Ant Species Composition and Diversity in the Sharavathi River Basin, Central Western Ghats

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Contents

SUMMARY

Insects form a major part of the animal biomass in the ecosystem and in recent times they have been used as indicator species. Ants represent a unique focal group, to be monitored, due to their ability to navigate across all trophic levels, along with their sensitivity to any changes in the environment. Endemism in ant species suggest that their occurrence and their absence could be due to certain specific reasons. In the Indian scenario, *Lasius* species of ants are present only at the base of Himalayas, *Harpegnathos saltator* only in the southern India, while *H.venator* occupies the northern regions of India. Species of *Strumigenys* are present in forests prominent of thick leaf litter, while *Tapinoma melanocephalum* is present in human interfered systems. This definitely shows in a small way, that ant fauna does vary geographically, across latitudes. To understand the diversity and the stability of an ecosystem, hence, it becomes important to study the species composition changes that occur due to variations in microclimate and habitat. This would help in biodiversity conservation endeavor as it aids in inventorying and mapping of biodiversity and also in demarcating the most seriously threatened ecosystems. With global remote sensing land cover data sets being nowadays increasingly available at high temporal resolutions, it becomes imperative to combine with it field surveys to provide powerful tools for biological resource assessments.

The study carried out at the Sharavathi river basin, Shimoga, Western Ghats, aims to determine the species composition and assemblages of ant fauna, across the varying landscape elements. GIS and Remote sensing have been used to derive information about the land cover and land use patterns, which are the niches for ants. This study has revealed that ant species composition varies drastically across vegetation types. Dominance of certain species increases while others decrease, with variation in habitat. Species that have highly specific requirements remain absent from disturbed habitats. This work has resulted in identifying certain biological indicators such as *Polyrhachis mayri* and *Oecophylla smaragdina* as species thriving in undisturbed evergreen- semievergreen forests and moist deciduous forests respectively, while *Anoplolepis longipes* has been identified as an invasive species. This study reveals the tremendous human pressure exerted towards the northern and eastern region of the river basin while contiguous forests were present only towards the western region (devoid of invasive species) of the study area.

What's the mean diameter of the Earth? 12,742 km
How many stars are there in the Milky way? 10^{11}
What's the mass of an electron? 9.1×10^{-28} grams.
How many species of organisms are there on Earth? We don't know – not even to the nearest order of magnitude
Edward Osborne Wilson

INTRODUCTION

Increasing interest is being expressed worldwide in environmental studies, especially for conservation largely as a result of a serious concern that has dawned due to the present state of both local and global environmental conditions. This dawn of awareness is based on the recent realization that the state of our biological systems is of fundamental importance for the survival of human activity and also because their influence on human activity is increasing exponentially.

Each year, during the past several decades, people have been destroying enough tropical forest to cover an area the size of Pennsylvania. The geographic range of many species in the tropics is generally far smaller than it is in the temperate or polar latitudes. Thus, in the tropics, the species found in one acre differ from those in an adjacent acre far more than is the case elsewhere. During the last century, almost one half of the rainforests on earth have been destroyed. At the current rate of destruction, there will be only tiny patches of rainforest left by the middle of the 21st century. Due to the tremendous concentration of species in the tropics and their often narrow geographic ranges, biologists estimate that tropical deforestation will result in the loss of half or more of the existing species on earth during the next 75 years. Humanity is now in the process of destroying roughly as many species during the next 50 to 100 years as were wiped out every 100 million years by natural causes. It is inconceivable that, during the coming millennia, evolution could replace with new species those lost to deforestation and other human actions.

Conservation and sustainable management requires detailed knowledge of the state of the ecosystem along with datasets that can provide information about the geographical distributions of species, environmental factors that define the resilience of ecosystems and species habitats and the processes that create or change the habitats. It's impractical and impossible to determine all the species or sample at all the places in a particular ecosystem due to logical constraints, which necessitates monitoring taxa that are true indicators of the ecosystem. This could be achieved with the knowledge of presence and absence of certain indicator species. Also with rapid assessments being more stressed on, the need for identifying certain indicator species that can indicate the state of the ecosystem is required. Species delineated as indicator taxa (Lawton *et al.* 1998) or as a focal group (Di Castri *et al.* 1992) hence must:

1. Be easy to sample and monitor,
2. Represent diverse groups of biological significance,
3. Exhibit interrelations with diversity of other taxa and
4. Respond to changes in the ecosystem (Oliver and Beattie 1996).

Appropriate conservation strategies are to be evolved and implemented in order to maintain the existing high levels of diversity and endemism at Western Ghats. This could be achieved with inventorying, regular monitoring and management.

INSECTS

Insects are virtually everywhere on the earth's surface, excluded only by the extremes of climate at the poles and on the peaks of highest mountains; just a few species live in the sea (Cheng, 1976**)**. May (1990) estimates show that there are around 750000 and 790000 insect species whereas Hammond (1992) estimates show that as 950000. For the purpose of inventorying a number of 8 million insects and 8.9 million arthropods is currently used, with a world total of all the species coming to about 12.25 million (Hammond, 1992). Currently estimates ranges from 1.84 million to 50 million, with around 10 million being more favoured (Samways 1994) and quoted. Insects are numerous as individuals and species, being by far the most dominant animal biomass, genetic variety and biotic species interactors in terrestrial ecosystems. One of the intricate across-taxon interaction has been insect-plant interrelations (Samways 1994). Insects have a strong hold and a major say in most ecosystem processes, as they are pollinators and nutrient cyclers. A large number of them act as insect predators and mutualists all of which require conservation. Using insects to study how creation of mosaics, fragmentation of land, deforestation and creation of monocultures have an impact on diversity and stability of an ecosystem is a challenging and interesting task as it not only involves taxonomy of the concerned group but is also related to the behavioural aspects of the taxa under study.

ANTS

Ants belong to the family *Formicidae,* super family *Vespoidea,* order *Hymenoptera*. Among the social insects ants are placed in the category of "eusocial insects" or "truly insects", where individual of the same species cooperate in caring for the brood, there is a reproductive division of labour with more or less sterile individuals working on behalf of the fertile individuals in the colony and there is an overlap of at least 2 generations in the life cycle capable of contributing to colony labour, so that offspring's assist the parents during some period of their lifetime. Ants tend to be very aggressive and have great ability to dominate themselves because of which direct interactions between them and plants and also with other arthropods and insects are distinctly seen. They are usually separated from the other Hymenopterans by the one or two-segmented node (modified II and III abdominal segments), connecting the alitrunk (thorax plus I abdominal segment fused, that is known as propodeum or mesonoma) and the gaster (abdomen proper minus II or III segments) and a metapleural gland invariably present in ants (Wilson, 1971).

Together with *Homo sapiens,* ants are one of the few animal groups that commonly manipulate and modify their surroundings to suit their needs and it's a truism that they occupy a position among terrestrial invertebrates equivalent to that occupied by our species in/among the vertebrates (Bolton 1995). They offer a lot to people who are interested in long-term monitoring, inventory and ecology.

ANTS DIVERSITY

Ants show tremendous diversity, numerical and biomass dominance in almost every habitat throughout the world. Ants constitute upto 15% of the total animal biomass in a Central Amazonian rainforest (Fittkau and Klinge, 1973). Ants can be called as herbivores as they harvest nearly 15% of the herbivory in tropical forests. Studies carried out by Erwin (1989) at Peru showed that 69% of the total insect specimens collected by fogging the forest canopy were ants. Wilson (1987) has reported that a single tree in Peruvian tropical lowland forest yielded 26 genera and 43 species of ants. Agosti *et al* (1994) have reported a collection of 104 ant species representing 41 ant genera in a 20 m^2 of leaf litter and rotting logs at Malaysia. Anderson and Clay (1996) have recorded ants under 248 species from 32 genera in a 18 sq km semiarid area in Australia. Anderson's work in semiarid north-western Victoria reports the presence of 105 species of ants in a 0.1 ha mallee plot, 100 species of ants from a 0.05 ha plot in tropical savanna at the Northern Territory, which are undoubtedly the richest local ant fauna of the world. Talbot (1975) has recorded 87 species under 23 genera of ants in a 5.6 sq km area in temperate Michigan. Fogging of 2 canopies of *Gouupis glabra* in the Central Amazonia revealed 100 species of ants representing 21 genera and 5 subfamilies. An overlapping of 28% was also recorded (Haraa and Adis 1997).

Sampling in 33, one hectare plots from 12 habitats at the Western Ghats, Gadagkar et al report the collection of 120 species from 31 genera.

Ants are highly variable in their morphology, measuring anywhere between less than 1 mm to 40 mm. Colony sizes of ants range from less than a 100 to several million individuals. Ants exhibit a high degree of variability in their feeding habits, reflecting their temperament, which are docile to highly aggressive. Food preference is extreme in ants – exhibiting a high degree of variability in food selection. They survive on both animal and vegetable matter and there are very few of those ants that are highly specific in their diet. Having exceptions as leaf cutter ants and some harvester ants most of the ants live in part at least by predation (Dumpert 1978). A lot of inconsistency is seen in the diets of ants as one species of the African army ant *Anomma molesta* not only bring back captured preys to their nest but also feed on bananas. A forest dwelling Ponerine species *Odontomachus*, a jumping ant, which was considered to be exclusively flesh-eater is known to take honeydew (Evans and Leston, 1971). Members of *Rhytidoponera* a Ponerine collect and utilize seed kernels (Haskins, 1970). *Oecophylla smaragdina* a Formicine has diverse diets, tuna fish in baits, coconut, honey, other ants (*Pheidole* sp) and termites. Members of most of the primitive genera are carnivores which chiefly hunt insects (Veeresh and Ali 1991). Members belonging to the primitive genera of *Amblyopone* sustain mainly on centipedes (Dumpert 1978). *Leptogenys processionalis* and *L.chinensis* are seen to be highly specific and exclusively feed on specific forms of insect diet as termites (Shivshankar 1985). Ants belonging to the genera of *Strumigenys, Cerapachys, Proceratium* are specialised predators that feed on restricted set of arthropods. Species belonging to *Strumigenys* are regarded as Collembolan specialists (Kaspari 2000 Ants). *Eciton burcelli* consumes more than 10000 captured animals per day, a majority of which are insects (Dumpert 1978). Though not specific *Harpegnathos saltator* preys on wolf spiders, *Diacamma rugosm* preys on other ants, spiders and termites. Some ants survive on plant exudates (Tennant and Porter 1991). The exudates are however got directly by harvesting nectar from flowers and extra floral nectarines or they are derived as 'honey dew', a secretion of homopterans (Veeresh and Ali 1991) (Huxley and Cutler 1991). Some cultivate fungus gardens to meet their food requirements, some are accomplished scavengers and necrophagous while a majority of species serve as general predators on other insect groups exerting enormous pressure on other invertebrate populations in their habitats.

