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Foraging activity of ants in open habitat of Elayirampannai, Tamil Nadu

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Abstract
Hymenopterans have still more significant role to play in controlling the population of agriculture pests, as some of them are effective predators and parasites of pests, affecting them in their various stages of life cycle. Ants are important gears of ecosystems not only because they compose a great part of the animal biomass but also because they act as ecosystem engineers. All the known species of ants are eusocial. Due to these beneficial uses of ants, the present work was aimed to study the foraging activity of ants in open area of Elayirampannai, Tamil Nadu.

Keywords: Ants, foraging, scavenger and predator

Introduction
Entomology is a branch of biology that focuses on the study of insects [1]. Phylum Arthropod is that the most successful of all the invertebrate phyla. Insects have very wide distribution [2]. Hymenoptera is the third largest insect Order, Coleoptera and Diptera being in the first and second positions respectively among all the orders [3]. Ants are one of the most interesting and diverse group of insects. All known species of ants are eusocial. The branch of science which deals with the study of ants is called as “Myrmecology”. Ants are social insects of the family Formicidae and, along with the related wasps and bees belong to the order Hymenoptera [4].
Foragers sometimes travel away from the nest in a linear trail and then fan out to search for seeds. In the absence of human intervention, colonies rarely form recruitment trails. Instead, foragers are widely dispersed and move slowly in search of seeds, then travel more quickly and directly back to the nest. Ants usually continue searching until they find a food item and foraging continues until high midday temperatures drive all ants back into the nest. Foragers are travelling in the same general direction. These regions can be very irregular in shape, often becoming more elongated during the course of the day, as areas closer to the nest become depleted [5].
A foraging track may be visible even when it is not used by any foragers that day, because the ants have previously cleared the vegetation along it [6]. ‘Foraging trail’, ‘foraging direction’ and ‘foraging range’ are used to refer to regions occupied by ants at a particular time, not to any features of the ground visible in the absence of ants. The area occupied by foragers of a particular colony changes from one day to the next. A mature colony may have up to eight habitual foraging directions, of which it uses about three to five a day. Each morning, a decision about which foraging direction to use is made by the patrollers, a distinct group of workers that search the foraging area before the foragers become active [5].

Materials and Methods
Activity schedule
The ant colonies in study sites were monitored at field to identify the species pattern of daily foraging. It was made during the dry and the wet season. All individuals going inside or outside colony entrances were recorded, during the first 15 min/h, between 6:00 A.M. to 7:00 P.M. Previously observation was used to decide the observations time. Temperature and humidity were recorded in each session using a dry and wet thermometer.

Survey of food items
All colonies found in the field were observed about food items. Several observation sessions were carried out during study period, resulting in a total of 66 h of observation on dry season

and 110 h on wet season, in sessions of variable time per colonies [7] about the species food preferences. The solid food items retrieved by the workers were surveyed by removing them from the mandibles of foragers. The colonies used to activity schedule did not use to survey of food items sampling. Food items were conserved dry or in 70% alcohol, depending on the composition, and brought to the laboratory for more detailed identification. The minor and major diameters of the items were measured. Also in laboratory, each collected item was kept in an oven at 60°C for 24 h, and its dry weight was determined. The liquid items, like nectar and animal secretion, used by this species were recorded, but for technical limitation, they had not been quantified.

Spatial foraging patterns

In order to determine the foraging area occupied by a colony, workers (N=50 individuals in each nest) from two colonies were marked with a non toxic paint and followed in the field. It was recorded maximum distance reached for the ants in terms of colony distance and height. These data were used to calculate an estimation of the volume of foraging area. All resources visited on plants by ants were registered and identified, plant species too. Additionally, also registered and identified all trees in a ray of 10 m around each colony. So, compare the available and effectively used substrate. In each period, 20 traps were left for 24 h on the ground (ten traps) and on the foliage (ten traps).

Statistical analysis

All mean values were accompanied by standard deviation. The Spearman's coefficient was used to express the correlation between number of workers and temperature and humidity. The sampling method was based on the previously reported one by Yamamoto and Del-Claro, 2008 [8] with some modifications.

Results and Discussion

During foraging activity totally 25 ant species were observed and tabulated (Table 1). Among the 25 species, 15 species are the generalized foragers; four species are scavengers, six species are considered as predators.

