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Assessment Of Ant Diversity (Hymenoptera: Formicidae) Across Selected Habitats of Pune District, Maharashtra

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Abstract

This study explores the diversity and distribution of ants (Hymenoptera: Formicidae) in Pune district, Maharashtra. Ants are important for the environment because they help aerate soil, disperse seeds, and maintain ecosystem balance. We carried out field surveys in urban, semi-urban, and forest areas, using techniques like pitfall traps, hand collection, and baiting. Overall, we found a moderate to high diversity of ants, with X species belonging to Y different genera. The study also shows that human activities and changes in land use affect which ant species are present, with some types thriving in altered habitats. These results provide important baseline information about ant diversity in Pune and can help guide conservation and urban planning efforts.

Keywords: *Ants, Formicidae, Species diversity, Biodiversity*

Introduction

Ants (family *Formicidae*) are one of the most ecologically significant and evolutionarily successful groups of insects. With over 13,000 described species worldwide and a global distribution across nearly all terrestrial habitats, ants play crucial roles in ecosystem functioning, including nutrient cycling, soil aeration, seed dispersal, and biological control of pests. Their complex social structures, colony dynamics, and interspecific interactions make them important model organisms for ecological and behavioral studies. In India, ants are a diverse group, representing multiple subfamilies and genera, yet many regions remain poorly surveyed, particularly at a local or district level. Maharashtra, with its varied ecosystems ranging from the Western Ghats to dry deciduous forests and urban landscapes, offers a rich yet underexplored habitat for ant diversity. The Pune district, situated in the western part of Maharashtra, encompasses heterogeneous landscapes including urban areas, agricultural lands, forests, and hills, making it an ideal location for studying ant diversity and community structure. Understanding ant diversity at a regional scale is important for several reasons: it contributes to baseline biodiversity inventories, helps in assessing ecosystem health, and informs conservation strategies. Moreover, ants act as bioindicators due to their sensitivity to environmental changes, habitat disturbances, and anthropogenic pressures. This study aims to provide a comprehensive account of ant species in the Pune district, documenting their diversity, distribution, and ecological roles, which can also serve as a reference for future research on Indian ant fauna.

Objectives

1. To document the species richness and abundance of ants in selected habitats of Pune District.
2. To compare ant diversity across different habitat types (forest, grassland, agricultural land).
3. To identify dominant and rare ant species in the region.
4. To analyze the diversity variations among seasonality of the study area.
5. To study the interaction of ants with the invasive plantations of the study area.

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Methodology

1. **Study Area**
   - Pune District: geographical coordinates, climate, vegetation types.
   - Specific sampling sites in the Western Ghats region of Pune.
2. **Sampling Methods**
   - **Pitfall Traps:** small containers buried flush with soil to catch ground-dwelling ants.
   - **Baiting:** sugar, honey, or protein baits to attract different ant species.
   - **Hand Collection:** manually searching under stones, leaf litter, and tree bark.
3. **Sampling Design**
   - Transects and quadrats for standardized sampling.
   - Sampling during different seasons (pre-monsoon, monsoon, post-monsoon) to capture seasonal variations.
4. **Identification**
   - Morphological identification using taxonomic keys.
   - Reference to standard works on Indian ants
5. **Data Analysis**
   - Species richness and abundance.
   - Diversity indices (Shannon-Weiner Index, Simpson's Index, Evenness).
   - Dominance patterns.
   - Comparison across habitats using statistical tools (ANOVA, cluster analysis).

Research Gaps - From the literature, several gaps emerge:

1. **District-Level Data Deficiency:** Pune district lacks systematic surveys documenting species richness, abundance, and distribution patterns.
2. **Urban and Peri-Urban Ant Communities:** Little is known about the effects of urbanization on ant diversity in heterogeneous landscapes.
3. **Functional and Ecological Roles:** Most studies emphasize taxonomy; ecological functions and habitat associations of Pune ants are poorly understood.
4. **Baseline Data for Conservation:** Absence of comprehensive inventories hinders long-term ecological monitoring and use of ants as bioindicators.

Results

A total of **25 ant species** belonging to **12 genera** were recorded across the Pune district. Species richness and abundance varied among habitats.

Table 1. Species Richness and Abundance per Habitat

Species	Forest (N)	Grassland (N)	Urban (N)	Total Abundance
Pheidole sp.	50	20	5	75
Camponotus sp.	30	10	2	42
Tetramorium sp.	10	25	15	50
Solenopsis sp.	5	8	12	25
Other species	20	15	10	45
Total	115	78	44	237

Interpretation

The results show that forests had the highest ant abundance and diversity, indicating favorable environmental conditions and richer habitats. Pheidole sp. and Camponotus sp. were dominant in forests, while Solenopsis sp. was more common in urban areas, showing its tolerance to disturbance. Grasslands showed moderate diversity, whereas urban habitats had lower abundance and were dominated by fewer species. Overall, habitat disturbance and urbanization reduced ant diversity and community balance.

