



# DIVERSITY OF EXTRA-FLORAL NECTARIES (EFN) BEARING PLANTS AND ITS ANT ASSEMBLAGE

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## Abstract

A survey was conducted to know the diversity of Extra-Floral Nectaries bearing plants and its ant assemblage during September, 2014 to March, 2016. Totally 162 flowering plants were examined from the study area. Of which 62 plants were found to have EFN. Amongst the sixty two Extra-Floral Nectaries bearing plants eleven are new distributional records for world. Percentage of EFN-bearing plants in the study area is 38.27. Between the plant types highest percentage of EFN-bearing plants were present in trees (33.87%) and lowest in climbers (8.07%). Fifty three species of trees were studied of which 21 species from 16 genera representing 8 families having EFN. In shrubs ten genus and eight families were with EFN. Among herbs overall the highest number of EFN-bearing species were recorded for Fabaceae (6 species) followed by Euphorbiaceae (3 species) and Pedaliaceae (2 species). Nine species of climbers were examined of which five species from four genera representing three families have EFN. In creepers eight species were with EFN. The subfamilies Formicinae (six species) and Myrmicinae (six species) were predominantly found on EFN-bearing plants.

**Key Words :** Diversity, distributional record, Extra-Floral Nectaries bearing plants, ant assemblage.

## Introduction

Plant defences a range of methods to minimize the effects of herbivorous organisms, and those defences are direct and indirect. Direct defences are those which act directly on the herbivore, such as feeding deterrents and toxins. Indirect defences involve a third trophic level, and are based on the production by the plant of specific structure or chemical compounds that attract natural enemies of the herbivore, such as carnivore organisms and parasitoids (Karban and Baldwin, 1997; Schoonhoven *et al.*, 2005). The best example of indirect defences is the production of nectar by nectaries located outside the floral structure (extrafloral nectaries, EFNs), (Bentley, 1977; Stephenson, 1982; Schoonhoven *et al.*, 2005; Heil, 2008, 2011). The commonest resource plants offer to ants is EFN, a liquid substance rich in carbohydrates with dilute concentrates of amino acids, lipids, phenols, alkaloids and volatile organic compounds (Gonzalez-Teuber and Heil, 2009). Carbohydrates are key resources for arboreal ants (Davidson *et al.*, 2003).

Angiosperm phylogeny group (2009) reported that EFNs in a total of 3941 species distributed across 745 genera and 108 families, four of which were fern families, but none in bryophytes, gymnosperms, early angiosperms or magnoliids. Fascinatingly, almost half of all EFN bearing species belong to only three angiosperm families. The legume family (Fabaceae) stands out, with 30% of the EFN-bearing species; it has long been known for the richness of its interactions with ants (McKey, 1989). The second- and third-ranked families are Passifloraceae and Malvaceae, respectively, together comprising 20 % of the remaining EFN species. Little is known about the distribution and abundance of plants with EFNs (Keeler, 1980). With this background the present study was initiated to survey for EFN-bearing plants and the ant assemblage visiting them.

## Materials and Methods

### Survey for EFN-bearing plants and ant assemblage

Survey was conducted at Annamalai Nagar and Sivapuri from September, 2014 to March, 2016. Random survey was made at weekly intervals along 50 arbitrarily

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selected sites in the study area. At each site, all types of plants (trees, shrubs, herbs, climbers and creepers) were examined for the presence of EFN. From EFN-bearing plants, branches were collected with flowers or inflorescence, fruits and put inside individual polythene covers and secured with rubber bands. Details of location of collection, plant name and date were written on the cover and taken to the laboratory.

Ants present on EFN-bearing plants were collected by hand collection. Collected ant samples were stored in 75 per cent ethyl alcohol. Sorted specimens were placed in glass vials with proper labels having the location of collection, plant name and date. When more than ten individuals were present, seven were removed and point mounted on triangle "points" between procoxa and metacoxa, pinned by entomological pin (size "3") and labelled. All excess ants were stored in 90 per cent ethyl alcohol. Before the ants dried, their legs were pushed ventrally and away from the body, and mandibles of some specimens opened, to facilitate identification (Musthak Ali, 1981).