Table 1: Species behaviour repertories for foraging

S. No	Species	Scavenger or Predator	Method of requirement for food sources
1	*Monomorium minimum*	Scavenger	Group requirement
2	*Monomorium pharaonis*	Scavenger	Group requirement
3	*Monomorium indicum*	Predator	Group requirement
4	*Crematogaster subnuda*	Generalized forager	Mass requirement
5	*Tetramorium bicarinatum*	Generalized forager	Mass requirement
6	*Pheidole spathifera*	Generalized forager	Group requirement
7	*Pheidole megacephala*	Generalized forager	Group requirement
8	*Messor barbarous*	Scavenger	Tandem running, Group requirement, Mass requirement
9	*Myrmica caeca*	Predator	Group requirement
10	*Solenopsis invicta*	Generalized forager	Mass requirement
11	*Solenopsis xyloni*	Generalized forager	Mass requirement
12	*Solenopsis geminata*	Generalized forager	Mass requirement
13	*Tetraponera rufonigra*	Predator	Individual
14	*Tetraponera nigra*	Predator	Individual
15	*Camponotus compressus*	Generalized forager	Individual
16	*Camponotus crispulus*	Generalized forager	Individual
17	*Camponotus sericeus*	Generalized forager	Tandem running
18	*Camponotus castaneus*	Generalized forager	Individual
19	*Camponotus rufoglaucus*	Generalized forager	Individual
20	*Camponotus mitis*	Generalized forager	Individual
21	*Paratrechina longicornis*	Generalized forager	Tandem running
22	*Lasius niger*	Scavenger	Mass requirement
23	*Tapinoma melanocephalum*	Generalized forager	Group requirement
24	*Odontomachus haematodus*	Predator	Tandem running
25	*Dorylus orientalis*	Predator	Group hunting

Food items collected by ants

The collected food items of ants are divided into two types (Plant and Animal) materials, the seasons also divided into dry and wet seasons.

In dry season and wet seasons of 2017, Grasses of Seeds (3.95; 3.94) was more taken by ants. In animal materials Hymenoptera (10.13; 13.50) was more taken by ants. Unidentified animals such as insects (3.69), egg (2.75), larvae (4.98), pupae (3.86) and parts of the animal (leg, head, *etc*.,) (4.12), Mollusca (3.69), Annelida (5.06), animal as a whole (4.46) and Parts of the animal (5.32) was collected from the ant nests. In wet season of 2017, Arachnida species whole animal (4.23) or part of the animal (3.90) was collected. Unidentified animals such as insects (5.42), egg (3.71), larvae (3.80), pupae (3.04) and parts of the animal (leg, head, *etc*.,) (5.09), Mollusca (4.56), Annelida (3.52), animal as a whole (4.18) and Parts of the animal (3.42).

In dry and wet seasons of 2018, Seeds of grasses (5.46; 4.41) was taken by ants. In animal materials Hymenoptera (14.86; 13.32) also was mostly collected by ants. Arachnida species it's whole animal (2.67) or part of the animal (3.29). Unidentified animals such as insects (4.89), egg (3.29), larvae (2.92), pupae (4.52) and parts of the animal (leg, head, *etc*.,) (3.76), Mollusca (3.01), Annelida (2.54), animal as a whole (4.33) and Parts of the animal (3.86). In wet season of 2018, Unidentified animals such as insects (4.21), egg (2.78), larvae (3.16), pupae (4.89) and parts of the animal (leg, head, *etc*.,) (4.12), Mollusca (3.74), Annelida (3.26), animal as a whole (3.07) and Parts of the animal (4.89) (Table 2; Plate 1).

