Research Article

Asia Pac. j. energy environ.

STUDIES ON ANT-PLANT INTERACTION IN A TROPICAL MANGROVES: IN PARTICULAR *RHIZOPHORA MUCRONATA* AND *AVICENNIA MARINA FROM* PONDICHERRY REGION, SOUTH INDIA

Hanuman Gawas[1], A. Yogamoorthi[2*]

[1]PG Student, Department of Ecology & Environmental Sciences, Pondicherry University Pondicherry, Pondicherry, **INDIA**
[2]Associate Professor, Department of Ecology & Environmental Sciences, Pondicherry University Pondicherry, Pondicherry, **INDIA**

*Email for Correspondence: ultrayoga1@gmail.com

Abstract

A short term field study was undertaken to understand ant-plant interaction in Rhizophora mucronata and Avicennia marina of Pondicherry mangroves. Our study revealed that both tree species Rhizophora mucronata and Avicennia marina of Pondicherry mangroves harbor rich and abundant ant fauna. A total of 10 species were recorded belonging to subfamilies Formicinae, Myrmicinae, Dolichoderinae and Pseudomyrmecinae during one season i.e. post monsoon. The abundance of ants was high in Avicennia marina with 9 species of ants and in compared with Rhizophora mucronata with only 7 species. Ants which were only found in Avicennia marina are Oecophylla smaragdina, Polyrchachis simplex, Camponotus sp. The foods for these ants are available as insects' eggs, scale insects and carcasses of herbivorous insects. The nesting behavior of these ants is also documented. The mutualistic ant-mangrove plants interaction is quite obvious from the field observations and is recorded with relevant photographs from the study area.

Key words

Ant, plant interaction, Rhizophora mucronata, Avicennia marina, scale insects-ants-cocoons

1/21/2016 **Source of Support:** None, **No Conflict of Interest:** Declared

INTRODUCTION

Ants are an ecologically important group of insects in tropical forest due to their high abundance and important ecological functions they perform as ecosystem engineers (Hölldobler and Wilson 1990). As in other arboreal ant communities, ant mosaic was also reported in tropical mangroves (Adams 1994). Starting with the first published study on ant -mangrove plant interactions by Johnstone (1985) from the Papuan coast, studies are also taken up in this line of rearch by De Baar & Hockey (1993) and revealed ants as the most abundant and influential group of insects in the communities. The presence of ants stimulates the production of honeydew from tended insects (Hill 1980). Ant attendance increased honeydew excretion by *Aphis craccivora* more than fivefold and altered the posture of the aphid larvae . On Aldabra Atoll,; ants reduce the numbers of a dispid scale predator, *Chiocorus nigritus*, providing protection for the Icerya scale (Hill 1980). Ozaki et al. (2000) provided compelling evidence of the reduction of a scale pest population (*Aulacaspis marina* Takagi and Williams o*n R. mucronata* by the ants C*onomorium floricola* (Jerdon) and *Paratrechina* sp. in a mangrove in Bali. Offenberg et al. (2004) also found a significant reduction in the herbivore community due to presence of ant (*Oecophylla smaragdina* Fab .) in young *R. mucronata* trees compared to control trees without ants in a Thai mangrove. Stout(1979) discovered homoptera living in association with *Myrmelachisia* ants inside hollowed-out stems of lauraceous understory trees in Costa Rica and after observing the swift removal of insect eggs placed on young stems and leaves by the ants, hypothesized that the benefits to the plant in protection from herbivory by the ants outweigh the losses incurred by mealy-bug feeding. Resident ants in myrmecophytic Macaranga in Southeast Asia tend scale insects inside the stems, and aid their host plants by removing young herbivores. In addition, they also cleared them of other pioneer plant species by biting off foreign plant parts that come in contact with host trees (Fiala, 1994). The common damages encountered in mangrove leaves are holes, galls

and miner attack in *Avicennia* spp., necrotic spots in *Rhizophora* spp. Veenakumari et al (1997) listed 197 species of herbivores on the Andaman and Nicobar Islands; some of the insect herbivores are serious crop pests that simply use mangroves as alternative hosts. The scale insect that often attacks seedlings of *Rhizophora mucronata* Poir was identified as *Aspidiotus destructor* (Hemiptera, Diaspidiae). The scale insect affects leaves first and shows yellow discolorations around areas of the sucking activity followed by brown necrosis (Kathiresan , 2001). Insects inflict an extensive damage to mangrove leaves, and in extreme cases evenkill the mangrove trees. Very little information on this aspect is available for Indian mangroves in India (Kathiresan ,1992; Veenakumari et al, 1997) and hence presently an attempt has been taken to study ant-plant interaction with reference to two major species viz. *Rhizophora mucronata and Avicennia marina*, profusely growing in a tropical mangrove forest in the Pondicherry region.

