Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

J E Z S Journal of Entomology and Zoology Studies

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2017; 5(1): 459-464

Received: 06-11-2016
Accepted: 07-12-2016

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Diversity and distribution of Ant species (Hymenoptera: Formicidae), in Pachaiyappa's College, Kanchipuram, Tamil Nadu, India

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Abstract
Ants are one of the most diverse and ubiquitous groups of social insects. Ants (Formicidae) are the largest family under the order Hymenoptera. They act as ecological indicators and ecosystem engineers. In this study, Ant species diversity and distribution in Pachaiyappa's college for Men campus (PACM), Kanchipuram (KPM) Tamil Nadu, India has been discussed. Ant species were collected from the three zones of the college campus (PACM), with the help of baits (B), All out Search Method (AOSM) and Hand Collection Method (HCM) during post monsoon seasons. In the studied area, totally 10 species belonging to 09 genera, 04 subfamilies of ants were recorded, out of the four subfamilies, the Formicinae was the most dominant subfamily in terms of species richness (5 species) followed by Myrmicinae (03 species), Pseudomyrmicinae (01 species) and Dolichoderinae (01 species). One-way ANOVA proved that significant differences (P<0.05) was found between ant species composition in various months. Similarity indices showed that zone-I and zone-II were similar in ant species composition, diversity and species richness in the college campus.

Keywords: Ant diversity, Formicinae, species diversity and *Camponotus* sp.

1. Introduction
Biodiversity conservation and management are of worldwide concerns. Ant is one of the most diverse and ubiquitous groups of the social insect. Ant belongs to a single large family Formicidae, largest of order Hymenoptera. It is represented by 26 extant subfamilies with 14,711 valid species and 428 valid genera [1]; out of these, 152 species are listed by IUCN and from India, 10 subfamilies are represented by 100 genera with 828 species. In India, Himalaya and the Western Ghats harbor a large number of ant species, 656 species from 88 genera were recorded from Himalaya, and 455 species from 75 genera were recorded from the Western Ghats, especially in Tamil Nadu, 184 species from 51 genera were recorded [2, 3]. They can serve as model organisms for exploring the nature and dynamics of ecological communities due to the ease with which they can be sampled and the potential for experimental manipulation [2, 3].
Ants are important components of ecosystems not only because they constitute a great part of the animal biomass but also because they act as ecosystem engineers. All the known species of ants are eusocial [4]. Ant species can be used in monitoring environmental impacts, ecosystem funding, and tools in ecological studies [5, 6, 7]. Ant species are used as excellent indicators of land management practices and restoration efforts [5, 6]. Sabu [8] estimated the diversity of forest litter inhabiting ants along elevations in the Wayanad region of the Western Ghats. Bharti and Sharma [9] carried preliminary investigations on diversity and abundance of ants along an elevational gradient in Jammu-Kashmir Himalaya. The food of ants consists of insects, terrestrial arthropods, excretion from plants, honey dew excreted by aphids and mealy bugs, secretion of the caterpillars of the family Lycaenidae, seeds of plants *etc* [4].
Every species of ant exert an immense impact on the environment. It directly or indirectly influences the development and destruction of flora and fauna of its surrounding environment. The first study suggesting the use of ants as bioindicators was done in early 1980's. High populations of *Wasmannia auropunctata* (Roger) were related to the marked reduction of other ant species, especially in regions where it has been introduced, such as Galapagos Islands [10].
The objective of this study was to find out ant diversity, density, species richness, evenness and distribution of ants in Pachaiyappa's College campus (PACM), Kanchipuram (KPM).

This study will generate some valuable information about distribution and richness of ant species in and around Kanchipuram (KPM).

2. Materials and Methods

2.1. Study area

Kanchipuram is situated on the northern East Coast of Tamil Nadu and is adjacent to Bay of Bengal and Chennai city (Latitude: 12.8341735 °N and Longitude: 79.7036402°E). Pachaiyappa's College for Men (PACM), Kanchipuram (KPM), a campus divided into three zones (I-Kannikapuram; II-Old men's hostel and III-History department west) was selected for finding the diversity, distribution, and composition of ant species. An extensive survey was carried out during the post-monsoon season from January to February 2015 in the study area.