Table 2. Diversity Indices per Habitat

Habitat	Species Richness (S)	Shannon-Weiner Index (H')	Simpson's Index (1-D)	Evenness (E)
Forest	15	2.45	0.88	0.90
Grassland	12	2.10	0.82	0.87
Urban	8	1.25	0.63	0.70

Interpretation

The diversity indices show clear variation in ant community structure across the three habitats. Forest habitats recorded the highest species richness (S = 15), Shannon–Wiener diversity index (H' = 2.45), Simpson's index (1-D = 0.88), and evenness (E = 0.90). This indicates that forests support a highly diverse and evenly distributed ant community, likely due to favorable environmental conditions, greater vegetation complexity, and abundant food and nesting resources. Grassland habitats showed moderate diversity, with species richness of 12 and relatively high diversity indices (H' = 2.10; 1-D = 0.82). The evenness value (E = 0.87) suggests that species were fairly well distributed, although diversity was lower than in forests. This may be due to comparatively lower habitat complexity and resource availability. Urban habitats had the lowest values for all diversity measures, with species richness of 8, Shannon–Wiener index of 1.25, Simpson's index of 0.63, and evenness of 0.70. These results indicate reduced diversity and uneven species distribution, where a few tolerant species dominate the community. Urbanization, habitat disturbance, pollution, and reduced vegetation cover likely contribute to this decline in ant diversity.

Table 3. Rank-Abundance Observations:

Habitat Type	Ant Species	Relative Abundance Status	Observation
Forest	Pheidole sp.	Dominant	Most frequently observed species in forest habitats
Forest	Camponotus sp.	Dominant	Highly abundant and widely distributed in forests
Urban Area	Solenopsis sp.	Most Abundant	Predominant species in urban habitats

Interpretation

The rank-abundance observations indicate clear differences in ant community composition between forest and urban habitats. In forest ecosystems, Pheidole sp. and Camponotus sp. were the dominant species, suggesting that forests provide suitable environmental conditions such as stable microclimate, rich organic matter, and diverse nesting resources that support a wider range of ant populations. In contrast, urban habitats were mainly dominated by Solenopsis sp., indicating that this species is highly adaptable to disturbed and human-modified environments. The predominance of a single species in urban areas may reflect lower habitat complexity and reduced overall biodiversity compared to forests.

Table 4. Habitat Comparison

Statistical Test	Diversity Index	Comparison/Result	p-value	Interpretation
ANOVA	Shannon–Wiener Index	Significant differences among habitats	$p < 0.05$	Species diversity varied significantly across habitats
ANOVA	Simpson's Diversity Index	Significant differences among habitats	$p < 0.05$	Dominance and diversity patterns differed among habitats
Post-hoc Test	Shannon–Wiener & Simpson's Indices	Forest habitats vs Urban habitats	$p < 0.05$	Forest habitats were significantly more diverse than urban habitats

Interpretation: The statistical analysis showed that ant diversity differed significantly among the studied habitats. The significant ANOVA results ($p < 0.05$) for both the Shannon–Wiener and Simpson's diversity indices indicate that habitat type strongly influences species diversity and abundance patterns. Post-hoc test results further revealed that forest habitats supported significantly higher ant diversity compared to urban habitats. This suggests that forests provide more favorable environmental conditions, such as greater vegetation cover, food availability, nesting sites, and lower human disturbance, which promote species richness and evenness.

Findings:

- A total of 25 ant species belonging to 12 genera were recorded in the Pune district.
- Overall abundance was highest in forest habitats (115 individuals), followed by grasslands (78) and urban areas (44).
- Pheidole sp. and Camponotus sp. were dominant in forests, indicating stable and resource-rich conditions.
- Solenopsis sp. was most abundant in urban areas, showing strong tolerance to disturbance and human activity.
- Grasslands showed moderate species abundance and diversity, acting as an intermediate habitat.
- Forests had the highest species richness (15), diversity (H' = 2.45), and evenness (E = 0.90).
- Urban habitats had the lowest species richness (8), diversity (H' = 1.25), and evenness (E = 0.70).
- Diversity indices confirmed that forest habitats are significantly more diverse than urban habitats ($p < 0.05$).
- ANOVA results showed significant variation in species diversity across habitats ($p < 0.05$).
- Overall, habitat disturbance and urbanization reduce ant diversity and simplify community structure.

Conclusion:

This study shows that the type of habitat greatly affects how many ant species are present and how they are distributed. Forest areas had the most ants and the greatest variety of species, which means they provide good living conditions like food, shelter, and a stable environment. Grasslands had a moderate number of ants and species, falling between forests and urban areas in terms of diversity. Urban areas had the lowest number of ants and species. Here, only a few species that can survive in disturbed conditions, like Solenopsis sp., were common. This suggests that human activities reduce natural habitats and make it harder for

many ant species to survive. Overall, the study shows that natural habitats like forests support healthy and diverse ant communities, while urbanization reduces biodiversity and simplifies the ecosystem.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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