MATERIALS AND METHODS

Description of study area-Pondicherry mangroves

The Pondicherry mangrove lies within the boundaries of latitude 11°46'03" to 11° 53'40"

North and longitude 79° 49'45" to 79°48'00" East. Mangrove exists as fringing vegetation over 168ha distributed along the sides of Ariankuppam estuary, it is seasonally bar-built and semi diurnal type that flows eastwards emptying in to the Bay of Bengal at Veerampatinam on south east coast of India. Seven true mangrove floral species belonging to 3 families were recorded by Saravanan et al (2008). *Avicennia marina*, is the extensively growing true mangrove distributed throughout the inundated area- very dense stand to the western and northern side of Thengaithittu, near the bridge and also at the small creek. Another prominent cover of A.marina is on the eastern part of Ashram islet at the creek and on the western part of Murungapakkam. Densely Bruguiera cylindrica spreads from the western end of Murungapakkam up to the eastern end of Ashram islet. Sixteen mangrove associate floral species belonging to 12 families are recorded with Clerodendrum inerme found in all the sites. *Calophyllum inophyllum, Pongamia pinnata, Thespesia populnea and Aleuropus logopoides* are present in all the inundated areas. (Saravanan et al, 2008). The tidal amplitude averages 20-70 cm and differs according to the lunar period, reaching its maximum during northeast monsoon. The climate is characterized by 65-75% relative humidityand 28ºC-30ºC temperatures. The annual rainfall is 1200 mm. The study was conducted from January to March 2015 in Pondicherry mangroves.

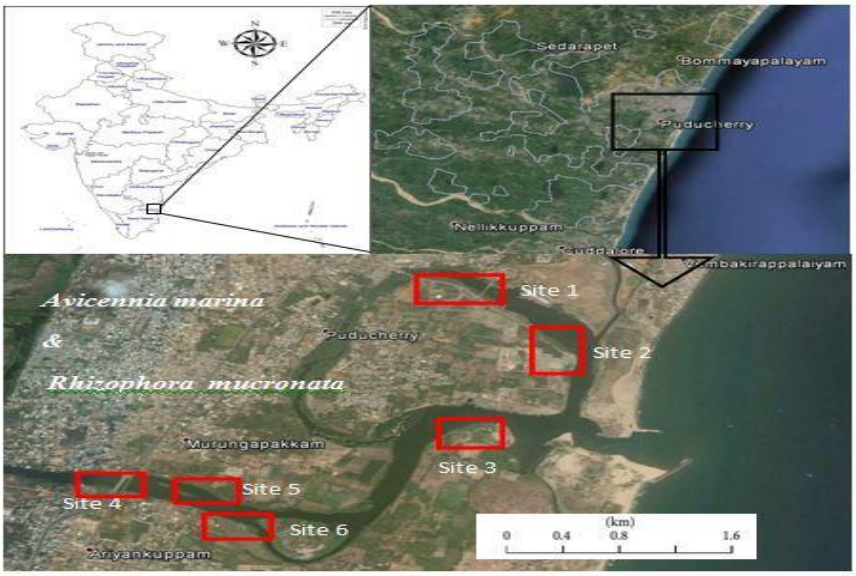


Fig 1: Study sites with thick batches of *Avicennia marina* and *Rhizophora mucronata*

