenne *et al.*, 2005). *Paratrechina longicornis* species are normally found in moist conditions which are ideal for the continuity of the colony and many small temporary nests can be found in plantations, gardens and buildings within spaces in the ground, plants and walls of buildings (Banks and Williams, 1989; McGlynn, 1999). *Monomorium* spp. builds nests mostly in soil or in plant cavities and under the stones. Some species of *Monomorium* even nest in the structural spaces (Jaffe *et al.*, 1990).

Many factors are responsible in the choice of food that foraging ants make. Fluctuations in the daily and seasonal foraging activity of ants mainly depend on various abiotic and biotic factors (Carroll and Janzen, 1973; Cerda *et al.*, 1998; Gibb, 2005; Wielgoss *et al.*, 2010). Soil surface temperature and relative humidity are the most important variables that influence foraging in ants (Holldobler and Wilson, 1990). As much information is not available on the feeding response of these ants to various foods, a study was conducted to determine their attraction to a range of foods in different seasons. The results of this investigation could be useful to understand the activities of some household ants for effective management practices.

## MATERIALS AND METHODS

**Study area:** The study was conducted once a week for a period of one year from November 2010 to October 2011 in gardens around structural buildings in the Bangalore University campus (latitude 12°58'N, longitude 77°35'E and elevation 921 m a.s.l.), Bengaluru, India. The study period included three seasons i.e., winter (November to February), summer (March to June) and rainy (July to October). Based on preliminary observations, the study site was selected such that the individual ant species chosen for the study were numerically dominant in the area.

**Ant species:** Four commonly occurring household ant species viz., *T. melanocephalum*, *S. geminata*, *P. longicornis* and *M. latinode* were chosen for the study.

**Food sources:** Different types of solid and liquid food sources made out of proteins, lipids and carbohydrates were used. They were small bits of freshly killed cockroach (carbohydrate: 172.4 mg g<sup>-1</sup>, protein: 438.2 mg g<sup>-1</sup> and lipid: 308.5 mg g<sup>-1</sup>) (Bao and Robinson, 2008), 20% condensed milk (diluted in water) (carbohydrate: 54%, protein: 8% and lipid: 9%) (Deeth and Hartanto, 2009), boiled and powdered egg yolk (carbohydrate: 1.2%, protein: 33% and lipid: 62.5%) (Powrie and Nakai, 1986), powdered peanut (carbohydrate: 21.26%, protein: 25.2% and lipid: 46.224%) (Ingale and Shrivastava, 2011), commercially available butter biscuits (Good Day-Butter, Britannia Company, India) (carbohydrate: 21%, protein: 14% and lipid: 88%), grated dry coconut (v: 9.3% and lipid: 67.5%) (Grimwood *et al.*, 1976), 20% honey (diluted in water) (carbohydrate: 85.17% and protein: 0.0612%) (Joshi *et al.*, 2000) powdered jaggery (carbohydrate: 99.5%, protein: 0.4%, lipid: 0.1%) (Rao *et al.*, 2007), commercially available semi-solid mixed fruit jam (Kissan Company, India) (carbohydrate: 98%) and 20% sugar solution (in water) (carbohydrate: 100%).

Different solid foods (2 g) were kept in test tubes individually and 10 ml of liquid foods were soaked in cotton wicks and then placed in separate test tubes. A dry cotton wick in a test tube was used as a control. A nest site of a particular ant species available in partial shade was identified and the test tubes with food were placed on the ground radially at 90 cm distance from the nest entrance. The test tubes were kept at distance of 60 cm from each other. Only one tube containing

each food type was placed at the site. The experiment was set up at 1030 h and the number of ants that were found present on each food source was counted every hour from 1100 to 1600 h. This time period was chosen as it was convenient for making observations. During the experiment, if other ant species were found intruding into the experimental area, they were removed with the help of an aspirator. The soil surface temperature and relative humidity in the study site during the study period was recorded with a digital Thermo-hygrometer (Temp.Tec:A09Q32).

**Statistical analysis:** To analyze the seasonal attraction to food by each ant species, the number of ants recorded on different food sources were log transformed and the data was subjected to Analysis of Variance test (ANOVA) and significant differences between treatments were determined by Tukey's Honestly Significant Difference Test (HSD) at probability level  $p < 0.05$  (SPSS Inc., 2006).

