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FOOD–CARRYING STRATEGY OF THE ANTS *PHEIDOLE ROBERTI*

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ABSTRACT- The ants *Pheidole roberti* were offered eight different types of foods having different weights and sizes, in their foraging area to note their food-carrying strategy. It is revealed that the ants *P. roberti* are habituated to apply any of the four food-carrying strategies viz. lifting strategy, pulling strategy, pushing strategy, and group strategy through the application of pushing and pulling strategy in a coordinated way. It is also well evident that the application of food-carrying technique is very much dependent on the weight and/or size of food particles to be transported to the nest. Depending upon the weight/size of the food article *P. roberti* are accustomed to modify the food-carrying technique accordingly, to ensure food-transportation success.

Key words: Ant *Pheidole roberti*, foraging, characteristics of food, food-carrying strategy.

I. INTRODUCTION

Ants are habituated to search food here and there in their foraging area. After coming in contact of the food source they decide the strategy for procuring the available foods to their nest. Depending upon the volume of food they may start to carry the food individually or in groups or may develop the trail to carry the food for a considerable length of time [1-26]. It is obvious that the ants formulate the food-carrying strategy depending upon the type and size/weight of the materials available to them. This indicates that the ants may apply different strategies to carry the liquid and solid but different sized food particles. Again, the size of the food particles may vary with the food type. Then, whether the ants would apply different strategy to carry different sized food particles belonging to different food varieties or they would convert the food particles to a reasonable size so as to enable them to carry the same to the nest by applying the strategy which is in practice. However, information on the said aspect of foraging in ants is limited to the studies of Orians and Pearson[1], Goss and coworkers[3-4], Portha et al.[11], Hashimoto and Yamane[21] and Wetterer and Hugel[27]. Accordingly, we designed some experiments by offering different kinds of foods in different sizes to the ants *Pheidole roberti* occurring in and around Garia, Kolkata, West Bengal, India to note the food-carrying strategy of the ant species in reference. The results we obtained are interesting and worthy for publication.

II. MATERIALS AND METHODS

We offered eight types of food viz. sugar cube, biscuit fragments, mustard seed, anise seed, coriander seed, tea granules, freshly dead mosquitoes and dry fish fragments to the ants *P. roberti*. These were supplied in different numbers in different trials. Thus, a total of 3190 sugar cubes, 390 biscuit fragments, 40 mustard seeds, 40 anise seeds, 10 coriander seeds, 30 tea granules, 60 mosquitoes and 120 dry fish fragments were offered to the ants in different trials, on different dates. In all cases irrespective of food-types, a good number of particles/fragments of a food-type were deposited at the experimentation sites. In any day second and subsequent trials were made only after exhaustion of the foods offered earlier, of course, at a different spot. In course of studies due attention was paid to note the strategy the ants applied to carry the concerned food particles to the nest.

III. Results

The ants *P. roberti* carried all the 3883 food particles irrespective of types, to the nest. They applied four strategies viz. lifting strategy (to hold up food particle by the help of jaws), pulling strategy (to carry the food particle by the help of a strong bite, on way of rubbing with the ground), pushing strategy (on way of forcing the food material forward through a strong bite, touching the ground), and group strategy (effected in a coordinated way through the application of pulling and pushing mechanisms). In cases of lifting strategy, pulling strategy and pushing strategy only one ant individual was involved in the carrying process while in group strategy participation of 2-8 individuals was inevitable.

Of the 3190 sugar cubes 1555 were carried by lifting strategy and 1603 were carried by pulling strategy by the ants. Each one of the remaining 32 pieces sugar cubes was carried to the nest by the ant through the application of group strategy where participation of 2-5 ants was inevitable. Likewise, 209 fragments of biscuits, all the mustard seeds and tea granules, 3 mosquitoes and 38 dry fish fragments were carried effectively by applying the lifting strategy while 176, 46 and 62 biscuit fragments, mosquitoes and dry fish fragments respectively were taken to the nest through the pulling strategy. The remaining 5 biscuit fragments, 11 mosquitoes, 20 dry fish fragments, 40 anise seeds and 10 coriander seeds were carried by the ants through the effective application of group strategy. The strategies applied by the ants to ensure food carrying success as regards to the supplied eight types of food materials have been shown in Table 1, and the effectiveness of the strategies applied to carry these food materials could be visualized at a glance from Figure1.