The diversity seen in ant fauna globally suggests that they have attained the ability to survive in various biotopes, which means that they have specialised nesting structures to suit different environmental conditions. Anthills and ant nests are a maze of internal subdivisions wherein they conceal their inhabitants in a highly ordered manner. Accurate and intelligent construction and positioning of the nest and its chambers and passages internally suffices for the specific temperature and moisture levels necessities of the eggs, larvae at different instars, the queen and the different classes of workers (Dumpert 1978). Ant nests are highly diverse taking a variety of forms and shapes. Ground nests are usually associated with most of the Ponerines as *Harpegnathos, Streblognathos, Paraponera, Dinoponera, Megaponera and Odontoponera* and majority of *Myrmicines* (Dumpert 1978). However, all their ground nests are not homogeneous and show variations. The nests would have a brood chamber, the queens chamber, a chamber wherein the young ones' are kept. In most of the cases the brood chamber and the queen would be found at the deepest point of the nest. A refuse-dumping pit is also present at the most inhabitable passage of the nest where the wastes from the colonies as dead nest mates, inedible parts of prey, are dumped (Dumpert 1978). *Cataglyphis bicolor* builds hill nests or crater nests usually seen in steppes and steppe regions (Schneider 1971). Dietary habits also determine nesting sites for instance *Crematogaster auberti* follows the tree roots with their passages to reach their diet — the root lice (Soulie, 1961). Nests of *Formica* sp are 70 cm deep into the ground (Brian and Downing 1958), nests of *Veromessor pergandei* attains a depth of 3 m and *Pogonomyrmex barbatus* nests may be over 5 m deep (Wray 1983). The shape of the ant hill can vary from being a flat nest to a steep dome shaped nest in accordance with the available moisture and exigencies of heat in the local environment (Dumpert 1978). In deciduous forests the nests are not very large but the colonies could be very large (Lange 1959). Breathtaking anthills are built by wood ants that are over 1 m in height and 9 m in circumference (Stammer 1938). Ants also nest under the stones which is seen exclusively on higher mountains as the stones lose less heat because of their faster drying out in summer and in addition to this, in these areas frosty nights occur in summer and nesting underneath the stone is an advantage as the temperature of a stone increases immediately at the onset of sunlight (Dumpert 1978). The largest ground nests are constructed by leafcutter ants that run 4 m deep and can penetrate to 8 m of ground with passages and chambers (Eidmann 1932; Jacoby 1953). Some ants belonging to the genera of *Crematogaster* and *Lasius* (Maschwitz and Holldobler 1970) build carton nests, which consist of fine sawdust, held together with a cementing material. Members of *Crematogaster* genus also divide tree hollows with carton nests (Soulie 1961). Ant plants or myrmecophytes support and provide nesting sites for ants belonging to the genera of *Crematogaster, Tetraponera, Monomorium*, and others. Plants provide hollow structures (*Humboltia* sp - *Crematogaster*) thorns (Bull horn Acacia - *Azteca* ants), pocket like structures with differing forms (Cocoa genus - *Azteca* ants) for nesting. *Strumigenys* and *Allomerus* colonies are seen on several South American species as *Maieta, Microphysca, Calophysca, Myrmidone, Tococoa, Hirtella* that have swellings on their petiole or at the base of the leaf (Wilson 1971). Very conspicuous swollen and cavernous trunks or stems are seen in trees and shrubs belonging to the dicotyledon families which always act as nesting sites for ants (Wilson, 1971). The silk nest constructed by *Oecophylla smaragdina*, the weaver ant, use the silk from their larvae and stitch living leaves together to get huge tent like nests (Green 1896; Holldobler and Wilson 1990).

STATUS

At present there are about 9000 species of ants described from world-over representing 296 genera and 16 subfamilies (Agosti et al, 2000). Ants have repeatedly turned up in fossils, so far 61 extinct genera of the living subfamilies have been recognized in addition to 14 genera which are grouped under 4 extinct subfamilies (Bolton 1995). The Indian subcontinent records ant species under 8 subfamilies representing 600 species and 92 genera. The subfamilies are *Aenictinae, Dolichoderinae, Dorylinae, Formicinae, Leptanillinae, Myrmicinae, Ponerinae* and *Pseudomyrmicinae* (Bingham 1903; Veeresh and Ali 1991). Ants belonging to 7 subfamilies represented by 125 species and 44 genera are known to occur in Karnataka. The subfamilies are *Dorylinae, Ponerinae, Myrmicinae, Formicinae, Pseudomyrmicinae, Cerapachyinae* and *Dolichoderinae* (Ali 1991; Ali 1992).

THE INDICATOR APPROACH

Identification of robust indicators in the ecological systems for their incorporation into land monitoring and assessment programmes is an interest expressed by most of the conservation biologists. The invertebrate group gets showered with a lot of focus because of their dominant biomass, exceedingly high diversity and intricate relations in the functioning of the ecosystem. Bioindicators are used to assess any kind of environmental perturbation that is generating a response from an ecosystem. The perturbation is often linked with human land use (Noss, 1990, Spellerberg, 1992). The bioindicator approach sometimes can also address (depending on the indicator used) the total species diversity, which would have very important implications in the field of conservation (Anderson

1997). Positive correlation between ants and invertebrate fauna (Majer, 1983), ants and plant species richness at uranium mine site (Anderson et al 1996) and ants with soil microbial biomass (Anderson and Sparling, in press) highlight the significance of essential studies on ants, while addressing issues of biological diversity and conservation.

Ant communities have been used as indicators in determining restoration process at mine sites; changes in soil microbial regimes, monitoring programmes associated with fire, in relation to environmental disturbance and stress. Ants have the potential to be used as indicators since they are sensitive and also because of the rapidity at which they adapt to changes brought about in the environment (Anderson 1990). A functional group concept put forward by Greenslade, which looks into behavior of the species instead only by taxonomic affinity, provides an acceptable system for habitat evaluation to detect environmental changes.

One of the most important studies done on ant communities was classifying 94 Australian ant communities similar to the way vegetation is classified according to predominating life forms by keeping their functional groups as attributes (Anderson, 1995). This study went further to classify that Dominant Dolichoderinae are analogous to trees, Generalised Myrmicinae to shrubs, and ruderal opportunists to grasses in terms of their responses to stress and disturbance. This study showed how these functional groups vary across vegetation types, such as open woodlands, forest, plantation, and treeless plant communities. It showed that abundance of dominant group of ants (a combination of Dominant Dolichoderines and Generalised Myrmicines) was positively correlated to species richness, while poor correspondence was seen between ant plant community structure types.

Ant communities when used as indicators of ecosystem restoration at mining sites have shown excellent successional patterns over a period of time thus proving that understanding of the functional groups and their signals that respond directly to any kind of stress and disturbance can lead to accurate prediction of ecosystem restoration. Monitoring ant communities for a 20-year period in Australia and changes in their composition has been used as an indication of restoration success following mining. The patterns in their changes reflect ecological changes at the mine site that is undergoing restoration Anderson (1997) showed that for the initial 5 years the species richness increases after which it stabilises, with the species varying from year to year depending on vegetation and other ecological factors. Ants have shown to be excellent indicator taxa to detect restoration of bauxite mines by long term work done by Majer and Nichols (1998). On planting seeds of mixed plant species in a mine pit, the first 2 years showed a rapid attainment of forest like ants.

A similar kind of work done in Brazil to see ant recolonisation at bauxite mines was carried out by Mayer (1996). Rehabilitated bauxite sites ranged from 0 – 11 years; rehabilitation done by planting mixed native forest tree species. Of the 206 species of ants collected, 26.21% were confined in rehabilitation areas, 39.80% exclusive in native vegetation and 33.98% were found in both the situations. Sampling done also in a Eucalyptus and Acacia plantation showed ant species richness as high as in native vegetation. The rehabilitated areas compared to the forest had proportionally more of generalists of soil and litter and fewer specialists. Extensive work done near Richards Bay, South Africa by Majer and Kock (1992) in 8 rehabilitated sand mined areas and 3 coastal dune forests showed that species richness increased for the first 2 years, declined and later again started increasing following rehabilitation for 8 years. Sampling ant fauna by Biserac and Majers (1997) in 7 rehabilitated (2 – 20 yr old) and 3 native healthlands at Western Australia recorded 96 species of ants compared to the 46 species got 17 years earlier. Ant species richness plotted against rehabilitation age showed a logarithmic curve indicating an improvement in conditions. Although there was an increase in species richness the ant composition and functional groups varied from 1980 to 1997. This gives an insight into ecological community as it seems that even after 17 years of rehabilitation which should have facilitated the rapid return of ant species, the composition of the original health land fauna has not yet been regained.

Work done in the Brazilian rain forest of Amazon basin in three 1ha, two 100ha and one 1ha lot revealed that ant species increased as forest area increased (Anonymous, 2000). This study also strongly suggests that forest fragmentation affect the structure of ground dwelling ant communities. At Venezuela it was seen that the densities of nests of *Atta sp* increased in small and medium islands (5.6 and 2.3 colonies per ha) compared to large islands (0.72 colonies per ha) and main land (0 nests in 5.5 ha). The incipient colonies however showed a reverse trend with number of colonies increasing in large islands. However, on a comparative basis their survival decreased in larger land areas (Rao, 2000). Greenslades' (1991) work in Tasmanian temperate rain forests showed that richness and abundance of ant fauna is very low.

Vanderwoude et al, (1997), used ants as indicators in forest monitoring programs to determine the impacts of different fire regimes on ant communities. Of the total 88 species of ants recorded under 43 genera in South East Queensland (Vanderwoude et al, 1997), the annually burned site recorded 74 species, the periodically burned site 63 species and 43 from the unburned site. The annually burned site recorded a relatively high abundance of 36% of the arid taxa and 8% of the cool temperate taxa with the opposite being true for the unburned site. The relative abundance of Dominant Dolichoderinae increased with fire frequency. 65% of the ants at the unburned sites were Opportunists, but they reduced to 16% at the annually burned site. Thus, reflecting on the potential of utilising the sensitivity of ant communities in fire management practices.

Majer et al (2001) examined the influence of decreasing latitude and elevational changes on richness and abundance of arboreal ants. This study was done in cool temperate forests, notophyll vine forests, high elevation notophyll vine forest, complex notophyll vine forest, complex mesophyll vine forest and mixed dipterocarp forests. Species richness was negatively correlated with both latitude and elevation. Majer's (1990) earlier work showed that richness of arboreal ants, tree ants and ground dwelling ants in Australian rain forests is very low compared to other tropical rain forests and was occasionally lower even when compared to the neighboring Eucalyptus plantation. *Oecophylla smaragdina* and *Crematogaster sp* were dominating in the tropical and sub tropical rain forests.

Galle et al (1998) described the species composition, diversity, population interactions and external correlates of ant assemblages in different successional plots of a sand-dune area in the Kampinos National Park, Poland. An increase in the species diversity was contradicted with a decrease in the last phase, which could be explained by the presence of red wood ant species, which are dominant in the interference competition. The Architecture of vegetation, number and condition of dead twigs on soil surface and temperature seem to be correlated with the composition of the ant assemblages. In the competitive network of the early successional ant communities, *Formica cinerea* and *Myrmica rugulosa* have the same rank.

A unique study was done at Mount Isa, Australia to detect responses of ant communities to dry sulphur deposition (Benjamin *et al*, 2000). Few species of ants showed a positive correlation with sulphur deposition, which were those, found in the disturbed sites of

Australia. Species richness however reduced with soil SO_4 concentration. High and medium sulphur zone levels showed less abundance of ants.

