Chapter 5

Ecological Roles of Ants

Camponotus compressus tending coccids for honeydew

Introduction

Ants are central to ecosystem function, their removal from the ecosystem would significantly alter the functioning of that ecosystem, and many other organisms would be impacted negatively.

This chapter elucidates the significant role of ants in the urban and agricultural ecosystems. It is based on observations made during the study period. Each observation is then elaborated upon with reports from other authors in their studies on the same aspects of the ecological significance of ants. (Figure 60 to Figure 71)

Observations

1. *Camponotus compressus and Camponotus sericeus* ants were seen tapping the abdomens of leafhoppers *Oxyrachis tarandus* with their antennae They were mostly present on trees like *Terminalia cattappa, Tamarindus indicus* and shrubs like *Acacia nilotica, Calotropis* sp. etc. This observation was made at all urban and agricultural sites at all times of the year.

In some plants like *Hibiscus rosa sinesis*, *Camponotus* ants were seen tending aphids and scale insects (Figure and). It was also noticed that these ants carried aphids from one place to another on the same plant and sometimes to other neighboring plants. *Oecophylla smaragdina* ants build translucent shelters for scale insects to ensure a prolonged presence of scale insects in the vicinity (Narendra and Kumar, 2006).

Many ants are engaged in mutualistic associations with other insects. Phloem-feeding hemipterans such as aphids, membracids such as leaf hoppers, scale insects and mealybugs are 'trophobionts' that provide ants with an energy-rich food source in form of carbohydrate-rich excretions.

These plant affiliated homopterans along with extra floral nectarines form the most valuable food resources. Ants also protect other myrmecophilous herbivores, most notably caterpillars of many lycaenid butterflies (Pierce et al. 2002). Associations between ants and their trophobionts can have widely varied effects on plants (Cushman and Addicott 1991).

Ant species tend aphids and their relatives (Homoptera) for their honeydew and in return, the aphids are protected by the ants from predators and parasites. Ants sometimes actively move aphids from plant to plant. This type of mutualism has been called protection mutualism.

2. **Ant-Acacia interaction was observed in all study sites. Large numbers of *Camponotus compressus* were seen on *Acacia nilotica* plants, feeding on Extra Floral Nectarines or extracting honey dew from leafhopper *Oxyrachis tarandus.*** Many plants provide ants with direct rewards in form of energy-rich extra floral nectar or pearl body's .These rewards encourage the presence and activity of ants on the plant. Ants thus attracted increase plant fitness by reducing damage caused by herbivores and/or pathogens.

A classic and best studied example of mutualism is this ant–Acacia interaction in which ants live in modified thorns of Acacia species and deter both insect and mammalian herbivores (Janzen 1983). Large hollow thorns of Acacia provide shelter to Pseudomyrmex ants along with nutrition from the extra floral nectarines and Beltian bodies. In return, Acacia-ants vigorously defend their host and colony from herbivores (Janzen 1969). Ant-acacias depend on protection afforded by ants and cannot grow in the absence of acacia-ants (Janzen 1966).

3. Ants were seen visiting flowers of certain plants and it has also been observed that pollens stick to the body of Camponotus sericeus and Camponotus compressus, both formicine ants that visit Acacia nilotica and Terminalis cattapa flowers for nectar.

Ants are common flower visitors. There are a variety of forms of this interaction. Many workers have reported this as mutualism and have suggested that ants can be effective pollinators especially in plant species with a low, dense flowering stature (Beattie, 1985 ; Gomez, 2000). Hölldobler and Wilson (1990) regard them as unlikely pollinators as their movements are usually restricted to short inter-plant distances. Moreover, secretions from glands on ant bodies (e.g., the metapleural gland) of some ant species generally reduce pollen viability (Beattie, 1985).

However, there seems a possibility that pollens are brushed off from the bodies of these ant visitors, on other flowers, resulting in pollination. The above observation was made in the summer months and could hold true as Hickman (1974) has proposed that the low energetic or water costs of attracting ants to flowers might select for ant-pollination in dry or hot habitats. The role of ants as pollinators is yet to be ascertained. Numerous hypotheses have been proposed to explain the global rarity of ant pollination, but no general conclusions have yet been reached.

Some studies report that, in other situations, ants can act as antagonists. They may negatively affect plant reproductive success. Stealing of nectar without pollinating and disrupting the visitation of effective pollinators thus reducing pollination (Wyatt, 1980; Fritz and Morse, 1981) could cause losses to plants. Ants might also damage reproductive structures such as pistils, ovaries (Galen, 1999), or pollen (Wagner, 2000; Galen and Butchart, 2003).