## RESULTS

The most attractive foods for different household ant species in different seasons are given in Table 1. During summer, honey, jam and sugar solution attracted significantly more number of *T. melanocephalum* when compared to other foods. However, the species attraction to egg, cockroach, peanut, jaggery and condensed milk was significantly more than that of butter biscuit and dry coconut ( $df = 9, 170$ ,  $F = 23.49$ ,  $p < 0.05$ ) (Fig. 1). In the rainy season, jam attracted the

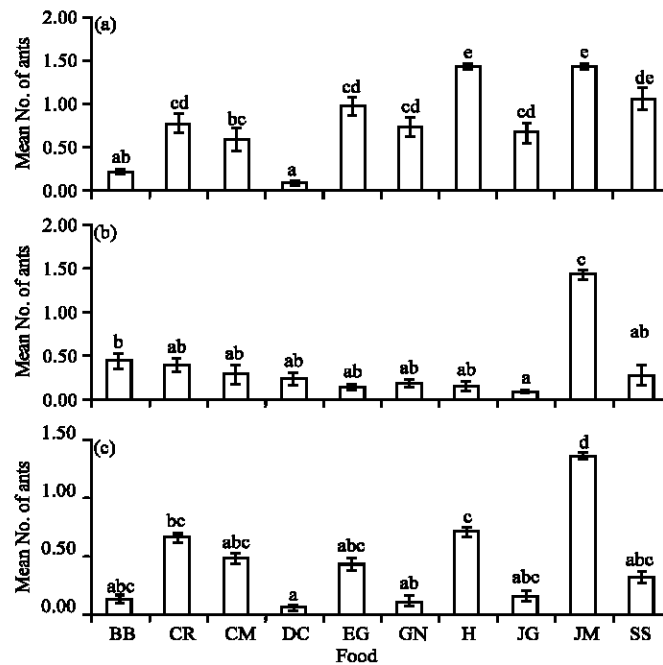


Fig. 1(a): (c): Attraction of *Tapinoma melanocephalum* to different food resources. Mean number of ants found at a food source during the (a) Summer, (b) Rainy and (c) Winter seasons, Bars with different small letters indicate significant differences amongst different food preferences at  $p < 0.05$  (One way ANOVA: Tukey HSD test), (Vertical lines indicate  $\pm$ SE of the mean number of ants feeding on a food), (BB: Butter biscuit, CR: Cockroach, CM: Condensed milk, DC: Dry coconut, EG: Egg, GN: Peanut, H: Honey, JG: Jaggery, JM: Jam, SS: Sugar solution)

highest number of ants followed by butter biscuit, cockroach, condensed milk, sugar solution, dry coconut, peanut, honey, egg and jaggery (df = 9,160, F = 27.61, p<0.05). In winter, *T. melanocephalum* was more attracted to jam followed by honey, cockroach, condensed milk, egg, sugar solution and butter biscuit, peanut and dry coconut (df = 9, 150, F = 9.67, p<0.05) (Fig. 1).

In summer, *S. geminata* was more attracted to butter biscuit, egg, cockroach, dry coconut and peanut than to other foods. However, the species attraction to jam and condensed milk was more than that of sugar solution, jaggery and honey (df = 9,170, F = 11.06, p<0.05) (Fig. 2). In the rainy

Table 1: Attraction of some household ant species to food sources in different seasons

Season	T (°C) (Mean±SE)	RH (%) (Mean±SE)	Most attractive food of different ant species			
			<i>Tapinoma melanocephalum</i>	<i>Paratrechina longicornis</i>	<i>Monomorium latinode</i>	<i>Solenopsis geminata</i>
Summer	32.51±0.53	56.49±2.98	Honey	Sugar solution, honey	Peanut, egg, cockroach, butter biscuit	Butter biscuit, egg
Rainy	28.24±0.47	74.25±1.47	Jam	Sugar solution	Peanut, dry coconut, egg	Butter biscuit, Peanut
Winter	27.93±0.76	51.40±4.85	Jam	Sugar solution, honey	Peanut	Peanut butter biscuit, drycoconut

