BEHAVIOURAL STRATEGY OF RETURNING FORAGERS OF THE ARBOREAL ANT *OECOPHYLLA SMARAGDINA* (FABRICIUS) DURING THE MONSOON[1]

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Field observations during the southwest monsoon showed that returning foragers of the arboreal ant *Oecophylla smaragdina* adopt a unique behavioural strategy to ensure stability and a firm grip on rain-washed, slippery tree trunks, and also to facilitate movement on the vertical surface of the nesting tree trunks during heavy rain. Within five minutes of a heavy shower, returning worker ants climbing the tree trunk assume a head downward position with their legs fully stretched out, and start aggregating into small clusters of 2-10 ants. With increase in the duration and intensity of rainfall, the clusters rapidly become more compact and increase to more than 50 ants. Finally, large single clusters of more than 100 ants are formed. Within 10-30 seconds of the rainfall slackening, the ants break away from the clusters rapidly and move up the tree trunk to the leaf nests with their heads oriented upwards. This behavioural strategy is an important adaptation of this tropical, arboreal ant species, enabling it to withstand heavy tropical rain.

Key words: *Oecophylla smaragdina,* monsoon rainfall, arboreal ants, cluster formation, behavioural strategy

INTRODUCTION

Arboreal ants belonging to the genus *Crematogaster* which make carton nests (Musthak Ali 1992), genus *Pseudomyrmex* which nest in the hollow thorns of Acacia (Janzen 1967) and genus *Tetraponera* which live in hollow internodes of bamboo (Klein *et al.* 1993), are widespread in the tropics. The territorial, arboreal ant *Oecophylla smaragdina*, which has mature colonies immense in size with a single queen and over half a million large workers (Hölldobler and Wilson 1995), makes nests of leaves still attached to trees (Hingston 1927). Polydomous nest organisation (several nests in one colony) of *O. smaragdina* has further facilitated the accommodation of large numbers of workers and enabled patrolling of distant parts of its three-dimensional (including tree canopies, tree trunks and the foraging ground) territories. While permanently tree-nesting ant species have solved the problem of living off the ground, some species such as *Paratrechina longicornis* nest in the leaf litter, but frequently shift the nests to trees during monsoon (pers. obs.). Although many arboreal ants, such as *Crematogaster* and *Oecophylla* tend homopterans present on trees and collect the excreted honeydew (Way 1963), the worker ants forage mainly on the ground (Déjean 1990a).

Fossil records indicate that the genus *Oecophylla* has been around for 30 million years (Hölldobler and Wilson 1995). This genus includes two closely related species, *O. smaragdina* (found in Asia and Australia) and *O. longinoda* (found in Africa) both of which defend three-dimensional territories (Hölldobler 1979, 1983). While the nest trees form the central territory of an *Oecophylla* colony, the worker ants descend via tree trunks to the ground to patrol and forage on the ground area or the secondary territory. The captured prey is taken back to the leaf nests singly or in groups (Hölldobler 1983). Most of the research on the two *Oecophylla* species has been laboratory based (Hölldobler and Wilson 1977; Hölldobler and Wilson 1978; Beugnon and Déjean 1992; Déjean and Beugnon 1996) and only short-term field studies have been carried out (Hölldobler 1979, 1983; Déjean 1990a, b). There has been no report, so far, on the behavioural adaptations of the returning foragers of an arboreal ant species during heavy rains, the subject of the present study.

MATERIAL AND METHODS

The study was carried out as part of a long-term project on the behavioural ecology of *O. smaragdina* in the Banaras Hindu University campus, where five colonies were identified in an area of 3000 sq. m in July 1997. *Oecophylla smaragdina* was found to use up to 14 species of trees and shrubs for nesting, predominantly *Mangifera indica* (Anacardiaceae), *Psidium jambolana* and *P. guajava* (Myrtaceae). The southwest monsoon in Varanasi occurs from July-September and decreases rapidly during October (Srivastava 2001). Observations were recorded on 11 rainy days from July to October, 1998-2001. The orientation, posture, number and size of ant clusters were observed up to a height of 1.5 m on the nest-tree trunks. The behaviour of the returning ants was also recorded on sunny days during March, 2003. The number of returning ants crossing an arbitrary mark on the tree trunk, located between 0.5 m and 1.5 m high per minute was noted. (The mark was selected below the bifurcation on the tree trunk, to facilitate counting of all the returning ants before they diverged to different branches bearing the leaf nests).

The number of ants returning without prey, the number of solitary ants returning with prey and the number of ants returning collectively (in groups of 2 or more) with prey per minute were recorded by taking five observations on five different nest tree trunks between 0900 and 1300 hrs on three different days. Behavioural features such as orientation of the returning foragers on the tree trunk, interactions with other ants and clustering behaviour was noted. Number of ants and number of clusters is given as mean ±SD.

