Open Access Research Journal of
Multidisciplinary Studies
Journals home page: https://oarjpublication/journals/oarjms/
ISSN: 2783-0268 (Online)

OARJ OPEN ACCESS RESEARCH JOURNALS

(RESEARCH ARTICLE)

Check for updates

Species Diversity and Community Composition of Ants (Hymenoptera: Formicidae) in Muhammad Sabki Urban Forest Park, Jambi City

Amirul Vickri, Asni Johari *, Anggit Prima Nugraha and Tia Wulandari

Department of Mathematics and Natural Sciences, Jambi University, Jl. Raya Jambi-Ma, Bulian, KM 15, Mendalo Darat, Jambi, Indonesia.

Open Access Research Journal of Multidisciplinary Studies, 2025, 10(02), 036-042

Publication history: Received on 14 September 2025; revised on 22 October 2025; accepted on 25 October 2025

Article DOI: https://doi.org/10.53022/oarjms.2025.10.2.0048

Abstract

Muhammad Sabki Urban Forest Park is an urban green area divided into three utilization zones: high, medium, and low. Variations in land-use intensity among these zones may influence habitat conditions and the diversity of organisms, including ant communities. This study aimed to identify ant species, analyze diversity, evenness, and dominance indices, and describe the level of ant diversity (Hymenoptera: Formicidae) in Muhammad Sabki Urban Forest Park. The research was conducted from April to July 2025, covering field sampling and data analysis at the Laboratory of the Faculty of Science and Technology, Jambi University. Sampling was carried out using a purposive sampling method in two zones medium and low utilization areas. Ants were collected using pitfall traps, bait traps, and active sampling with a Berlese-Tullgren funnel. The results revealed four subfamilies comprising 21 species with a total of 3,819 individuals. The species diversity index (H') was 1.87, indicating a moderate level of diversity; the evenness index (E) was 0.61, classified as high; and the dominance index (D) was 0.25, categorized as low. The ant community in Muhammad Sabki Urban Forest Park was relatively stable and dominated by the subfamily Formicinae, particularly *Formica gagates*. Principal Component Analysis (PCA) indicated that air humidity and soil temperature were the most significant environmental factors influencing ant diversity. Overall, environmental conditions in Muhammad Sabki Urban Forest Park were within the optimal range for ant activity and reproduction in tropical regions.

Keywords: Ant Diversity; Formicidae; Muhammad Sabki Urban Forest Park; Urban Ecology; Jambi

1. Introduction

Ants (Hymenoptera: Formicidae) are social insects commonly found in various terrestrial habitats, including urban forests. According to [1], ants are among the most abundant terrestrial organisms, excluding polar regions. In natural ecosystems, ants play vital roles as predators, decomposers, seed dispersers, and soil aerators that maintain ecological balance. Their high sensitivity to environmental changes makes them effective biological indicators for assessing ecosystem conditions [2]. Therefore, studying ant diversity in urban forest ecosystems is important to understand their ecological stability.

Muhammad Sabki Urban Forest Park is a green open space in Jambi City that serves as an area for environmental education and ecotourism, as designated by Jambi City Regulation No. 7 of 2009. The park is managed by the Urban Forest Technical Management Unit under the Department of Environment and maintains relatively natural ecosystems that support diverse flora and fauna [3]. Several entomological studies have been conducted in this area, including research on termite nests [4], butterfly diversity [5], and the morphological study of *Euborellia arcanum* [6]. However, information regarding the diversity and composition of ants (Formicidae) in Muhammad Sabki Urban Forest Park remains limited.

* Corresponding author: Asni Johari

The Muhammad Sabki Urban Forest Park area is divided into three utilization zones—high, medium, and low—each differing in land-use intensity and vegetation structure [6]. These differences may influence habitat conditions and insect community composition. According to [7], ant distribution is affected by land-use type, food availability, nesting sites, and environmental factors. Habitat disturbances may reduce species diversity and disrupt ecological functions [8]. Based on these considerations, this study aims to examine the relationship between habitat types and the diversity of ant species in Muhammad Sabki Urban Forest Park, Jambi City