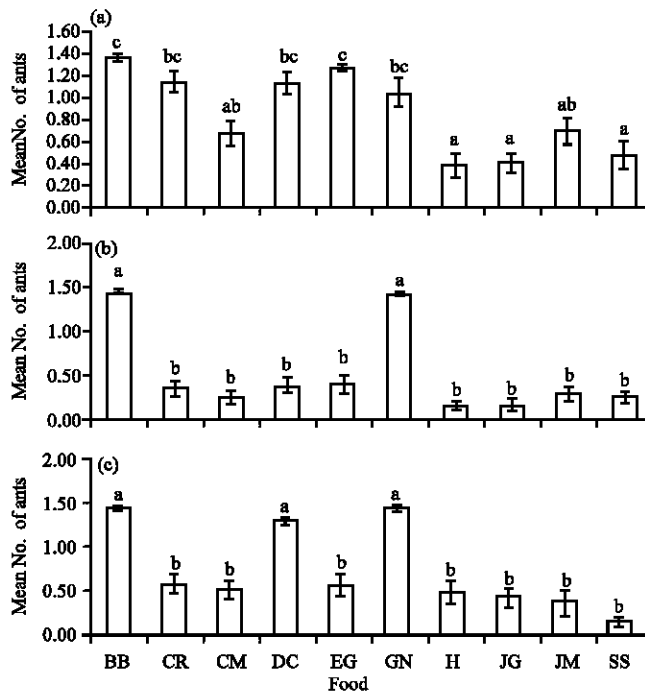


Fig. 2(a-c): Attraction of *Solenopsis geminata* to different food resources. Mean No. of ants found at a food source during the (a) Summer, (b) Rainy and (c) Winter seasons, Bars with different small letters indicate significant differences amongst different food preferences at p<0.05 (One way ANOVA: Tukey HSD test), (Vertical lines indicate±SE of the mean No. of ants feeding on a food), (BB: Butter biscuit, CR: Cockroach, CM: Condensed milk, DC: Dry coconut, EG: Egg, GN: Peanut, H: Honey, JG: Jaggery, JM: Jam, SS: Sugar solution)

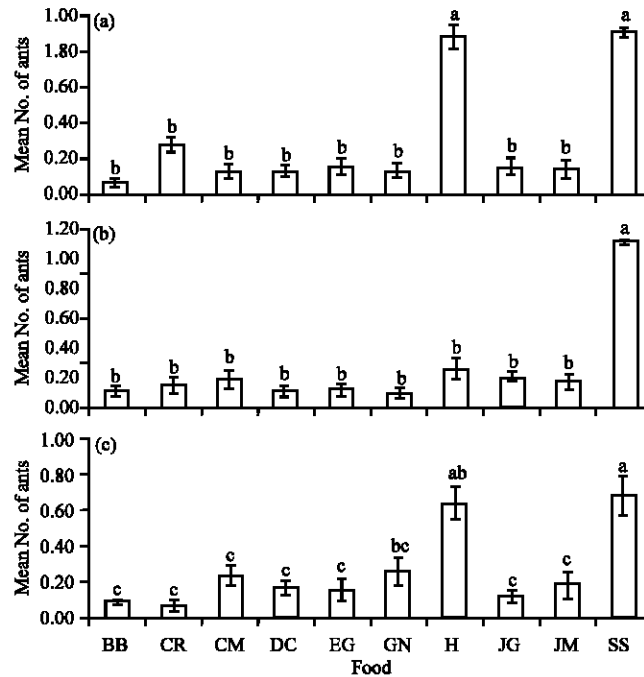


Fig. 3(a-c): Attraction of *Paratrechina longicornis* to different food resources. Mean number of ants found at a food source during the (a) Summer, (b) Rainy and (c) Winter seasons, Bars with different small letters indicate significant differences amongst different food preferences at  $p < 0.05$  (One way ANOVA: Tukey HSD test), (Vertical lines indicate  $\pm$ SE of the mean number of ants feeding on a food), (BB: Butter biscuit, CR: Cockroach, CM: Condensed milk, DC: Dry coconut, EG: Egg, GN: Peanut, H: Honey, JG: Jaggery, JM: Jam, SS: Sugar solution)

season, the species was significantly more attracted to butter biscuit and peanut than to egg, dry coconut, cockroach, jam, sugar solution, condensed milk, jaggery and honey ( $df = 9, 160$ ,  $F = 28.76$ ,  $p < 0.05$ ) and in winter butter biscuit, peanut and dry coconut attracted greater number of ants than egg, cockroach, condensed milk, honey, jaggery, jam and sugar solution ( $df = 9, 150$ ,  $F = 22.02$ ,  $p < 0.05$ ).

