Uttar Pradesh Journal of Zoology

Volume 46, Issue 1, Page 171-176, 2025; Article no.UPJOZ.4519
ISSN: 0256-971X (P)

Observations on the Composition and Diversity of Ant Communities in Different Habitats in a Campus Ecosystem

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: https://doi.org/10.56557/upjoz/2025/v46i14752

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.mbimph.com/review-history/4519

Original Research Article

Received: 03/11/2024
Accepted: 06/01/2025
Published: 11/01/2025

ABSTRACT

Ants are more sensitive to ecosystem changes and their fast response to habitat alterations enable them as a useful tool for natural areas restoration efforts. A preliminary investigation was conducted to determine the diversity and distribution of ants from various habitats selected across the campus of Sree Narayana College, Thiruvananthapuram, Kerala State. A total of seventeen species belonging to four subfamilies, fourteen genera and 234 individuals were collected. The subfamily

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Cite as: *Swapna, S., R.P. Athira, A.S. Adarsh, S. Parvathy, and M. Solih. 2025. "Observations on the Composition and Diversity of Ant Communities in Different Habitats in a Campus Ecosystem". UTTAR PRADESH JOURNAL OF ZOOLOGY 46 (1):171-76. https://doi.org/10.56557/upjoz/2025/v46i14752.*

Myrmicinae is the most diverse followed by Formicinae, Ponerinae and Dolichoderinae. In the present study, Diversity Index, Dominance index and Evenness index of ant species were determined. Diversity varied from 0.49 to 0.82 indicating low diversity. Dominance index value ranged from 0.17 to 0.47 while Evenness index value from 0.63 to 0.92. The results showed low diversity and dominance of ant species in the campus area indicating the severity of human interference in the campus ecosystem.

Keywords: Ant communities; diversity index; dominance index; evenness index; human impact.

1. INTRODUCTION

One of the greatest marvels of living world is insects starting from a single simple form, evolved into multitude and diversity of species found in the world today (Nayar et al., 1983). They are highly specialised group of invertebrates belonging to the largest animal phyla, the Arthropoda (Chetan & Revathi, 2024). Insects encompass remarkable diversity and dominance (Oliver & Beattie, 1996). Order Hymenoptera in the insect class comprises ants, wasps and bees. Evaluation of environment based on assessing the biodiversity of arthropods are well established (Hoffman& Anderson, 2003). While studying the species diversity, ants had many advantages among other arthropod groups. They are eusocial insects exhibiting wide geographical distribution and contribute significantly to terrestrial animal biomass. Ants are ecologically significant invertebrates that positively affect physical and chemical properties of soil as well as distribution of organisms. They are ubiquitous organisms living in natural habitats as species markers (Ross, 1964), pollinators (Hernandez, 2005), bioindicators (Bokl et al., 2015). Ants are highly responsive to human impact and in altered habitats their diversity and richness seems to be reduced. Ant communities depend on moisture, structure and temperature of soil as well as other invertebrate population and vegetation structure. Their abundance and stability and complex interactions with rest of the ecosystem, they are often considered as bio indicators of environmental alterations. Many authors have elucidated the species assemblage and community structure of ants (Javid et al. 2019; Kayoum et al. 2023; Barton et al. 2024). Urban biodiversity research, conservation and education can be apprehended by exploring university as well as college campuses. Ant diversity is an interesting topic among faunal exploration in campuses for biologists. Many authors previously studied the ant diversity in various campuses across India (Khan, 2018; Antony et al. 2021; Gnanamani et al.2023). Objective of the present investigation was to determine the species diversity, dominance and richness index of ant communities across the different habitats in Sree Narayana College, Campus.

2. MATERIALS AND METHODOLOGY

Present study was carried out in the Sree Narayana College Campus (8.5681° N, 76.9101° E) in Thiruvananthapuram District, Kerala State. Ants were collected from different sites in the campus representing different habitats ie Site 1 (Garden), Site 2 (Banana Plantation), Site 3 (Damp Area), Site 4 (De-vegetated area) and Site 5(Garbage Area). Pitfall trap as well as hand picking methods were employed for ant collection. Collected specimens were preserved in 70% ethyl alcohol and were identified using identification keys (Bingham, 1903; Bolton, 1994).

2.1 Community Analysis

Diversity index (H') was calculated with the following equation (Odum, 1971):

$$H' = -\sum \left(\frac{ni}{N}\right) log \left(\frac{ni}{N}\right)$$

Where ni- number of individuals in each species
N- Total number of individuals

Dominance index was calculated using the equation (Odum, 1971):

$$c = \sum \left(\frac{ni}{N}\right)^2$$

Evenness index was calculated using the formula (Odum, 1971):

$$E = \frac{H'}{\log S}$$

Where S- number of species

3. RESULTS AND DISCUSSION

Ants are ideal invertebrates to study species diversity and community ecology (Alyssa et al., 2019). A total of seventeen ant species belonging

to four subfamilies and fourteen genera and 234 individuals were collected from five different habitats across the campus of Sree Narayana College (Tables 1-5). Subfamily Myrmicinae is species rich with 7 species, followed by Formicinae 5 species, Ponerinae 3 species and Dolichoderinae with 2 species. Present study results are similar to previous studies (Herwina et al., 2020). Ant species showed difference in distribution because of the alterations in habitat conditions such as temperature, availability of food, microhabitat structure and nest site availability. The number of ants collected from Site 5 was highest (52) followed by Site 3 with 51 individuals, Site 4 and 1 (with 48 individuals) and least number of ants were collected from Site 2.