Sampling for ants in a Mediterranean grassland by Cerda and Retana (1990) fetched 13 species of ants, with *Pheidole pallidula* being the most dominant, followed by *Tapinoma nigerrium* and *Aphaenogaster senilis*. Kondoh (1990) studied the ant communities at Mt Fuji and came up with interesting communities of ants with particular vegetation types. The scoria grassland vegetation corresponds with *Myrmica kuroki – Formica lemani* community, deciduous woodland with *Myrmica kuroki – Formica lemani – Leptothorax acervorum* community, coniferous evergreen forest of *Abies* with monospecies community of *Myrmica kuroki* and shrub with *Myrmica kuroki – Formica lemani – Leptothorax acervorum – Formica sanguinea* community. Coniferous evergreen forest which is disturbed by scoria drift and its marginal vegetation corresponds with 2 communities; one is *Myrmica kuroki – Camponotus sachalinensis – Leptothorax acervorum – Formica sanguinea – Lasius niger;* the other being *Formica lemani – Leptothorax acervorum – Formica sanguinea – Camponotus sachalinensis.*

Anderson and Majer (1991) report that several of the rainforest species as *Oecophylla, Oligomyrmex, Quadristruma,* certain *Leptogenys, Crematogaster* and *Polyrhachis* provide biogeographic links with the east coast of Australia. They also point out that most of the cryptic species of the rain forest are areas with moist litter only in dry seasons. The most common ants found in their study were *Pheidole, Monomorium* and *Tetramorium*. This study also differentiates ants based on their foraging strata as whether they forage on litter, vegetation or ground.

REMOTE SENSING AND GIS

Remote sensing in the field of conservation and management of natural resources has had varied applications. It has been used for census of wildlife especially marine mammals, and carnivores in savannas. It is also used in monitoring the movement of wildlife. But the increasing applications of remote sensing have been primarily in the area of plant sciences. Practically most of the work done in remote sensing revolves around vegetation classification, crop monitoring and harvesting, mapping patterns in different forests, range lands, agricultural lands and diseases detection in crops (James, 1996). GIS along with remote sensing data help in inventorying, monitoring and assessing the natural resources on both spatial and temporal scale.

OBJECTIVES

Most of the ants have either a direct or an indirect relationship with vegetation. Some of these are highly specific to the habitat in which they occur, depending on the maximum benefits they attain for nesting, mating and food availability. Their preferences of microhabitat due to the above mentioned criteria were investigated by sampling ant fauna in various habitats along with mapping the vegetation using remote sensing and GIS (macro level analyses) to provide a detailed idea of the distribution of ant fauna, endemism and changes in patterns with habitat. By further determination of spatial distribution of certain indicator ant species the degree of stress and disturbance for prioritising conservation strategies for this section of the Western Ghats was analysed.

STUDY LOCATION

WESTERN GHATS

At the great mountains on the west coast of peninsular India are one of the richest biological areas of South Asia, *the Western Ghats,* one of the 34-biodiversity hotspots of the world (Myers et al, 2000) covering 5% of India's land area. The *Ghats* run up to 1600 metres from the southern most tip of peninsular India (8^{o}N) all the way up till the mouth of river Tapti (21°N) between 73°E – 77°E longitude. Western Ghats cover a total area of 160,000 sq km containing eight national parks and 39 wildlife sanctuaries. With rainfall varying from 1000 mm to over 6000 mm along with mountain ranges that have an elevation over 2000 metres, landscape heterogeneity is abundant in the *Ghats* (Subhashchandran 1997, Ramachandra et al., 2007). These ranges cut across political boundaries of Tamilnadu, Kerala, Karnataka, Goa, Maharashtra and Gujarat. Except for the Palghat gap separating the Nilgiri ranges from the Anamalai hills the *Ghats* are more or less continuous. In the West the *Ghats* descend steeply to face the Arabian sea while in the East they slope down gradually merging with the Deccan Plateau. T*he Ghats* support a variety of endemic flora and fauna because of the diverse habitats, which have got created due to the varying topography and climate (Menon and Bawa 1997). The original rich tropical evergreen, moist deciduous and dry deciduous forest of the *Ghats* today present themselves as a mosaic of natural forest types, plantations of rubber, eucalyptus, wattle, casuarina, beetlenut, fields of paddy and gardens due to degradation and human intervention into the biological system

High species diversity and endemism is associated with the Western Ghats. Daniels (1997) quotes high levels of endemism in 2000 species of higher plants, 84 species of fishes, 87 species of amphibians, 89 species of reptiles, 15 species of birds and 12 species of mammals at the Western Ghats. The montane evergreen or shola forests of high altitudes of the Western Ghats are known to harbour a relatively rare assemblage of bird species (Pramod *et al* 1997) while monoculture and plantations harbour species that exhibit high values of hospitality (extent of cohesion) and high levels of ubiquity or rarity. Of the 480 species of reptiles recorded from India, 197 have been reported from the Western Ghats (Johnsingh, 2001). It has also been well established that the natural vegetation show relatively high diversity of birds, butterflies and vegetation compared to monocultures, scrub and grassland (Kunte *et al* 1999).

Despite demonstrating such high levels of diversity and endemism, Western Ghats is experiencing large scale deforestation due to lack of conservation measures. Fragmentation has resulted in either losses or conversion of 40% of primary forests within a span of 50 years between 1920-1970 (Menon and Bawa, 1997). Within the latter part of 30 years 85.6 km^2 of forests have been converted to plantations, 42 km^2 to encroachments and 36.4 km^2 to reservoirs (Ramesh et al, 1997).

The present study was done at the Sharavathi river basin in the central Western Ghats located between 13°43′24 N and 14°11′57 N, 74°40′58 E and 75°18′34 E (**Figure 1a**), with elevation ranging between 80 and 1340 m. It spans Hosanagar, Sagar, and Thirthahalli taluks covering a total area of 2000 sq kms. The western part of the study area receives 2500 mm of annual rainfall while the eastern region receives 900 mm. Maximum rainfall occurs during the monsoon between June and September (data acquired from Drought Monitoring Cell, Bangalore).

The western region of the study area, Nagodi, Karani and Kodachadri were rich in indicators of climax vegetation, prominent being *Poeciloneuron indicum, Myristica dactyloides* along with *Dipterocarpus indicus, Aglaia anamallayana, Holigarna grahamii* and *Ficus nervosa*. Certain moisture loving species as *Garcinia talbotii, Mastixia arborea, Elaeocarpus tuberculatus* were also present. Poor regeneration of the few present deciduous species such as *Terminalia paniculata*, *Terminalia tomentosa*, *Terminalia bellarica, Lagerstroemia microcarpa,* ascertained the presence of fire in the past. The shrub layer was dominated by *Psychotria flavida, Pinanga dicksoni, Polyalthia fragrance, Strobilanthus* species. A scrub savannah habitat with barren hilltops characterised the 25 km stretch from the reservoir on the western region to Tumri. Along the eastern region, evergreen forests were found particularly as small fragments and also only to the south. This included the Sharavathi state forest, Hilkunji, Nilvase and Kavaledurga, wherein *Artocarpus hirsutus, Olea dioica, A.anamallayana, Dimocarpus longan, Vataria indica, Hopea ponga*, and *Knema attenuata* dominated along with deciduous species as *Vitex altissima* and *T.paniculata*. The extreme level of land utilisation and encroachment seen in the planes towards the eastern region suggests the undulating topography in the southeast is responsible for remnant forests in the region. Monoculture plantations of Acacia towards the northeast were products of recent conversions of large state forests to meet the requisites of the local population and city dwellers. The eastern region had an unprecedented increase in the agricultural and wasteland area and built-up regions. With evergreen species restricted to *Aporosa lindleyana, H.ponga and Polyalthia sp*, the deciduous forests dominated, represented by *T.bellarica, T.paniculata, Xylia xylocarpa, L.microcarpa* and *Buchanania lanzan.* In the northeastern region, the invasive weed *Euphatorium odoratum* were abundant, indicating extreme degree of disturbance. Sampling plots that had 90% of evergreen trees were called evergreen forests, while less than 90% were semievergreen forests. Anthropogenic activities in recent times has resulted in large scale fragmentation, creating a mosaic of land cover patterns of agricultural fields, monocultures of acacia, eucalyptus, rubber, arecanut, pine, casuarina and cashew along with evergreen forests, moist deciduous and scrub jungles in the river basin.

MATERIALS AND METHODS

LAND COVER ANALYSES

Land cover analysis was done to delineate the areas under vegetation and soil (non-vegetation). The land use analysis was carried out for the region to identify the use of land, emphasising the functional role of the land in economic activities. Land use patterns reflect the characters of a society's interaction with the physical environment, while land cover in its narrowest sense often designates only the vegetation cover extent on the Earth's surface, as the spectral reflectance in green band (visible range of EM spectrum) and near-infrared would represent the photosynthetically active vegetation. A cloud free IRS-1C satellite multi spectral imagery of LISS III sensors with spatial resolution of 23.5m was used for the analyses. A land cover analysis was done through computation of vegetation indices, which was either Slope based or distance based (depending on the landscape type - hilly, arid, etc.). The Normalised Difference Vegetation Index (NDVI) was used to delineate vegetative from the non-vegetative features. High values in a vegetation index identify pixels covered by substantial proportions of healthy vegetation. Due to inverse relationship between vegetation brightness in the red (R) and near infrared (IR) region, a normalised difference ratioing strategy can be very effective. Once the extent of vegetation cover was determined, further analyses were done to classify image with field data. FCC image was generated by merging all 3 bands, which aided in identifying the heterogeneous patches for selection of training sites. Attribute information corresponding to these training sites were collected from field using Global Positioning System (GPS). In addition to this, GPS was used to map the tree species, which were sampled along 200 m transect with 20 x 20m quadrant. Gaussian maximum likelihood classifier was used to classify the data based on the attribute data collected from field. The statistical probability of a given pixel present in a specific land use category was calculated and each pixel in the data was categorised into the land use class it most closely resembled or the probability of occurrence.

SAMPLING STRATEGY

Sampling was done along four transects (Figure 1a) moving away from the reservoir towards the end of the river basin. Undulating topography in the area resulted in non-uniform length of the transects varying from 4 to 32 km. Three sampling plots of 30 sq. m each were located at every 4 km distance along the transects. These plots were placed in a mini-transect of 400 m at a 200 m interval, perpendicular to the main transect resulting in a total of 78 samples, distributed as 31 samples in moist deciduous forests, 16 in semievergreen, 11 in scrub jungles, 10 in acacia plantations, 7 in semievergreen forests, 2 in evergreen forests and one in a pine plantation. At each of these plots the entire package of baits (described below) were laid for collecting ants. Pine plantations, *Pinus roxburghii* being extremely few in the study area, resulted in only one sample. Predominance of deciduous forests in the study area resulted in the highest number of samples. The Northern region being very close to the dam, the catchment area was very small resulting in only 2x3 samples. A large number of samples towards the east and north were under extreme human pressure.