2.2. Sample collection

Ant species were collected during the morning and evening time using different methods as described by Gadagkar [4] and Alonso [11]. Two methods were employed for collection of ant samples in the college campus during the post monsoon seasons.

2.3. Sampling methods

a) Bait Trap (BT): Four bait types: -Egg yolk, fried coconut, honey, un-boiled rice, millet and dead insects were used and placed in the zone- I, zone- II and zone- III in the (PACM) college campus. The baits were left undisturbed for four hours and later ant species were collected for a period of twenty minutes from all the six baits [4]
b) All-Out Search Method (AOSM): An intensive All- out search method was carried out to collect ant species seen in the zone- I, zone- II and zone- III in the PACM campus during the post monsoon seasons [4, 11].

The collected ant species were identified up to genus and for few, species level identifications were done with the help of keys given by Ali [12] ; Bingham [13]; Bolton, [14, 15]; Rastogi [16]; Tiwari [17] and Varghese [18, 19]. The collected ant species were identified and confirmed by Dr. Himender Bharti, Department of Zoology and Environmental Sciences, Punjabi University, Patiala and Dr. Preethy John, Division of Entomology, Kerala Forest Research Institute, Kerala.

2.4. Diversity Indices

The ant species diversity data were converted to fourth-root square transformed before analysis to reduce the weight of common species [20]. The computer program PRIMER-E (ver. 6.1.7) (Plymouth Routines in Multivariate Ecological Research), was used for univariate and multivariate analysis of data [21].

2.5. Statistical Analysis

Statistical analysis was performed by the GraphPad Prism version 5.0. One way Analysis of Variance (ANOVA) was used to access difference in abundance of ant species diversity for each zones. One-Way ANOVA was conducted, assuming there were no significant differences among the ant species at (p<0.05) level of significance, followed by Bonferroni's Multiple Comparison Test (BMCT) are used to compare the all zones, baits, density and months.

3. Results and Discussion

In this study, Ant species diversity and distribution in Pachiyappas College for Men (PACM), Kanchipuram (KPM) in three zones (zone- I-Kannikapuram; zone-II- Oldmen's hostel; zone-III- history department west) were studied. Ant species densities (Mean+SE) from the college campus (PACM, zone I to zones III) were counted, during the post-monsoon seasons (Figure.1 and 2).

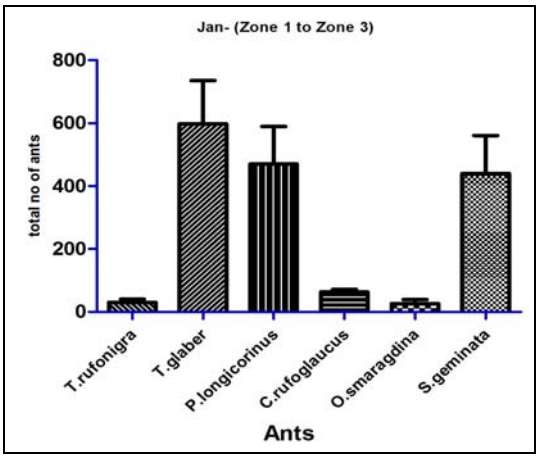

Fig 1: Ant species density in three zones (Mean+SE) during January

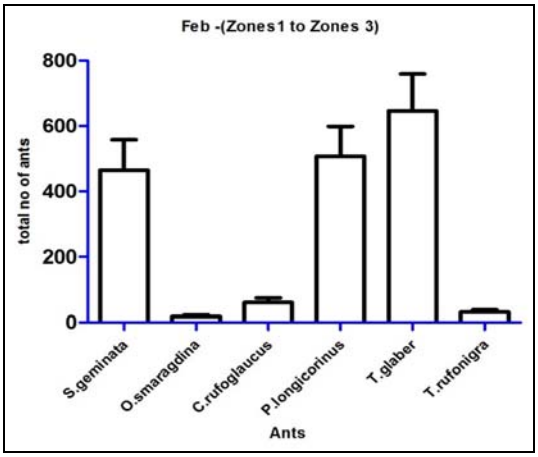

Fig 2: Ant species density in three zones (Mean+SE) during February

To collect ant species from the sampling area, we provide egg yolk, fried coconut, honey, un-boiled rice, millet and dead insects; among them, the egg yolk has attracted more number of ant species during the study period (Figure 3 and 4).