Table 1. Ant species collected from Site 1 (Garden)

SL No.	Sub-Family	Genus	Species
1	Formicinae	*Camponotus*	*C. rufoglaucus* (Jerdon, 1851)
2		*Oecophylla*	*O. smaragdina* ((Fabricius, 1775)
3	Myrmicinae	*Pheidole*	*P. (minor)* (Westwood,1839)
4		*Meranoplus*	*M. bicolour* (Guerin- Meneville, 1844)
5		*Tetramorium*	*T. obesum* (Andre, 1887)
6	Ponerinae	*Diacamma*	*D. rugosum* (Le Guillou, 1842)
7	Dolichoderinae	*Tapinoma*	*T. indicum* (Forel, 1895)
8			*T. melanocephalum* (Fabricius, 1793)

Table 2. Ant species collected from Site 2 (Banana Plantation)

SL No.	Sub-Family	Genus	Species
1	Formicinae	*Camponotus*	*C. rufoglaucus* (Jerdon, 1851)
2		*Oecophylla*	*O. smaragdina* (Fabricius, 1775)
3		*Plagiolepis*	*sp.* (Mayr, 1861)
4	Myrmicinae	*Pheidole*	*P. (minor)* (Westwood,1839)
5		*Meranoplus*	*M. bicolor* (Guerin- Meneville, 1844)
6		*Tetramorium*	*T.obesum* (Andre, 1887)
7	Ponerinae	*Diacamma*	*D. rugosum* (Le Guillou, 1842)
8	Dolichoderinae	*Tapinoma*	*T. indicum* (Forel, 1895)

Table 3. Ant species collected from Site 3 (Damp area)

SL No.	Sub-Family	Genus	Species
1	Formicinae	*Nylanderia*	*N. birmana* (Forel, 1902)
2		*Plagiolepis*	*sp.* (Mayr, 1861)
3	Myrmicinae	*Crematogaster*	*sp.* (Lund, *1831)*
4		*C. dohrni*	*C. dohrni* (Mayr, 1879)
5		*Pheidole*	*P.(minor)* (Westwood,1839)
6		*Monomorium*	*M.bicolor*(Guerin- Meneville, 1844)
7	Ponerinae	*Leptogenys*	*L. peuqueti* (Andre, 1877)

Table 4. Ant species collected from Site 4 (De-vegetated area)

SL No.	Sub-Family	Genus	Species
1	Formicinae	*Anoplolepis*	*A. gracilipes* (Smith, 1857)
2		*Nylanderia*	*N. birmana* (Forel, 1902)
3	Myrmicinae	*Pheidole*	*P. (minor)* (Westwood,1839)
4		*Monomorium*	*M. bicolor* (Guerin- Meneville, 1844)
5		*Tetramorium*	*T. lanuginosum* (Mayr, 1870)
6	Ponerinae	*Diacamma*	*D. rugosum* (Le Guillou, 1842)
7		*Odontomachus*	*O. simillimus* (Smith, 1858)

Table 5. Ant species collected from Site 5 (Garbage area)

SL No.	Sub-Family	Genus	Species
1	Formicinae	*Anoplolepis*	*A. gracilipes* (Smith, 1857)
2		*Nylanderia*	*N. birmana* (Forel, 1902)
3	Myrmicinae	*Pheidole*	*P. (minor)* (Westwood,1839)
4		*Monomorium*	*M. bicolur* (Guerin- Meneville, 1844)
5	Ponerinae	*Odontomachus*	*O. simillimus* (Smith, 1858)
6	Dolichoderinae	*Tapinoma*	*T. melanocephalum* (Fabricius, 1793)

