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Seasonal diversity and temporal variation in the assemblage of ants on trees raised under urban habitat

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Abstract
The seasonal assemblage of ants and their species composition on Teak (*Tectona grandis*), Sisoo (*Dalbergia sissoo*), Neem (*Azadirachta indica*), Bahada (*Terminalia bellirica*), and Sandal wood (*Santalum album*) were studied from April'14 to February'15, in the campus of Forestry college, O.U.A.T., Bhubaneswar. In proportion to the total ants collected through bait and pitfall traps, Myrmicinae, Formicinae, Dolichoderinae, Ponerinae, and Pseudomyrmicinae constituted about 55.7%, 20.12%, 17.16%, 6.68% and 0.35%, respectively across seasons and trees studied. Irrespective of seasons, ant activity varied with the type of the tree. Myrmicine ants predominated on Sandalwood, Teak and Neem and formicine ants on bahada, while the dolichoderine ants exceptionally predominated on Sissoo. Further, ants represented by Myrmicinae were found active in all seasons excepting monsoon months, which otherwise favoured the formicinae and dolichoderinae ants. The species richness was higher in the case of Myrmicinae (10species), Formicinae (4 species) and Ponerinae (4 species). More than 12 ant species have been documented on neem, sissoo, teak and sandal wood. Among the myrmicinae ants *Crematogaster* sp., *C. soror*, *C. subnuda* and *Monomorium* sp. were populous in most seasons. Among the formicinae ants *Camponotus compressus* remained more populous from summer to post-rainy season on all trees. The odorus ants, *Tapinoma melanocephalum* (Dolichoderinae) were more populous on sissoo during July-August. The Simspon's Index of diversity (SID) also showed diversity in species composition not only with respect to trees, but also with the seasons.

Keywords: Seasonal ant diversity, species composition, species richness, urban habitat, myrmicinae ants

1. Introduction
Ants have numerous advantages that make them suitable for biodiversity and environmental monitoring studies [1]. The association and mutual interactions between ants and plants are a widespread phenomenon, with plants provided housing or food for ants meanwhile plant will receive the protection from other herbivores [2]. In ant communities, a plethora of abiotic and biotic complex factors affect the specific interactions, composition structure, and species diversity dynamic within ecosystems [3, 4]. There are three main types of ant-plant association i.e. non-myrmecophytic species, incipient myrmecophytes and obligate myrmecophytes [5]. Ant activity follows seasonal cycles that are generally correlated with physical changes in the environment, those changes mainly being temperature [6, 7] and food supply cycling [8]. In the recent past, seasonal analysis and spatial patterns were done on ground foraging ants, and it was observed a marked seasonal fluctuations [9]. Despite the crucial importance of ants and their position as keystone species in most terrestrial ecosystems, their role, ecology, and diversity dynamic patterns are not fully understood, a fact that greatly undermines their potential usefulness in agro-forest conservation and pest management programs [10]. In view of the above facts attempts have been made during 2014-15 to document the patterns of seasonal variations in ant assemblage on trees under Bhubaneswar (Odisha) climatic conditions.

2. Materials and methods
The studies were made from April'14 to February'15, in the campus of Forestry college where perennial trees like Teak (*Tectona grandis*), Sisoo (*Dalbergia sissoo*), Neem (*Azadirachta indica*), Bahada (*Terminalia bellirica*), and Sandal wood (*Santalum album*) were maintained to mimics the urban forest garden. Five trees each of the above mentioned trees were selected and ants were sampled by placing five plastic cups (6 cm in diameter and 7cm in length) half filled with water and few drops of liquid detergent around each selected tree. Plastic tubes (9cm long

and 2.5cm wide) with sugar bait (candy) were also placed in the similar fashion at each selected tree. The arboreal ants were trapped by tying plastic tubes with sugar bait to the tree trunk at a height of 6ft from the ground. The ants trapped in various traps were collected after 24 hrs of their placement. Such sampling of ants were made during April – May'14, July - August'14, October - November 14 and January - February'15 coinciding with summer, rainy, winter and spring seasons. Most of the taxa were sorted out based upon the colour, size and some basic morphological features and preserved in 70% alcohol. The sorted ant specimens were then counted and identified up to genus level (some to species level) using Trinocular zoom stereoscopic microscope (Model: BD42-A) and the keys provided by Bolton and Musthak Ali [11, 12]. The Simpson's Index of Diversity (SID) in ant species collected from various trees and in different seasons has been worked out as suggested by Dash and Patnaik [13].

3. Results and discussion

Ants sampled from April'14 to February'15, varied with the seasons and the type of trees and they were mostly represented by five distinct sub-families viz., Myrmicinae, Formicinae, Dolichoderinae, Ponerinae and Pseudomyrmicinae. In proportion to the total ants, the predominant subfamilies irrespective of seasons and trees sampled, were recorded as Myrmicinae (55.7%), Formicinae (20.12%), Dolichoderinae (17.16%), Ponerinae (6.68%) and Pseudomyrmicinae (0.35%) (Fig.1).

