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Ants' food contact: A chance event or a cue-induced behaviour

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Abstract
Ants are habituated to collect the food from their foraging grounds. But it is not clear whether they locate the food by vision or by chemical cue or by chance contact. To verify the same, experiments were carried out by supplying the sugar cubes to the ants *Camponotus compressus*, *Oecophylla smaragdina* and *Solenopsis geminata* in their foraging ground at Jhalda, Purulia, West Bengal, India. The foraging ground was a grassland and each one of 10 sugar cubes was placed amongst grasses at a point 60 cm away from the nest hole or tree base but 15 cm apart from each other. Observations were made for a period of 6 hours following supply of the sugar cubes. Based on 45 trials against each species it is revealed that, on average 3.37 ± 0.09 SE, 3.02 ± 0.11 SE and 2.82 ± 0.16 SE sugar cubes were procured by *C. compressus*, *O. smaragdina* and *S. geminata* respectively in each trial. Tukey's HSD test indicated that there exists a significant difference between the number of sugar cubes carried by *C. compressus* and *O. smaragdina* as well as *C. compressus* and *S. geminata*. But the differences noted in the rate of procurement of the sugar cubes by *O. smaragdina* and *S. geminata* are not statistically significant. Results of t tests clearly indicated that there exists a significant difference between the sugar cubes collected by each ant species. It is most likely that the difference in the rate of sugar cube collection is influenced by the efficiency of the ant species to react the chemicals emitted by the sugar cubes as a cue.

Keywords: Ants, foraging ground, food location, searching cue

Introduction

Ants collect various types of food from their foraging ground (Carroll and Janzen 1973, Traniello 1989, Naskar and Raut 2015, 2016, Kolay *et al* 2020) [5, 28, 17-18, 15]. Of these foods some are either carbohydrate or protein or fat in nature while many others are a mixed variety. The scout ants are habituated to locate the source of foods and then mark a pathway by using pheromone on their way back to the nest. The nest mates, following communication with the scout ant follow the pheromone marked tract to reach the food source.

It is an established fact that the nutritional status of an ant colony varies with time in respect to occurrence and abundance of developing stages of the life cycle of the ant species concerned. As the nutritional requirement differs with the developing morphs of the ant species the scouts are most likely pay due attention to locate the need based food item (Carroll and Janzen 1973, Brian and Abbott 1977, Abbott 1978, Howard and Tschinkel 1981, Sorensen and Vinson 1981, Sorensen *et al*. 1985, Hölldobler and Wilson 1990, Cassill and Tschinkel 1999, Portha *et al*. 2002, Dussutour and Simpson 2009) [5, 3, 1, 14, 24, 25, 13, 6, 20, 8] in their foraging ground. But it is a matter of interest to know how does an ant come in contact of a food source as per need of the colony. It is simply an accidental touch as a consequence of random searching process or a reflection of cue- induced behaviour.

To address the above queries we performed a simple experiment by offering sugar cubes to the ants *Camponotus compressus*, *Oecophylla smaragdina* and *Solenopsis geminata* occurring in and around Jhalda (Lat-23º22´ Long-85º59´Alt 263 m) Purulia, West Bengal, India and the findings are worth reporting.

Materials and Methods

We selected three different sites within an area of 100 m^2 in the Achhruram Memorial College campus, Jhalda in respect to availability of the nests of the ants *Camponotus compressus*, *Oecophylla smaragdina* and *Solenopsis geminata*. The nests of the ants *C. compressus* and *S. geminata* were built in the ground. In case of *Camponotus* the nest was constructed at the base of a mango tree and the *Solenopsis's* nest was confined to the under space of stone. *O. smaragdina* constructed the nest in the branch of a tree adhering few leaves of the said branch. Each nest was approximately 50-60 m away from the other.