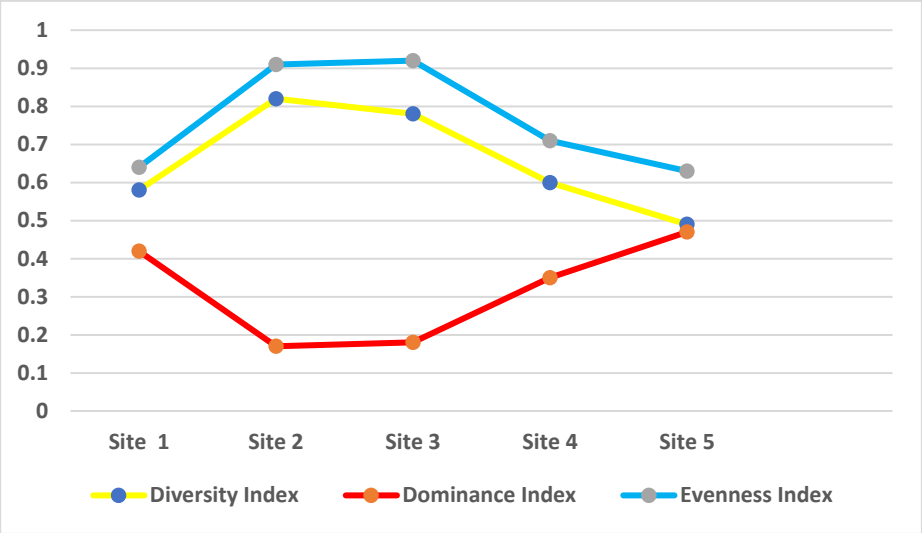

Fig. 1. Diversity, Dominance and Evenness index of ant community

Ant communities are susceptible to environmental alterations. Their abundance and distribution are invariably related to soil structure and moisture conditions as well as vegetation structure (Wang et al., 2000). Because of their complex interactions with the rest of the ecosystem, ants are often considered as bio indicators. Diversity index is a quantitative measure that describes the amount of species diversity in a specific area. Species diversity of community can be categorised as follows; H'>3-extreamly high species diversity; between 1.6 and 3 high species diversity; between 1 and 1.5 moderate diversity; and if H'<1, low diversity. In the present study, the diversity index (H') varied from 0.49 to 0.82, hence low diversity (Fig. 1). Highest diversity index (0.82) was observed at Site 2 (Banana plantation) followed by Site 3 (Damp area) with 0.78, Site 4 (De-vegetated area) with 0.60, Site 1 (Garden) with 0.58. Lowest diversity index was at Site 5 (Garbage area) with 0.49. Lowest species number and abundance recorded at Site 5, garbage area could be attributed to the change in microenvironmental factors like vegetation, soil structure etc (Bokl et al., 2015). Ecosystem stability is closely related to diversity, in a stable ecosystem diversity level is tend to be high, while disturbed ecosystem shows low level of diversity (Odum, 1971).

Dominance index value varied from 0.17 to 0.47. Dominance index is categorised as follows; dominance index value 0.50 indicate no species dominance; 0.50 to 0.75 indicate moderate dominance; 0.75 to 1.0 high dominance. Site 5 had the highest value (0.47) followed by Site 1(0.42), Site 4 (0.35), Site 3 (0.18), and lowest value at Site 2 (0.17). Accordingly, no specific species dominance was observed in the study area. Evenness index value is limited between 0 to 1. In the present study, the value varied from 0.63 to 0.92.

In terms of numerical abundance, *Anoplolepis gracilipes* peaked with 34 individuals at Site 5, while Pheidole (minor) ranked in second position with 30 and 26 individuals at Site 1 and 4 respectively. Lowest abundance value of 1 individual was for following species, *Tetramorium lanuginosum* at Site 4, *T. obesum* at Site 1 and 2;

Leptogenys peuqueti at Site 3 and *Tapinoma indicum* at Site 1. Ant species showed variable association with the habitat selected for the study. Difference in microhabitats along with the specific foraging behaviour could be attributed to the variation in ant species at the study sites (Herwina et al., 2018).

A. gracilipes were collected numerous numbers from garbage area. This is a widely distributed invasive species globally spread through human mediated pathways (Lee & Yang, 2022). This species prefers warm and humid areas and thrive well in highly disturbed habitats. It has been listed as one among 100 worst invasive alien species by IUCN. Species such as *Pheidole*, was collected from all the habitat types. Further their density was maximum at disturbed areas Site 1 and 4. The species had wide tolerance of environmental conditions (Correa et al., 2006) hence predominant in all terrestrial ecosystem. Garden and de-vegetated areas represent frequently disturbed habitats in the campus. Thus, the species abundance in different habitats helps us to assess how severely microhabitats are altered by human interactions relative to natural state. Abundance and distribution of ants are invariably related to soil structure and moisture conditions as well as vegetation structure. Because of their complex interactions with the rest of the ecosystem, ants are often considered as bio indicators. Studies on spatial distribution clearly reflect the impact of anthropogenic activities on species diversity, dominance and richness of ant communities. This preliminary investigation can provide a baseline data for myrmecologists for conservation planning.

4. CONCLUSION

Ants are highly susceptible to habitat changes hence suitable as bioindicator species for biodiversity studies as well as for soil ecosystems. Collection of seventeen ant species from five different sites in the campus showed that ant communities are different among the habitats. Myrmicinae subfamily was most diverse. Further certain species of ants were found in greater number in habitats providing enough food, soil water content, temperature etc. Species diversity, dominance and evenness values were low owing to the severe human interferences in the habitats selected.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Authors hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

ACKNOWLEDGEMENT

The authors express their gratitude to the Department of Zoology, Sree Narayana College for providing facility for carrying out this research work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://prh.mbimph.com/review-history/4519