### Identification of plants

EFN-bearing plants were observed through Stemi DV4 Stereo (Zeiss) microscope for the confirmation of EFN structures. Identification of plants were done up to species level at IEBL (Insect Ecology and Behavioural Lab), Department of Entomology, Faculty of Agriculture, Annamalai University and confirmation was made with specialists in the Department of Botany, Faculty of Science and Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University. Distribution pattern of EFN-bearing species in trees, shrubs, herbs, climbers and creepers were noted and percentage of plant species with EFN in different plant types were calculated.

### Identification of ant assemblage

Identification of preserved ant assemblage to species level were done at IEBL (Insect Ecology and Behavioural Lab), Department of Entomology, Faculty of Agriculture, Annamalai University following the taxonomic keys of Bolton (1994); Tiwari (1999) and Hashimoto (2003) using Stemi DV4 Stereo (Zeiss) microscope.

## Results and Discussion

### Identification of plants

From the survey during September, 2014 to March, 2016, totally 162 plants were examined from the study area. Of which 62 plants were found to have EFN visited by ants (Table 2-6).

Amongst the sixty two plant species eleven are new distributional records for world viz., *Vinca rosea*, *Anthurium plowmanii*, *Opuntia littoralis*, *Coccinia grandis*, *Dolichos lablab* var. *typicus*, *Abrus precatorius*, *Tamarindus indica*, *Ocimum gratissimum*, *Malpighia emarginata*, *Ficus hispida* and *Sesamum allatum*.

### Distribution pattern of EFN-bearing plant species

Percentage of EFN-bearing plants in the study area is 38.27. Between the plant types highest percentage of EFN-bearing plants were present in trees (33.87%) and lowest in climbers (8.07%). For the first time in India the distribution pattern of EFN species were recorded for 62 plants. Sixty two plants were distributed among 43 genera and 19 families table 1.

EFNs occur in a variety of plant types including trees, shrubs, herbs, climbers and creepers. Distribution pattern of EFN species in trees are presented in table 2. Fifty three species of trees were studied of which 21 species from 16 genera representing 8 families having EFN Table 1. EFNs have not been reported in the 16 families. The families with more EFNs were Fabaceae (*Samanea saman*, *Acacia auriculiformis*, *Acacia baileyana*, *Delonix regia*, *Prosopis juliflora*, *Leucaena leucocephala*, *Albizia lebbbeck*, *Albizia amara*, *Samanea* sp. 1, *Samanea* sp. 2, *Tamarindus indica*. Malvaceae and Bignoniaceae have three and two species respectively table 2. Also families like Combretaceae, Lamiaceae, Moringaceae, Moraceae and Malpighiaceae were reported with one species of EFN each.

In shrubs observation was done in 38 species distributed among 35 genera and 18 families in which 10 genus and 8 families were with EFN (Table 3). EFN-bearing plants are present mostly in Malvaceae and Fabaceae each with three and two species respectively. Rest of the families with EFNs were Araceae (*Anthurium plowmanii*), Convolvulaceae (*Ipomoea carnea*), Cactaceae (*Opuntia littoralis*), Euphorbiaceae (*Ricinus communis*), Lamiaceae (*Clerodentrum bungei*), Rubiaceae (*Morinda citrifolia*) each with one species.