SAMPLING METHODS

Ants were collected from each sample using bait traps, pitfall traps, leaf litter techniques and visual collections. Terrestrial and arboreal baits were placed using 70% honey, tuna fish and fried coconut. Terrestrial baits (T) were placed on the ground and the arboreal baits were tied to a tree at a height of 6 ft from the ground. The terrestrial baits were placed in an equilateral triangle formation maintaining a distance of 30m between two traps. The arboreal baits (A) were alternated such that between a terrestrial honey and tuna fish bait, a coconut arboreal bait trap was laid. A distance of 30m was maintained between arboreal traps. The traps were laid at 0700 hrs and were picked up at 1700 hrs. A 10 cm long cylindrical tube with a mouth-opening diameter of 5 cm was used as a pitfall trap (P). A pit was dug with a mallet and the tubes were placed such that their mouth was flush with the ground. Five such pitfall traps were laid in every sample for a 24h period, 4 in the corners of each plot and one in the center. Each of these traps had 90% ethyl alcohol with 3 drops of glycerin (to prevent quick evaporation). The Burlese leaf litter technique was used in extracting ants from the leaf litter in four, 1x1 m quadrants at each sample. The quadrants were placed in the four smaller quadrants (L), between the pitfall traps and baits in four directions. The entire litter in the quadrant was pushed from the sides to the centre and the litter was picked up and put in a funnel. The funnel was fitted with a vial with ethyl acetate. A powerful light of 60 watts was shone on the litter in the funnel over a 12h period, so that all insects would drop down into the funnel. The insects were then sorted and ants were separated for identification. A visual collection was also done which involved sweep net method, checking in barks, rotting logs and on leaves. For the purpose of quantification, visual sampling was restricted for a period of an hour at each sample. Ants collected from all traps were sorted, cleaned and preserved in 70% ethyl alcohol. The vials were labeled with the place, date of collection and sample codes.

Ants were cleaned with saltwater solution, mounted and identified using the keys in Bingham (1975) and Bolton (1994). Only the workers were counted, disregarding the males and queens. A reference collection is maintained by TMM in the Entomology Laboratory at the University of Agricultural Sciences.

The maps of the study area were digitised using Mapinfo 5.0 (creation of vector layers). IDRISI was used to determine the NDVI index and also to arrive at a second level classification using a supervised classification approach - Maximum Likelihood Classifier (raster analyses). Geographic Resource Analysis Support System (GRASS) was used to build the 3-D image depicting high and low species richness of ants for the entire study area.

RESULTS

LAND COVER ANALYSES: IRS-1C satellite data having a 23.5 m resolution has detected 70% vegetation cover at the Sharavathi river basin, of which 20% comprises moist deciduous and evergreen forests (**Figure 1b**). Field investigations coupled with satellite imagery shows large patches of undisturbed evergreen forests towards the western region of the study area (**Figure 1c**), while the eastern region is extensively disturbed distinct of only fragments of deciduous vegetation amidst settlements.

ANT DIVERSITY: A total of 84 species representing 31 genera and 5 subfamilies (**Table 1**) were collected from the study area, with an average of 9 (±3) species in 30sq.m area. Species belonging to 3 different subfamilies (Formicinae, Ponerinae, and Myrmicinae) were the most frequently occurring species for the entire study area. Ant specificity and requirement resulted in not all species being present in all the habitats. Species presence, varied from a least of 7% in pine plantations to a maximum of 76% in moist deciduous forests. Sampling revealed moist deciduous forests to harbour the most diverse ant species while evergreen forests had the highest ant species density. Scrub jungles recorded a higher species density than acacia plantations, despite having a similar species percentage (51%). Ant species were more evenly distributed in evergreen forests than the lesser but uniform evenness exhibited in the other habitats. Less than 30% of species of all subfamilies were present in evergreen forests.

ABUNDANCE AND SPECIES RICHNESS: Of the 84 species of ants collected (**Table I**), *Pheidole sp 1* was the most dominant (10.63%), followed by *Pheidole sp 2* (7.34%) and *Myrmicaria brunnea* (6.77%). *Solenopsis geminata, Bothriomyrmex sp, Pachycondyla tesserinoda, Monomorium floricola, Camponotus (Colobopsis) sp* and *Recurvidris recurvispinosa* were represented by a solitary individual. *Monomorium sp 2* and *Monomorium indicum* dominated the genus *Monomorium*, which was represented by 11 species. *Crematogaster* was represented by 9 species, wherein *Crematogaster sp 1* and *C.wroughtoni* were highly dominant. *C.sericues, C.compressus* and *C.rufoglaucus* dominated the genus *Camponotus*, which was represented by 9 species. *Pheidole sp 1, Pheidole sp 2* and *Pheidole parva* dominated the genus *Pheidole,* which was represented by 8 species.

A maximum of 7.5 species per plot (30 x 30 m) was acquired from evergreen forests followed by 5.57 species in semi evergreen forests (**Table 1**). Moist deciduous forests were the most species rich forests with 76.19% of the recorded ant fauna (**Table 1**). This was followed by dry deciduous and semi evergreen forests, which had 63.09% and 46.24% of the recorded ant species respectively. Acacia and scrub jungles both had the same number of species (not the same species) with scrub jungles having a higher species per plot richness. Pine plantations recorded a lowest of six species with only one plot being sampled. A lowest of 2.06 species per plot in moist deciduous forest was attributed to a relatively large number of replicates of this forest type. Similarity tests reveal that pine plantations have extremely low levels of similarity with all the other habitats (**Figure 2**) except for evergreen forests wherein no species overlapping was present. They do express maximum similarity of 10.9% with dry deciduous forests. Moist deciduous and dry deciduous forests shared a maximum of 55.8% of their species.

The first, eight abundant species belonged to the subfamily *Myrmicinae* (**Figure 3**). The ninth abundant species was a *Formicinae, Oecophylla smaragdina* (3.92%). Further members belonging to *Formicinae* were ranked eighteenth and nineteenth in abundance and were represented by *Anoplolepis longipes* and *C.compressus* respectively. *Diacamma rugosm* was the most abundant *Ponerinae* (0.66%) ranked twenty sixth, followed by *Leptogenys processionalis* (0.26%) ranked thirty sixth. *Tetraponera nigra* was the most abundant *Pseudomyrmicinae* (0.49%) ranked thirty third followed by *T.rufonigra* (0.25%) ranked thirty eighth. *Technomyrmex albipes* was the most dominant *Dolichoderina*e (0.25%) ranked thirty seventh, followed by *Dolichoderus sp* (0.24%) ranked thirty ninth.

Myrmicinae: The abundance values did suggest a great dominance exhibited by the subfamily *Myrmicinae.* Sampling done in the seven forest types substantiates that the subfamily *Myrmicinae* is extremely dominant. **Figure 5** depicts that more than 50% of the inhabiting species in dry deciduous, scrub jungles and evergreen forests were *Myrmicines* and also more than 40% of the species present in acacia, moist deciduous and semi evergreen forests were *Myrmicines*. This extreme dominance exhibited by *Myrmicinae* subfamily suggested the presence or easy availability of their food and their nesting sites. Niche and food requirements are one of the primary limiting factors of an ant population (Kaspari 2000). The highly abundant genus *Pheidole* had been recorded to feed on grass seeds, along with all the baits offered (species varied). Their habit of feeding on grass seeds has also been recorded by Ali (1992). *Tetramorium* and *Monomorium* also exhibited the same traits. *M.indicum* had been recorded to feed on insects also. *M.scabriceps* has been recorded to collect and store 150 – 600 g of seeds during October – December in India (Ali 1992). Certain species of *Crematogaster* fed exclusively on honey and few on tuna fish, while some feed on both. Also the subfamily had exclusively arboreal and terrestrial taxa. *Meranoplus* and *Lophomyrmex* had nests in open canopy areas, *Myrmicaria* and *Apahaenogaster* had terrestrial nests at tree base, *Pheidole* nested in soil, under leaflitter and occasionally nests had also been seen under trees. *Catalaucus* nested in rotten wood on trees, *Crematogaster* made carton nests, sometimes nesting in dead wood on trees.

High *Myrmicine* species percentage (**Figure 5**) was seen in acacia plantations (56%) and in scrublands (58%). Although many species representing *Myrmicinae* were present (**Figure 4**), the subfamily was pushed to third and fourth position in dry deciduous (65%) and moist deciduous forests (72%) respectively. They were overtaken in semi evergreen forests (36%) by species belonging to *Pseudomyrmicinae, Ponerinae* and *Formicinae*. *Myrmicinae* is known to have a diverse range of feeding habits with some being specialist predators, scavengers, seed harvesters and nectarivores (Majer *et al*. 2001). Less specificity and easy availability of the required resources coupled with varied and non-specific niche requirements and dominance in both arboreal and terrestrial zones has resulted in dominance of the subfamily *Myrmicinae*.

Formicinae: Subfamily *Formicinae* was the immediate successor to *Myrmicinae* subfamily. *Formicines* were dominant in moist and dry deciduous forests. *Formicines* were always second in dominance in all forest types except for pine plantation, wherein they took over from the *Myrmicinae* subfamily (**Figure 5**). The most dominant among them were *O.smaragdina* (**Figure 3**), a truly arboreal species. These ants nest in shady places and require broad leaves to stitch their nests. They were most dominant in moist deciduous, semi evergreen and evergreen forests. They were totally absent from plantations and scrub jungles (**Table 1**) implying on the necessity of broad leaves for their nest construction. Only a few foragers were collected from acacia plantations, only when moist deciduous forests were in the vicinity (where the nests were traced to). Dry deciduous forests did not provide shelter for these ants. The only instance wherein nest was found in dry deciduous forests was when lianas had intertwined cluster of trees and created a small narrow shaded area. *A.longipes* makes terrestrial nests and were dominant in moist deciduous and pine plantations. However, they were totally absent from evergreen, semi evergreen and scrub jungles (**Table 1**). Though dominant in moist deciduous and pine plantations they were not frequently occurring as only 22.8% of the sampled moist deciduous forests (**Table 2**) harbored this ant species. This species was found in areas which were disturbed and also wherein grazing, sweeping of leaf litter for manure was common. Settlements were always found close to such habitats. This species was found in acacia plantations also only when disturbance is seen and in other instances were totally absent. They did not have a liking towards close canopy and thick leaf litter niches. They preferred hard soil with canopies just touching each other. Nests were very common in walk paths in the forests used by people. They occupied all the disturbed habitats where the canopy was open for penetration of sunlight. Their absence however in the evergreen and semi evergreen forests suggests that those forests were not disturbed and close canopy areas were still persistent in these forests. With only 10% of the scrubs jungles harboring these species (**Table 2**), their affinity to open canopy areas was also doubtful. *C.compressus* was very dominant in all forest types. Absence of this species in evergreen forests was because of very few samples in evergreen forests. *C.angusticollis* was another dominant species present as we reached the interiors of the forest. They were absent from scrub jungles and pine forests (**Table 1**). Their dominancy reduced in monocultures and in dry deciduous forests. They required overlapping canopy cover for nests and areas where sunlight penetrates, for foraging. They were very specific about this requirement, which reflects in their high frequency of occurrence (**Table 2**) in semievergreen forests (75%). *C.sericeus* was one of the open canopy system specialists. They made chimney like nests in scrub jungles while they made underground nests in totally barren lands. Lands that got submerged in the monsoon season and exposed during the other parts of the year provided inhabitation only for this species. *C.sericeus* was a frequently occurring species in scrub jungles and dry deciduous habitats (**Table 2**), vouching for their preferences of open canopies and dry hard soil. *P.mayri* was an arboreal species present in moist deciduous and semi evergreen forests (**Table 1**). Plots wherein this species was found were undisturbed and were under no human influence. These plots were characteristic of thick canopy cover with no sunlight penetration and thick leaf litter. *P.rastellata* was extremely dominant in moist deciduous, semi evergreen and evergreen forests. They were absent from plantations. Foragers were found in scrub and dry deciduous forests only when moist deciduous or semi evergreen forests were in the vicinity. All the recorded species of *Polyrhachis* were arboreal and made their nests by stitching leaves.

75% of the recorded *Formicines* were present in dry deciduous forests (**Figure 5**) while 80% of them were found in moist deciduous but was overtaken by the *Ponerinae* subfamily.