4. **Several species of ants such as *Pheidole* spp., *Monomorium* spp., *and Paratrechina longicornis* were seen carrying seeds. Seed chaffs were seen on the nest entrances of these ants in all urban and agricultural sites.**

By carrying those seeds to their nest, ants play a major role as seed dispersers and can provide suitable conditions for seed germination. Some seeds rely on fleshy lipid-rich appendages as attractants to ants. *Ricinus communis* (the commonly known castor) seeds are primarily dispersed by autochory but probably present secondary dispersal by ants especially Myrmicinae species, once they bear a lipid-rich elaiosome. Removal of elaiosomes causes germination of the seeds when they are in the ant mounds (Martins *et al.*, 2006).

5. Formica rufa , Camponotus compressus, C.sericeus, Monomorium minimum and Oecophylla smaragdina were seen carrying and feeding upon dead insects, butterflies, caterpillars etc .

Many species of ants are fierce predators, and as such can be beneficial. For example, studies in Washington and Oregon, have reported that ants accounted for 85 % reduction of pupae of two defoliating moths (Torgerson *et al.,* 1990). Smaller species of ants (Myrmica and Leptothorax species) prey on small arthropods, e.g., springtails (Collembola).

Species of genera *Formica* and *Camponotus* can have huge nests, containing tens of thousands of workers, so it is conceivable that they have significant impact on ecosystem health by preying on the caterpillars of important defoliators.

Ants are important scavengers too. They clean the environment of debris by removing food scraps, dead remains of insects and other unwanted material. They are responsible for recycling huge amounts of organic material from fallen fruit to a dead butterfly.

6. Ants of subfamilies like Formicinae (eg. Camponotus spp., Formica spp., Crematogaster spp.,) Myrmicinae (e.g. Monomorium spp., Pheidole spp., Solenopsis spp.,) and Ponerinae were seen around crop plants in agricultural field sites.

Wild cotton (*Gossypium thurberi*) EFNs attract a number of generalist ant species that consume and disturb herbivores. When ant visitation was reduced, plants supported more herbivores, experienced greater leaf damage, and produced fewer flowers and seeds. Furthermore, fewer ants visited plants with experimentally reduced EFNs; leaf damage was higher and seed number was lower compared to plants with ambient levels of EFN, indicating that EFNs mediate the benefits of ants (Rudgers 2004)

7. The nests of ants are built by overturning large amount of soil. Nests of terrestrial ants like Solenopsis spp., Pheidole spp. and Camponotus spp. have large mounds of grainy soil and pebbles around the entrances. Dead remains of other ants, flowers, petals and dried twigs are used to decorate these nest entrances.

Ants are considered "ecosystem engineers". They modify soil characteristics in ways that benefit many other organisms. Ants create pockets of organic matter with in the soil by burying large amounts of organic materials. Some of them build large nest mounds which have special chambers for food storage, brood rearing, and refuse. Harvester ants concentrate seeds and other organic materials in and around their mounds, thus influencing soil organic matter (MacMahon *et al.* 2000). Leaf-cutter ants build under-ground gardens where they raise particular types of fungi on the pieces of leaves and plant materials brought back by foragers (Hart *et al.,* 2002). The transport and burial of organic matter also creates areas of increased nutrients with ant mound soils. Ant mounds have been found to typically be higher in nutrients such as phosphorus (P) and potassium (K) than surrounding soils (Dostál *et al.,* 2005), or richer in magnesium and calcium than surrounding soils (Whitford 2003). Other studies have linked ant mound soils to higher levels of microbial activity (Dauber *et al.,* 2001). By collecting and consolidating organic materials in their mounds, ants create "hotspots" of microbial activities and diversity.

Ants of all ground dwelling species like *Camponotus* spp., *Monomorium* spp., *Pheidole* spp., etc. overturn the soil when excavating tunnels and chambers. This has a profound effect upon organic matter and texture of the soil. Also, materials transported to the surface are mixed with body fluids to form uniform pellets of soil as found in studies on Atta texana (Weber, 1966) affecting the soil qualities.

Ants are one of the few species that transport subsoil mineral nutrients to the surface where they can be utilized by plants (Lockaby and Adams, 1985). Ants prune the vegetation, stimulate new plant growth, break down vegetable material rapidly, and, in turn, enrich the soil (Hölldobler and Wilson, 1990). The importance of *A. texana* ants for soil development (Kulhavy et al., 1998), and pedoturbation, or soil mixing (Hole, 1961) has been established.