RESULTS

On sunny days, solitary returning foragers without prey (14.72 ± 13.14) and solitary ants with prey (2.76 ± 4.12) were observed to move straight upwards with head directed upward. An extremely brief encounter with a maximum duration of 1 second was noted in 90.66% of the returning ants and outgoing foragers. Returning foragers bringing a prey (0.2 ± 0.692) collectively (in groups of 2-3) were seen moving upwards while constantly changing their orientation as they held the prey from two or three sides and carried it up the tree trunk. Not a single solitary returning ant was seen with its head pointing downwards and no clumping was ever observed (n=75) (Fig. 1).

After the first few raindrops, the returning workers were seen moving slowly and hesitantly. The initial light drizzle slowed their upward movement on the tree trunk, but their heads remained directed upwards. Within 5 minutes of a heavy shower, a large number of the returning foragers (66.43 ±12.32% ants) adopted a head downwards position with their legs spread wide on the vertical surface of the tree trunk. The returning ants started aggregating into small clusters of 2-10 (6.66 ± 2.83 clusters). The cluster size increased with increase in the intensity of the rain, more ants joining each cluster, so that after 10-15 minutes moderate sized clusters each of 11-20 ants (2.4 ± 0.72 clusters) and of 21-50 ants (1.6 ±0.69 clusters) were also found (Fig. 2). Formation of large clusters of more than 50 ants (1.18 ±0.8 clusters) was recorded only 15-20 minutes after the rainfall began intensifying, as ants from smaller clusters as well as late returning foragers came close together (Fig. 2). The time period of adoption of head downwards orientation and increase in cluster size with intensification of rain is shown in Figs 3 and 4. Ants with head downwards were found to a greater extent in the upper parts of large clusters (Fig. 2).

Ants gripping prey in their mandibles were more often found to have their heads up and surrounded by other ants from all sides. Chains of ants on all sides gripped large prey

Fig. 1: Returning foragers moving up the tree trunk singly with head oriented in upward direction on a sunny day

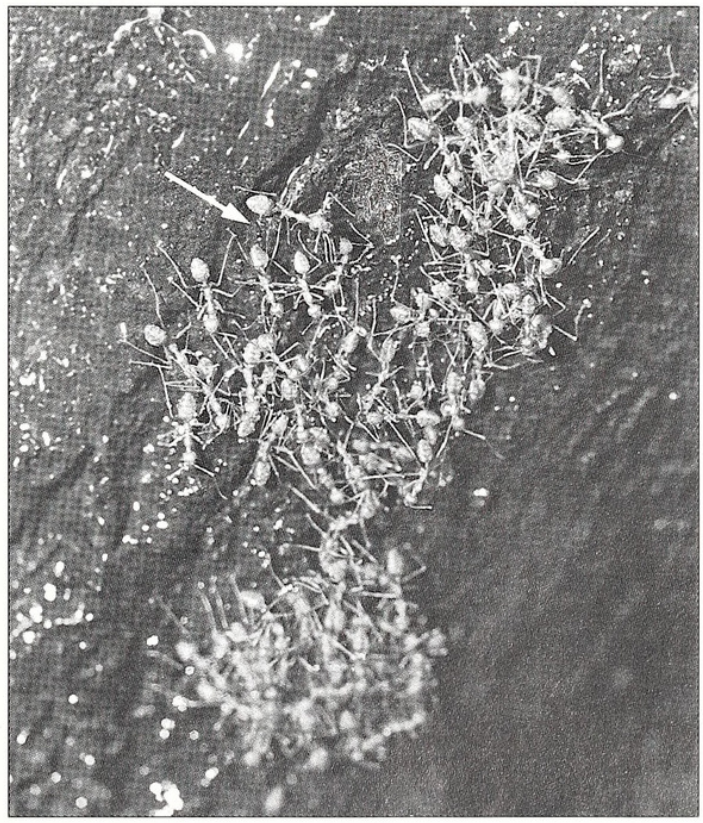

Fig. 2: Arrow shows that with increase in the intensity and duration of rainfall ants from moderate size clusters (11-20) move closer to form larger clusters (>50). White spots indicate the raindrops