We offered 10 sugar cubes, each 2 mg in weight white in colour at 10 different points, 60 cm away from the nest in cases of *C. compressus* and *S. geminata*. But, in the case of *O. smaragdina* the sugar cubes were placed 60 cm away from the base of the tree on which the nest was constructed. One sugar cube was placed on the ground 15 cm apart from the other sugar cube. The ground was covered by small grasses. As a whole the ground was dry throughout the study period. We noted the time of offering the sugar cubes against each ant species and observation was continued for a period of 6 hours to note the number of sugar cubes carried by the foragers of concerned ant species. The experiment was repeated 45 times for each species. The study period was confined to December 22 – May 23. During the said period the atmospheric temperature was ranged from 8 ºC - 46 ºC. All the 45 trials for each species were made during day time 06.00 h- 18.00 h. The time for experimentation was selected at random during the said day time. We performed only one trial of any ant species on a day selected for study. The study day was selected based on the dry and sunny surroundings. In cases of sudden occurrence of rain during the period of 6 hours targeted for data collection the said trials were discarded.

Statistics

To analyse the data obtained from the experimental trials performed we applied one-way analysis of variance (ANOVA) to determine if there are any significant differences among ant species and the number of sugar cubes procured by them.

Hypothesis: Null Hypothesis (Ho): There are no significant differences among the ant species and the food items.

Alternative Hypothesis (Ha): There are significant differences among the ant species and the number of sugar cubes carried by the ants.

Assumptions: The data should meet the assumptions of ANOVA, including normality, independence, and homogeneity of variances. If these assumptions are not met, appropriate transformations or nonparametric tests should be considered.

Post -hoc test

If the results of ANOVA test indicate a significant difference between the means of two or more groups then a post -hoc test would apply. This would enable us to identify the act of which ant species is significantly different from the other ant species. As the results obtained from the tests it is implied that the Tukey's honestly significant difference (HSD) test would be befitting as post-hoc test and accordingly we applied.

To get information whether the ants collected the sugar cubes by coming in contact of the same by chance or they moved in right direction sensing the chemical cue emitted by the sugar cubes.

To have a clear cut idea we applied t-test between the ant species depending on the data of the sugar cubes they collected in the experimental trials. We used the software SPSS for analysis of the data.

Results

It is noted that *C. compressus* carried 2- 4 (mean 3.37 ± SE 0.09), *O. smaragdina* carried 2- 4 (mean 3.02 ± SE 0.11) and *S. geminata* carried 1- 5 (mean 2.82 ± SE 0.16) sugar cubes per trial (Figs 1-3).

Results of ANOVA tests (Table 1) clearly indicate that there exists a statistically significant difference between the means of the three species of ants (F= 4.78, p= 0.01, df=2).

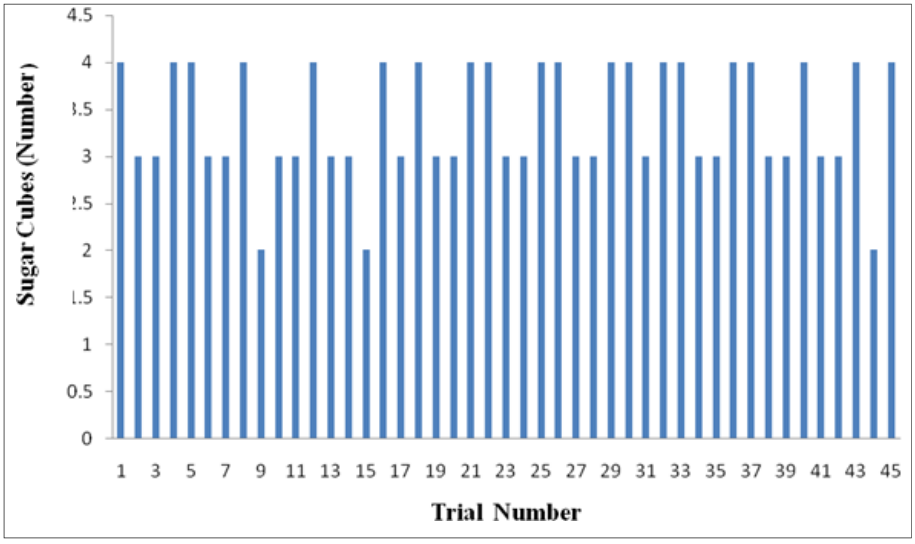

Fig 1: Number of sugar cubes carried by *Camponotous compressus* in different trials

