



RESEARCH ARTICLE

Effect of Abiotic Factors on Activity of *Myrmecocystus setipes* in Subtropical Region

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Received: 25th Nov. 2012, Revised: 28th Dec. 2012, Accepted: 7th Jan. 2013

ABSTRACT

The bio-ecological studies on ants *Myrmecocystus setipes* Forel was carried out at Agra, situated on the right bank of the river Yamuna in the Western Uttar Pradesh. Agra lies within the subtropical belt (Lat. 27.15° N Long. 78.0° E) and its climate is characterized by extremes of temperature and humidity. Temperature is one of the most important environmental factors for the animal life. Temperature affects activity, foraging, nest building, choice of nesting sites, direction of movement, reproduction, caste determination and many other aspects of the life of ants.

Key words: *Myrmecocystus setipes*, Foraging, Nest building, Brood-tending, Myrmecology, Territorial behaviour.

INTRODUCTION

Ants are members of the family of social insects meaning that they live in organized colonies. Ants make up the family- Formicidae of order Hymenoptera. The ant family contains more than 4500 described species that can be found in tropical and temperate areas around the world. Most of the described and unknown species are found in the rain forests. In a colony of ants you find wingless, infertile female workers predominate in defense, foraging and brood-tending. The fertilized winged female becomes the queen and may found her own nest after the mating season. In some species they may also stay in the colony or the surrounding area. Males die after mating. The queen starts laying eggs that develop into white larvae, then pupae and after those adults.

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". As per the recent classification, all ants are grouped into 21 subfamilies. All of these fall into a single family, the formicidae.

Myrmecocystus setipes Forel is the sole representative of the genus *Myrmecocystus* in Agra and is confined to the drier parts of Western U.P., Madhya Pradesh, Punjab and Rajasthan. Its distribution, however, extends westwards into Persia through Pakistan and Afghanistan. It is a subterranean form and constructs nests in exposed situations. Nests usually occur on bare ground devoid of vegetation. In case the nests are afterwards overgrown with grass, herbs or other vegetation, they are abandoned and new nests are excavated. Nesting site is usually selected on a sloppy and sunny ground. The excavated soil during nest construction is accumulated unequally around the opening of the nest to form a sort of crater. The entrance to the nest is characteristically crescentic-shaped with the longitudinal axis orientated in the east-west direction. From one side of the crescentic nest opening a small pointed mud projection is formed which perhaps partly divides the entrance into two portions to regulate the traffic.

There are roughly two cycles of nest building activities during the year. *Myrmecocystus setipes* Forel is fond of higher temperature and drier conditions. It can comfortably tolerate as high a temperature as 55°C. Its lower threshold temperature lies at 13°C. The range of optimum

temperature is extremely wide and varies from 22°C to 55°C. Its cold tolerance is not rather as pronounced as that of *Oecophylla smaragdina* Fabr. Sunshine has a profound influence over the activity of this ant. In the early and late hours of the day, the activity is almost brought to a stand still while midday exhibits the maximum activity. Wind does not seem to have any effect on this ant. *Myrmecocystus setipes* Forel is more sensitive to humidity than *Oecophylla smaragdina* Fabr. Rains have marked adverse effect on the activity of *Myrmecocystus setipes* Forel. The incidence of nests in an area markedly declines during, rainy season. Preference for drier conditions seems to be at the back of the selection of sleepy ground for nest building which provides protection against flooding by rains.

Under laboratory conditions *Myrmecocystus setipes* Forel shows a marked avoiding reaction to water. The high degree of cooperation in running the daily routine of life as seen in *Oecophylla smaragdina* appears to be lacking in *Myrmecocystus setipes* Forel. During heavy rains *Myrmecocystus setipes* Forel workers show clustering tendency at entrance of nest. Tandem-running resembling in pattern somewhat to that of *Oecophylla smaragdina* Fabr. is also observed. In *Myrmecocystus setipes* Forel, the mating flights take place between March and April and not at onset of monsoons. The ant collects seeds of plants and petals of flowers for food.