Ants affect the diversity of vegetation and the diversity of other soil biota around them. Ant mounds can affect the below-ground distribution of plant roots (Dostál *et al.,* 2005), as well as the above ground distribution of plants that are allowed to grow. Harvester ants typically remove vegetation from the mound surface, possibly as a means of increasing the temperature within the mound. These mounds show increased levels of mycorrhyzal fungi, which contribute to increased growth of grasses and woody plants at the edges of mounds disks (MacMahon *et al.,* 2000).

Penetration of the soil by organisms creates pore spaces which influence water movement, gas exchange and soil chemistry (Gabet *et al.,* 2003). Researchers think that ant burrows increase water infiltration and that during the initial phase of a rainfall event (Wang *et al.,* 1996). Some species of harvester ants show increased levels of water in nests soil, compared to areas outside of the nest (MacMahon *et al.,* 2000).

Lasius flavus, a European species, has been shown to affect soils by mixing of lower and upper layers, and by creating large mounds that rise above the natural soil surface (Dostál *et al.,* 2005). This is also true for *Lasius* species found in this study.

8. Birds and other organism were seen in agricultural fields of all agricultural study sites.

Birds and ants are two predators that often occur together and their effects on prey assemblages differ significantly. Ants are both bird prey and bird competitors. In all agricultural fields of Vadodara birds like *Bubulcus ibis* (cattle egret), *Acridotheres tristis* (common myna), *A ginginanus* (Bank Myna), *Strunus pagodarum* (Brahminy Myna), *Vanellus indicus* (red wattled lapwing), Columba livia (Blue Rock Pigeon), *Coracias bengalensis* (Indian roller), *Pisstacula krameori* (Rose Ringed Parakeet),*Eudynamus scolopacca* (Koel),*Centropus sinensis* (Crow Pheasant) were seen.

Ants limit bird foraging success via interference or exploitative competition. Two studies of ground-nesting ants in northern Europe have demonstrated that bird activity (number of visits and total time of visits) may decrease on trees or in territories with ants (Haemig, 1992). Reduced bird activity in trees may be a direct result of ant aggression (Haemig, 1996). Ants lower food availability for birds; decreased food availability within ant territories may negatively affect reproductive success of particular bird species. Thus exploitative and interference competition between ants and birds exists in temperate areas with ground-nesting ants.

Ants are staple food for many birds, e.g., the pileated woodpecker (Torgersen and Bull, 1995).This is also an indication of their significance in ecosystem function. Ants are also an important dietary component for bears (Raine and Kansas, 1990).

Other organisms seen in agricultural fields were reptiles like *Calotes versicolor* (common garden lizard), *Varanus bengalensis* (monitor lizard), (Hemidactylus flavivirdis) Brook's Gecko, *Sitana pontiuriana* (fan throated lizard) etc. and rodents like Mongoose, *Herpestes edwardsi* (common grey shrew, field rats and five striped palm squirrels.).

Dorylus and *Pheidole* ants were seen feeding on *Odontotermes obesus* (Pardeshi, 2008).

9. Several species of ants are considered as pests. Tapinoma melanocephalum, Pheidole spp., Solenopsis spp., Formica spp., Oecophylla smaragdina are pests in agricultural fields. Pheidole spp., Camponotus spp., Crematogaster spp., and Monomorium spp. are known as urban pests.

The interviews with farmers revealed that directly there is no harm caused by harms to the crops growing in the fields of Vadodara, however the ants (e.g. *Formica* spp., *Solenopsis* spp.,*Oecophylla smaragdina*) cause nuisance by their bites and stings. They also protect and transfer Membracids (Homopterans), which are plant pests, from plant to plant causing their spread.

In Urban areas ants are considered as household pests spoiling food items, stored grains, and roots of potted plants and are seen as a menace in kitchens and wash areas.

According to various other workers ants are problematic to farmers because large homopteran populations tended by ants reduce plant fecundity or increase plant mortality (Way, 1963; Banks and McCauley, 1967). These Homopterans are also vectors of many viral diseases (Way and Khoo, 1992). Moreover, ants interfere with biological control efforts. For example, in coffee farms, ants defend scale insects (Hemiptera: Coccidae) from natural enemies. Ants protect coccids from natural enemies (Philpott and Armbrecht, 2006), defend red scales (Saissetia *coffeae* Walker) from coccinellid beetles (Azya *luteipes Mulsant*) (Coleoptera: Coccinellidae) (Anonymous, 1990), and protect green scales (Coccus *viridis* Green) from coccinellid and nitidulid predators (Hanks and Sadof, 1990)

Other Roles of Ants

Ants as Bio-control Agents

Ants, being generalist predators, are often used as biological control agents of insect pests and fungal pathogens in agro ecosystems. They reduce undesirable pests by directly preying upon them, by chemically deterring them and by causing pests to drop from the host plants that they are attacking (Way and Khoo, 1992). In addition, ants may indirectly reduce herbivore populations, for example, army ants increase movement of arthropods that are then consumed by army-ant following birds (Roberts et al., 2000). Ants also reduce fungal phytopathogens by removing spores (de la Fuente and Marquis, 1999) or by restricting interactions between plants and disease vectors (Leston, 1973; Khoo and Ho, 1992).