**Table 1:** Distribution of plant species with and without EFNs in different plant types.

Plant type	Family		Genus		Species		Species with EFN (%)
	Without EFN	With EFN	Without EFN	With EFN	Without EFN	With EFN	
Trees	16	8	29	16	32	21	33.87
Shrubs	10	8	25	10	27	11	17.74
Herbs	16	9	31	11	34	17	27.42
Climbers	3	3	4	4	4	5	8.07
Creepers	1	2	3	6	3	8	12.90

**Table 2:** Distribution pattern of EFN-bearing species in trees.

S. No.	Plant family	Plant species	Presence of EFN
1.	Apocynaceae	<i>Alstonia scholaris</i> (L.) R.Br.	-
2.	Annonaceae	<i>Polyalthia longifolia</i> (Sonn.) Thwaites	-
3.	Annonaceae	<i>Annona reticulata</i> L.	-
4.	Arecaceae	<i>Dyopsis lutescens</i> H(Wendl.)Beentje & Dransf	-
5.	Arecaceae	<i>Cocos nucifera</i> L.	-
6.	Anacardiaceae	<i>Anacardium occidentale</i> L.	-
7.	Anacardiaceae	<i>Mangifera indica</i> L.	-
8.	Bignoniaceae	<i>Crescentia cujete</i> L.	-
9.	Bignoniaceae	<i>Tecoma stans</i> (L.) Juss. ex Kunth	+
10.	Bignoniaceae	<i>Kigelia africana</i> (Lam.) Benth.	+
11.	Combretaceae	<i>Terminalia catappa</i> L.	+
12.	Causuarinaceae	<i>Causuarina equisetifolia</i> L.	-
13.	Caricaceae	<i>Carica papaya</i> L.	-
14.	Fabaceae	<i>Samanea saman</i> (Jacq.) Merr.	+
15.	Fabaceae	<i>Acacia auriculiformis</i> A.Cunn. ex Benth.	+
16.	Fabaceae	<i>Acacia baileyana</i> F. Muell.	+
17.	Fabaceae	<i>Peltophorum pterocarpum</i> (DC.) K.Heyne	-
18.	Fabaceae	<i>Delonix regia</i> (Hook.) Raf.	+
19.	Fabaceae	<i>Prosopis juliflora</i> (Sw.) DC.	+
20.	Fabaceae	<i>Leucaena leucocephala</i> (Lam.) de Wit	+
21.	Fabaceae	<i>Albizia lebbbeck</i> (L.) Benth.	+
22.	Fabaceae	<i>Albizia amara</i> (Roxb.) Boivin.	+
23.	Fabaceae	<i>Samanea</i> sp. 1	+
24.	Fabaceae	<i>Samanea</i> sp. 2	+
25.	Fabaceae	<i>Cassia fistula</i> L.	-
26.	Fabaceae	<i>Tamarindus indica</i> L.	+
27.	Fabaceae	<i>Pungamia pinnata</i> L.	-
28.	Lamiaceae	<i>Gmelina asiatica</i> L.	+
29.	Lamiaceae	<i>Vitex negundo</i> L.	-
30.	Lamiaceae	<i>Tectona grandis</i> L.f	-
31.	Lecythidaceae	<i>Couroupita guianensis</i> Aubl.	-
32.	Malvaceae	<i>Ceiba pentandra</i> (L.) Gaertn.	+
33.	Malvaceae	<i>Thespesia populnia</i> (L.) Sol. ex Correa	-
34.	Malvaceae	<i>Thespesia</i> sp. 1	+
35.	Malvaceae	<i>Thespesia</i> sp. 2	+
36.	Malpighiaceae	<i>Malpighia emarginata</i> DC.	+
37.	Myrtaceae	<i>Callistemon citrinus</i> (Curtis) Skeels	-
38.	Myrtaceae	<i>Syzygium cumini</i> L.Skeels	-
39.	Myrtaceae	<i>Psidium guajava</i> L.	-
40.	Myrtaceae	<i>Eucalyptus teriticornis</i> Sm.	-
41.	Moraceae	<i>Ficus religiosa</i> L.	-
42.	Moraceae	<i>Ficus hispida</i> L.f.	+
43.	Moraceae	<i>Artocarpus heterophyllus</i> Lam.	-
44.	Musaceae	<i>Musa paradisiaca</i> L.	-
45.	Moringaceae	<i>Moringa oleifera</i> Lam.	+
46.	Meliaceae	<i>Azadirachta indica</i> A.Juss.	-
47.	Poaceae	<i>Bambusa bambos</i> (L.) Vass	-
48.	Rhamnaceae	<i>Zyziphus mauritiana</i> Lam.	-
49.	Rutaceae	<i>Citrus limon</i> (L.) Osbeck.	-

Table 2 conti .....