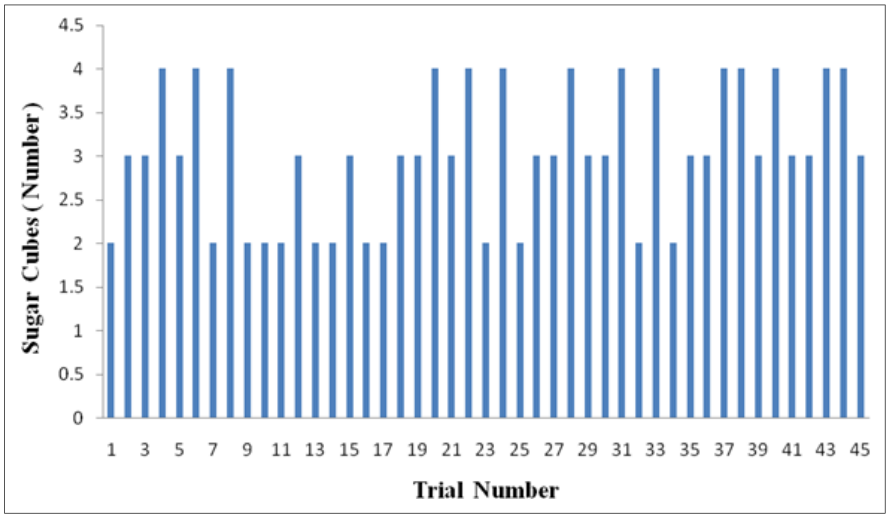

Fig 2: Number of sugar cubes carried by *Oecophylla smaragdina* in different trials

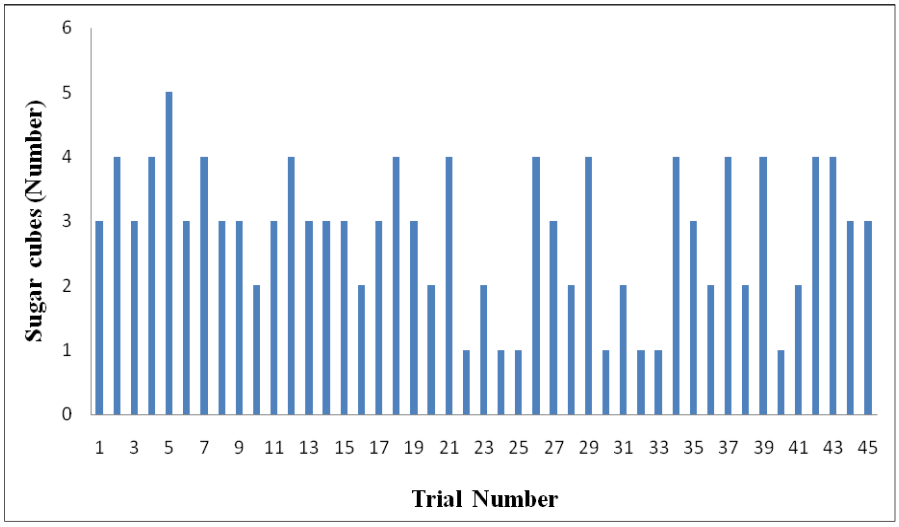

Fig 3: Number of sugar cubes carried by *Solenopsis geminata* in different trials