MATERIAL AND METHODS

Temperature of the air, nests and soil were recorded with the help of ordinary centigrade mercury thermometers, while for minimum and maximum reading a minimum-maximum thermometer was used. A dry and wet bulb thermometer was helpful in getting an idea of the prevailing humidity. Meteorological data on the climatic conditions collected by the Government Meteorological Laboratories. Centimeter and meter scales as well as measuring tapes and vernier-calipers were the instruments used for length and distance measurements.

A stop watch has been frequently used in the measurement of the speed of ants. Collections of ants have been made by picking either with hand or with forceps and also by letting the individuals stick to the tip of a broomstick moistened with syrup, honey or molasses. Small collections for microscopically examination were preserved in F.A.A. (Formic Acetic Acid) solution, while large collections for population studies were stored in formalin.

RESULT AND DISCUSSION

A. EFFECT OF TEMPERATURE: The importance and influence of temperature as an outstanding ecological factor which effect the activity of *Myrmecocystus setipes* Forel. The effect of temperature on activity we can understand under following heads -

(i) Activity- The temperature has an important effect upon the various life processes of *Myrmecocystus setipes* Forel. The number of *Myrmecocystus setipes* Forel workers active at any one time is limited. Under the optimum conditions of activity no more than about two dozen ants can be seen excavating the soil at the nest and some would be found foraging in the hot sun to long distances.

The workers engaged in the excavating duties move in groups like the formations of an army. They generally march in a formation of two rows of six workers each. The whole squad (approximately 12 in number) moves together into the entrance of the nest, gathers minute bits of earth in mandibles and turns about to deposit their load outside the nest. Activity unit of *Myrmecocystus setipes* Forel in the present considerations has therefore been expressed in terms of the actual number of ants excavating or otherwise found active within one meter diameter round the nest hole at any given time. It will be useful here to point out that activity at all the nests even under the same conditions of temperature does not exhibit a uniform pattern.

From the data given in Table- 1 it is apparent that *Myrmecocystus setipes* Forel is a very hardy ant and can tolerate comfortably as high a temperature as 55°C at which its activity does not show any

decline. It is reasonably safe to assume that *Myrmecocystus setipes* Forel may find even still higher temperatures quite favourable. On the lower scale its activity completely ceases at 13°C beyond which it just lives without showing any activity. With a gradual rise of temperature upto about 22°C there is a proportionate rise in activity. The maximum is recorded from 22°C to beyond 55°C. It is quite indicative that the optimum temperature for activity of *Myrmecocystus setipes* Forel lies between an extremely wide ranges, that is, from 22°C to 55°C. At Agra the temperature in the shade never goes beyond 45°C during the whole year and consequently *Myrmecocystus setipes* Forel is never immobilized due to high temperature and can be seen quite commonly even during the hottest months.

Table 1: Temperature-activity relations of *Myrmecocystus setipes* Forel

Observation No.	Temperature °C	Activity
1	12	0
2	13	2
3	14	3
4	16	8
5	17	12
6	18	12
7	21	12
8	22	25
9	25	25
10	30	25
11	35	25
12	40	25
13	45	25
14	50	25
15	55	25

Table 2: Average activity of *Myrmecocystus setipes* Forel, expressed in average number of ants active, at different hours during different months

Months	Number of ants active at different times					Average
	6.00 am	12.00 am	6.00 pm	8.00 pm	10.00pm	
January	0	6	0	0	0	1.2
February	0	10	8	6	0	4.8
March	3	12	10	10	5	8.0
April	5	10	8	5	6	6.8
May	8	14	8	8	6	8.8
June	6	18	7	2	0	6.6
July	3	8	2	0	0	2.6
August	2	10	9	0	0	4.2
September	0	6	2	0	0	1.6
October	0	12	9	1	0	4.2
November	0	10	0	0	0	2.0
December	0	6	0	0	0	1.2
Average	2.3	10.0	5.3	2.7	1.5	

By study of table-2 reveals that dry and hot months of March, April, May and June, when the shade temperature maybe as high as 45°C and open sunny ground temperature 55°C are most favourable for the activity of *Myrmecocystus setipes* Forel. The minimum activity is recorded during the cold months of December and January when the average maximum temperature never rises beyond

21°C with a minimum average temperature of 5°C. Daily average activity also shows that during mid-day when the temperature is the highest during the day, maximum activity is attained, while both in the morning and evening with low temperatures there is a proportionate decline in the activity (Table-2). At low temperatures the activity is confined to the act of excavations at the nests while it is only at very high temperatures and specially in sun that the ants go for foraging.