It is to be mentioned here that, the ant was seen to carry some of the food particles viz. tea granules, mosquito and dry fish fragments through the pushing strategy, off and on, the said ant was seen to change the position to act the pulling strategy. Also, in cases of group strategy the ants were seen to change their position from one side to other. In lifting strategy there was hardly any chance of rubbing of the food particles with the ground in course of carrying the same while in pulling strategy and also in most cases of group strategy rubbing of the food particles with the ground was inevitable.

In group strategy a food particle was either carried by two or three or four or more ants in a coordinated way by applying either pushing strategy or pulling strategy or by applying both the pulling strategy and pushing strategy simultaneously (Table 1). Variations in group strategy application are well marked in respect to the food particles offered to the ants (Table 2).

IV. DISCUSSION

Of the supplied 3880 food particles, irrespective of the types, *P. roberti* carried 1875 (48.32%), 1887 (48.64%) and 118 (3.04%) particles by applying lifting strategy, pulling strategy and group

strategy respectively. Though, in some cases the ant tried to carry a food particle individually by applying pulling strategy in some other cases an ant was seen to apply pulling strategy and pushing strategy alternatively. It is not clear why some food particles were carried to the nest by applying the pushing strategy and others were taken by pulling strategy. In both the pushing strategy and pulling strategy an ant was seen to capture the food particle by the help of a strong bite and food particle had a close contact with the ground. This indicates that the food particles selected to be carried by lifting strategy were comparatively lighter than those particles selected by the ants for pulling strategy or pulling and pushing strategy alternately. Though an ant individual is able to carry a food particle five times heavier or can lift objects 50 times heavier than its own body weight [28-29], it is most likely that the food particle heavier than the expected weight to be carried by an ant through the lifting strategy but lighter than the particle to be carried by pulling act in respect to the size and/or ability of the forager ant individual then there exists no alternative but to carry the said food particle through the application of pushing strategy or pushing and pulling strategy alternately by the said ant individual. Thus, it seems that the size rather than the weight of the food particle determines which food particle would be carried by which strategy. This could be justified from the fact of application of pushing strategy by the ants to carry a mosquito and both pushing and pulling strategies to carry a coriander seed and anise seed. As the weight of the mustard seed and anise seed is fixed the ants were unable to carry such a seed individually either by pushing or by pulling alone but by the application of both pushing and pulling in group strategy. It is reported that an ant can carry an object that is even larger than its own body in the jaws. Though food-carrying ability of ants varies with the castes and the strengths of the individuals concerned experimental studies revealed that an individual belonging to *Formica japonica* is capable of lifting an object weighing 5 times as much as their own weight and also is able to carry an object weighing up to 25 times as much as its own body weight at the maximum by dragging it along the ground to the nest [17]. Thus, it is evident that food carrying strategy in ants depends mostly on two factors-the body weight or strength of the ant and the weight of the food matter. It is most likely that, a food matter of heavy weight would require more number of individuals belonging to the said ant species to carry the said object to the nest. Of course, it is one of the many strategies which is very much in practice among the ants to ensure procurement of food materials to the nest.

But, perhaps natural selection forced certain ant species especially those who are very small in size, to develop another device for the procurement of food matters as fragments of a large sized-food matter. Because, it may not be possible to carry a heavier food matter by a group of small sized ants to the nest. Since they are in need of such foods for their colony members[30] in respect to the developmental stages of the broods concerned tearing of the said food matter into minute pieces seems to be the best option. Indeed, ants have developed such strategy to ensure their food collection[29].

In the present experimental studies fragments of different food particles were offered to ants *P. roberti* and they were seen to carry these fragments either individually or in a group. Thus, it is very difficult to predict whether *P. roberti* are habituated to tear the large-sized food particle to have small particles of the same, to ensure collection of the same. This is more so, because they did not consider it proper to cut the mosquito into pieces so as to carry them easily by applying lifting strategy and/or pulling strategy instead of group strategy at least to avoid rubbing with the ground. Undoubtedly, rubbing of the food matter with the ground in course of carrying act creates hindrance in smooth pulling. Thus, this sort of behaviour most likely, species specific.