Table 1: Results of ANOVA test

Source of Variation	SS	df	MS	F	P-value	Fcrit
Rows	30.59259	44	0.695286	0.933544	0.591811	1.514726
Columns	7.125926	2	3.562963	4.783906	0.01066	3.100069
Error	65.54074	88	0.744781			
Total	103.2593	134				

Table 2: Results of pair-wise sugar cube procurement rate by the three ants species using Tukey's HSD, 95% confidence interval

Comparison	Mean difference	(95% CI)	p-value
C. compressus - O. smaragdina	-2.144532	(-3.456348, -0.832717)	0.002371
C. compressus - S. geminata	-2.472222	(-3.784038, -1.160406)	0.000925
O. smaragdina - S. geminata	0.327689	(-0.984145, 1.640523)	0.747451

Now, it is clear that there is a real difference in the mean number of sugar cubes collected by the three species of ants. However, to determine which species is collecting the most sugar cubes we considered the results of post-hoc test (Table 2). The results of the Tukey's HSD test show that there is a significant difference in the mean number of sugar cubes carried by the *C. compressus* and *O. smaragdina*. The mean number of sugar cubes collected by *C. compressus* is significantly lower than the mean number of sugar cubes collected by *O. smaragdina*. There is also a significant difference at the mean number of sugar cubes collected by *C. compressus* and *S. geminata*. The mean number of sugar cubes collected by *C. compressus* is significantly lower than the mean number of sugar cubes collected by *S. geminata*. However, there is no significant difference in the mean number of sugar cubes collected by *O. smaragdina* and *S. geminata*

The results of the t-tests have been shown in Table 3a-c.

Table 3a: t-Test: Paired Two Sample for Means

	S. geminata	***O. smaragdina***
Mean	2.822222	3.022222
Variance	1.194949	0.613131
Observation	45	45
Pearson Correlation	-0.10149	
Hypothesized Mean Difference	0	
df	44	
t-Stat		
P(T<=t) one-tail	-0.95303	
t Critical one-tail	0.172892	
P(T<=t) two-tail	0.345784	
t Critical two-tail	2.015368	

Table 3b: t-Test: Paired Two Sample for Means

	O. smaragdina	***C. compressus***
Mean	2.822222	3.022222
Variance	1.194949	0.613131
Observation	45	45
Pearson Correlation	-0.10149	

Hypothesized Mean Difference	0	
df	44	
t-Stat		
P(T<=t) one-tail	-0.95303	
t Critical one-tail	0.172892	
P(T<=t) two-tail	0.345784	
t Critical two-tail	2.015368	

Table 3c: t-Test: Paired Two Sample for Means

	S. geminata	***C. compressus***
Mean	2.822222	3.377778
Variance	1.194949	0. 376768
Observation	45	45
Pearson Correlation	-0.03312	
Hypothesized Mean Difference	0	
df	44	
t-Stat	-2.93151	
P(T<=t) one-tail	0.002667	
t Critical one-tail	1.68023	
P(T<=t) two-tail	0.005334	
t Critical two-tail	2.015368	

It is clear that there exists a significant difference between the means of the number of sugar cubes collected by each ant species.

Discussion

Foraging is a fundamental activity in animals because through such activity they enable themselves to collect food to ensure survival and reproduction (Gilard *et al*. 2022) [11]. Foraging is also a time and energy consuming activity (Fewell 1988, Brown and Koffer 2004) [9, 4]. Various sensory modalities such as visual, auditory olfactory and tactile ones are used to locate the food (Müller and Wehner 2007, Roth *et al*. 2008, Heimbauer *et al*. 2012, Schneider *et al*. 2014) [16, 22, 12, 23]. In ants, olfactory cues are acquired easily and are resilient to extinction (Piqueret *et al*. 2019) [21]. *Lasius niger* ants can learn olfactory cues after one trial, while more trials are necessary when using spatial cues (Oberhauser *et al*. 2019) [19].