Field surveys were conducted to examine the ways in which interaction exists between ants and particular mangrove plants viz. *Avicennia marina* and *Rhizophora mucronata.* Totally six study sited were selected across the habitat which were marked by getting the coordinates using Trimble Juno 3B handheld GPS device during initial sampling.. On each site 3 plants for each species were brought under observation. Observations were done during day time –low tide period consecutively on every 7th day for period of Three months (Jan – March 2015). Ants attending parts like roots, trunk, branch, flowers, buds, insects with particular focus on ants were thoroughly inspected and recorded for duration of one hour on each sampling site.. We also checked whether the selected trees with myrmecophytes encountered searching for domatium-like structures containing holes, crevices, broken branches and other type of

nests that ants could populate. If nest was found it was checked to find feeding preference of ants by detecting carcass of arthropods and other insects nesting in them. An *All out search* (hand collection) *method* was applied to search ants using a pair of forceps , an aspirator , small screw caped bottles to collect all ants as done by Kusnezov (1943)and collected ants were brought to laboratory preserved in 70% alcohol and labeled accordingly. Identification of ants into different was done with the help of taxonomic keys provided by Bhingham in Fauna of British India series (1903) ,Bolton in Identification Guide to the Ant Genera of the World (1994), by Holldobler and Wilson in Ants (1990). Dual Mag. Stereo Microscope with built in camera available in the Department was utilized for identification of ants collected from the field.

RESULTS

A total of ten species were recorded belonging to subfamilies Formicinae, Myrmicinae, Dolichoderinae and Pseudomyrmecinae during one season i.e. post monsoon. Comparing ants of both mangroves the diversity of Ants in *Avicennia marina* was high compared to *Rhizophora mucronata.* Three species namely, *Crematogaster* sp., *Pheidologeton* sp. and *Prenolepis* sp. were found to be abundant foragers in *R. mucronata* and least forages includes *Camponotus* sp and *Tapinoma melanocephalum*. The abundance of ants was high in *Avicennia marina* with 9 species of ants and in compared with *Rhizophoramucronata* only 7 species. Ants which were only found in *Avicennia marina* are *Oecophylla smaragdina, Polyrchachis simplex, Camponotus* sp.1. and in *Rhizophoramucronata* the genus *Monomorium pharaoins* is only ant found foraging on twigs (Fig.2 & 3). One more interesting aspect observed is that ant developing scale insects that are present in small temporary so called nest formed by adhering two leaves of *Avicennia marina* such nest are presumed to be constructed by the larva of lepidopteron(Fig.4&6-7) . The caterpillar secrete a pasty substance which stitches the leaves present on a single node in which the larva grows and emerges out as an adult. The nests made by these larvae are used by the scale insects to cuddle as they grow up there (Fig.7). *Crematogaster subnuda* nests on the hollow and broken cavities of these mangrove plants . Many individuals could be sighted living within a small broken cavum (Fig.4 & 5*)*. Ant species like *Polyrchachis simplex*, *Tapinoma melanocephalum* and *Phidologiton affinis* were most abundant in *Avicennia marina* and actively forages on leaves and insects. Some of the least abundant ants include *Prenolepis longicornis* , *Camponotus* sp. We found nest and foraging individuals of *Tapinoma melanocephalum* (Fig. 6).The nest was crafted carton type on dry branches of *A. marina* at the height of 0.5m from ground more than 50 individuals were sighted within the nest. Figures 7 & 8 show how the pasty secretion of the larvae helps to form temporary nest/dormatium to rear the young ones from eggs to crawlers and Fig.9 shows the eggs laid on the upper leaf lamina presumably by the herbivory insects as food for the ants.