In the summer *P. longicornis* was more attracted to honey and sugar solution than cockroach, egg, jaggery, jam, peanut, dry coconut, condensed milk and butter biscuit ( $df = 9, 170$ ,  $F = 31.39$ ,  $p < 0.05$ ). In winter, *P. longicornis* was more attracted to honey and sugar solution than to other foods. However, peanut attracted more number of ants than condensed milk, jam, dry coconut, egg, jaggery butter biscuit and cockroach ( $df = 9, 150$ ,  $F = 6.47$ ,  $p < 0.05$ ) (Fig. 3) but in the rainy season, the ants preferred sugar solution to condensed milk, jaggery, cockroach, jam, egg, butter biscuit and dry coconut ( $df = 9, 160$ ,  $F = 40.95$ ,  $p < 0.05$ ).

*Monomorium latinode* was more attracted to egg, peanut, butter biscuit and cockroach than to other foods in summer. However, the species attraction to jaggery and jam was significantly more than that of honey, sugar solution, condensed milk and dry coconut ( $df = 9, 170$ ,  $F = 10.15$ ,  $p < 0.05$ ) (Fig. 4). In the rainy season, *M. latinode* was significantly attracted to peanut, dry coconut and egg. However, the species attraction to butter biscuit, jaggery and cockroach was significantly more than that of honey and sugar solution which in turn was significantly more than that of condensed

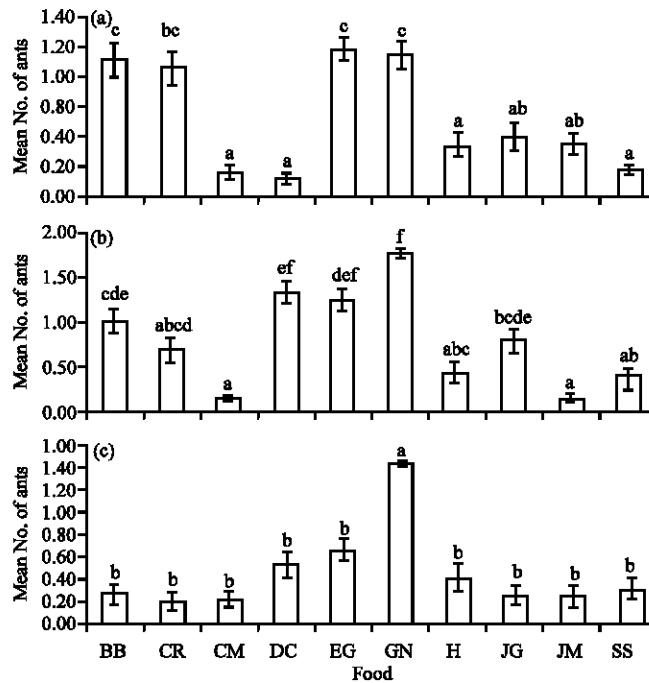


Fig. 4(a-b): Attraction of *Monomorium latinode* to different food resources, Mean number of ants found at a food source during the (a) Summer, (b) Rainy and (c) Winter seasons. Bars with different small letters indicate significant differences amongst different food preferences at  $p < 0.05$  (One way ANOVA: Tukey HSD test), (Vertical lines indicate  $\pm$ SE of the mean number of ants feeding on a food), (BB: Butter biscuit, CR: Cockroach, CM: Condensed milk, DC: Dry coconut, EG: Egg, GN: Peanut, H: Honey, JG: Jaggery, JM: Jam, SS: Sugar solution)

milk and jam ( $df = 9,160$ ,  $F = 16.77$ ,  $p < 0.05$ ), while in winter, peanut attracted greater number of ants than egg, dry coconut, honey, sugar solution, butter biscuit, jam, jaggery, condensed milk and cockroach ( $df = 9,150$ ,  $F = 8.90$ ,  $p < 0.05$ ).

