

Scale insects (Hemiptera: Coccoidea) and Ants (Hymenoptera: Formicidae) Association in Tumkur University Campus, Tumakuru, India

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Abstract: A preliminary study was conducted in Tumkur University campus, Tumakuru to focus on the diversity of ants and scale insects species which have been mutually associated with each other. The study includes the visual observation, photography and identification of associated partners and their host plants. In the study area a total of 18 species of scale insects belong to 5 families were found infesting 20 different host plants and associated with 12 species of ants from 6 genera of 3 subfamilies of Formicidae. The genus *Crematogaster* was found to be more diversified with 7 species and associated with 12 species of scale insects. The scale insect family Coccidae was dominated with 5 genera and 9 species associated with 7 species of ants followed by Pseudococcidae with 5 genera and 6 species associated with 8 ant species. The ecological factors of the study area have attributed to the occurrence of wide variety of scale insects and their association with ant species. The study provides a base line data for future research work on integrated pest management and further its implication to agricultural crops.

Keywords: Scale insects, mutual association, Formicidae, Tumkur University.

I. INTRODUCTION

Trophobiosis is a well-studied phenomenon of association of ants with honeydew-producing Hemiptera (aphids, scale insects, membracids, etc.), or with nectar producing larvae of lycaenid butterflies. It is a kind of mutualistic relationship in which trophobionts provide honeydew, a sugary excreta to numerous ant species as a stable source of energy in turn, they are attended by ants and protected from natural enemies [1], [2], [3]. Hemipteran-tending ants are mostly species of the subfamilies Myrmicinae, Dolichoderinae and Formicinae [2], [4]. The coccoids display obvious behavioural adaptation to living with ants. The degree of dependence of scale insects on ants varies from strong and almost necessary associations to weak, causal seasonal relationships [2], [5]. Benefits of coccoids to ants are that the coccoids serve honeydew a source of proteins, lipids in addition to carbohydrates. Honeydew accounts for more than half of the diet of many temperate wood ants (*Formica* spp.) and it is the dominant food source of some subterranean ants [6]. In some studies, there are observations that the ants feed on scale insects [7], [8]. Benefits of ants to coccoids are the removal of honeydew which provides sanitation of scale insects aggregation by reducing physical fouling caused by both the sugary excreta and the sooty molds that grow on it [2]. Ants protect the scale insect colonies from their natural enemies either by direct attack or incidental disturbance and reduce their mortality from parasitism [9], [10]. Some species of ants are known to transport scale insects to new feeding sites on the same plants or to uninfested plants, thus greatly facilitating the spread of scale insect populations [11], [12].

As the scale insects are polyphagous sap sucking pests of many agricultural crops, the controlling of their populations by the effective establishment of predators has failed by the presence of ants [13], [14]. Excluding ants or controlling ant's population in the field is one such method in scale insect pest management.

The extensive studies have been conducted on pest management of mealy bugs and other scale insects at the world wide level as well as at the subcontinent level^[4], but there is less availability of literature on the association of scale insects and ants and their evolutionary relationship with their host plants. The present study aims to provide a preliminary data on the association of scale insects and ants and their host plants, on which the association is observed, pertaining to Tumkur University campus, Tumakuru.

II. MATERIALS AND METHODS

Study area:

The study was conducted at Tumkur University campus, Tumakuru. It is located in the heart of the Tumkur city. Tumkur University campus has thick vegetation with diverse flora and fauna. The University campus is about 90 acres and infrastructure is about 98,800 sq. ft. Tumkur belongs to the group of districts called the maidan (plains) districts of South Eastern Karnataka, India. Tumkur is situated at a distance of 70 km (43 miles) northwest of Bengaluru, a state capital at 13°20'16" N and 77°7'13" E in the plains of Deccan plateau of peninsular India. The temperature throughout the year varies between average 36°C - 38°C. Annual rain fall between 500mm to 900mm (Tumkur District Gazetteer-2017).

Methods:

The study was conducted in all the vegetative areas of Tumkur University campus, Tumakuru regularly from January 2018 to June 2018. During this period the coccoid's infested plants particularly woody, ornamental and fruit plants were studied from their ground level to aerial level. The survey includes the visual observation by using hand lens, dissection needles and painting brushes. The infested host parts were photographed by using digital camera Olympus of 12 mega pixels. During the survey, a special care was given to collect the samples of the ants attending the colonies of scale insects in separate carry bags with minute perforations. The collected samples with their host leaves/twigs were brought into the laboratory and were examined, identified up to their species level and photographed by using Lawrence and Mayo Stereomicroscopes for further studies. The collected scale insects and ants were identified with the help of experts from National Bureau of Agricultural Insect Resources (NBAIR), Hebbal, Bengaluru, literature survey, Scale Net Database and Ant web, Ant wiki Net sources.