Therefore, different strategies may be applied by the ants belonging to different species to carry the same food matter. In this regard it may be stated that the ants have developed the unique strategy to carry the liquid food substance. In case of liquid food matters the ants are habituated to engulf the same from the foraging area and store in their crop. When the crop is fully packed with the said liquid food the ant moves to the nest and deposit the collected food matter at the respective site of the nest on way of regurgitation [27]. Recently, Gill [17] reported another strategy of foraging by the ants. In the said report it is stated that the ant workers carry over friends to help forage for food.

The worker *Pachycondyla chinensis* ants when find very cumbersome snacks, they return to their nest and literally grab another ant in their jaws, carry it over and drop it next to the food [17]. Thus, it appears that ants have developed various strategies to ensure foraging success. In this context, the models developed by different workers [1, 3-4] are impressive and important to trace the evolutionary trends of ant's foraging behaviour. However, according to Li and coworkers [20] effective foraging of ants mainly depends on their nest as well as their physical abilities and knowledge due to experience. Also, they opined that ants use their intelligence and experience to navigate. This suggests that foraging strategy in ants have not been evolved haphazardly rather on way of introduction, application and modification of original food collection device in respect to time to achieve success under increasing inter and intra specific competition and compulsion to collect food from so-called unusual food sources. Thus, it is concluded that the devices developed by the ants for collection of food are nothing but induced impact of the food matters in respect to inability to carry the same individually. Therefore, under any circumstances self operating strategy in transporting the food individually, seems to be most effective and beneficial for the ants, even being a member of social insect.

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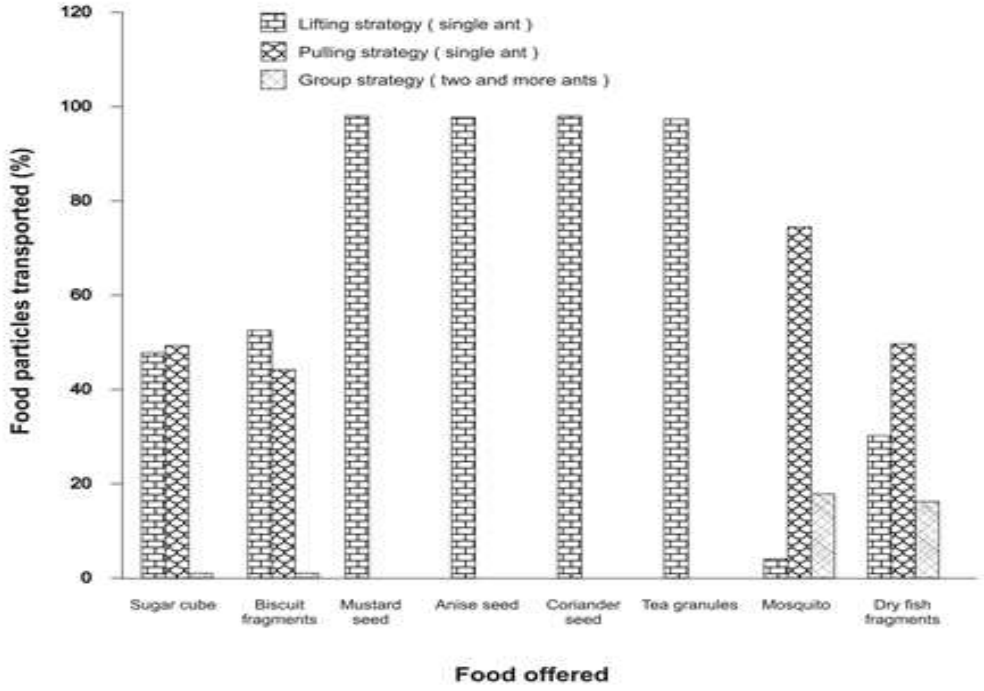

Fig. 1. Food-carrying strategies exhibited by the ants *P. roberti* in respect to supply of different types of food particles of eight different food varieties.