Fig. 2: Pheidologeton affinis feeding on Scale insects

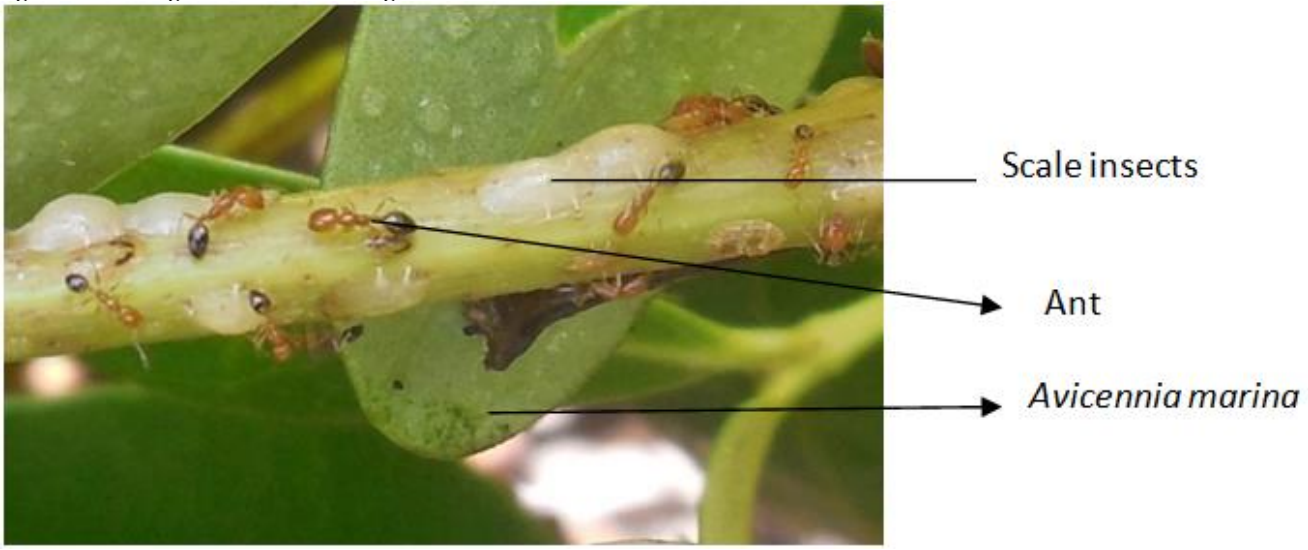


Fig. 3: Scale Insect tended by *Polyrchachis simplex*

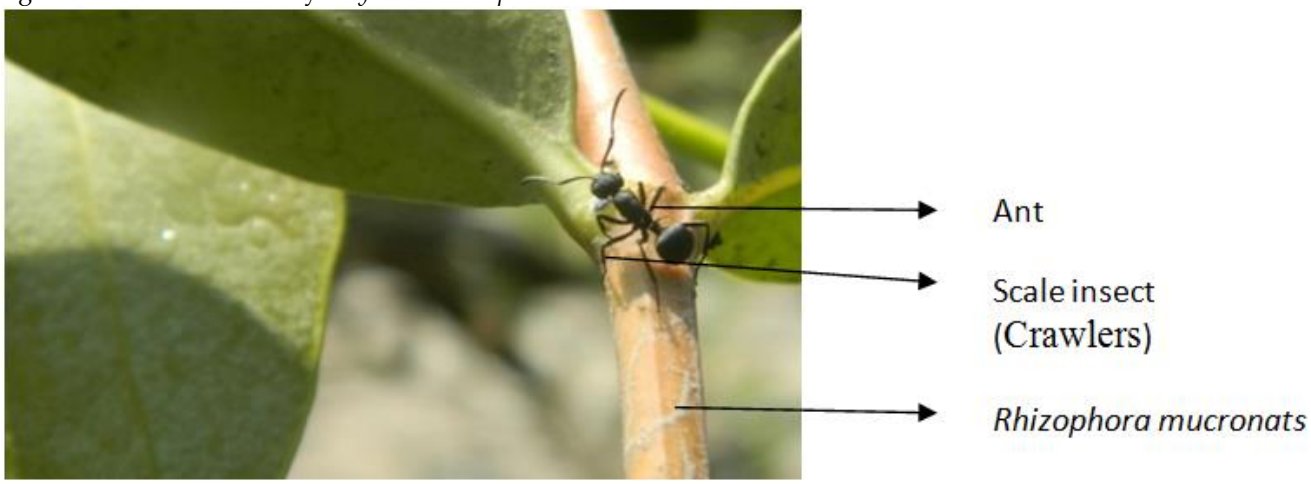


Fig. 4: Avicennia leaves twitched together