III. RESULTS AND DISCUSSION

A total of 18 species of scale insects belonging to 5 families of the super family Coccoidea were found infesting 20 different host plants and were associated with 12 species of ants belong to 6 genera of 3 sub families of Formicidae. Ants of 3 subfamilies namely the Dolichoderinae, Formicinae and Myrmicinae were found to be in association with different species of scale insects. The observation was in congruence with the findings of Gullan^[2]. Subfamily Dolichoderinae represented by *Tapinoma melanocephalum* was associated with 4 families of scale insects that were noticed from the study area.

Subfamily Formicinae was represented by 3 species of ants *Oecophylla smaragdina*, *Camponatus vagus* and *Lasius niger* and were attending the colonies of all the 5 families of scale insects that noticed during the study period.

Subfamily Myrmicinae was represented by 8 species of ants namely *Crematogaster pilosa*, *C. scutellaris*, *C. melanogaster*, *C. castanea*, *C. transvaalensis*, *C. cerasi*, *C. erecta*, *Solenopsis germinate* were found associated with different species of all the 5 families of scale insects.

From the present study the genus *Crematogaster* was found to be more diversified with 7 species of ants and were associated with 12 species of scale insects belong to Coccidae, Monophlebidae and Pseudococcidae.

In scale insects the family Coccidae was dominated with 5 genera namely *Ceroplastes*, *Coccus*, *Parasaissetia*, *Pulvinaria* and *Saissetia* represented by 9 species and were associated with 7 species of ants belong to three genera *Tapinoma*, *Crematogaster* and *Camponatus*. The second most diversified family was Pseudococcidae with 5 genera namely *Antonina*, *Ferrisia*, *Maconellicoccus*, *Phenacoccus*, and *Planococcus* represented by 6 species and were attended by 8 ant species from 5 genera *Solenopsis*, *Oecophylla*, *Tapinoma*, *Crematogaster* and *Camponatus*. The remaining three families Asterolecaniidae, Monophlebidae and Ortheziidae were represented by single genus with one species each.

From the study area 7 different species of *Crematogaster* were found attending various species of scale insects from Coccidae, Monophlebidae apart from Pseudococcidae on different host plants as shown in the Table 1. This was in partial acceptance with the earlier findings where the *Crematogaster* spp. and *Oecophylla smaragdina* were found to be common

ant species which were attending the mealy bugs in India ^{[15], [16]}. This shows that the *Crematogaster* spp. not only attends mealy bugs but they attend scale insect species from other families too.

Some of the findings from different parts of the world have shown that the soft scale *Coccus hesperidum* on various host plants was attended by ant species like *Anoplolepis custodiens* (F. Smith), *Linepithema humile* (Mayr), *O. smaragdina*, *Camponatus aethiops* (Latreille) ^{[2], [17]}. Our observations were slightly deviate from the earlier results that *C. hesperidum* on different plants were found associated with *Crematogaster pilosa*, *C. scutellaris*, *Tapinoma melanocephalum* and the ant species *O. smaragdina* was attending *Icerya aegyptiaca* of Monophlebidae.

Armoured scale insects *Aspidiotus destructor*, *Aspidiotus nerii*, *Chrysomphalus aonidium*, *Diaspis boisduvalii*, *Pinnaspis aspidistrae* noticed from the study area were not attended by any of the ant species. Our data substantiate the earlier findings of ^{[18], [19], [20]}. The Diaspididae are one of a few families of scale insects that do not produce honeydew ^{[18] [19] [20]}. Armoured scale insects feed on the parenchyma tissues of host plants rather than on phloem or xylem fluids.

Our findings with more number of especially *Ferrisia virgata*, *Phenococcus solenopsis*, *Maconellicoccus hirsutus* (Pseudococcidae), *Orthezia insignis* (Ortheziidae) and *Ceroplastes cirripediformis* (Coccidae) during the study period were in appeal with the results of Nixon ^[21], who has shown that the survival and reproductive capacity of the coccoids might have enhanced by the association of ants. As the ants scavenges the colonies of coccoids and protect them from their predators and fungal infection. During the study, it was found that all the species of ants listed in Table 1 were visiting the young females, adult females and their first and second instars of all the species of coccoids. Most of the studies across the world have interpreted more about the association of ants with soft scales and mealy bugs only but our findings have shown that the ants have mutual association with species of coccoids from other families too, particularly the families like Monophlebidae, Asterolecanidae and Ortheziidae. The work is first of its own kind pertaining to the study area.