The ants use an array of mechanisms to achieve the success of food collection. Visual cues, mostly the sun-position, wind direction, the earth's geomagnetic field and light polarization are used for navigation over long distances while olfactory cues help to find food over shorter ones (Müller and Wehner 2007, Bregy *et al*. 2008, Chu *et al*. 2008, Steck *et al*. 2009a, 2011, Fleischmann *et al*. 2018) [16, 2, 7, 26-27, 10]. In the present experimental studies the ants were offered sugar cubes very close to their nest only 60 cm away. The sugar cubes were very small and were placed in the grass covered foraging ground it is hard to assume that the sugar cube was visible to the ants *C. compressus, O. smaragdina* and *S. geminata* from a distance. But, in fact they were able to locate some of the sugar cubes within a period of 6 hours exposure time.

It is evident that the ants, *C. compressus*, *O. smaragdina* and *S. geminata* are apt to respond the chemical cue of the sugar cubes the differences noted in collection of mean number of sugar cubes among the ant species seem to related with the variations in the degree of selectivity of olfactory mechanism in respect to the chemical cue involved. This means that ants are not simply collecting the sugar cubes by chance due to sudden contact that is, these ants responded to the chemical cue of sugar cubes. Since, from the data it is evident that the *S. geminata* ants collected the most sugar cubes followed by the *C. compressus* and *O. smaragdina* ants it is apparent that *S. geminata* are more sensitive to such chemical cue than the other two ant species in question. Thus, the present findings suggest that the attraction to a particular type of food is influenced by the chemical cue emitted by the food item and also this sort of cue-reading behaviour enables ants to collect other resources that are important for their survival. This is more so, as the ants need various types of food at different times to maintain the nutritional status of the colony.

However, in respect to the collection of few out of the supplied 10 sugar cubes within a time period of 6 hours it is apparent that these ant species are unable to sense the chemical cue emitted by the small sugar cube from a distance of 60 cm but certainly at a distance less than that. This could be justified from the fact that the ants coming out of their nest-site move at random to different directions toward foraging ground. Thus, on their way, when they arrive at a point from where they became able to read the cue of the chemical emitted by the supplied sugar cube, they made no mistake to come in contact with the same to ensure procurement of the said sugar cube to the nest. So, it can be presumed that the sugar cubes which were left as such at the supplied spots up to 6 hrs, following the time of placement of the same, may be collected by some other ants who would move to the foraging ground through the chemical cue- reading area encircling a sugar cube, subsequently. In this context it is important to know the duration of such chemical cue to enable the ants to read the same.

Conclusion

The ants, *C. compressus*, *O. smaragdina* and *S. geminata* collect the sugar cubes sensing the chemical cue emitted by the same. That is, food collection in ants is influenced by the cues. However, it is most likely that the chemical cue-reading ability in respect to distance between the ant and food material varies to a great extent among ant species. In respect to the results of the present studies that *C. compressus* is more efficient to read the chemical emitted by the sugar cube in respect to *O. smaragdina* and *S. geminata*.