(ii) Choice of nesting sites- The response shown by *Myrmecocystus setipes* Forel in the choice of its nesting sites in relation to temperature. Most of the nests of *Myrmecocystus setipes* Forel are generally situated on south-facing sloppy areas, as already described, where optimum conditions of temperature during the greater part of the day are available. Growth of grass and other vegetation near or round the nest also reduces the effect of favourable insulation by obstructing the sun's rays and preventing them from reaching the nest hole. The vegetation also lowers the temperature there on account of its general cooling effect. The result is that nests are usually found on exposed ground devoid of vegetation. Further when a nest is over grown with grass, it is abandoned. The effect of the availability of exposed situations to some extent results in a greater abundance of nests during the months of February, March, October and November, which are months of scanty vegetation. Nests on flat ground or on north-facing slopes have also been occasionally seen from May to August, when due to high temperature insulation is perhaps not an acute problem.

Myrmecocystus setipes Forel almost always prefers higher temperature wherever it is available. During low temperature conditions the nest temperature 10.0 cm below the surface is invariably found to be relatively higher than the temperature prevailing outside the nest. The low unfavourable outside temperature coupled with comparatively higher temperature within the nest makes the ants retire to their colonies causing a pronounced fall in their activity. On the contrary during hot months when the temperature is relatively higher outside the nest than inside, the ants move out of their colonies in greater number for various activities. This shows that the ants take the fullest advantage of the favourable temperature conditions provided by the variations in temperature between the nest temperature and the external temperature. It is significant to record that the temperature of the nest throughout the year does not show a very wide range of variation. It fluctuates within a rather relatively narrow range of 14°C to 35°C as compared to the wide range of optimum temperature for the ant's activity which lies between 22°C and more than 55°C. The fluctuations in temperature immediately below the surface of the soil are fairly wide and well marked, but in deeper layers of the soil the fluctuations are generally obliterated, and an almost constant temperature with a very narrow variation is maintained.

B. EFFECT OF LIGHT: No worker has until now recorded anything about the light as an environmental factor and its bearing on the life of *Myrmecocystus setipes* Forel. A perusal of table-2 shows that the activity of the ant is at its peak at mid-day hours and in months from March to June which are periods of great intensities of light. The ant therefore prefers strong light for its activity. As the light decreases activity also goes down. In case of *Myrmecocystus setipes* Forel, the peak conditions of activity are recorded only for four months, that is, from March to June. In July and August months lesser intensities of light due to clouds and rains, hence, the activity of *Myrmecocystus setipes* Forel is much reduced. *Myrmecocystus setipes* Forel, therefore, it seems, prefers greater light intensities. Similarly daily activity of *Myrmecocystus setipes* Forel also demonstrates a preference for the sunny hours of the day. In the early and late hours of the day the activity is almost brought to a stand still as compared to peak activity during the mid-day period of intense sunshine.

C. EFFECT OF WIND: Wind has not been found to have any effect on the activity of *Myrmecocystus setipes* Forel.

D. EFFECT OF HUMIDITY: The effect of temperature and humidity on the activity of *Myrmecocystus setipes* Forel is more. For the sake of simplicity and clarity the average monthly activity of *Myrmecocystus setipes* Forel as shown column 7 or table-2 and it is divided into three grades.-

- | | | |
|-------------|---|------------|
| 1. Low | - | 1.2 - 2.6m |
| 2. Moderate | - | 4.2 - 4.8m |
| 3. High | - | 6.6 - 8.8m |

Relative humidity between 45% to 75% is most favourable for activity. This preference for drier conditions a fall in activity. This preference for drier conditions is further emphasized by the distribution of the species which is normally confined to the sandy and arid zones. The picture presented by the graph as a whole also demonstrates that influence of humidity is relatively more pronounced than that of temperature. The requirements of greater intensities of light for *Myrmecocystus setipes* Forel also show its preferences for low humidity and drier conditions, because the solar radiations effect the humidity adversely. During seeds and stores up in the nest. This seed collecting habit is a clear indication of aridity-loving temperature.