## DISCUSSION

The study indicated a varied attraction response among the four species of household ants in different seasons to the various foods. An increased collection of proteins and lipids (egg, cockroach, peanut and butter biscuit) by *M. latinode* and *S. geminata* during summer could indicate the presence of more number of developing larvae in the colony needing protein for their growth (Vinson, 1968; Stradling, 1987; Weeks *et al.*, 2004). Similarly, *Solenopsis invicta* Buren collects more protein in the warmer season (Stein *et al.*, 1990). Attraction of *S. geminata* and *M. latinode* to lipid-rich foods (butter biscuit, dry coconut and peanut) during the rainy and winter seasons may be for utilizing high energy to perform many tasks as observed by Markin (1970) in the Argentine ant, *Iridomyrmex humilis* (Mayr) and also for a long term storage as reported by Judd (2006) in the seed-caching ant, *Pheidole ceres* Wheeler. Lipid foods are a source of energy and mainly used by workers and larvae (Sorenson *et al.*, 1983). Collection of more lipids as observed in the study could indicate an active ant colony requiring more energy to perform various tasks as well as the presence of a larger number of larvae in the colony as observed by Markin (1970) in the Argentine

ant, *Iridomyrmex humilis* (Mayr) and by Sorenson *et al.*, 1983 in *Solenopsis invicta* Buren. *Monomorium latinode* workers foraging on protein (egg and cockroach) in the rainy and winter seasons could be to use it at the time of food shortage as observed in the big headed ant, *Pheidole megacephala* (F.) and the black house ant, *Ochetellus glaber* (Mayr) (Cornelius and Grace, 1997). Stored protein foods by *M. latinode* may also be used to rear a winter batch of larvae as reported by Gayahan and Tschinkel (2008) in *S. invicta*.

*Paratrechina longicornis* was attracted to carbohydrate-rich liquid foods (honey and sugar solution) in all the seasons irrespective of varying temperature and humidity, whereas *T. melanocephalum* was attracted to the same liquid foods only in summer. However, it preferred semi-solid carbohydrates (jam) in the rainy and winter seasons. Although, all the types of food were placed at the study site in all the seasons, *P. longicornis* and *T. melanocephalum* were more attracted to carbohydrate-rich food. Eisner (1957) and Holldobler and Wilson (1990) reported that the ability to collect various types of liquid foods could explain the differences between species in the amount of carbohydrate and protein consumed. Many species of ants forage mainly on carbohydrates because of the easy availability of high energy food (Dussutour and Simpson, 2008; Markin (1970). More intake of liquid carbohydrate foods by *T. melanocephalum* and *P. longicornis* could be due to ease of storing liquids in their modified proventriculus (Davidson, 1997; Eisner, 1957). The modified proventriculus allows ants to rapidly drink and store a large volume of liquid food (Davidson *et al.*, 2004). Although, carbohydrates are required by ants for energy, both carbohydrates and proteins are needed for the production of new workers and reproductives (Sorenson and Vinson, 1981; Cassill and Tschinkel, 1999). However, though *T. melanocephalum* and *P. longicornis* were not found to forage in higher numbers on protein foods that was provided, it is probable that they may be getting their share of easily accessible and available protein from the plant nectar/hemipteran honeydew that is present in the surroundings as reported by Stradling (1978) and Abbott and Green (2007) in some formicines.

Ants that feed on a variety of foods select their food according to nutrient imbalances, the availability of resources as well as active competition (Markin, 1970; Nonacs, 1991; Kay, 2002; Bluthgen and Fiedler, 2004; Dussutour and Simpson, 2008). The study showed that the household ants were attracted not only to different foods but their attraction to the foods changed over the seasons. Generally, *S. geminata* and *M. latinode* foraged on lipid-rich solid foods, whereas *T. melanocephalum* and *P. longicornis* fed on carbohydrate-rich liquid/semi-solid foods.

Foraging activity of these ants may have depended on the richness and type of food resource, fluctuating temperature and humidity in the environment in different seasons as well as the physiological needs of the colony (Vinson, 1968; Stein *et al.*, 1990; Cornelius and Grace, 1997; Portha *et al.*, 2002; Weeks *et al.*, 2004; Judd, 2005; Dussutour and Simpson, 2008). Eventhough the results do not show much change in the attraction of different ant species to various food resources in different seasons, there are subtle differences in the attraction of ant species to some foods. This knowledge of the basic differences in the kind of food these ants are attracted to could provide an insight into what the bait should be composed of to bring about maximum attraction in order to trap them in different seasons of the year for their effective management.

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