2. Materials and Methods

This research was conducted at the Muhammad Sabki Urban Forest Park in Jambi City from March to May 2025. The study included field sampling and subsequent laboratory analysis. Specimens collected from the field were identified at the Biology Laboratory, Faculty of Science and Technology, Jambi University. This study employed a descriptive quantitative design aimed at describing the diversity and abundance of ant species based on field observations. Samples were collected using three methods: pitfall traps, bait traps, and active collection with a Berlese-Tullgren extractor. The collected specimens were then sorted, labeled, identified to the species level, and quantitatively analyzed. Sampling was carried out at predetermined observation points within the designated utilization zones of Muhammad Sabki Urban Forest Park. Each specimen was preserved in a sample vial containing 70% ethanol and labeled with information on location and collection date. Identification was based on morphological characteristics using appropriate taxonomic keys [9].

Data were analyzed quantitatively and descriptively by calculating several ecological indices, including the Shannon-Wiener diversity index (H'), Pielou's evenness index (E), and Simpson's dominance index (C). The Shannon-Wiener index was calculated using the formula $H' = -\Sigma (Pi \ln Pi)$, where Pi is the proportion of individuals of a species relative to the total number of individuals ($Pi = ni/N$). According to [10], an H' value greater than 3 indicates high diversity, $1 \leq H' \leq 3$ indicates moderate diversity, and $H' < 1$ indicates low diversity.

Species evenness was determined using Pielou's formula, $E = H' / \ln S$, where S is the total number of species. An evenness value (E) < 0.4 indicates low evenness, $0.4 < E \leq 0.6$ indicates moderate evenness, and $E > 0.6$ indicates high evenness [10]. The dominance index was calculated using Simpson's formula, $C = \Sigma (ni^2 / N^2)$, where ni is the number of individuals of each species and N is the total number of individuals. Based on [10], C values between 0–0.5 indicate low dominance, 0.5–0.75 indicate moderate dominance, and 0.75–1 indicate high dominance. The results were presented in tables and figures to illustrate the diversity, evenness, and dominance patterns of ant species across different habitat zones within Muhammad Sabki Urban Forest Park

3. Results

3.1. Species Composition

The results of the study conducted in the Muhammad Sabki Urban Forest Park revealed a total of 21 ant species belonging to four subfamilies, with a total of 3,819 individuals collected (Table 1). The subfamily Formicinae contributed the highest number of species and individuals, followed by Myrmicinae, Ponerinae, and Dolichoderinae. Among all species, *Formica gagates* was the most dominant with the largest number of individuals, while *Carebara pygmaea* and *Technomyrmex lisae* were represented by the fewest individuals. Although both stations exhibited variations in the number of individuals, the difference was not significant.

Table 1 Composition of Ant Species in the Muhammad Sabki Urban Forest Park

No.	Subfamily	Species	Station		Total
			I	II	
1.	Formicinae	*Polyrhachis armata*	46	63	109
		Polyrhachis cyrtoyma	0	3	3
		Polyrhachis myrma	0	14	14
		Anoplolepis gracilipes	62	158	220
		Formica gagates	721	1040	1761
		Nylenderia kraepelini	1	7	8
		Camponotus Tanaemymex	4	26	30
		Euprenolepis procera	13	0	13
		Paraparatrechina opaca	107	7	114
2.	Myrmicinae	*Cataulacus horridus*	0	4	4
		Pheidole aristotelis	197	17	214
		Acanthomyrmex ferok	1	1	2
		Pheidole ghigii	6	0	6
		Carebara pygmea	1	0	1
		Aphaenogaster feae	227	5	232
3.	Ponerinae	*Playtyhyrea clyeata*	37	8	45
		Odontomachus minangkabau	102	115	217
		Odontoponera denticulata	102	154	256
4.	Dolichoderinae	*Dolichoderus thoracicus*	220	346	566
		Tapinoma melanocephalum	0	3	3
		Technomyrmex lisae	1	0	1
Total			1848	1971	3819

3.2. Diversity Analysis

Three ecological indices were calculated to describe the structure of the ant community in Muhammad Sabki Urban Forest Park: the Shannon-Wiener diversity index (H'), Pielou's evenness index (E), and Simpson's dominance index (C). The calculated values are presented in Figure 1.