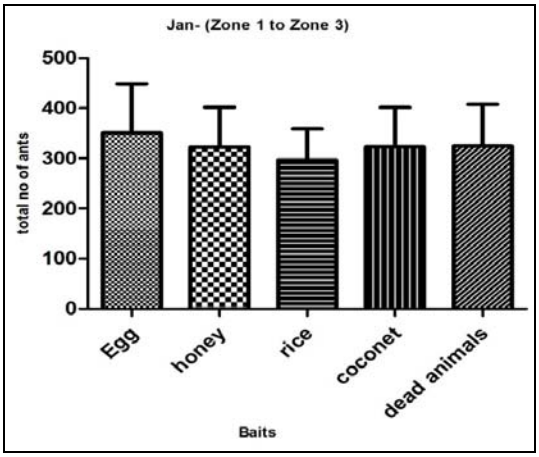

Fig 3: Ant species collected in three zones by using different baits during January

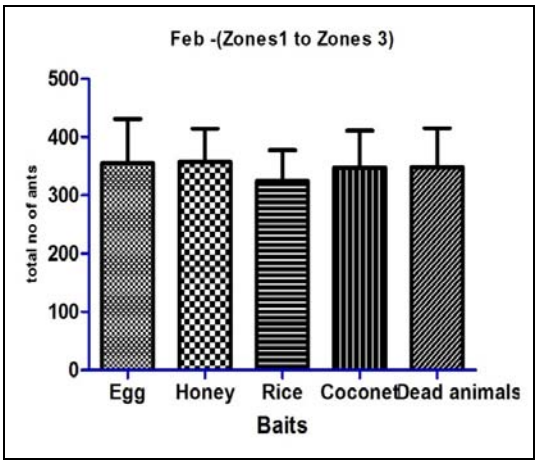

Fig 4: Ant species collected in three zones by using different baits during February

From the sampling area, we have recorded the total of 10,087/ no's ant's in college campus (PACM). Totally 10 species belonging to 09 genera, 04 subfamilies were recorded, out of the 4 subfamilies, the Formicinae was the most dominant subfamily in terms of species richness (5 Species) followed by Myrmicinae (03 species), Pseudomyrmicinae (01 species) and Dolichoderinae (01 species) (Table 1.)

Among the 10 species specimens collected, only eight specimens could be identified to the species level. The *Camponotus* was the most species-rich genera with two species followed by Myrmicinae with three species (Table.1 and 2). During the present investigation, comparatively low species diversity (No of species: 04) was observed in zone III and high diversity of species (No of species: 08) was noticed in the zone I and moderate species diversity (No. of. species: 7) were recorded in zone II of the college campus.

Table 1: Ant species collected from three zones in Pachaiyappa's College for Men (PACM), Kanchipuram (KPM)

Subfamilies	Genera	Number of species
Formicinae	*Camponotus*	2
	Solenopsis	1
	Oecophylla	1
	Paratrechina	1
Pseudo myrmicinae	*Tetraponera*	1
Myrmicinae	*Myrmicaria*	1
	*Crematogaster**	1
	*Pheidole**	1
Dolichoderinae	*Trichomyrmex*	1
Total: 4	**9**	**10**

Table 2: Subfamily wise distribution of Ant genera and identified species in Pachaiyappa's College for Men (PACM), Kanchipuram (KPM).