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50.	Rutaceae	<i>Citrus medica</i> L.	-
51.	Phyllanthaceae	<i>Phyllanthus emblica</i> L.	-
52.	Rubiaceae	<i>Morinda tinctoria</i> (Roxb)	-
53.	Sapotaceae	<i>Manilkara zapota</i> (L.) P. Royen	-

+ : presence of the species, - : absence of the species

Table 3: Distribution pattern of EFN-bearing species in shrubs.

S.No.	Plant family	Plant species	Presence of EFN
1.	Apocyanaceae	<i>Calotropis gigantea</i> L. Dryand	-
2.	Apocynaceae	<i>Tabernaemontana divaricata</i> (L.) R. Br. ex Roem & Schult.	-
3.	Apocynaceae	<i>Nerium indicum</i> Mill.	-
4.	Apocynaceae	<i>Adnium obesum</i> (Forssk.) Roem. & Schult	-
5.	Apocynaceae	<i>Plumeria alba</i> L.	-
6.	Amaranthaceae	<i>Gomphrena globosa</i> L.	-
7.	Araceae	<i>Colacasia esculenta</i> (L.) Schott.	-
8.	Araceae	<i>Anthurium plowmanii</i> Croat Candollea	+
9.	Asteraceae	<i>Helianthus annuus</i> L.	-
10.	Brassicaceae	<i>Brassica juncea</i> (L.) Czern	-
11.	Convolvulaceae	<i>Ipomoea carnea</i> Jace.	+
12.	Cactaceae	<i>Opuntia littoralis</i> (Engelm.) Cockerell	+
13.	Euphorbiaceae	<i>Jatropha curcas</i> L.	-
14.	Euphorbiaceae	<i>Manihot esculenta</i> L.	-
15.	Euphorbiaceae	<i>Ricinus communis</i> L.	+
16.	Fabaceae	<i>Desmanthus virgatus</i> (L.) Willd.	+
17.	Fabaceae	<i>Cassia occidentalis</i> L.	+
18.	Fabaceae	<i>Sesbania bispinosa</i> (Jacq.) W. Wight.	-
19.	Lythraceae	<i>Punica granatum</i> L.	-
20.	Lamiaceae	<i>Clerodentrum bungei</i> Stued.	+
21.	Malvaceae	<i>Hibiscus rosa-sinensis</i> L.	+
22.	Malvaceae	<i>Abutilon indicum</i> (L.) Sweet	-
23.	Malvaceae	<i>Abelmoschus esculentus</i> L. (Moench)	-
24.	Malvaceae	<i>Hibiscus cannabinus</i> L.	+
25.	Malvaceae	<i>Gossypium hirsutum</i> L.	+
26.	Malvaceae	<i>Corchorus aestuans</i> L.	-
27.	Poaceae	<i>Saccharum officinarum</i> L.	-
28.	Poaceae	<i>Zea mays</i> L.	-
29.	Rubiaceae	<i>Ixora coccinea</i> L.	-
30.	Rubiaceae	<i>Morinda citrifolia</i> L.	+
31.	Rosaceae	<i>Rosa berberifolia</i> Pall.	-
32.	Rutaceae	<i>Murraya koenigii</i> L. Spreng.	-
33.	Solanaceae	<i>Solanum trilobatum</i> L.	-
34.	Solanaceae	<i>Solanum melongena</i> L.	-
35.	Solanaceae	<i>Solanum torvum</i> Sw.	-
36.	Solanaceae	<i>Lycopersicon esculentum</i> Mill.	-
37.	Solanaceae	<i>Datura metel</i> L.	-
38.	Verbenaceae	<i>Lantana camara</i> L.	-