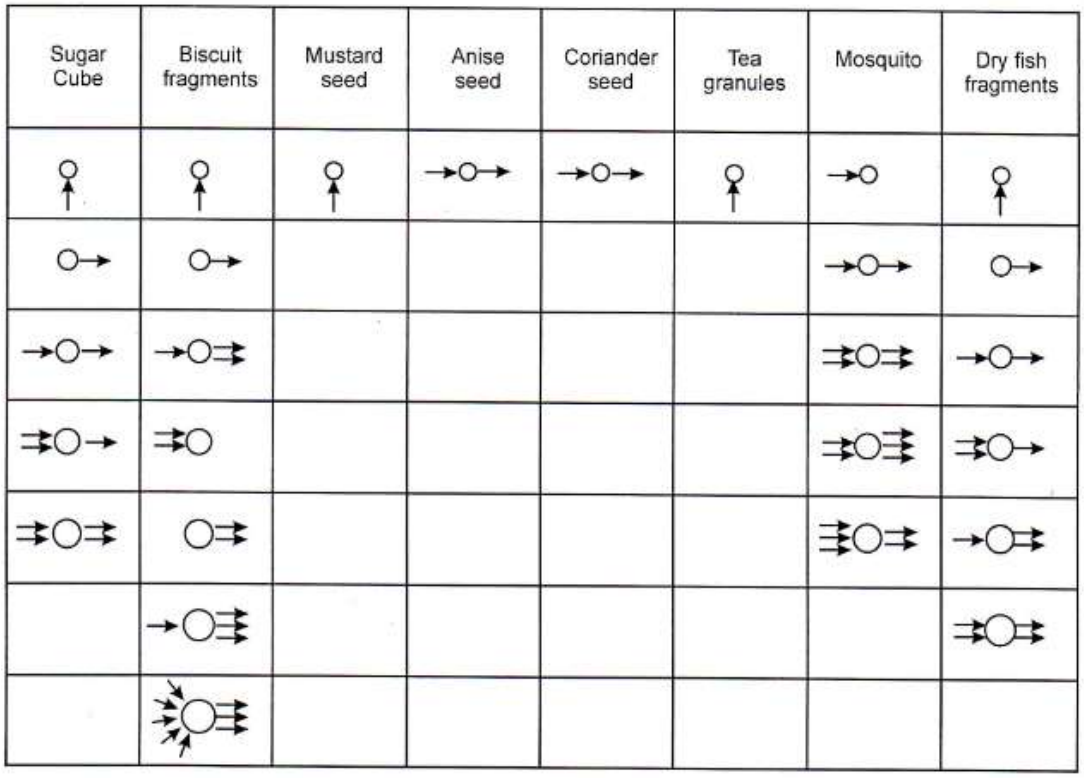

Table 1. Food-carrying strategies of the ant *P. roberti* in respect to supply of eight kinds of foods of different weights and sizes in their foraging area. ['O' indicates food, arrow pointing upward below the food symbol indicates lifting strategy ; arrow(s) locating on the left side of the food symbol indicating pushing act, arrow(s) locating on the right side of the food symbol indicating pulling act. Each arrow represents an ant individual involved in food carrying act].

Number of individuals took part in the food carrying act	Number of food articles transported					
	Sugar cubes	Biscuit fragments	Anise seed	Coriander seed	Mosquito	Dry fish fragments
2 individuals : 1 in pushing act and the other 1 in pulling act	22	-	40	10	8	14
3 individuals: 2 in pushing act and 1 in pulling act	6	-	-	-	-	4
3 individuals: 1 in pushing act and 2 in pulling act	-	1	-	-	-	1
4 individuals: 2 in pushing act and 2 in pulling act	4	-	-	-	1	1
2 individuals: both are in pushing act	-	1	-	-	-	-
2 individuals: both are in pulling act	-	1	-	-	-	-
4 individuals: 1 in pushing act and 3 in pulling act	-	1	-	-	-	-
8 individuals: 5 in pushing act and 3 in pulling act	-	1	-	-	-	-
5 individuals: 2 in pushing act and 3 in pulling act	-	-	-	-	1	-
5 individuals: 3 in pushing act and 2 in pulling act	-	-	-	-	1	-

Table 2. Variations in group strategy applied by the ants *P. roberti* to carry a piece of food belonging to different varieties supplied in their foraging area.