E. EFFECT OF RAIN: The rain as an ecological factor has much more pronounced effect on *Myrmecocystus setipes*. A reference to table-3 would reveal that maximum activity is attained during the arid month of March, April, May and June, and with the onset of rain the activity shows a marked decline in the month of July. Low relative humidity is not the sole factor which determines activity. Its effects are modified by temperature to some extent. Low humidity with high temperature as in drier months is an extremely favourable condition. High temperature alone, however, (with high humidity) has contradictory influence. Similarly the favourable effect of low humidity is offset by the low temperature prevailing in winter months of December and January and the activity diminishes.

Myrmecocystus setipes Forel shows its maximum activity during hot drier months. Rains in winter have a uniform effect of reducing the activity of both of these ants due to the modifying influence of low temperatures. In the case of *Myrmecocystus setipes* Forel even mild showers quickly drive the ants into their nests, which emerge again after the stoppage of rain to resume their excavating activity with renewed vigour, perhaps to reconstruct the craters damaged by the rains. The watering of the land around the nests of *Myrmecocystus setipes* Forel has also the same effect of reducing the activity. The number of nests occurring in an area is greatly effected by the rains. As is evidenced, the percentages of nests during drier months, like February, March, October and November, are much higher than in rainy months of July, August and September.

Table 3: Activity of the *Myrmecocystus setipes* Forel at different conditions of rainfall

Month	Average rainfall in inches	Average activity
January	2.6	1.2
February	0.6	4.8
March	0.9	8.0
April	0.0	6.8
May	0.4	8.8
June	2.9	6.6
July	10.8	2.6
August	10.4	4.2
September	9.9	1.6
October	0.0	4.2
November	0.3	2.0
December	0.7	1.2

The preference for drier conditions seems to be at the back of the selection of sloppy ground for nest-building which provides protection against flooding by rain. Similarly the formation of craters is undoubtedly an adaptation against floods.

CONCLUSION

For a fuller appreciation of the effects of rain on *Myrmecocystus setipes* Forel it is worth while to mention some special behaviour patterns of the ants towards the water stimulus. This ant exhibits a marked avoidance reaction to water. Under laboratory conditions when the water is provided in a tilted Petri-dish, the ants always remain on the drier raised up part of the dish and reach the water very carefully for drinking, like the cattle do from the side of a pond. *Myrmecocystus setipes* Forel dies within half a minute when sealed in tubes full of water. When experimentally liberated in a glass trough half full of water, the *Myrmecocystus setipes* Forel workers vigorously swim out towards the rim of the trough to escape but due to their inability to climb a vertical polished glass surface they fail to do so. As soon as a small stick touching the edge of the glass surface is provided the worker immediately uses it as a bridge to climb out of the water. If by some chance the workers happen to fall on the backs in a puddle of water, they swim for some time on their backs, then bring the selves in normal position and make for the nearest place where dry ground may be available.

Water provided for the workers of *Myrmecocystus setipes* Forel in Petri dishes in artificial nests has very often been found filled up and Petri dishes completely covered by pallets of soil excavated by the ants.

In case water enters the nests, the workers immediately engage themselves in removing their stores of seeds of *Lantana species* and of other plants, pupae and other contents to the outside for drying. It is a common experience to find scattered around the nest hole of *Myrmecocystus setipes* Forel a variety of seeds, dead insects and other nest contents, after the rain is over. Generally during the rains *Myrmecocystus setipes* Forel workers go deep into the galleries, but occasionally they come up to near the nest hole in groups and block the passage- a habit so common in *Camponotus compressus* Fabr. This perhaps happens when a gallery is flooded and the occupants are forced out to seek other drier places in the colony.

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