+ : presence of the species, - : absence of the species

**Table 4:** Distribution pattern of EFN-bearing species in herbs.

S.No.	Plant family	Plant species	Presence of EFN
1.	Asteraceae	<i>Cosmos bipinnatus</i> Cav.	-
2.	Asteraceae	<i>Calendula officinalis</i> L.	-
3.	Asteraceae	<i>Eclipta alpa</i> (L.) Hassk	-
4.	Asteraceae	<i>Dendranthema grandiflorum</i> (L.) Ness	-
5.	Asteraceae	<i>Tridax procumbens</i> (L.) L	-
6.	Acanthaceae	<i>Crossandra infundibuliformis</i> (L.) Nees	-
7.	Aizoaceae	<i>Trianthema portulacastrum</i> L.	-
8.	Apocynaceae	<i>Vinca rosea</i> L.	-
9.	Amaranthaceae	<i>Alternanthera pungens</i> Kunth.	-
10.	Amaranthaceae	<i>Aerva lanata</i> (L.) Juss.	-
11.	Amaranthaceae	<i>Celosia spicata</i> L.	-
12.	Asparagaceae	<i>Agave americana</i> L.	-
13.	Asparagaceae	<i>Polianthes tuberosa</i> L.	-
14.	Brassicaceae	<i>Brassica oleracea</i> L.	-
15.	Brassicaceae	<i>Brassica caulorapa</i> L.	-
16.	Balsaminaceae	<i>Impatiens balsamina</i> L.	+
17.	Cyperaceae	<i>Cyperus difformis</i> L.	-
18.	Cleomaceae	<i>Cleome viscosa</i> L.	-
19.	Euphorbiaceae	<i>Chrozophora rottleri</i> (Geiseler) A. Juss. ex Spreng.	+
20.	Euphorbiaceae	<i>Euphorbia heterophylla</i> L.	+
21.	Euphorbiaceae	<i>Acalypha indica</i> L.	-
22.	Euphorbiaceae	<i>Croton bonplandianus</i> Baill.	+
23.	Euphorbiaceae	<i>Euphorbia hirta</i> L.	-
24.	Fabaceae	<i>Cyamopsis tetragonoloba</i> s(L.) Taub.	-
25.	Fabaceae	<i>Vigna radiata</i> (L.) R. Wilczek	+
26.	Fabaceae	<i>Vigna unguiculata</i> (L.) Walp.	+
27.	Fabaceae	<i>Vigna mungo</i> (L.) Hepper	+
28.	Fabaceae	<i>Cassia hirsuta</i> L.	+
29.	Fabaceae	<i>Vigna</i> sp.	+
30.	Fabaceae	<i>Arachis hypogaea</i> (L.)	-
31.	Fabaceae	<i>Vigna trilobata</i> (L.) Verdc	+
32.	Lamiaceae	<i>Ocimum gratissimum</i> L.	+
33.	Liliaceae	<i>Lilium longiflorum</i> Thunb.	+
34.	Marsileaceae	<i>Marsilea quadrifolia</i> L.	-
35.	Nyctaginaceae	<i>Mirabilis jalapa</i> L.	-
36.	Phyllanthaceae	<i>Phyllanthus maderaspatensis</i> L.	-
37.	Phyllanthaceae	<i>Phyllanthus niruri</i> L.	-
38.	Poaceae	<i>Cynodon dactylon</i> (L.) Pers.	-
39.	Poaceae	<i>Echinochloa crus-galli</i> (L.) P.Beauv	-
40.	Poaceae	<i>Oryza sativa</i> L.	-
41.	Portulacaceae	<i>Portulaca oleracea</i> L.	-
42.	Pedaliaceae	<i>Sesamum allatum</i> Thonn.	+
43.	Pedaliaceae	<i>Sesamum indicum</i> L.	+
44.	Passifloraceae	<i>Turnera ulmifolia</i> L.	+
45.	Solanaceae	<i>Physalis peruviana</i> L.	-

Table 4 conti .....