They were least represented in scrub jungles with 35% of the recorded species present. With the presence of arboreal species as *Oecophylla* and *Polyrhachis, Formicines* were dominant in moist deciduous forests. There was a mix of species that were both specific and generalistic with their food and niche requirements, and pushing them behind the *Myrmicinae* subfamily.

Ponerinae: *Ponerinae* subfamily was more specific about its niche requirements and food habits. The jumping ant *H.saltator,* an endemic species to the Western Ghats was highly specific about its food requirements. Field observations have revealed that 90% of the food, brought to the nest by these solitary foragers were flying insects as wasps, bees, and hoppers, other than which, they fed on termites, roaches and other ants. Spiders were one more of their favorite food but occasionally the ants did succumb to them. Their nesting sites were more specific, present always under overlapping canopy covers (recorded once in scrub jungles in the vicinity of moist deciduous forests) and were always absent from monocultures (**Table 1**). This was in strong contrast to the situation in places around Bangalore wherein *H.saltator* was recorded in Eucalyptus plantations (Ali 1991). They showed high dominance in moist deciduous, evergreen and semi evergreen forests. The other *Ponerine, D.rugosm* was extremely dominant in acacia plantations with 72.7% of the acacia plantations harboring this species (**Table 2**), making it a highly consistent species in acacia plantations. *D.rugosm* fed on other ants, spiders, roaches and termites. *H.saltator* fed on all most all of *D.rugosm's* food and also had the ability to capture flying insects. Though both species were present in moist deciduous, semi evergreen and scrub jungles, the degree of overlapping in the sampled plots was as low as 5%, but overlapping was obvious in food niches. Both species preferred to nest in hard grainy soils. Nests of both species were never found in same plots. This suggests that the only reason for the non-existence of these two species together in an ecosystem is probably because the competition would be too fierce, which might result in removal of one of these species from the system. All three species of *Pachycondyla* were present in moist deciduous forests, while the entire genus of *Pachycondyla* was absent from evergreen forests (**Table 1**). The acacia and pine plantation record one species *Platythyrea sagei* and *Platythyrea parallela* each, respectively. *Pachycondyla rufipes*, a *Ponerine*, preferred small breaks in the forest for nesting purposes. These breaks were either due to logging or natural fall of old trees, resulting in a clearing in the forests. These ants were present in semi-evergreen, moist and dry deciduous forests. Foragers were recorded in scrub jungles only when moist deciduous forests were in vicinity. Nests of these species were absent from scrub jungles. The genus *Leptogenys* was absent from pine plantations and scrub jungles as well. They did not prefer open canopy areas. They were present in forests, which had dense canopy and thick leaf litter, wherein they are usually seen in long trails. Small foraging (five to eight individuals) hunting groups were also observed. An unidentified *Leptogenys sp* was found only in acacia plantations, often taking shelter under leaf debris. Termites seemed to be the chief diet of *Leptogenys*, along with their ability to attack and kill centipedes also.

Moist deciduous (90%) and semi evergreen forests (72%) had a high *Ponerine* species percentage (**Figure 5**). The species percentage reduced drastically in pine plantations (0.11%), acacia plantations (36%) and scrub jungles (36%). The specific niche and food requirement among *Ponerines,* along with their incompatibility with other *Ponerines* to be in same niches, arguably has resulted in less abundance and low species richness in the subfamily *Ponerinae.*

Dolichoderinae: *Dolichoderinae* was a very subdued subfamily in this region as compared to its stature in Australia wherein species of *Iridomyrmex* dominated the ant fauna (Anderson 1997). Also *Dolichoderinae* referred to be highly dominant all over the world presents a different scenario here. It was pushed behind with species of *Tapinoma* occurring only where human habitation was seen. It has been recorded in two samples, one a moist deciduous and the other a semi-evergreen forest (**Table 1**), both of which were under tremendous human stress. *Tapinoma* acts as an excellent indicator species to determine human interference (Viswanathan & Ajay 2000). The *Formicine, A.longipes* was absent in both these samples due to thick leaf litter and overlapping canopy cover present. *Tapinoma* has been recorded to tend to extra floral nectarines. *Bothriomyrmex sp* is recorded only from an evergreen forest. *Technomyrmex albipes* was dominant in acacia plantations and in moist deciduous forests and were absent from scrub jungles. *Dolichoderus sp* was absent from both semi evergreen and evergreen forests. They were however dominant in pine plantations.

All species of *Dolichoderinae* recorded have terrestrial nests. Dolichoderines had a highest species percentage in pine plantations (**Figure 5**), while 75% of them were present in moist deciduous forests.

Psuedomyrmicinae: Only one genus *Tetraponera* representing *Pseudomyrmicinae* has been recorded. These ants are solitary foragers and make their nests in fallen dead wood and rotten logs. They feed on insects. They were also retrieved from tuna fish and honey baits. *Tetraponera* was absent from pine plantations. *T.nigra* was dominant in dry deciduous forests. *T.aitkeni* was dominant in moist deciduous forests, while *T.rufonigra* was dominant in both moist deciduous forests and semi evergreen forests. Their absence from evergreen forests is possibly because of fewer samples. However, all three species were present in scrub jungle and in semi evergreen forests (**Figure 5**).

COMMUNITY COMPOSITION: The top four abundant genera, *Pheidole, Crematogaster, Tetramorium* and *Monomorium*, were not equally dominant in all the samples. They showed a lot of variation within forest types. An acacia plantation had a *Pheidole* and *Crematogaster* community; pine plantations had *Pheidolegeton*; moist deciduous forests had ant communities as *Pheidole* and *Lophomyrmex*; dry deciduous and scrub forests had a *Crematogaster* and *Tetramorium* ant community. The semi evergreen forests exhibited *Pheidole* and *Tetramorium* ant community; while in evergreen forests *Pheidole* and *Monomorium* ant communities were present. Dominancy of the two genera together was never seen in the samples. This meant that if one genus was dominant in one site, then the others either becomes a subordinate or in some instance would be absent from the system.

When the top four genera did not dominate and if the habitat was a dry deciduous or a scrub jungle, *Lophomyrmex quadrispinosa* suddenly dominate the region. In a moist deciduous forest, whenever the top four genera were not dominant, *Myrmicaria brunnea* and *Pheidolegeton diversus* were dominant. However, as mentioned earlier, both of them did not show dominancy in the same plots. *M.brunnea* had highly diverse feeding habits - both saccharine and meat lovers (bait traps) and are called as tropical climate specialists (Agosti *et al*. 2000). They dominated the system only when the top four genera did not. But however their dominancy was not spread to the plantations and scrubland. *P.diversus* had a much wider niche preference, as other than moist deciduous forests they also dominated in plantations, dry deciduous, scrub jungles and in semi evergreen forests.

ANTS ALONG THE RADIANS: Radian 4 on the western side of the study area was the most species rich radian (**Figure 6**) recording fifty-seven species (67.85%) of ants. It was followed closely by radian 3, at the southern region, with fifty-one species (60.71%), radian 2 on the eastern region with forty-five species (54.21%) and then radian 1, towards the northern region, with twenty-six species (30.95%) of ants (**Table 3**).

At radian 1 (**Table 4**), most of the forest areas have been converted to acacia plantations. Acacia plantations had their own unique ant composition along with high percentage of *D.rugosm*. But truly arboreal ant taxa as *Oecophylla* were seen only in certain areas close to the reservoir (Table 5), where small patches of moist and dry deciduous forests still existed. However, these areas were under severe human stress exemplified by the dominancy of *A.longipes* in the dry deciduous forests. Moving further away from the reservoir, extensive acacia plantations areas were present, wherein *D.rugosm* dominated the ant fauna. As seen earlier, truly arboreal taxa were absent from plantations.

Along radian 2, ants of the genera *Monomorium, Tetramorium, Crematogaster* and *Camponotus* were present at all distances away from the reservoir (**Table 5**). The entire radian was under heavy human stress, with settlements and agricultural fields present close to the forest. Only the areas close to the reservoir were less disturbed, characterised with overlapping canopies and thick leaf litter for the entire radian. *Harpegnathos, Leptogenys* and *Oecophylla* are seen here. *Pachycondyla, Lophomyrmex, Anoplolepis* and *Tapinoma* were absent which suggests the kind of forest type present with reference to earlier discussions. Moving away from the reservoir, disappearance of *Oecophylla* and *Harpegnathos* is strongly related to the disappearance of continuous patches of moist deciduous and evergreen forests. Presence of *Pachycondyla,* as we moved away from the reservoir concretes the idea that evergreen forests were absent, but certain small patches of semievergreen, moist and dry deciduous forests with distinct canopy gaps were present, essential for the survival of this species. Moving closer towards the end of the catchment area, and away from the reservoir, *A.longipes, D.rugosm*, along with generalistic species as *Pheidole, Myrmicaria, Monomorium* and *Tetramorium* were present, suggesting large scale human interaction with the system.

Along the radian 3, a mix of acacia plantations and moist deciduous forests were present close to the reservoir. High levels of human interaction in forests revealed *A.longipes*, acacia plantations sheltered *D.rugosm*, while moist deciduous forests harbour *Oecophylla* (**Table 6**). Undisturbed forests present halfway along the radian, harboured *Harpegnathos*, along with truly arboreal taxa as *Oecophylla* and *Polyrhachis*. Due to obvious reasons, *A,longipes* was absent from the system. However, the undisturbed forests were not devoid of breaks that were revealed by the presence of *Pachycondyla*. However, towards the end of the catchment area, the ant composition of arboreal taxa along with *Pachycondyla, Pheidole* and *Crematogaster* coupled with the absence of *A.longipes* suggest the presence of moist and dry deciduous forests with a lesser degree of human stress on the system as compared to the second radian (**Table 7**).

Most prominent along radian 4, was the absence of *Anoplolepis,* which was because of less degree of human stress on the system along the entire radian. The absence of *Ponerines* for the first 16 km except *Diacamma,* suggests a different land feature compared to the other three radians (**Table 7**). Here the first 16km comprised of undulating barren hills and acacia plantations. This was characterised by the presence of *Lophomyrmex, Camponotus* and *Meranoplus* along the first half of the radian. Also, wherever acacia plantations were planted on the hills, *Diacamma* was extremely dominant. The only records of *Solenopsis geminata* and *Holcomyrmex* sp, on this radian suggested the presence of a new niche, *the barren hills*. Towards the latter part of the radian truly arboreal taxa as *Oecophylla* and *Polyrhachis, Harpegnathos, Pachycondyla, Leptogenys* were present, suggesting the presence of dense evergreen and semi evergreen forests. Also, the only records of *Polyrhachis mayri* were from these regions of radian 4 (west). However, towards the end of the catchment area, this radian was again under human influence confirmed by the presence of *Tapinoma*. But however, the human intrusion in the environment not being in huge proportions and also because of overlapping canopy areas with thick leaf litter, *Anoplolepis longipes* was *still absent* (**Table 7**).