Subfamily	Genus	species
Formicinae	*Camponotus*	*rufoglaucus* (Jerdon, 1851) *compressus* (Fabricius, 1787)
	Solenopsis	*geminate* (Fabricius, 1804)
	Oecophylla	*smaragdina* (Fabricius, 1775)
	Paratrechina	*longicornis* (Latreille, 1802)
Pseudo Myrmicinae	*Tetraponera*	*rufonigra* (Jerdon, 1851)
Myrmicinae	*Myrmicaria*	*brunnea* (Saunders, 1842)
	Crematogaster	*sp
	Pheidole	*sp
Dolichoderinae	*Trichomyrmex*	*glaber* (André, 1883)

The ant species diversity (Shannon-Weiner index- H'), Species richness (d) and species evenness (Pielous evenness- J) were calculated. Shannon-Weiner index- H' at zones I, II and III in the month of January ranges from (0.3327 to1.4778; 0.6782 to 1.3982 and 0.3426 to 1,2276 respectively; February zones I, II and III ranges from 0.3692 to 1.3870; 0.3327 to 1.3907and 0.6140 to1.3952 respectively. The species diversity ranged from 0.3327 to 1.3982, species richness ranged from 0.4409 to 1.6497, species evenness ranged from 0.4402 to 0.9982. The species richness estimators like Chao1, Chao2, Jack knife 1 and Jack knife 2, clearly indicates the diversity uniqueness of an assemblage (Figure 5).

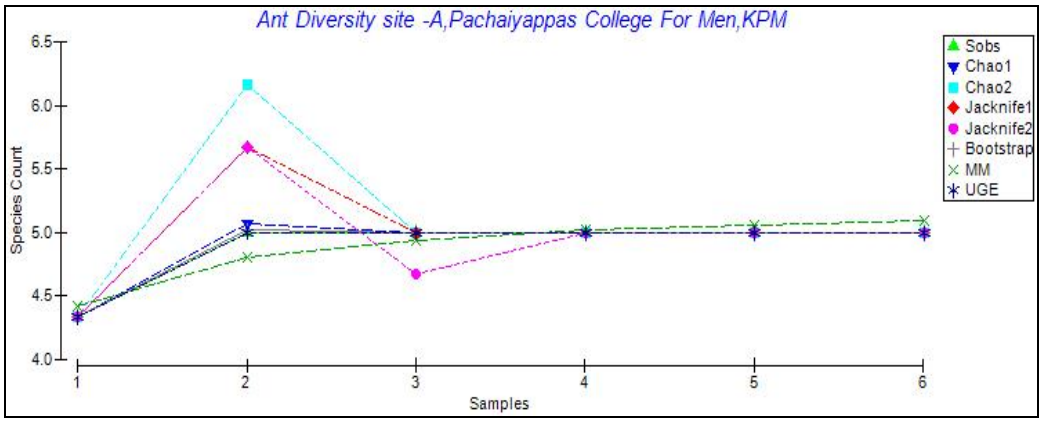

Fig 5: Ant species diversity species count (Square root transformation) in Zone I, PACM

The geometric class (0-2, 2-4, 4-6 and 6-8) for zones 1, 2 and 3 represent (% species 0-28, 10-22, 5-32 and 0-20) respectively (Figure.6). All similarity indices indicate that zone-I and zone-II were similar in ant species composition, diversity and species richness in the college campus (PACM).