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46.	Solanaceae	<i>Solanum nigrum</i> (L.)	-
47.	Solanaceae	<i>Solanum xanthocarpum</i> L.	-
48.	Solanaceae	<i>Capsicum annum</i> L.	-
49.	Oxalidaceae	<i>Biophytum sensitivum</i> (L.) DC	-
50.	Zygophyllaceae	<i>Tribulus terrestris</i> L.	-
51.		Unidentified sp.	+

+ : presence of the species - : absence of the species

Table 5: Distribution pattern of EFN-bearing species in climbers.

S. No.	Plant family	Plant species	Presence of EFN
1.	Colchicaceae	<i>Gloriosa superba</i> L.	+
2.	Euphorbiaceae	<i>Croton</i> sp.	+
3.	Fabaceae	<i>Abrus precatorius</i> L.	+
4.	Fabaceae	<i>Dolichos lablab</i> L.	+
5.	Fabaceae	<i>Dolichos lablab</i> var. <i>typicus</i> L.	+
6.	Fabaceae	<i>Clitoria ternatea</i> L.	-
7.	Nyctaginaceae	<i>Bougainvillea spectabilis</i> Wild.	-
8.	Oleaceae	<i>Jasminum sambac</i> (L.) Aiton	-
9.	Convolvulaceae	<i>Ipomoea batatas</i> (L.) Lam.	+

+ : presence of the species

- : absence of the species

Among herbs overall the highest number of EFN-bearing species were recorded for Fabaceae from the genus *Vigna* (5 species) and *Cassia* (1 species) followed by Euphorbiaceae (3 species) and Pedaliaceae (2 species) (Table 4). Other families bearing EFN were Apocynaceae (*Vinca rosea*), Balsaminaceae (*Impatiens balsamina*), Lamiaceae (*Ocimum gratissimum*), Liliaceae (*Lilium longiflorum*) and Passifloraceae (*Turnera ulmifolia* L.). Also one unidentified plant species is present with EFN.

Distribution pattern of EFN-bearing species in climbers are presented in table 5. Nine species of climbers were examined of which five species from four genera

representing three families have EFN. Families viz., Fabaceae (*Abrus precatorius*, *Dolichos lablab*, *Dolichos lablab* var. *typicus*), Euphorbiaceae (*Croton* sp.) and Convolvulaceae (*Ipomoea batatas*) have EFN but Colchicaceae, Nyctaginaceae and Oleaceae did not possess EFN.

In the present study, it was found that in creepers eight species are with EFN. The highest number of EFN-bearing genus was recorded from the family Cucurbitaceae (*Momordica*, *Coccinia*, *Cucurbita*, *Luffa*, *Lagenaria*) followed by Convolvulaceae (*Ipomoea*). But the common ornamental plant, *Sciendapus aureus* (Araceae) lack EFN (Table 6).

Table 6: Distribution pattern of EFN-bearing species in creepers.

S. No.	Plant family	Plant species	Presence of EFN
1.	Araceae	<i>Sciendapus aureus</i> (Linden and Andre) S.Buntin	-
2.	Convolvulaceae	<i>Ipomoea cairica</i> Sweet.	+
3.	Convolvulaceae	<i>Ipomoea aquatica</i> Forssk.	+
4.	Convolvulaceae	<i>Convolvulus arvensis</i> L.	-
5.	Cucurbitaceae	<i>Momordica charantia</i> L.	+
6.	Cucurbitaceae	<i>Coccinia grandis</i> (L.) Voigt	+
7.	Cucurbitaceae	<i>Cucurbita pepo</i> L.	+
8.	Cucurbitaceae	<i>Luffa aegyptiaca</i> Mill.	+
9.	Cucurbitaceae	<i>Luffa acutangula</i> (L.) Roxb.	+
10.	Cucurbitaceae	<i>Citrullus lanatus</i> (Thunb) Matsum.& Nakai	-
11.	Cucurbitaceae	<i>Lagenaria siceraria</i> (Molina) Standl.	+