CONCLUSION

Ant species composition and their diversity patterns in different forest types at the Sharavathi river basin have been analysed in this study. This study emphasises the dominancy exhibited by the subfamily *Myrmicinae* within the ant communities, due to their ability to adapt to different niches with a variety of feeding habits. Dominancy exhibited by *Ponerinae* and *Formicinae* subfamilies in only certain habitats has been related to their very specific niche and food requirements. Habitats providing these specific niches were less frequently present. Results showed that the usually considered *species deficient* monocultures as acacia and pine plantations harbored certain ant species unique to their habitat, while truly arboreal ants were absent. Ants causing high diversity in such monocultures were those that are more generalistic in behavior. Behavioral data being sparse for ants represented by very few individuals, limits discussions. However, the absence of ants that thrived in moist deciduous and evergreen forests, which were specialists, suggests the lacking niches in plantations, dry deciduous forests and scrub jungles. The west radian, presents to the ants, larger number of niches than the others, suggesting, that though the western region was fragmented there still existed certain contiguous patches providing more niches for the ants (of all groups) to thrive, resulting in high species richness. Also, absence of certain species has revealed that the western region of the study area is under less degree of human stress compared to the other regions. We conclude by emphasising in classifying ants on the basis of their behavior than taxonomically, to pave way for further conservation and management programs. Further work in cataloguing the needs and requirements of different ant species to understand ant geography is in progress.

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Table 1 Ant composition along different habitats

Subfamily	Species across Forest types	Acacia plantation	Pine plantation	Moist deciduous	Dry deciduous	Scrub jungles	Semi evergreen forests	Evergreen forests
Ponerinae	*Diacamma rugosm*	+		+	+	+	+	
	Harpegnathos saltator			+		+	+	+
	Leptogenys diminuta	+		+			+	+
	Leptogenys processionalis			+	+		+	
	Leptogenys sp	+						
	Platythyrea parallela		+	+				
	Platythyrea sagei	+		+	+		+	
	Pachycondyla henrie			+		+	+	
	Pachycondyla luteipes			+	+		+	
	Pachycondyla rufipes			+	+	+	+	
	Pachycondyla tesserinoda			+				
Dolichoderinae	*Bothriomyrmex sp*							+
	Dolichoderus sp	+	+	+	+	+		
	Tapinoma sp			+			+	
	Technomyrmex albipes	+		+		+		
Formicinae	*Acantholepis sp*			+	+			
	Acantholepis opaca			+	+			
	Anoplolepis longipes	+	+	+	+	+		
	Camponotus angusticollis	+		+	+		+	
	Camponotus compressus	+	+	+	+	+	+	

	Camponotus invidus			+	+			
	Camponotus irritans					+	+	
	Camponotus paria	+		+	+	+	+	
	Camponotus rufoglaucus	+		+	+			
	Camponotus sericeus	+	+	+	+	+	+	
	Camponotus sp	+			+			
	Camponotus (Colobopsis) sp			+				
	Oecophylla smaragdina	+		+	+		+	+
	Paratrechina longicornis	+		+	+	+		
	Paratrechina sp			+				
	Prenolepis			+	+		+	
	Polyrhachis mayri			+			+	
	Polyrhachis rastellata			+	+	+	+	+
	Polyrhachis simplex	+			+			
	Polyrhachis tibialis						+	
Myrmicinae	*Aphaenogaster beccari*	+		+	+	+	+	
	Cardiocondyla sp	+						+
	Cardiocondyla wroughtonii	+		+	+	+		
	Cataulacus taprobanae	+		+	+			+
	Crematogaster nr dohrni				+	+		
	Crematogaster rothneyi	+		+				+
	Crematogaster sp 1	+		+	+	+	+	
	Crematogaster sp 2	+		+	+	+	+	
	Crematogaster sp 3	+		+	+	+		
	Crematogaster sp 4			+				

	Crematogaster sp 5	+			+			
	Crematogaster sp 6			+		+		
	Crematogaster wroughtoni			+	+	+	+	+
	Holcomyrmex sp					+		
	Lophomyrmex quadrispinosa	+		+	+	+	+	
	Meranoplus bicolor	+		+	+	+	+	
	Monomorium dichroum	+		+				+
	Monomorium floricola			+				
	Monomorium gracillimum				+	+		
	Monomorium indicum	+		+	+	+	+	
	Monomorium latinode			+	+			+
	Monomorium pharaonis			+	+			
	Monomorium scabriceps			+				
	Monomorium sp 1	+		+	+	+	+	
	Monomorium sp 2			+		+	+	
	Monomorium sp 3			+	+			
	Monomorium sp 4			+				
	Myrmicaria brunnea			+	+	+	+	
	Pheidole nr sharpi					+		
	Pheidole parva	+		+	+	+		
	Pheidole sp 1	+		+	+	+	+	+
	Pheidole sp 2	+		+	+	+	+	+
	Pheidole sp 3	+		+	+	+		+
	Pheidole spathifera	+				+	+	
	Pheidole watsoni	+			+	+		
	Pheidole wood-masoni				+			

	Pheidologeton affinis	+	+	+				
	Pheidologeton diversus	+		+	+	+	+	+
	Recurvidris recurvispinosa				+			
	Solenopsis geminata					+		
	Tetramorium sp 1	+		+	+	+	+	
	Tetramorium sp 2			+	+	+		
	Tetramorium sp 3	+		+				
	Tetramorium sp 4				+		+	
	Tetramorium sp 5						+	
	Tetramorium walshi	+		+	+			
Pseudomyrmicinae	*Tetraponera aitkeni*	+		+		+	+	
	Tetraponera nigra				+	+	+	
	Tetraponera rufonigra	+		+	+	+	+	
	Total species	43	6	64	53	43	39	15
	Percentage of species in each habitat to the total acquired	51.19	7.14	76.19	63.09	51.19	46.24	17.85

Table 2 Species occurrence (expressed as percentage) across habitats.

Subfamily	Species across Forest types	Acacia plantation	Pine plantation	Moist deciduous	Dry deciduous	Scrub jungles	Semi evergreen forests	Evergreen forests
Ponerinae	*Diacamma rugosm*	72.72	0	35.48	41.17	60	50	0
	Harpegnathos saltator	0	0	9.67	0	10	12.5	50
	Leptogenys diminuta	9.09	0	16.12	0	0	25	50
	Leptogenys processionalis	0	0	9.67	17.64	0	25	0
	Leptogenys sp	9.09	0	0	0	0	0	0
	Platythyrea parallela	0	100	3.22	0	0	0	0
	Platythyrea sagei	36.36	0	6.45	11.76	0	25	0
	Pachycondyla henrie	0	0	3.22	0	30	12.5	0
	Pachycondyla luteipes	0	0	3.22	5.88	0	25	0
	Pachycondyla rufipes	0	0	3.22	11.76	20	37.5	0
	Pachycondyla tesserinoda	0	0	3.22	0	0	0	0
Dolichoderinae	*Bothriomyrmex sp*	0	0	0	0	0	0	50
	Dolichoderus sp	9.09	100	6.45	11.76	10	0	0
	Tapinoma sp	0	0	3.22	0	0	12.5	0
	Technomyrmex albipes	9.09	0	9.67	0	10	0	0
Formicinae	*Acantholepis sp*	0	0	6.45	11.76	0	0	0
	Acantholepis opaca	0	0	12.90	5.88	0	0	0
	Anoplolepis longipes	9.09	100	22.58	5.88	10	0	0
	Camponotus angusticollis	27.27	0	32.25	11.76	0	75	0
	Camponotus compressus	27.27	100	54.83	52.94	40	25	0
	Camponotus invidus	0	0	3.22	5.88	0	0	0
	Camponotus irritans	0	0	0	0	10	12.5	0
	Camponotus paria	9.09	0	12.90	17.64	10	12.5	0
	Camponotus rufoglaucus	9.09	0	22.58	23.52	0	0	0
	Camponotus sericeus	9.09	100	32.25	58.82	50	12.5	0

	Camponotus sp	18.18	0	0	11.76	0	0	0
	Camponotus(Colobopsis) sp	0	0	3.22	0	0	0	0
	Oecophylla smaragdina	18.18	0	29.03	5.88	0	75	50
	Paratrechina longicornis	18.18	0	16.12	29.41	30	0	0
	Paratrechina sp	0	0	3.22	0	0	0	0
	Polyrhachis mayri	0	0	3.22	0	0	12.5	0
	Polyrhachis rastellata	0	0	29.03	5.88	20	50	100
	Polyrhachis simplex	9.09	0	0	5.88	0	0	0
	Polyrhachis tibialis	0	0	0	0	0	12.5	0
	Prenolepis sp	0	0	6.45	11.76	0	12.5	0
Myrmicinae	*Aphaenogaster beccari*	36.36	0	19.35	17.64	40	50	0
	Cardicondyla sp	18.18	0	0	0	0	0	50
	Cardiocondyla wroughtonii	9.09	0	16.12	29.41	10	0	0
	Cataulacus taprobanae	9.09	0	3.22	11.76	0	0	50
	Crematogaster nr dohrni	0	0	0	5.88	20	0	0
	Crematogaster rothneyi	9.09	0	9.67	0	0	0	50
	Crematogaster sp 1	36.36	0	29.03	41.17	20	25	0
	Crematogaster sp 2	45.45	0	32.25	35.29	30	37.5	0
	Crematogaster sp 3	36.36	0	3.22	5.88	10	0	0
	Crematogaster sp 4	0	0	3.22	0	0	0	0
	Crematogaster sp 5	9.09	0	0	5.88	0	0	0
	Crematogaster sp 6	0	0	3.22	0	10	0	0
	Crematogster wroughtoni	0	0	9.67	17.64	60	12.5	100
	Holcomyrmex sp	0	0	0	0	10	0	0
	Lophomyrmex quadrispinosa	9.09	0	25.80	29.41	40	12.5	0
	Meranoplus bicolor	18.18	0	6.45	5.88	10	12.5	0
	Monomorium dichroum	9.09	0	3.22	0	0	0	50
	Monomorium floricola	0	0	3.22	0	0	0	0
	Monomorium gracillimum	0	0	0	5.88	10	0	0
	Monomorium indicum	18.18	0	22.58	29.41	10	12.5	0
	Monomorium latinode	0	0	9.67	17.64	0	0	50

	Monomorium pharaonis	0	0	6.45	11.76	0	0	0
	Monomorium scabriceps	0	0	3.22	0	0	0	0
	Monomorium sp 1	9.09	0	29.03	17.64	40	12.5	0
	Monomorium sp 2	0	0	12.90	0	20	25	0
	Monomorium sp 3	0	0	3.22	5.88	0	0	0
	Monomorium sp 4	0	0	3.22	0	0	0	0
	Myrmicaria brunnea	0	0	29.03	17.64	30	25	0
	Pheidole nr sharpi	0	0	0	0	10	0	0
	Pheidole parva	9.09	0	12.90	5.88	20	0	0
	Pheidole sp 1	27.27	0	32.25	17.64	40	37.5	50
	Pheidole sp 2	54.54	0	32.25	52.94	30	62.5	50
	Pheidole sp 3	27.27	0	12.90	23.52	10	0	100
	Pheidole spathifera	9.09	0	0	0	20	12.5	0
	Pheidole watsoni	9.09	0	0	5.88	10	0	0
	Pheidole wood-masoni	0	0	0	11.76	0	0	0
	Pheidologeton affinis	18.18	100	3.221	0	0	0	0
	Pheidologeton diversus	18.18	0	25.80	17.64	10	50	50
	Recurvidris recurvispinosa	0	0	0	5.88	0	0	0
	Solenopsis geminata	0	0	0	0	10	0	0
	Tetramorium sp 1	9.09	0	25.80	35.29	20	37.5	0
	Tetramorium sp 2	0	0	9.67	29.41	10	0	0
	Tetramorium sp 3	9.09	0	3.22	0	0	0	0
	Tetramorium sp 4	0	0	0	11.76	0	37.5	0
	Tetramorium sp 5	0	0	0	0	0	12.5	0
	Tetramorium walshi	9.09	0	3.22	11.76	0	0	0
Pseudomyrmicinae	*Tetraponera aitkeni*	9.09	0	3.22	0	10	12.5	0
	Tetraponera nigra	0	0	0	17.64	20	12.5	0
	Tetraponera rufonigra	18.18	0	12.90	5.88	10	25	0