The present study was more focused about the association between scale insects and ants. Their mutual beneficial and harmful aspects are yet to be of our interest in order to use them effectively in integrated pest management.

TABLE 1: LIST OF SCALE INSECTS AND THEIR HOST PLANTS ASSOCIATED WITH ANTS

Family/ Species name	Host plant	Ant species
Family: Asterolecaniidae		
<i>Bambusaspis bambusae</i>	<i>Phyllostachys acuta</i>	<i>Camponatus vagus</i>
		<i>Tapinoma melanocephalum</i>
Family: Coccidae		
1. <i>Ceroplastes cirripediformis</i>	<i>Duranta erecta</i>	<i>Tapinoma melanocephalum</i>
	<i>Psidium guajava</i>	<i>Camponatus vagus</i>
2. <i>Ceroplastes destructor</i>	<i>Syzygium cumini</i>	<i>Crematogaster pilosa</i>
3. <i>Ceroplastes rusci</i>	<i>Palmeira areca</i>	<i>Crematogaster scutellaris</i>
4. <i>Coccus hesperidum</i>	<i>Syzygium cumini</i>	<i>Crematogaster pilosa</i>
	<i>Acasia auricularis</i>	<i>Crematogaster scutellaris</i>
	<i>Ixora coccinea</i>	<i>Tapinoma melanocephalum</i>
5. <i>Coccus longulus</i>	<i>Psidium guajava</i>	<i>Crematogaster pilosa</i>
	<i>Acasia auricularis</i>	<i>Crematogaster pilosa</i>
6. <i>Parasaissetia nigra</i>	<i>Hibiscus moscheutos</i>	<i>Crematogaster melanogaster</i>
7. <i>Pulvinaria psidi</i>	<i>Syzygium cumini</i>	<i>Crematogaster castanea</i>
	<i>Ixora coccinea</i>	<i>Crematogaster transvaalensis</i>
8. <i>Pulvinaria vitis</i>	<i>Phyllostachys acuta</i>	<i>Crematogaster pilosa</i>
9. <i>Saissetia coffeae</i>	<i>Tabernaemontana divertica</i>	<i>Tapinoma melanocephalum</i>
Family: Monophlebidae		
1. <i>Icerya aegyptiaca</i>	<i>Psidium guajava</i>	<i>Crematogaster pilosa-</i>
	<i>Magnolia champaca</i>	<i>Lasius niger</i>
	<i>Acalypha hispida</i>	<i>Oecophylla smaragdina</i>
Family: Ortheziidae		
1. <i>Orthezia insignis</i>	<i>Duranta repens</i>	<i>Tapinoma melanocephalum</i>
		<i>Camponatus vagus</i>
	<i>Ixora coccinea</i>	<i>Tapinoma melanocephalum</i>
	<i>Millingtonia hortensis</i>	<i>Camponatus vagus</i>

Family: Pseudococcidae			
1.	<i>Antonina graminis</i>	<i>Phyllostachys acuta</i>	<i>Crematogaster castanea</i>
2.	<i>Ferrisia virgata</i>	<i>Casia mountana</i>	<i>Crematogaster cerasi</i>
		<i>Cassia occidentalis</i>	<i>Crematogaster cerasi</i>
		<i>Pongamia pinnata</i>	<i>Crematogaster castanea</i>
		<i>Phanera purpurea</i>	<i>Camponatus vagus</i>
3.	<i>Maconellicoccus hirsutus</i>	<i>Hibiscus rosasinensis</i>	<i>Solenopsis germinate</i>
			<i>Camponatus vagus</i>
4.	<i>Phenococcus solenopsis</i>	<i>Codiaeum variegatum</i>	<i>Crematogaster cerasi</i>
		<i>Pongamia pinnata</i>	<i>Crematogaster pilosa</i>
5.	<i>Planococcus citri</i>	<i>Ixora coccinea</i>	<i>Oecophylla smaragdina</i>
		<i>Codiaeum variegatum</i>	<i>Tapinoma melanocephalum</i>
6.	<i>Planococcus lilacinus</i>	<i>Psidium guajava</i>	<i>Crematogaster erecta</i>

IV. CONCLUSION

The results of the present study showed that, the occurrence of wide variety of scale insect species, their infestation to different host plants and their association with variety of ant species in the study area. Certainly the result implies that the floral diversity of the University campus is under threat by pest infestation. So, the present work reiterates the significance of scale insect association with ants in inducting integrated pest management in the study area. Further more research work on scale insects including their infestation, molecular, taxonomy, association with ants and their predators are yet to be conducted in the University campus. A comprehensive study on the biology of scale insects necessitates in resolving some of the serious damages caused by these sap-sucking pests to the agricultural crops. This project provides a base line data for further more work on these aspects.

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