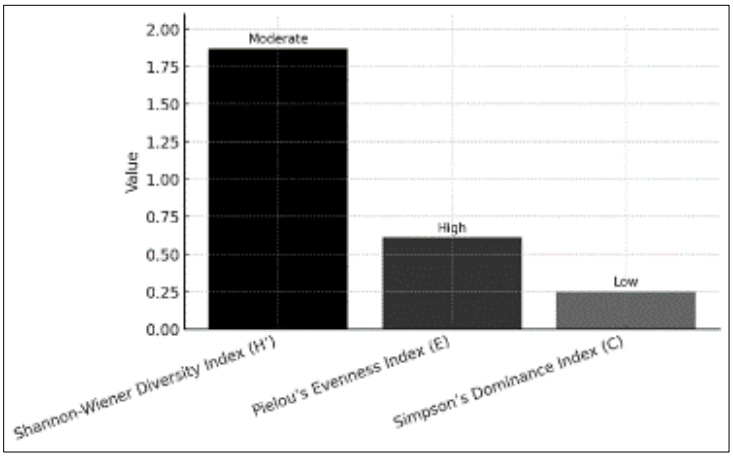

Figure 1 Biological Index Values of Ants in the Muhammad Sabki Urban Forest Park

The results show that the diversity index (H' = 1.87) falls within the moderate category, the evenness index (E = 0.61) indicates a high level of evenness, and the dominance index (C = 0.25) is classified as low. These findings suggest that the ant community in Muhammad Sabki Urban Forest Park is relatively stable, with no single species exhibiting excessive dominance, thus indicating a balanced ecosystem structure.

3.3. Environmental Parameters

The presence and diversity of ants are strongly influenced by environmental factors. The measured environmental parameters at both stations are summarized in Table 2.

Table 2 Environmental Parameters at the Muhammad Sabki Urban Forest Park

Parameter	Station		Mean ± SD
	I	II	
Soil temperature (°C)	27±1,13	26,76±0,64	26,9±0,90
Soil humidity (%)	52,57±7,75	52,43±5,86	53±6,50
Soil pH	5,07±0,55	5,15±0,67	5,1±0,59
Air temperature (°C)	28,58±2,71	29,16±1,81	28,87±2,25
Air humidity (%)	89,86±5,01	87,83±5,49	88,9±5,12
Light intensity (lux)	763,29±415,67	819±415,67	791,79±553,79

Although there were slight variations between the two stations, the differences were not statistically significant. Principal Component Analysis (PCA) was conducted using R software to assess the relationship between environmental factors and ant diversity (Figure 2)