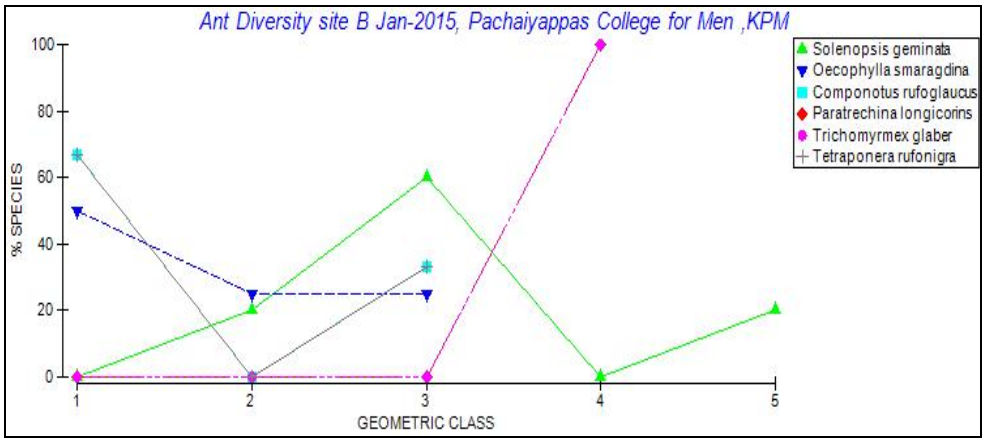

Fig 6: Geometric Class Plot (Species abundance distribution) for ant species diversity at PACM

Besides this, to study the similarity/dissimilarity, (Bray-Curtis Similarity) the data (Square root) of baits and ant compositions were also taken for cluster analysis. Among the ant's species, *Solenopsis geminate, Paratrechina longicornis* and *Trichomyrmex glaber* grouped at the highest level of similarity followed by ant *Camponotus rufoglaucus*, *Oecophylla smaragdina* and *Tetraponera rufonigra*. Further, a cluster of ant *Solenopsis geminate, Paratrechina longicornis* and *Trichomyrmex glaber* have formed a single cluster at the next level of similarity and cluster of *Camponotus rufoglaucus*, *Oecophylla smaragdina* and *Tetraponera rufonigra* grouped successively to this at the next level similarity. Cluster analysis is useful in finding the grouping of samples, such that samples within a group are more similar to each other than the samples in different groups. (Figure7).

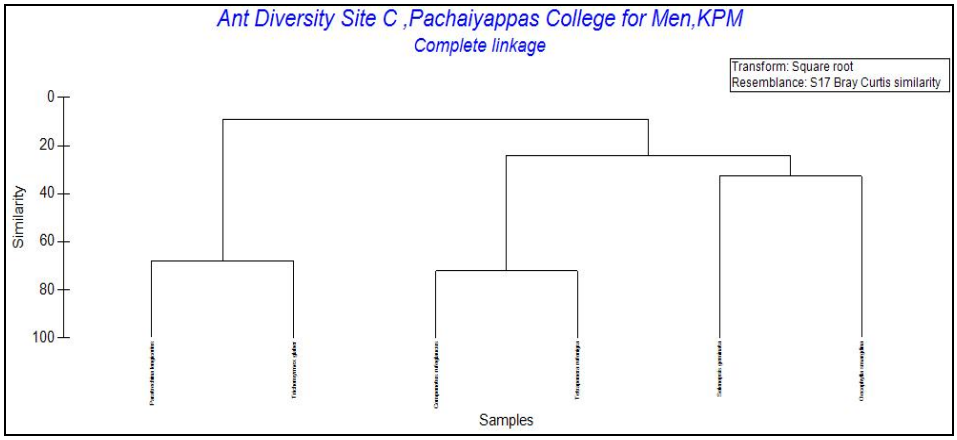

Fig 7: Hierarchical Cluster analysis (Complete linkage Square root- D1 Bray-Curtis similarity) for ant species diversity in PACM

In one-way ANOVA it is proved that, significant difference between ant species composition in various months at $P<0.05$ level of significance (P-value < 0.0001, R-squared (0.9969); ant species diversity between zones were not significant at $P<0.05$ level of significance (P value =0.0013), F value (8.413) and R-squared value (0.7781). Bonferroni's Multiple Comparison Test (BMCT) results show that the mean differences of ant species density between months were found significant at ($P<0.05$) level of significance; these results indicate that each species prefers its own food choice and selective habitat in the college campus (PACM).

Genera *Camponotus* of Formicinae and *Trichomyrmex* of Dolichoderinae were commonly found in all the area and more localities. The genus *Pheidole* and *Camponotus* were dominant in the cultivated and Riverine area [22]. Palanichamy [23] also reported that black ant *Camponotus* sp. plays a major role in pollination of some flowering plants. Sunilkumar [24] reported that ant species richness generally increased with increase in vegetation. Rajagopal [25] recorded a total of twenty-five species of ant belonging to fourteen genera distributed in six subfamilies. This study showing that a lesser amount of ant species (10) were recorded in the zones I, II and III.