Fig. 5: *Polyrchachis simplex* nesting in *Avicennia marina*

Fig. 6: C. Subnuda nesting in Avicennia marina

Fig. 7: Folded leaves made as domatia of scale insects

Fig.8: View inside folded leaves

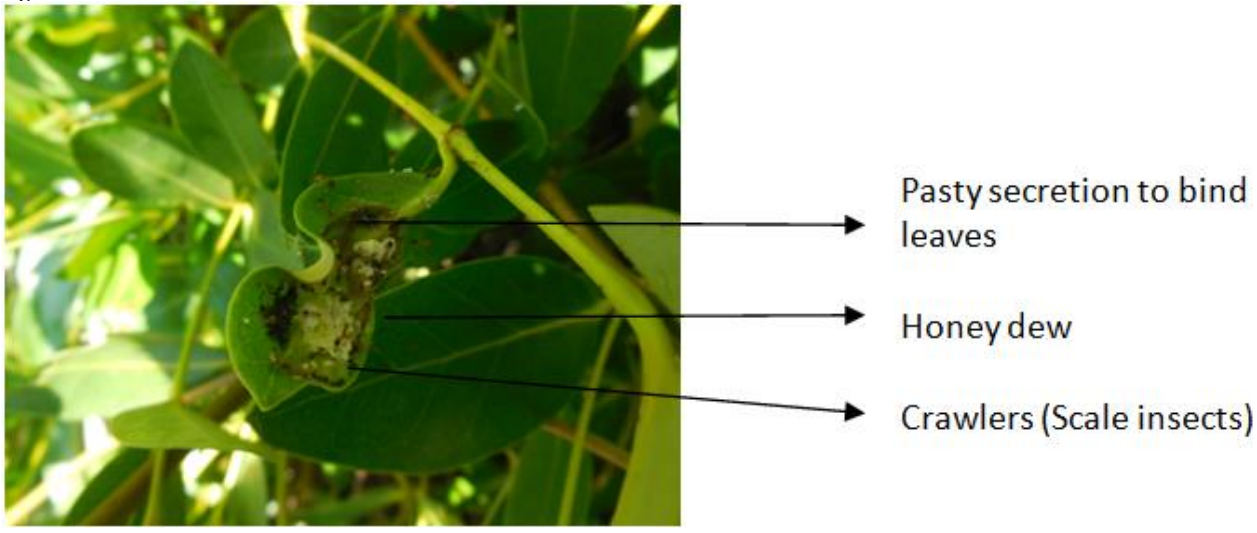
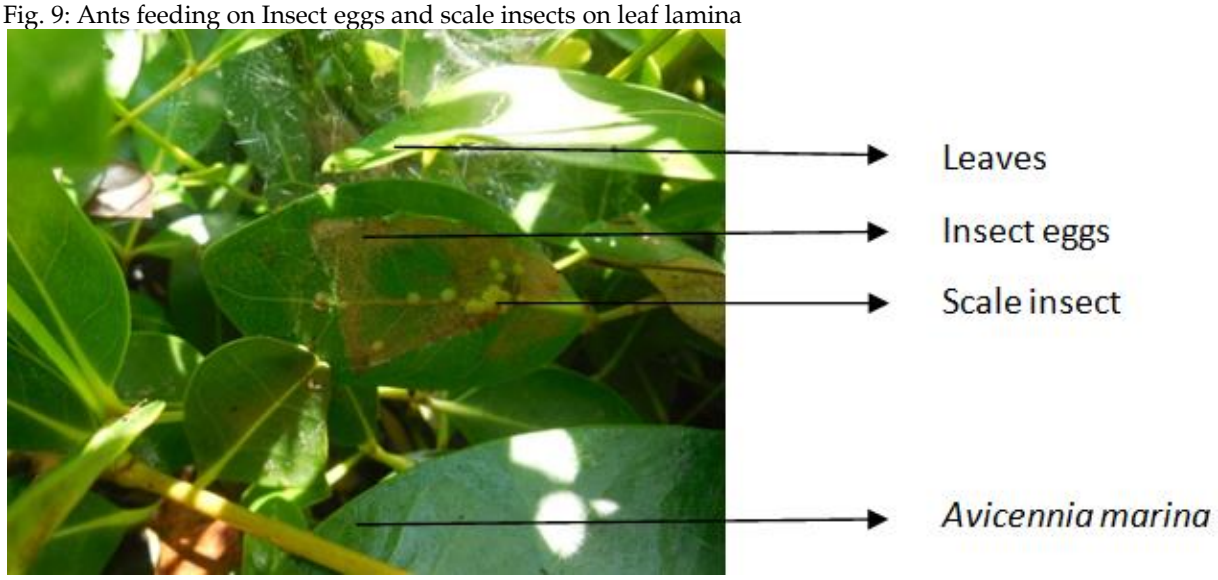