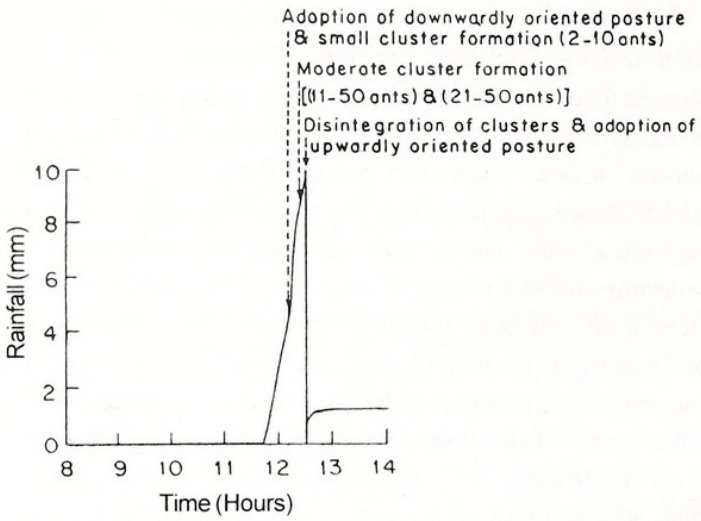

Fig. 3: Time sequence of adoption of head downwardly oriented postures and of progressive increases in cluster size with the intensification of rainfall on October 1, 1998. Total rainfall measured was 11.2 mm

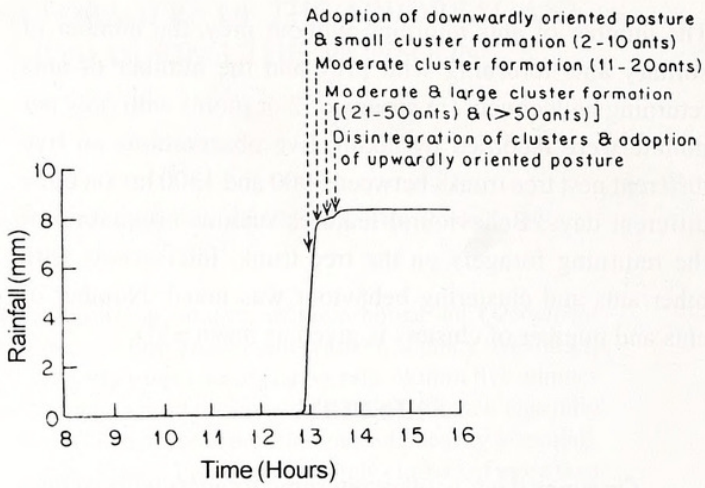

Fig. 4: Time sequence of adoption of head downwardly directed orientation and of progressive increases in cluster size with increase in duration and intensity of the rainfall on September 26, 2001. Total rainfall measured was 44.0 mm

such as grasshoppers and crickets.

The legs and body parts of the aggregated ants became meshed, as the clusters became tighter and more compact with intensifying rain. During heavy rain, the ants were found slowly but continuously changing their positions and coming closer to one another, so that when heavy rainfall lasted more than 30 minutes, extremely large clusters of more than 100 ants were found. The ants took shelter in the nooks between bifurcated parts of the tree trunk, under large, partially folded leaves of shrubs in contact with the trunk, or on the side of the tree trunk opposite to that facing the wind and rain. Within 10-30 seconds of the rainfall slackening, the clusters loosened rapidly, and the ants broke away from the aggregates, and in 2-3 minutes, they disintegrated completely as the ants moved to the leaf nests in their usual posture.

DISCUSSION

The arboreal ant *Oecophylla smaragdina* which nests in the leaves of trees and shrubs obtains honeydew from homopterans (Way 1954; Way 1963). However, the workers forage mainly on the ground, so they have to carry the food up the tree trunk to the leaf nests. Consequently, during heavy rain they are especially vulnerable, since they have to move up a slippery tree trunk, besides facing the falling rain drops. The present study shows that the ants have evolved a three-pronged behavioural strategy to avoid getting washed away during heavy rain. While the outspread legs provide stability on slippery, vertical tree trunks, the downwardly directed head posture probably helps in avoiding the direct onslaught of the raindrops on the head, as the ants slowly move about to form clusters in sheltered places in the tree trunk. Further stability as well as tighter grip on the slippery surface of the substratum is provided by cluster formation and the intertwining of legs and other body parts. The returning workers do not form clusters or show downward orientation on dry days (Fig. 1).

Wojtusiak and Déjean (1995) have demonstrated the importance of the arolia on the feet of *O. longinoda* for the successful capture and transport of large prey. I suggest that the well developed adhesive pads on the feet of *O. smaragdina* workers also play a crucial role in enabling the ants to grip and climb the slippery surface of tree trunks on a rainy day. The resistance of the trail pheromones, reinforced by faecal markings, to rainwater has been demonstrated in the African weaver ant *O. longinoda* for as long as ten months (Beugnon and Déjean 1992). Thus, while the arboreal nesting habit and leaf nests provide shelter from the rain, the trails marked by faecal spots are resistant to rainfall. Furthermore, adoption of downward direction and cluster formation strategy during heavy rain enables the returning workers to successfully ascend the tree trunks, seek temporary shelter from the rain and finally reach the nest. All these adaptive features have undoubtedly contributed to the success of *Oecophylla* in its tropical, arboreal habitat.

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