The present study shows that only two species of *Camponotus sp.* were recorded. *Camponotus* ant is called as carpenter ant because of their "Nesting Behaviors". They dwell in the tree trunks for a living and inside but do not feed on the wood [26]. Tree hollow, tree holes and dead limbs are the most common nesting site for this species [26, 28]. The carpenter ant is the most important insect pests which cause damages in the buildings. Douglas and Sudd [27] and Robinson [28] reported that majority of carpenter ant (*Camponotus* spp.) normally feed on honeydew of aphids. The same observation was reported in North America in which *Camponotus compressus* and *Camponotus sericeus* were considered as serious pests of the largest and most heterogenous ant genera in tropical and neotropical regions [28]

Oecophylla smaragdina species was rich in the coconut field in cultivated areas [25]. The same observation was reported by Kumaresan [29]. *Oecophylla smaragdina* is considered as a major pest of Coconut, Portia, Moringa, Teakwood, Mango and Citrus spp [25, 29]. Weaver ant nest are formed basically of living leaves and stem bound together with larval silk [29]. In this study, it was found that the weaver ants had their nests

hanging on the tree of Neem and Pungam, in the summer season of the PACM campus.

Gadagkar [4, 33] have sampled ant from 12 different localities in the Uttara Kannada district of Karnataka and reported 140 species of an ant under 32 genera belonging to 6 subfamilies. Anu and Sabu [30] analyzed leaf litter ant in the Wayanad region of Western Ghats and collected 22 species from 16 genera. Subfamily Formicinae was the highly spacious in evergreen forests. Bharti and Sharma [9] carried preliminary investigations on diversity and abundance of ant along an elevation gradient in Jammu-Kashmir Himalaya. They found that subfamily Myrmicinae is the most abundant, followed by Formicinae, Ponerinae, and Dolichoderinae [34]. Savitha [31] observed the response of ant to disturbance gradients in and around Bengaluru, India and estimated that ant species richness and abundance was higher in the undisturbed site.

The poorer diversity of ant was recorded in the zone-III. This may be due to the pollutants from house hold; anthropogenic activities were severely reducing the diversity of ant population. Odum [32] reported that the species diversity was greatly reduced when ant communities were subjected to periodic perturbation by a man in nature [25]. The same observation was noticed on waste and sewage that almost reduced the diversity of natural systems into which the ants are residing. Relative abundance of predatory ant of subfamilies including Formicinae and Myrmicinae were found to be dominant in Pachaiyappa's College campus (PACM), Kanchipuram (KPM).

4. Conclusion

Ants (Formicidae) are the largest family under the order Hymenoptera. They act as ecological indicators and ecosystem engineers. A total of ten species represented by eight genera and four subfamilies have been recorded from Pachaiyappa's college campus (PACM), Kanchipuram (KPM). During this study, out of four subfamilies, the Formicinae was the most dominant subfamily in terms of species richness followed by Myrmicinae, Pseudomyrmicinae, and Dolichoderinae. The ant *Camponotus* was the most species-rich genera with two species followed by Myrmicinae with three species. The species richness estimators like Chao1, Chao2, Jack knife 1 and Jack knife 2 clearly indicates the diversity uniqueness of an assemblage. All similarity indices indicate that zone-I and zone-II were similar in community composition, diversity and species richness. Ant performs many ecological roles, which are beneficial to a human being, including the suppression of insect populations. The present study will yield valuable information on ant species availability in this region. Finally, to sum up, this study provides a significant contribution in the field of Ecology.

5. Acknowledgements

We extremely thank Dr. Himender Bharti, Department of Zoology and Environmental Sciences, Punjabi University, Patiala and Dr. Preethy John, Division of Entomology, Kerala Forest Research Institute, Kerala for identification and confirmation of ant species.

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