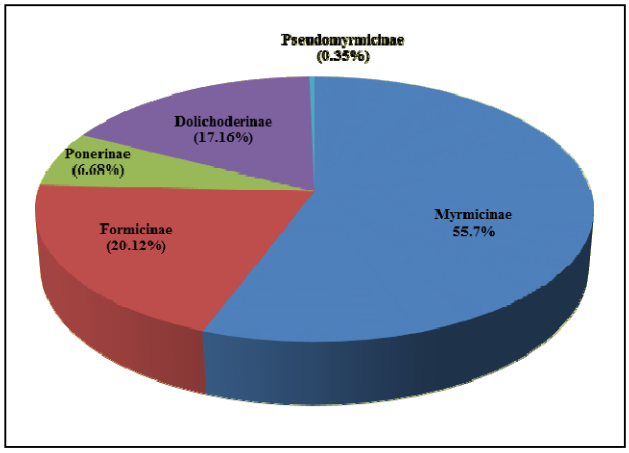

Fig 1: Predominance of ant sub-families across seasons and trees sampled

The myrmicine ants also predominated in terms of their proportion to total ants on trees *viz*., Sandalwood (15.43%), Teak (14.23%) and Neem (14.07%) irrespective of seasons, while the dolichoderine ants exceptionally predominated on Sissoo (9.35%) (Table 1). The ants represented by sub-family Ponerinae were recorded in low proportion of 0.88 -1.57% on various trees studied. The activity of pseudomyrmince ants was found to be negligible and only 0.35% of the total ants was recorded by neem.

Table 1: Relative proportion of ants represented by major sub-families in some trees at Bhubaneswar (Odisha)

Sub-family	Proportion (%) of ants on trees,				
	Neem	Teak	Bahada	Sisoo	Sandal wood
Myrmicinae	14.07	14.23	6.93	5.04	15.43
Formicinae	2.93	4.31	6.71	1.92	4.25
Ponerinae	0.88	1.29	1.57	1.57	1.35
Dolichoderinae	0.19	2.61	3.37	9.35	1.64
Pseudomyrmicinae	0.35	0.00	0.00	0.00	0.00

Irrespective of trees, the proportion of ant sub-families varied with seasons. Myrmicine ants were found to predominate constituting of 57.37, 73.78 and 71.06 % during April-May'14 October-November'14 and January-February 15, respectively (Table2). While, during rainy season their activity was found to be low and constituted only 29.80% of total ants. A higher proportion of ants belonging to Formicinae (24.65%) and Dolichoderinae (42.02%) were also noticed during rainy season. Ponerine and Pseudomyrmicine ants appeared to be active during summer and rainy seasons, respectively. In general on trees the ant assemblage irrespective of species was found to be appreciable during rainy season (29.37%) followed by summer (27.76%) and spring (22.95%). Earlier, it was observed the dominance of myrmicine ants during summer (April – May) and post rainy (October-November) seasons; formicine ants during rainy (July – August) and post rainy seasons (October-November) and dolichoderine ants during summer and rainy seasons irrespective of outdoor and indoor habitats [13]. However, it was reported that the spring season is most favourable for ant activity in both disturbed (crop fields) and undisturbed (orchard) habitats [14] which contradicts with the present findings.

The temporal changes in ant assemblages with the seasons are driven by seasonal climatic conditions [15]. Scientists had also indicated that each ant species may respond uniquely to changes in climate [16]. The species richness in undisturbed habitat like the one in the present study showed a prevalence of about 21 ant species across the seasons and trees studied which was in conformity with the early findings [14]. In general, myrmicine, formicine and ponerine ants were found speciose with 10, 4 and 4 species being documented (Table 3). This was in conformity with the early findings of Dash and Patnaik [13].

Table 2: Seasonal variation in relative proportion of ants irrespective of trees sampled

Sub-family	Proportion (%) of ants represented by sub-families, during			
	Apr- May'14	July-Aug'14	Oct-Nov.'14	Jan-Feb.15
Myrmicinae	57.37	29.80	73.78	71.06
Formicinae	19.27	24.65	17.22	17.83
Ponerinae	11.00	2.47	7.11	6.45
Dolichoderinae	12.36	42.02	1.74	4.66
Pseudomyrmicinae	0.00	1.07	0.16	0.00
Mean	27.76	29.37	19.92	22.95

Irrespective of seasons more number of species was recorded on neem (14) which was followed by sissoo (13) and while, teak and sandal wood trees recorded 12 species each. On the contrary only 10 species have been documented on bahada tree. Among the sub-families, Myrmicinae represented by 6-7 species dominated on all the trees excepting bahada (4 species). The formicine ants with 2-4 species were the next predominating in such undisturbed ecosystem across seasons.