One of the first documented examples of farmer awareness of natural enemies is the manipulation of predatory ants by Chinese citrus growers, dating back to ancient times. These farmers placed nests of *Oecophylla smaragdina* in mandarin orange trees to help control leaf feeding insect pests and used bamboo bridges to help the ants cross between trees (McCook 1882, in DeBach, 1964).

Solenopsis geminata predates on larvae of brown plant hopper *Nilaparvata lugens* (Stål) infesting rice plants. S. geminata also attacks other insects like leaf folders throughout their egg and larval stages.

Studies in Washington and Oregon, have reported that ants accounted for 85 % reduction of pupae of two defoliating moths (Torgerson et al. 1990). Smaller species of ants (Myrmica and Leptothorax species) prey on small arthropods, e.g., springtails (Collembola).

Many predatory ant species have been found to significantly reduce agricultural pests and damage in annual and orchard crops (Carrol and Risch 1990; Peng et al. 1995; Van Mele and Cuc 2001).

Some species of ants control fungal diseases such as D. thoracicus that limits Phytophthora palmivora outbreak on cacao pods by reducing disease transmission (Khoo and Ho, 1992).

Ants reduce mired attacks minimising sticky lesions that attract dipteran vectors of P. palmivora. Additionally, O. longinoda feeds on caspids thereby controlling Calonectria rigidiuscula, which attacks where caspids have fed (Leston, 1973).

Ants as Human Food

Ants are also part of human food. They have been widely used as both food and medicine in China for over 3000 years. They are extremely rich in nutrients, including significant amounts of vitamins B1, B2, B12, D and E, contain as much as 67% protein and provide 8 essential amino acids. They also contain enzymes and other active substances and 20 trace elements such as magnesium, calcium, phosphorus, iron, selenium, and especially zinc.

Current published research has verified these benefits, especially by demonstrating the potent anti-inflammatory properties of *Polyrhachis*.

In Australia some of the insects were eaten by the Aborigines. The natives would dig into the ground looking for the nests of 'honeypot ant' workers these ants collect honeydew from scales and psyllids and feed it to other worker ants, which would become storage containers for the sweet liquid). In Australia, the *Oecophylla* ants are eaten as bush food by eating live the abdomen of insects. It's tasty with a sweet and sour flavour and considered thirst quenching (www.ca.uky.edu/entomology/dept/bugfood2.asp)

The larvae and pupae of Asian weaver ant *Oecophylla smaragdina* are commonly eaten in Thailand and the Phillipines. *O.smaragdina* is used as medicine in India. In the Bastiar region (Chattisgarh, India) the adult ants are directly used in the treatment of rheumatism, as oil to cure stomach infection and as an aphrodisiac (Oudhia, 1998).

In Java, Indonesia, the larvae and pupae of *O.smaragdina* ants are commercialized as songbird food and fishing bait. (Cesard, 2004)

Ant- fungus Mutualism

Leafcutter ants of the genus Atta cut pieces of freshly sprouted shoots, leaves and flowers that are brought to the nest to grow a fungus. The fungus disperses, cultivates and gets protection by the ants. In exchange the fungus digests the cellulose and other plant products normally inaccessible to the ants. (Hölldobler and Wilson, 1990). Adult ants are fundamentally nectar feeders, scavengers and predators. Larvae and newly hatched ants are fed with the fungus. (Hölldobler and Wilson, 1990).

Figure 60. *Camponotus compressus* tending *Oxyrachis tarandus*

Figure 61. *Camponotus compressus* ants on *Acacia nilotica*

Figure 62. *Camponotus compressus* tending an aphid

Figure 63. *Camponotus compressus* tending scale insects

Figure 64. *Camponotus sericeus* visiting flowers (Pollen grains can be seen sticking to the body of the ant)

Figure 65. *Camponotus compressus* – a potential pollinator?

Figure 66. Workers of *Oecophylla smaragdina* transporting an ant corpse.

Figure 67. *Solenopsis invicta* workers ants feasting on a larva

Figure 68. Loose overturned soil around a *Pheidole* nest in a garden site

Figure 69. Mound nests of *Lasius* sp.

Figure 70.
Bubulcus ibis (Cattle egret) in agricultural fields.

Figure 71.
Pheidole ants carrying *Danaus chrysippus*, butterfly wing