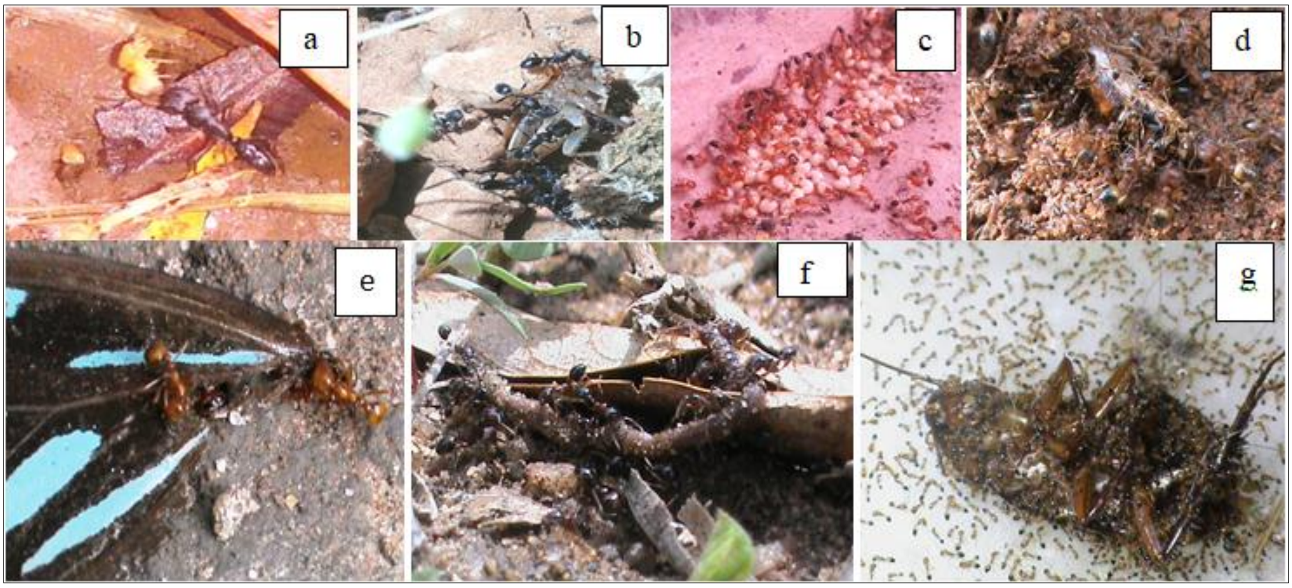

Plate 1: Food items collected by ants: a) Ants carrying termite; b. c, d, e, f and g is Group requirement of ants for collecting the various animals as food

Statistical Analysis

During the dry season of 2017 temperature (r =0.9615, P= 0.0001) and humidity (r= 0.9612, P= 0.005) and in wet season of 2017 temperature (r =0.3632, P= 0.0001) and humidity (r= 0.3108, P= 0.005).

The dry season of 2018 temperature (r =0.7405, P= 0.0001) and humidity (r= 0.6851, P= 0.005) and in wet season of 2018 temperature (r =0.3173, P= 0.0001) and humidity (r=0.7697, P=0.005). The food collection was positively correlated with temperature and humidity during the study period (Table 3). In dry season collection of food items are higher when compare to wet season. Correlation between the numbers of food items collected and both the dry and wet season temperature and humidity was positively correlated [9]. suggested that the foraging temperature for *S. invicta* worker ants is lower in China than in Florida [10]. Reported the number of ant specimens in May decrease more than half if compare to March might be the factor of weather. Rains are known to limit ants foraging activity [6]. Stated that rainfall may be able to reduce the ant activity because rainfall may washing away pheromone and lose their way to back home.

Table 2: Food items collected by ant workers in a study area Dry season (Feb- June) and Wet season (July- Jan)

Taxonomic identify of food items	2017		2018	
	Dry season no of records (%), n= 1165	Wet season no of records (%), n= 1052	Dry season no of records (%), n= 1063	Wet season no of records (%), n= 1044
Plant materials				
Capsicum annum	2.75	1.33	1.98	1.44
Solanum incanum	2.40	3.33	3.20	3.54
Solanum lycopersicum	3.00	2.19	3.86	2.01
Ficus religiosa	0.86	1.71	2.22	1.72
Seeds of grasses	3.95	3.94	5.46	4.41
Animal materials				
Insecta				
Blattodea	2.33	1.71	2.48	1.15
Coleoptera	4.61	4.28	4.52	5.27
Diptera	5.06	6.46	5.74	10.16
Hemiptera	3.69	4.85	5.36	5.84
Hymenoptera	10.13	13.50	14.86	13.32
Isoptera	3.66	2.76	3.01	4.41
Lepidotera	5.49	4.85	4.55	3.07
Orthoptera	5.46	3.80	3.73	3.93
Arachnida				
The animal as a whole	4.89	4.23	2.67	2.78
Parts of the animal	3.78	3.90	3.29	2.87
Unidentified				
The animal as a whole	3.69	5.42	4.89	4.21
Egg	2.75	3.71	3.29	2.78
Larvae	4.98	3.80	2.92	3.16
Pupae	3.86	3.04	4.52	4.89
Parts of the animal	4.12	5.09	3.76	4.12
Mollusca	3.69	4.56	3.01	3.74
Annelida	5.06	3.52	2.54	3.26

The animal as a whole	4.46	4.18	4.33	3.07
Parts of the animal	5.32	3.42	3.86	4.89

Table 3: Correlation Coefficient between number of individuals in foraging, Temperature and humidity

Study period		**2017**		**2018**	
		Dry Season	**Wet Season**	**Dry Season**	**Wet Season**
Temperature	R	0.9615	0.3632	0.7405	0.3173
	P	0.0001	0.0001	0.0001	0.0001
Humidity	R	0.9612	0.3108	0.6851	0.7697
	P	0.005	0.005	0.005	0.005

Conclusion
Foraging success was significant for survival. In order to exploit their environment efficiently, organisms have developed a wide variety of foraging strategies. Significance of this kind of study to understanding the foraging activities of ants was emphasized. Future studies will therefore enhance the control of pests using the ants as a predator.

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