Table 3
Ant composition (genera level) along the Radians

Genera/Radians	E	S	N	W
Acantholepis	+	+	+	+
Anoplolepis	+	+	+	
Aphaenogaster	+	+		+
Bothriomyrmex				+
Camponotus	+	+	+	+
Cardiocondyla		+	+	+
Cataulacus	+	+		+
Crematogaster	+	+	+	+
Diacamma	+	+	+	+
Dolichoderus	+	+	+	
Harpegnathos	+	+		+
Holcomyrmex				+
Leptogenys	+	+	+	+
Lophomyrmex	+	+	+	+
Meranoplus		+		+
Monomorium	+	+	+	+
Myrmicaria	+			+
Oecophylla	+	+	+	+
Pachycondyla	+	+	+	+
Paratrechina	+	+		+
Pheidole	+	+	+	+
Pheidolegeton	+	+	+	+
Polyrhachis	+	+	+	+
Prenolepis	+			
Recurvidris	+			
Solenopsis				+
Tapinoma		+		+
Technomyrmex	+	+		
Tetramorium	+	+		+
Tetraponera	+	+	+	+

Table 4

North Radian

Genera/Distance from the reservoir (kms)	0 1	4 2
Acantholepis	+	
Anoplolepis	+	
Aphaenogaster		
Bothriomyrmex		
Camponotus	+	+
Cardiocondyla	+	
Cataulacus		
Crematogaster	+	+
Diacamma	+	+
Dolichoderus	+	
Harpegnathos		
Holcomyrmex		
Leptogenys	+	
Lophomyrmex	+	
Meranoplus		
Monomorium	+	+
Myrmicaria		
Oecophylla	+	
Pachycondyla		+
Paratrechina		
Pheidole	+	+
Pheidolegeton	+	
Polyrhachis	+	
Prenolepis		
Recurvidris		
Solenopsis		
Tapinoma		
Technomyrmex		
Tetramorium		
Tetraponera		+

Table 5
East Radian

Genera/Distance from the reservoir (kms)	0 1	4 2	8 3	12 4	16 5	20 6	24 7	
Acantholepis		+						+
Anoplolepis					+		+	+
Aphaenogaster	+	+	+	+		+		+
Bothriomyrmex								
Camponotus	+	+	+	+	+	+	+	+
Cardiocondyla								
Cataulacus		+	+					+
Crematogaster	+	+	+	+	+	+	+	+
Diacamma		+			+	+	+	+
Dolichoderus		+		+				+
Harpegnathos	+							+
Holcomyrmex								
Leptogenys	+		+	+		+	+	+
Lophomyrmex			+					+
Meranoplus								
Monomorium	+	+	+	+	+	+	+	+
Myrmicaria	+		+	+	+	+		+
Oecophylla	+		+					+
Pachycondyla		+		+	+			+
Paratrechina	+	+	+	+	+	+		+
Pheidole	+	+	+	+	+		+	+
Pheidolegeton				+		+		+
Polyrhachis		+		+	+			+
Prenolepis	+	+	+			+		+
Recurvidris							+	+
Solenopsis								
Tapinoma								
Technomyrmex	+		+					+
Tetramorium	+	+	+	+	+	+	+	+
Tetraponera		+	+	+		+	+	

Table 6
South Radian

Genera/distance from the reservoir (kms)	0	4	8	12	16	20	24	28	32
Acantholepis	+					+		+	
Anoplolepis	+	+							
Aphaenogaster						+			
Bothriomyrmex									
Camponotus	+	+	+			+	+	+	+
Cardiocondyla			+			+		+	+
Cataulacus	+								
Crematogaster	+		+	+	+	+	+	+	
Diacamma		+	+	+		+	+		
Dolichoderus		+	+				+		
Harpegnathos						+	+		
Holcomyrmex									
Leptogenys	+		+		+	+	+		
Lophomyrmex						+	+	+	+
Meranoplus						+			
Monomorium	+	+					+	+	+
Myrmicaria									
Oecophylla	+		+	+	+		+	+	
Pachycondyla	+	+	+		+	+	+	+	+
Paratrechina		+	+					+	
Pheidole	+	+	+	+	+	+	+	+	+
Pheidolegeton		+	+	+	+		+	+	
Polyrhachis	+			+	+	+	+		
Prenolepis									
Recurvidris									
Solenopsis									
Tapinoma				+					
Technomyrmex						+		+	
Tetramorium		+	+						
Tetraponera	+			+			+		

Table 7

West radian

Genera/Distance from the reservoir (kms)	0	4	8	12	16	20	24	28
Acantholepis			+					
Anoplolepis								
Aphaenogaster		+		+		+	+	
Bothriomyrmex						+		
Camponotus	+	+	+	+	+	+	+	+
Cardiocondyla			+			+		
Cataulacus						+		
Crematogaster	+	+	+	+	+	+	+	+
Diacamma	+	+	+	+	+	+	+	
Dolichoderus								
Harpegnathos						+		
Holcomyrmex		+						
Leptogenys						+	+	
Lophomyrmex	+	+	+				+	
Meranoplus	+	+		+			+	
Monomorium	+	+	+	+	+	+	+	+
Myrmicaria	+			+	+	+		+
Oecophylla			+			+	+	+
Pachycondyla		+				+	+	+
Paratrechina	+	+	+			+		
Pheidole	+	+	+	+	+	+	+	+
Pheidolegeton	+					+	+	+
Polyrhachis					+	+	+	+
Prenolepis								
Recurvidris								
Solenopsis		+						
Tapinoma							+	
Technomyrmex								
Tetramorium	+		+	+	+		+	
Tetraponera	+			+		+	+	

Figure 1a

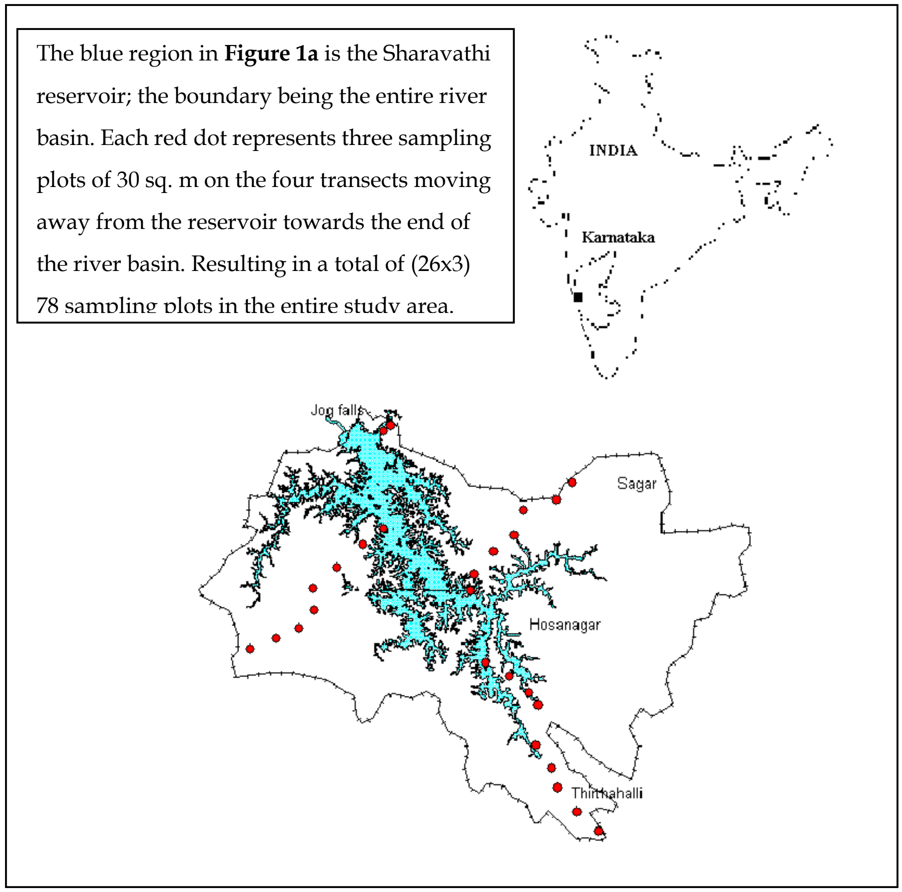


Figure 1b

Normalized Difference Vegetative Index

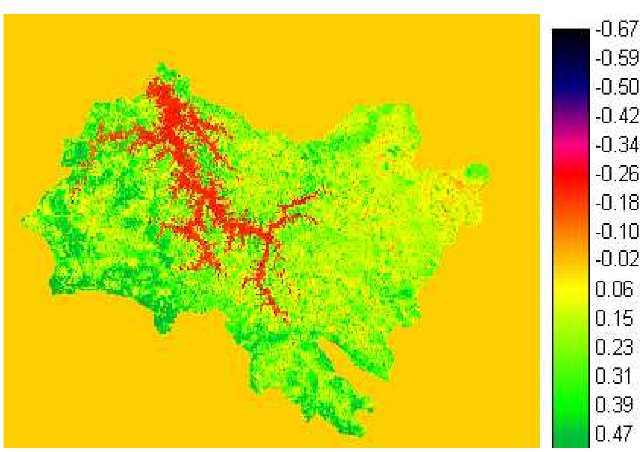


Figure 1c

Supervised Classification

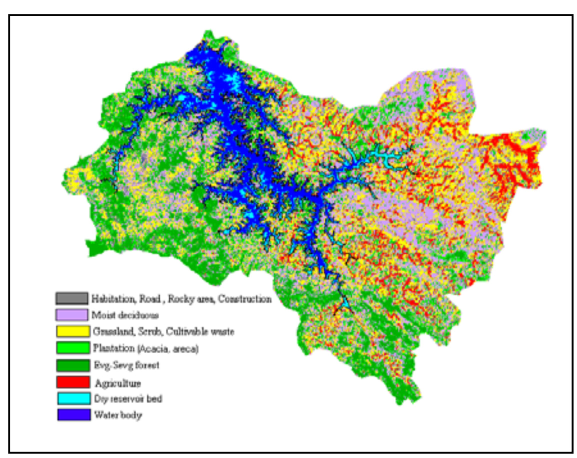


Figure 2

Jaccards index represented as a dendrogram, plotting the presence/ absence of species across different habitats to determine the similarity between habitats.