Fig. 9: Ants feeding on Insect eggs and scale insects on leaf lamina



DISCUSSION

In many ant- plant interactions ants protect their plant partners against natural enemies like herbivores, since ants prey on insects, they reduce the number of herbivorous insect on the plant where they forage (Beattie, 1985). It is also widely reported that ant- plant protective mutualism ants serve as biological control against a variety of forest systems (Way and Kahoo, 1992). Among insects ants are considered important indicators in biodiversity evaluation and monitoring because of their numerical dominance (Folgarait,1998; Underwood & Fisher 2006). Little has been published on other mangrove dwelling insects and most general information about the ant fauna of mangroves derives from broader investigations and surveys (Ellway 1974; De Baar, 1994). Our study suggests that both tree species *Rhizophora mucronata* and *Avicennia marina* of Pondicherry mangroves harbor rich and abundant ant fauna. A total of 10 species were recorded belonging to subfamilies Formicinae, Myrmicinae, Dolichoderinae and Pseudomyrmecinae during one season i.e. post monsoon. The abundance of ants was high in *Avicennia marina* with 9 species of ants and in compared with *Rhizophora mucronata* only 7 species. Ants which were only found in *Avicennia marina* are *Oecophylla smaragdina, Polyrchachis simplex, Camponotus* sp.1. and in *Rhizophora mucronata ,Monomorium pharaonis* is only ant found foraging on twigs Comparing ants of both mangrove plants, the diversity of Ants in *Avicennia marina* was higher compared to *Rhizophora mucaranata* . *Prenolepis* sp. were found to be the abundant foragers in *R. mucronata* and least forages includes *Camponotus* sp and *Tapinoma melanocephalum*. The Observed records were compared with the reports from mangroves of Heymadi kodi,Sandpit mangroves, Karnataka (Pradeep & Vijay, 2013) , Dakshina Kannada west coast of Karnataka (Pradeep & Vijay, 2014) and in Darwin harbor, Australia (Clay and Anderson 1996), it could be stated that Pondicherry mangroves is seemed to supporting almost same level of ant fauna diversity during a short time survey. These reports are based on one year observation whereas in the present study 10 species are recorded in three- months observation; annual survey covering different seasons, would bring out little more species from Pondicherry mangroves. On arriving at the benefits of the presence of such ants in the mangrove plants, Ozaki et al. (2000) provided a strong evidence of the reduction of a scale pest population by the ants *Monomorium floricola* (Jerdon) and *Paratrechina sp*. in a mangrove in Bali. on *R. mucronata* . Offenberg et al. (2005) also found out from his experimental studies a significant reduction in the herbivore community on ant (*Oecophylla smaragdina* Fabr.) visited young tress of *R. mucronata* in a Thai mangroves.

The movement of ants in *Avicennia marina* was from stem to leaves and leaves of one tree to neighboring tree searching for food viz. honey dew .As reported by Ammar (1985) and Carver et al (1991)honeydews are produced by insects like hemipterans which feed on plant sap and digest it through a complex digestive system works in such a way that the surplus water, sugars and other elements in the gut is eliminated speedily through the hind gut as droplets;(In family Diaspididae, most of the Sternorrhyncha and Auchenorrhyncha emit, through the anus), these droplets of excreta is known as honeydew on which ants feed on (Fig.3).

One more interesting aspect observed is quite obvious from Fig.4 that ant developing scale insects that are present in small temporary nest formed by adhering two leaves of *Avicennia marina* (which are presumed to be constructed by the larva of lepidopteron).This is possible because of the softness of the young leaves and least tannin content of *Avicennia marina when compared to R.mucronata.* According to Ben-Dov et al. (2001) the lepidopteron caterpillar secretes a pasty substance which stitches the leaves present on a single node in which the larva grows and emerges