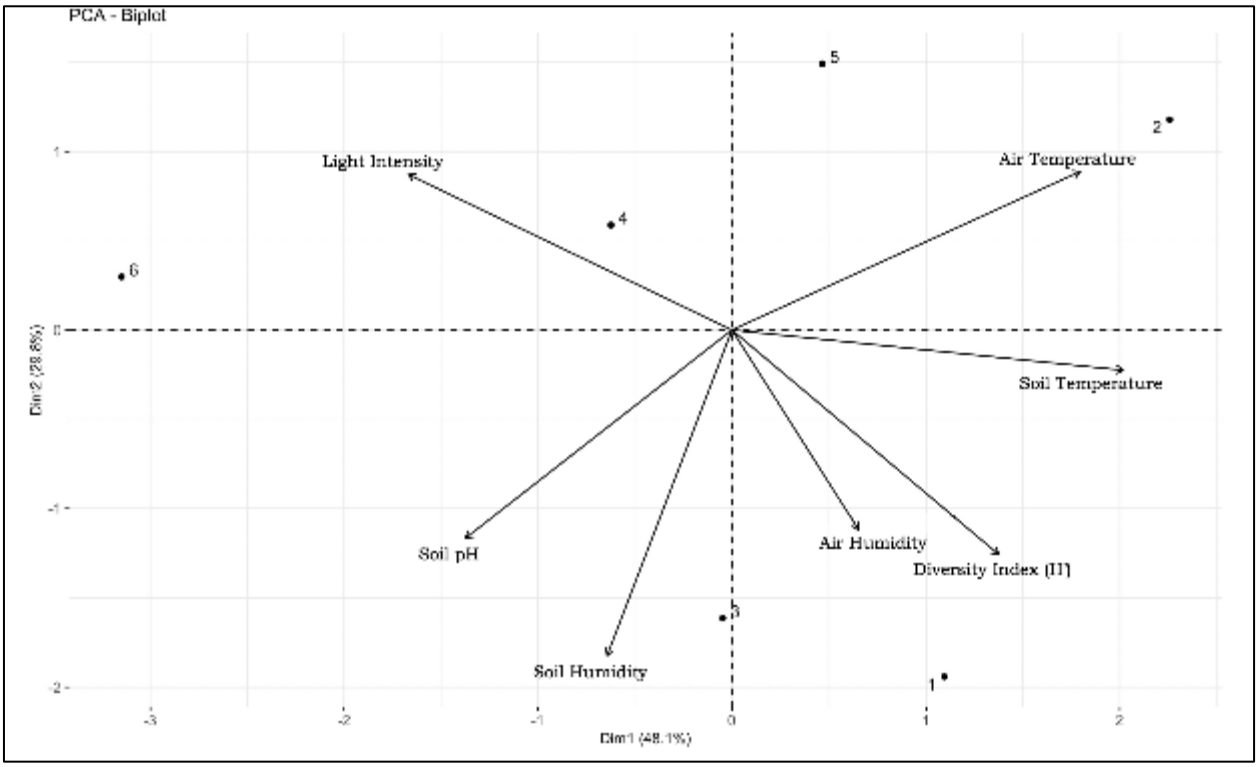

Figure 2 Principal Component Analysis (PCA) of Environmental Factors and Ant Diversity

The PCA results indicated that air humidity and soil temperature had a positive correlation with ant diversity in Muhammad Sabki Urban Forest Park. This finding suggests that optimal moisture and temperature levels play an

important role in supporting ant activity, nesting behavior, and reproduction in tropical ecosystems. Based on Figure 2, the PCA results show that air humidity and soil temperature are positively correlated with the ant diversity index in the Muhammad Sabki Urban Forest Park. This is consistent with the direction of the positive vector in the PCA diagram.

4. Discussion

4.1. Composition and Distribution of Ant Species

The study in Muhammad Sabki Urban Forest Park recorded four ant subfamilies: Formicinae, Myrmicinae, Ponerinae, and Dolichoderinae. Among them, Formicinae was the most dominant, consistent with global patterns where this subfamily comprises over 3,000 described species [11,12,13]. The species *Formica gagates* showed the highest abundance, reflecting its broad habitat tolerance and adaptability. *Formica gagates* thrives in both natural and disturbed habitats, supported by its mutualistic relationship with mealybugs that enhances colony growth [14]. Its dominance is linked to efficient foraging behavior, high adaptability, and preference for sugary food sources [15].

In contrast, *Technomyrmex lisae* and *Carebara pygmaea* were the least abundant, each found as a single individual. The rarity of *T. lisae* may be due to its canopy-dwelling habit and narrow distribution [16,17]. Its low capture rate likely reflects unsuitable ground-level habitats and sampling limitations that did not reach its preferred canopy zone.

4.1.1. Diversity Index Analysis

The ant diversity index in Muhammad Sabki Urban Forest Park (H’ = 1.87) indicates a moderate level of diversity, reflecting a relatively stable ecosystem despite the dominance of *Formica gagates*. This stability is influenced by diverse vegetation, particularly rubber trees, which provide nesting sites and food resources for genera such as *Formica*, *Camponotus*, and *Polyrhachis*. Additionally, ground-dwelling ants from the subfamily Ponerinae, such as *Odontoponera denticulata*, act as predators that help maintain ecological balance.

The evenness index (E = 0.61) was classified as high, suggesting a relatively equal distribution of individuals among species, while the dominance index (C = 0.25) was low, indicating the absence of strongly dominant species. This pattern reflects a stable ant community structure, where various species coexist and contribute to overall ecosystem balance without intense interspecific competition.

Community composition and stability in Muhammad Sabki Urban Forest Park are also shaped by interspecific competition and eusocial behavior, which establish a natural hierarchy within the community. These findings are consistent with other urban forest studies in Indonesia, showing that habitats with diverse vegetation cover tend to maintain moderate species diversity and good ecological stability.