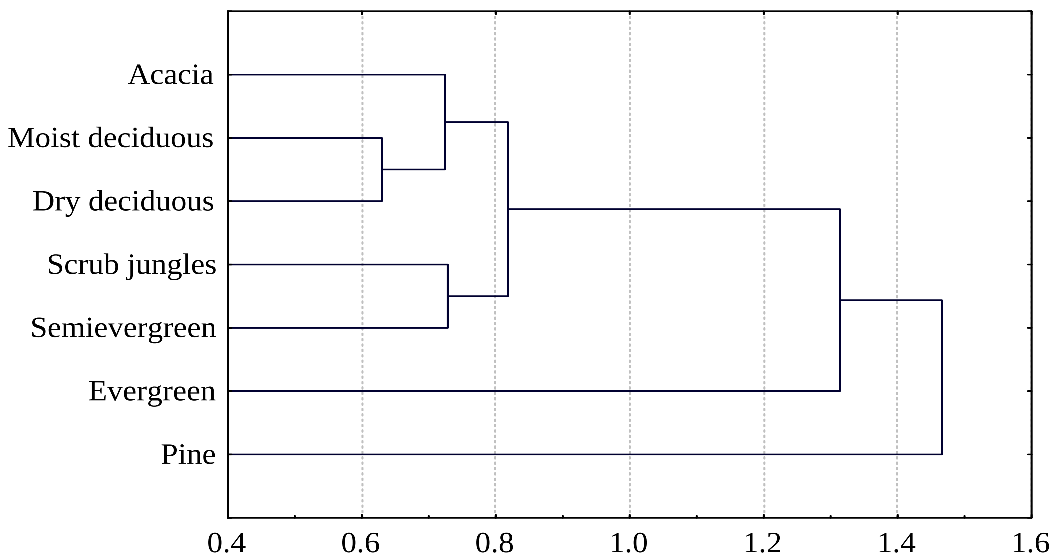


Figure 3

Abundance per plot in the entire river basin is shown. Only the first 40 species are shown to accommodate species belonging to all the subfamilies.

Figure 4 represents species richness in each subfamily across different habitats. The nullified patterns of richness in the other subfamilies is much better understood in Figure 5, wherein across the habitats the species in each subfamily are represented as a percentage of the species acquired to the total species in each of the subfamilies.

Figure 4

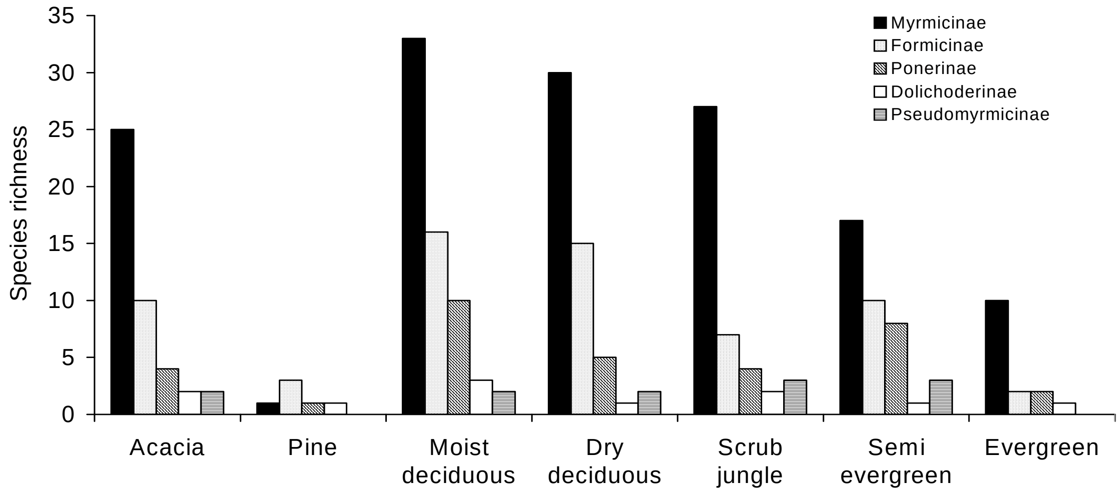


Figure 5

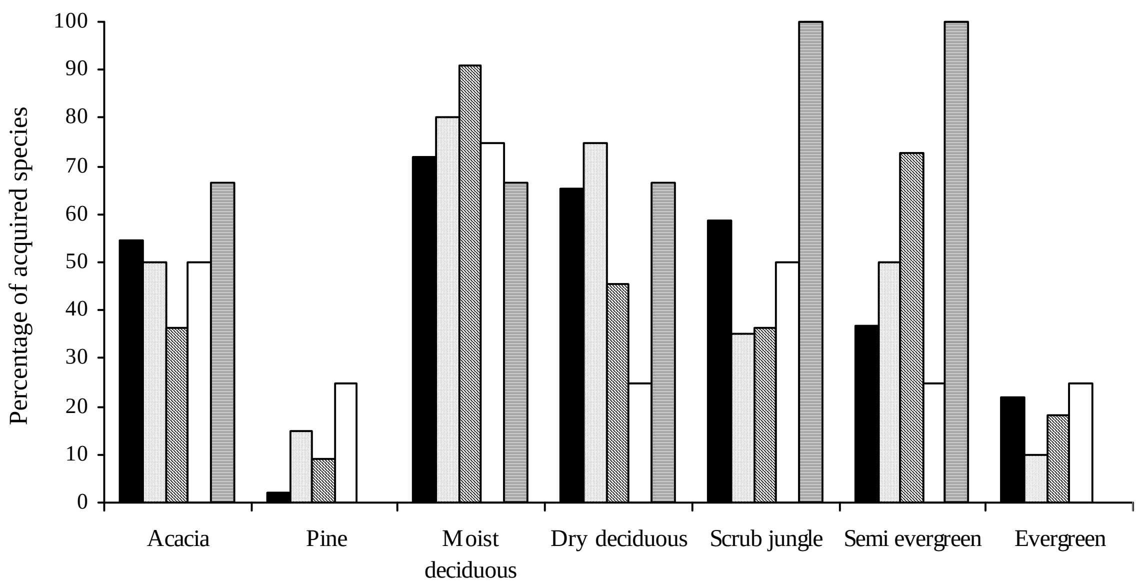
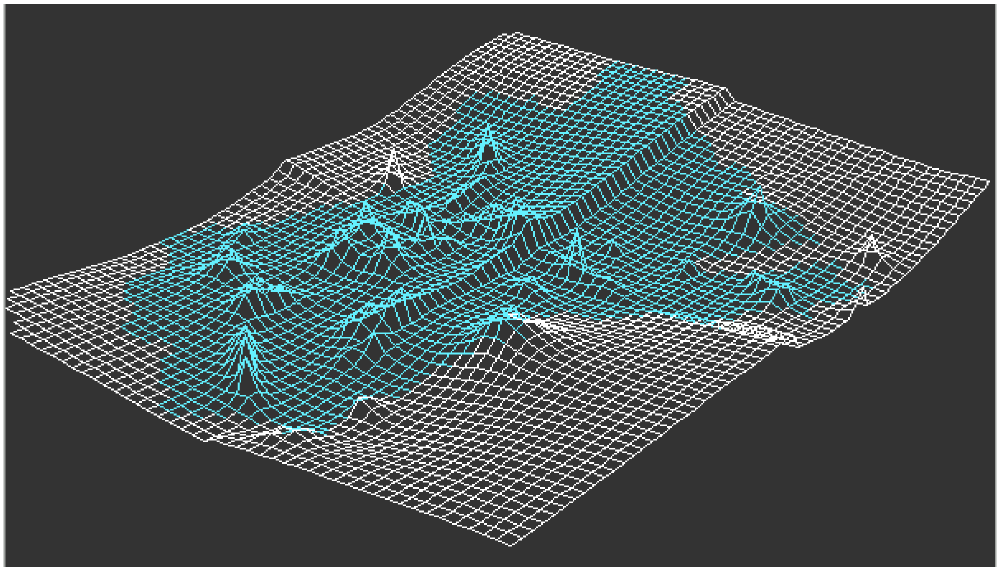


Figure 6

Ant species richness at the Sharavathi River basin

(generated using GRASS)



Aphaenogaster beccari

Anoplolepis longipes

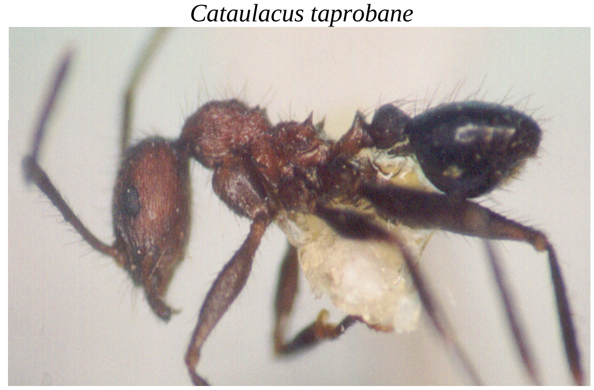
Pheidole parva (major worker).

Camponotus paria

Front view of *Pheidole sp*. Major worker

Cataulacus taprobane

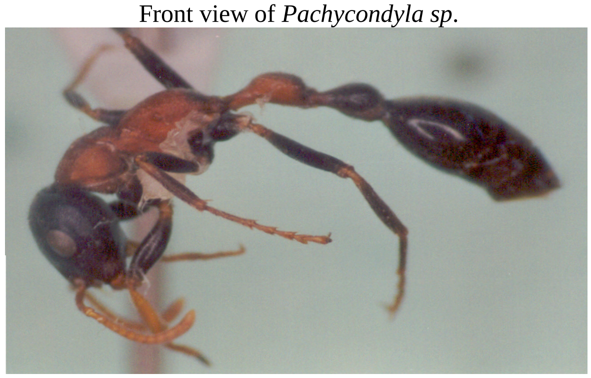
Pheidole parva (minor worker)



Crematogaster sp.

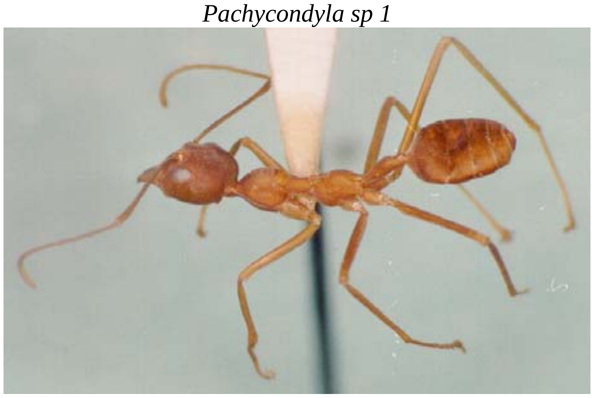
Pachycondyla rufopis

Front view of *Pachycondyla sp*.



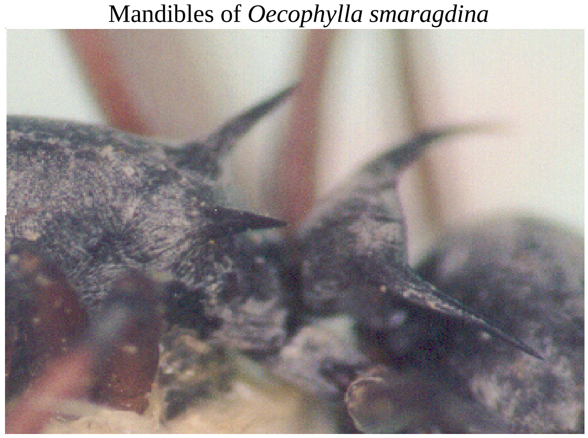
Pachycondyla sp 1

Tetraponera rufonigra



Oecophylla smaragdina.

Mandibles of *Oecophylla smaragdina*



Polyrhachis mayri

Spines on the thorax of *Polyrhachis mayri*

SOME OF THE ANTS AT SHARAVATHI CATCHMENT AREA – SHIMOGA

Diacamma rugosm.

Petiole of *Diacamma rugosm*

Harpegnathos saltator.

Mandibles of *Harpegnathos saltator*

Myrmicaria brunnea at the morning dew

H.saltator with a wolf spider