out as an adult. The nests made by these larvae are used by the scale insects to cuddle as they grow up there. Eggs are either laid in a cavity under the female body or in a waxy cover attached to the body. The scales that are newly born or hatched are known as crawlers. Adult females of armored and soft scales are sessile, legless, wingless, and do not have a clear head and body region (Fig.2 and 3). At this stage the ants enter their domicile and crops out cocoon and feeds on it. From the present observation, it is presumed that ant feed on cocoon and thereby destroys the developing scale insects indirectly protecting the plant from scale insects. Evidence of reduction in scale insect population by ants *Monomorium* sp. and *Paratrechin*a sp. on *Rhizophora mucronata* was found by Ozaki et al(2000) and Johnstone (1985). Offenberg (2005) found similar observations by ants *Oecophylla smaragdina* . It is hypothesized that the scale insects during metamorphosis secrets a sticky waxy substance covering itself and grows into a pupae at latter stage called as cocoon (Fig.7&8).. Fig.8 shows the eggs laid on the upper leaf lamina on which presumably by the herbivory insects-a food for the ants and thus leaves are used as rearing zone from which herbivory would come out and destroy the leaves. But ants living in the tree would eat away those eggs and thereby reduce the rate of recruitment of the herbivory population in that plant. Such an ant-plant interaction could also be cited for excellent example of mutualism between two extremely different category of living things.

Many ants build a protective shelter, or a tent, made of plant debris, over their aggregations on plant favorable sap sucking sites. These shelters protect their trophobionts against parasites or predators, and from the rain incidence. (Way, 1963; Delabie 1990;Dejean et al.1996). *Crematogaster* sp. was the major foragers of foliage and branches and the other genus of *Pheidologeton* sp. were abundant forages on young branches. *Crematogaster subnuda* nests on the hollow and broken cavities of these mangrove plants (Fig.5). Many individuals can be sighted living within a small broken cavum we found a maximum of 46 individuals residing in the cavity of *Avicennia marina* . On *Avicennia marina* ant species like *Tapinoma melanocephalum Polyrchachis simplex*,and *Pheidologeton affinis* were most abundant and actively forages on leaves and insects. The least abundant ants include *Prenolepis longic ornis, Camponotus* sp.

CONCLUSION

The ants of genus *Tapinoma* crafted carton type on dry branches of *A. marina* at the height (Fig.6) of 0.5m from ground more than 50 individuals were sighted within the nest. Nielson (2000) who hypothesized that *Tapinoma* sp. ants forage outside the nest as no coccids are found in it and was also found to be true in our study. *Polyrchachis* species of ants that are known as Black weaver ants were found to be nesting at the base of *A. marina*(Fig.8). We found *Pheidologeton affinis* tending aphides and scale insect on trees of *Avicennia marina* .Saunders(1967) sighted theses ants tending aphides on the roots of the plants and that arthropod fragments are often found in the upper portions of their nests. Ozaki et al. (2000) have shown a considerable positive effect on plant survival if it had addressed this issue by prolonging the study period. Saplings in plantations with no ants experienced scale insect infestation levels (>200 females/ leaf) resulting in the death of seedlings within 5 months resulting about 70% mortality, whereas nearby natural mangroves with ants had almost no scale insects. Thus, present short term survey revealed that ant-plant interaction in mangroves are quite obvious and also interesting to know about temporary shelters/breeding chamber by scale insects and the non-stop of exploration of ants in search of honeydew and their nesting behavior which is primarily attract ecologists in general; functional ecologists in particular. Further studies on seasonal variation in ant community linked with herbivorey population and nesting behavior of different ant communities, would add more to the annals of ant-plant interactions in tropical mangrove forest.

REFERENCE

Adams E. S. (1994) Territory defense by the ant *Azteca trigona*: maintenance of an Arboreal ant mosaic. Oecologia 97, 203–8.

Ammar, E.-D, (1985) Internal morphology of leaf hoppers and plant hoppers,In L.R. Nault & J.G. Rodriguez,

Beattie AJ, (1985) The Evolutionary Ecology of Ant plant Mutualisms. Cambridge University Press, Cambridge, 182.

Ben-Dov, Y., Miller, D.R. & Gibson, G.A.P. (2001) ScaleNet, Query, Scales in a Genus, *Icerya*. ScaleNet, Life Histories, 309: 49–66.

Bingham, C.T. Hymenoptera,(1903) The fauna of British India, including Ceylon and Burma. 2, 649-698

Bolton, B. MA (1994), Identification Guide to the Ant Genera of the World. Harvard University Press.232.

Carver, M., G.F. Gross & T.E. Woodward.(1991) Hemiptera, CSIRO, The insects of Australia. Cornell University Press, 1991, 542, 429-515.