4.2. Environmental Factors Influence

Ant diversity is strongly influenced by environmental conditions in their habitats. As small organisms sensitive to climate change, ants depend heavily on temperature, humidity, and resource availability [18]. Environmental measurements at the study site showed an average soil temperature of 26.9°C and air temperature of 28.9°C, both within the optimal range for ant activity in tropical regions [19].

Soil humidity averaged 53% and air humidity 88.9%, with a light intensity of 791.79 lux. These conditions were affected by canopy density, which increased humidity and organic matter availability as a food source. Stable humidity supports foraging activity and colony development [20]. The soil pH value of 5.1, classified as acidic, was still suitable for ants and other soil fauna [21].

Based on PCA results, air humidity and soil temperature were the most influential environmental factors affecting ant diversity at Muhammad Sabki Urban Forest Park. Both factors showed a positive correlation with the number of individuals and species, indicating that warm and humid conditions promote ant activity and reproduction [22,23,24,25,26,27].

5. Conclusion

The study conducted in Muhammad Sabki City Forest Park recorded 3,819 ant individuals (Hymenoptera: Formicidae) belonging to 4 subfamilies and 21 species. The Shannon-Wiener diversity index (H' = 1.87) indicated a moderate

diversity level, with a high evenness index (E = 0.61) and a low dominance index (C = 0.25), reflecting a relatively stable ecosystem with well-distributed species. The ant community was dominated by the subfamily Formicinae, particularly *Formica gagates*. PCA analysis revealed that air humidity and soil temperature were the most influential environmental factors affecting ant diversity, both providing optimal conditions for ant activity and reproduction in tropical habitats

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest exists among the Authors.

References

[1] Putra, I.L.I., Haris, S., and Novilia, S. 2021. Diversity of ant species (Hymenoptera: Formicidae) around campus 4 of Ahmad Dahlan University, Yogyakarta. Biospecies. 14(2): 20-30.

[2] Herwina, H., Rijal, S., and Mairawita. 2018. The Faces of Exotic Ants in the Biology Education and Research Forest (HPPB), Rajawali Pers, Depok.

[3] Sakinah, A.N., Tia, W., Dhean, P.P., dan Robet, S. 2024. The long-horn beetles (Family: Carabycidae) in the muhammad sabki city forest area, jambi city. Jurnal Biologi Tropis. 24(2b): 46-52.

[4] Johari, A., Anggun, R.A., and Tia, W. 2022. Nest types and distribution of termite (Isoptera) species in urban forests and oil palm plantations in the Jambi region. AL-KAUNIYAH: Journal of Biology. 15(2): 191-198.

[5] Rahayu, S.E., and A., Basukriadi. 2012. Abundance and diversity of butterfly species (Lepidoptera: Rhopalocera) in various habitat types in the Muhammad Sabki city forest, Jambi city. Biospecies. 5(2): 40-48.

[6] Putra, D.P., Tia, W., Audriella, N.S., dan Robet, S. 2024. Morpholgiical study of cocopet aracanum (Order: Dermaptera) in the muhammad sabki urban forest area, jambi city. Organism. 4(2). 56-62.

[7] Ruslan, H., Christina, F.R.P., and Imran, S.L.T. 2023. Description of ants in closed and open habitats in the urban forest area of the Cibubur Arboretum, East Jakarta. Biome 19. 1(1): 1-12.

[8] Maman, Y., Slamet, R., and Herlina, D. 2024. Diversity of ant species (Formicidae) in the green open space jogging track of Tanjungpura University, Pontianak City. Journal of Tropical Forest Environment. 3(2): 213-224..

[9] Fajar, A., Apriza, H.P., and Rivo, Y.V. 2019. Diversity of ant species (Hymenoptera: Formicidae) in the Guguk customary forest, Merangin district, Jambi province. Biocolony. 2(1): 32-42.

[10] Putro, H.S., Siti, M.K., and Anwari, M.S. 2021. Diversity of terrestrial ant species based on habitat type in the secondary forest of Jelimpo Village, Jelimpo District, Landak Regency. Journal of Sustainable Forestry. 9(4): 559-572.