Table 3: Sub-family wise species richness of ants on different trees, irrespective of seasons

Ant Sub-family	Species richness documented	No. of species (species richness) on trees,				
		Neem	Teak	Bahada	Sissoo	Sandal wood
Myrmicinae	10	6	6	4	7	6
Formicinae	4	4	3	3	2	3
Ponerinae	4	2	2	2	3	2
Dolichoderinae	2	1	1	1	1	1
Pseudomyrmicinae	1	1	0	0	0	0
Total	21	14	12	10	13	12

The sub-family Myrmicinae was represented by 10 species out which *Crematogaster* sp., *C. soror*, *C. subnuda* and *Monomorium* sp. were populous in most seasons. The peak population of these ant species varied with the seasons and trees. In January-February, *Crematogaster* sp. population dominated on bahada, while in April-May it dominated on teak and in October-November on neem and sandal wood. Similarly, peak activity of *C.soror* (January-February), *C. subnuda* (January-February) and *Monomorium* sp. (January-February and April-May) were noticed on teak, sissoo and bahada, respectively. Among the formicine ants *C. compressus* remained more populous from summer to post-rainy season on all trees. The activity of ponerine ant species *Diacamma rugosum* was recorded on bahada (Jan-Feb.), sissoo (July-Aug.) and neem (Oct.-Nov.), while that of *Pachycondyla* sp. on sandal wood (April-May) and teak (Oct.-Nov.). Two out of five ponerine ant species *viz*., *Pachycondyla sulcata* and *Diacamma rugosm* predominated at Bhubaneswar, Odisha [13, 14]. The odorus ants, *Tapinoma melanocephalum* (Dolichoderinae) was noticed on almost all tree species studied, but it was recorded as populous on sissoo during July-August. According to Bharti four ant species namely *Monomorium pharaonis, M. indicum, P. longicornis* and *T. melanocephalum* have emerged as weedy species in India with few more turning to be notorious as well [17]. *Paratrechina* spp. and *T. melanocephalum*, were reported to occur abundantly in indoor habitats during monsoon and summer months, respectively [13]. However, in the present investigations *T. melanocephalum* occurred on different trees in outdoor habitat during monsoon months which need due attention.

The species richness with respect to seasons showed variation in species composition of ants on different trees. Appreciable species richness on sissoo (9 species), bahada (7 species), neem (7species), and teak (7 species) were found during January-February, April—May, July-August and October-November, respectively (Table 4). However, Patnaik and his co-worker reported that in stable habitat like orchard the species richness was maximum during February-March (19 no. of species) and November-December (12 no. of species) at Bhubaneswar [14].

Table 4: Seasonal variation in species richness of ants

Tree	No. of species (species richness), during				Total species recorded
	Jan-Feb	Apr-May	July-Aug	Oct-Nov	
Neem	6	5	7	5	14
Teak	7	5	3	7	12
Bahada	8	7	6	3	10
Sissoo	9	6	3	6	13
Sandal wood	6	5	5	4	12

The composition of ant species is unique to each habitat, and most likely governed by the vegetation, biota around it, soil characteristic and anthropogenic disturbances [18, 19]. Keroumi and his co-worker indicated that higher abundance and richness values occurred in the dry period of the year [10]. On the contrary, while observing ants in Mukurthi National Park. Selvam and his co-worker revealed that the Pre-monsoon (March- May) and South West monsoon seasons (June-August) are highly preferred by most of the ant species [20].

The diversity in species composition as indicated from the species diversity indices like Simspon's Index of diversity (SID) showed variation with respect to trees and seasons (Table 5). Relatively high SID values (0.80 – 0.83) indicated diversity in species composition of ants found on teak, bahada and sandal wood. Similarly, high diversity (SID=>0.80) in ant species was noticed in Jan.- Feb. as compared to other periods.

Table 5: Diversity in ant ant community with respect to seasons and trees

Tree	Simpson's Index of Diversity (SID)				
	JAN-FEB	APR-MAY	JULY-AUG	OCT-NOV	Overall
Neem	0.61	0.76	0.74	0.23	0.75
Teak	0.57	0.69	0.65	0.76	0.83
Bahada	0.82	0.75	0.73	0.44	0.83
Sissoo	0.81	0.62	0.28	0.78	0.70
Sandal wood	0.65	0.69	0.74	0.31	0.80

4. Conclusion

The diversity dynamic patterns of ants on various trees in urban habitat as observed in the present investigation indicated absence of anthropogenic pressures. So it was suggested to maintain a variety of habitat types in order to conserve the high species richness in urban areas.

5. Acknowledgements

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6. References

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