Clay, R.E. and Andersen, A.N.(1996) Ant fauna of a mangrove community in the Australian seasonal tropics, with particular reference to zonation. Australian journal of Zoology, 44:521-533

De Baar M.(1994) New records, food plants and life-history notes for lycaenids(Lepidoptera) and formicids (Hymenoptera) News Bulletin ,Entomological Society of Queensland , [Abstract]., 1994,22, 50–52.

Dejean A. & Gibernau M. (2000), A rainforest ant mosaic: the edge effect (Hymenoptera: Formicidae), Sociobiology, 35, 385–401.

Delabie, J.H.C., Paim, V.R.L.D.M., Nascimento, I.C.D., Campiolo, S. and Mariano. E.C.D.S.F.(2006) Ants as biological indicators of human impact in mangroves of thesoutheastern coast of Bahia, Neotropical, Entomology, 35(5):602-615.

Ellway CP. 1974. An Ecological Study of Corio Bay, Central Queensland. Habitat. Environmental survey prepared for Capricorn Coast Protection Council, Yeppoon. The world's mangroves 1980–2005, FAO Forestry Paper 153,

Fiala B, Grunsky H, Maschwitz U and Linsenmair KE., (1994) Diversity of ant-plantInteractions: protective efficacy in *Macaranga* species with different degrees of ant Association, Oecologia 97: 186-192.

Folgarait, P.J.(1998) Ant biodiversity and its relationship to ecosystem functioning Biodiversity and Conservation: 7: 1221-1244.

Hill, M. G. and Newberry, D. M. C., (1980) The distribution and abundance of the coccid lcerya seycttellarum Westw. on Aldabra atoll, Ecol. Entomol, , 5, 115-119

Hölldobler B and Wilson EO,(1990) The Ants. The Belknap Press of Harvard University Press, Cambridge, Massachusetts, p.732.

Johnstone, I.M., Consumption of leaves by herbivores in mixed mangrove stands., 1985, Biotropica, 13, 252–259.

Kathiresan K., and Bingham B.L., Biology of mangroves and mangrove ecosystem Advances in Marine Biology, 2001, 40: 81-251.

Kusnezov, N. Introduction preliminaries para la caza de las hormigas Miscelaneas Fundacion Miguel Lillo, 61, 1943, 28.

Nielsen, M.G. (2000) Distribution of the ant (Hymenoptera: Formicidae) fauna in the Canopy of the mangrove tree *Sonneratia alba* , Aust. J. Entomol, 39: 275-279.

Offenberg, J., Nielsen, M.G., Macintosh, D.J., Havanon, S., Aksornkoae, S., 2004. Observation on ecology of weaver ant *Oecephalus smaragadina* in a Thai mangrove ecosystem. Biotropica 36 (3)344-351

Ozaki, K., S. Takashima & O. Suko. (2000)Ant predation supresses populations of the Scale insect Aulacaspis marina in natural mangrove forests. 32: 764-768.

Pradeep and vijay (2013) Diversity and distribution of ant fauna in Heyamadi kodi,Sandpit, Karnataka. Halteres, 4 : 33-47

Pradeep and Vijay (2014) Ant fauna of mangroves of Dhakshin Karnataka.J.Entomologival research; 38 (1):59-66

Saravanan et al (2002) Floral and faunal diversity of mangroves of Pondicherry region. Tropical Ecology, 49 (1):91-94

Saunders, G.W.(1998) Funnel ants (Aphaenogaster spp., Formicidae) as pasture pests in North Queensland:I.Ecological background, status and distribution, Bulletin of Entomological Research , 57, 419–432.

Stout, J.(1979) An association of an ant, a mealy bug and an understory tree from a Costa Rican rain Forest, Biotropica 1979, 11(4), 309-311

Underwood EC and Fisher BL (2006), The role of ants in conservation monitoring: if,when, and how, , Biological Conservation: 132: 166-182.

Veenakumari, K., Mohanraj, P.and Bandyopadhyay, A.(1997) Insect herbivores and their natural enemies in the mangals of the Andaman and Nicobar islands, J. Nat.Hist,31, 1105–1126.

Way, M.J. and Khoo, K.C,(1992) Role of ants in pest management. Annu. Rev. Entomol 37: 479-503.

-- 0 --