[11] Putri, P.E., Henny, W., and Dahelmi. 2015. Inventory of Ants of the Formicinae Subfamily in the Anai Valley Nature Reserve Area, Tanah Datar Regency, West Sumatra. Andalas University Biology Journal. 4 (1): 15-25.

[12] Ward, P.S., Bonnie, B.B., and Brian, L.F. 2016. A revised phylogenetic classification of the ants subfamily formicinae (Hymenoptera: Formicinae), with resurrection of the genera Colobopsis and Dinomyrmex. Zootaxa 4072. (3): 343-357.

[13] Borowiec, M.L. 2016. Generic revision of the ant subfamily dorylinae (Hymenoptera, Formicidae). ZooKeys. 608: 1-280.

[14] Saroj, S., and Arnab, M. 2024. Mutualistic relation between Formica gagates Latreille (Hymenoptera: Formicidae) and Mealybugs in the forests of Eastern Himalayas. Zoological Survey of India. 124 (2): 163-167.

[15] Haneda, N.F., and Nisfi, Y. 2020. The role of ants in the ecosystem transformation of lowland tropical rainforests. Journal of Forestry Science. 14. 16-27.

[16] Sharaf, M.R., Hathal, M.A.D., Abdulrahman, S.A., 2018. Review of the ant genus Technomyrmex Mayr, 1872 in the Arabian Peninsula (Hymenoptera, Formicidae). Zookeys. 780: 35-59.

[17] Jaitrong, W., Zhenghui, X., and Salinee, K. 2022. A new species of the ant Platythyrea clypeata species group (Hymenoptera, Formicidae, Ponerinae) from continental Asia. Zookeys. 1115: 151-168.

[18] Haneda, N.F., and Nisfi, Y. 2015. Ant communities (Hymenoptera: Formicidae) in four different ecosystem types in Bungku Village, Jambi Province. Journal of Tropical Silviculture. 6(3): 203-209.

[19] Putra, I.M., Mochamad, H., and Rully, R. 2017. Ant Community Structure (Hymenoptera: Formicidae) in Organic and Inorganic Agricultural Land in Batur Village, Getasan District, Semarang Regency. Bioma. 19 (2): 170-176.

[20] Rosa, N., Iswan, D., and Hari, P. 2019. Ant diversity (Formicidae family) in peatlands around the new building of the Faculty of Forestry, Tanjungpura University, Pontianak. Journal of Sustainable Forestry. 7 (2): 723-732.

[21] Saputra, A., Zainal, A., and Riyanto. 2020. Behavioral Patterns of the Presence of Ants of the Formicidae Family on the Banks of the Musi Gandus River, Palembang City, South Sumatra. Journal of Tropical Biology. 20 (1): 116-124.

[22] Bulan, F.H.S., Budi, A., Rion, A., and Henri. 2024. Ant diversity (Hymenoptera: Formicidae) in Grandma's Hill, Mount Permisan Nature Tourism Park, South Bangka. Agrifor Journal. 23(1): 1-18.

[23] Johari, A. 2015. Abundance of Thrips palmi Karny and the phenomenon of Thrips sp. (Thysanoptera: Thripidae) attack as pest and virus vectorat vegetables plantation in Jambi region. ARPN J. Engg. Appl. Sci., 10: 2570-76.

[24] Johari, A., Hermanto, A.M. and Wulandari, T. 2021a. Ant diversity inhabited oil palm plantations in a peatland in Sumatra, Indonesia. Nusantara Biosci., 13: 158-63.

[25] Johari, A., Rahmah, N., Wulandari, T., Muswita. and Naswir, M. 2024a. Investigating insect pest diversity and feeding preferences on eggplants in Jambi, Indonesia. J. ent. Res., 48: 152-56.

[26] Johari, A., Fitri, F.R., Muswita, Harlis. and Yelianti, U. 2024b. Exploring the diversity of pollinator insects in cocoa agroforestry systems: an observational approach. J. ent. Res., 48: 380-83.

[27] Johari, A, Meliana Febri Syafitri, Muswita, Dara Mutiara Aswan and M. Naswir. 2025. Diversity analysis of thrips pests on eggplant in the Botanical Garden of Solok village, Muaro Jambi Regency, Indonesia: A case study of a local agroecosystem. J. ent. Res., 49(3): 706-709.