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References

1. Abbott A. Nutritional dynamics of ants. In: Brian MV, ed. Production ecology of ants and termites. Cambridge University Press, 1978, 233-244.
2. Bregy P, Sommer S, Wehner R. Nest-mark orientation versus vector navigation in desert ants. Journal of Experimental Biology,2008:211(12):1868-1873.
3. Brian MV, Abbott A. The control of food flow in a society of the ant *Myrmica rubra* L. Animal behaviour,1977:25:1047-1055.
4. Brown JS, Kotler BP. Hazardous duty pay and the foraging cost of predation. Ecology letters,2004:7(10):999-1014.
5. Carroll CR, Janzen DH. Ecology of foraging by ants. Annual Review of Ecology and Systematics,1973:4(1):231-257.
6. Lee Cassill D, Tschinkel WR. Regulation of diet in the fire ant, *Solenopsis invicta*. Journal of Insect Behaviour,1999:12:307-328.
7. Chu J, Zhao K, Zhang Q, Wang T. Construction and performance test of a novel polarization sensor for navigation. Sensors and Actuators A: Physical,2008:148(1):75-82.
8. Dussutour A, Simpson SJ. Communal nutrition in ants. Current Biology,2009:19(9):740-744.
9. Fewell JH. Energetic and time costs of foraging in harvester ants, *Pogonomyrmex occidentalis*. Behavioural Ecology and Sociobiology,1988:22:401-408.
10. Fleischmann PN, Grob R, Müller VL, Wehner R, Rössler W. The geomagnetic field is a compass cue in *Cataglyphis* ant navigation. Current Biology,2018:28(9):1440-1444.
11. Gilad T, Dorfman A, Subach A, Libbrecht R, Foitzik S, Scharf I. Evidence for the effect of brief exposure to food, but not learning interference, on maze solving in desert ants. Integrative Zoology,2022:17(5):704-714.
12. Heimbauer LA, Antworth RL, Owren MJ. Capuchin monkeys (*Cebus apella*) use positive, but not negative, auditory cues to infer food location. Animal Cognition,2012:15:45-55.
13. Hölldobler B, Wilson EO. The ants. Harvard University Press, 1990.
14. Howard DF, Tschinkel WR. The flow of food in colonies of the fire ant, *Solenopsis invicta*: a multifactorial study. Physiological Entomology,1981:6(3):297-306.
15. Kolay S, Boulay R, d'Ettorre P. Regulation of ant foraging: a review of the role of information use and personality. Frontiers in Psychology,2020:11:734.
16. Müller M, Wehner R. Wind and sky as compass cues in desert ant navigation. Naturwissenschaften,2007:94:589-594.
17. Naskar K, Raut SK. Ants' foraging, a mystery. International Journal of Innovation Science and Research,2015:4(2):064-067.
18. Naskar K, Raut SK. Ants' food examination. In: Proceedings of the Zoological Society,2016:70(2):119-131. New Delhi: Springer India.
19. Oberhauser FB, Schlemm A, Wendt S, Czaczkes TJ. Private information conflict: *Lasius niger* ants prefer olfactory cues to route memory. Animal Cognition,2019:22(3):355-364.
20. Portha S, Deneubourg JL, Detrain C. Self-organized asymmetries in ant foraging: a functional response to food type and colony needs. Behavioral Ecology,2002:13(6):776-781.
21. Piqueret B, Sandoz JC, d'Ettorre P. Ants learn fast and do not forget: associative olfactory learning, memory and extinction in *Formica fusca*. Royal Society open science,2019:6(6):190778.
22. Roth II TC, Cox JG, Lima SL. Can foraging birds assess predation risk by scent? Animal Behaviour,2008:76(6):2021-2027.
23. Schneider ER, Mastrotto M, Laursen WJ, Schulz VP, Goodman JB, Funk OH, et al. Neuronal mechanism for acute mechanosensitivity in tactile-foraging waterfowl. Proceedings of the National Academy of Sciences,2014:111(41):14941-14946.
24. Sorensen AA, Vinson SB. Quantitative food distribution studies within laboratory colonies of the imported fire ant, *Solenopsis invicta* Buren. Insectes sociaux (= Social insects),1981:28(2):129-160.
25. Sorensen AA, Busch TM, Vinson SB. Control of food influx by temporal subcastes in the fire ant, *Solenopsis invicta*. Behavioral Ecology and Sociobiology,1985:17:191-198.
26. Steck K, Wittlinger M, Wolf H. Estimation of homing distance in desert ants, *Cataglyphis fortis*, remains unaffected by disturbance of walking behaviour. Journal of Experimental Biology,2009:212(18):2893-2901.
27. Steck K, Hansson BS, Knaden M. Desert ants benefit from combining visual and olfactory landmarks. Journal of Experimental Biology,2011:214(8):1307-1312.
28. Traniello JF. Foraging strategies of ants. Annual review of entomology,1989:34(1):191-210.