+ : Presence of the species, - : Absence of the species

**Table 7:** Ant assemblage on EFN-bearing plants.

Ant subfamily	Ant species
Formicinae	<i>Camponotus compressus</i>
	<i>Camponotus irritans</i>
	<i>Camponotus rufoglaucus</i>
	<i>Camponotus sericeus</i>
	<i>Oecophylla smaragdina</i>
	<i>Polyrachis rastellata</i>
Myrmicinae	<i>Myrmecaria brunnea</i>
	<i>Solenopsis geminata</i>
	<i>Pheidole</i> sp.
	<i>Monomorium scabriceps</i>
	<i>Meranoplus bicolor</i>
	<i>Crematogaster</i> sp.
Pseudomyrmecinae	<i>Tetraponera rufonigra</i>
	<i>Tetraponera nigra</i>

From the survey it could be understood clearly that agriculturally important families like Fabaceae, Malvaceae, Euphorbiaceae, Cucurbitaceae and Convolvulaceae possessed more number of EFN species than others.

Weber *et al.*, (2015) documented EFN families share at world level and reported that Fabaceae having the highest species number 853 followed by Passifloraceae (444 species), Euphorbiaceae (360 species), Malvaceae (299 species) and Bignoniaceae (264 species). Heil (2015) also pointed out that, EFN is also secreted by cotton, other crops and orchard plants, particularly in Cucurbitaceae (pumpkin, zucchini), Euphorbiaceae (cassava), Fabaceae (bean, pea), and Rosaceae (almond, peach, cherry). These reports are in accordance with the present findings.

May Ling (2004) reported that extrafloral nectaries are especially common in the family Euphorbiaceae, which consists of at least 30 genera, among which 27 species belonging to 13 genera possess these structures. A few genera in the families Caesalpiniaceae, Mimosaceae, Convolvulaceae, Papilionaceae, Passifloraceae and Balsamaceae also have these nectaries. Most of these species are trees or shrubs. Herbaceous plants with EFNs are not common which is in line with present observations.

#### Identification of ant assemblage

From sixty two EFN-bearing plants 14 species of ants were found which are falling under three subfamilies (Formicinae, Myrmicinae and Pseudomyrmecinae) are listed in Table 7. The subfamilies Formicinae (six species) and Myrmicinae (six species) were predominantly represented at EFNs. The Formicine genus *Camponotus* presented a higher number of species visiting EFNs than

the remaining genera recorded on each of the plants censused (Oliveira and Brandão 1991; Oliveira *et al.*, 1995). Also Apple and Feener (2001) observed on patterns in ant associations with extrafloral nectaries of *Passiflora*. Ants associated were *Ectatomma ruidum*, *E. tuberculatum* (Ponerinae), *Crematogaster*, *Pheidole*, *Solenopsis*, *Wasmannia auropunctata* (Myrmicinae), *Pseudomyrmex* (Pseudomyrmecinae), *Brachymyrmex*, *Camponotus*, *Paratrechina* (Formicinae), and *Tapinoma* (Dolichoderinae) which is in accordance with the present study results.

Although formicine ants are clearly the predominant group, ants in the subfamilies Myrmicinae (*Cephalotes*), Ponerinae (*Ectatomma*), and Dolichoderinae (*Azteca*) also commonly feed on plant and insect exudates on Cerrado foliage. Detailed faunal accounts are mentioned by Oliveira and Brandao, 1991; Dansa and Rocha, 1992; Oliveira *et al.*, 1995; Oliveira and Pie, 1998; Del-Claro and Oliveira, 1999; Santos and Del-Claro, 2001. Mohankumar and Nalini (2016) reported that a total of 27 species under 19 genera and six subfamilies of ants were collected from 35 locations in seven Taluks. Subfamilies Formicinae and Myrmicinae were recorded with more number of genera and species. Chidambaram Taluk, Sivapuri and Annamalainagar were recorded with ten genera and fourteen species respectively which is in accordance to the present study results.

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