

Diversity of Ants (*Formicidae*) in the Bedengan Camping Ground Area, Malang Regency

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Received: December 18, 2024

Revised: April 14, 2025

Accepted: June 25, 2025

Published: June 30, 2025

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DOI: [10.29303/jppipa.v11i6.10094](https://doi.org/10.29303/jppipa.v11i6.10094)

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Abstract: Ant diversity (Formicidae) plays an important role in the ecosystem, especially as an environmental indicator. This study aims to identify the diversity of ant species in the Bumi Camping area, Malang Regency, East Java, and to evaluate the factors that influence it. Ants have evolved into insects that are easily found in terrestrial ecosystems. Of the total number of insect species in the world, approximately 12.000 of them are ants, most of which are spread across tropical areas. Data collection was carried out at six points around the musholla area using two trap methods, namely bait traps and fill traps. The ants caught were collected and identified using a stereo microscope, determination keys, and supporting applications. The study found 9 different ant species, including *Paratrechina longicornis*, *Camponatus atriceps*, and *Monomorium pharaonis*. The diversity of ant species is influenced by environmental factors such as altitude, humidity, and food availability. The results showed that the study area had a low diversity index value, possibly due to antibiotic factors and land conversion. This study contributes to the understanding of ant diversity in tropical areas and the importance of ant habitat conservation in forest ecosystems.

Keywords: Ant diversity; Bait traps; Camping ground; Ecosystem; Fill trap; Formicidae; Malang district

Introduction

Ants belong to the order Hymenoptera and the family formicidae, are easily recognizable animals even though there are other insects that closely resemble ants (Sujak et al., 2023). Ant colonies are divided into three castes, namely queens, males, and workers. The queen is larger than the other castes and is usually winged, although the wings are released after the mating process (Trible et al., 2023; Amiri et al., 2017; Vander Meer et al., 2021). Ants are the most dominant group of terrestrial animals in the tropics. Of the 750.000 insect species in the world, 9.500 or 1.27% of them are ants (Rakotomalala et al., 2021) and can form 15 - 25% of terrestrial animal biomass (Lawes et al., 2017). Ants are a group of land animals that dominate (Parker & Kronauer, 2021). The

diversity of ant species in tropical forests is generally influenced by many factors, including altitude. Ant diversity decreases in highland areas, while in lowland areas it increases. This is likely due to a change in the ecosystem (Kunene et al., 2022; Rubiana & Meilin, 2020).

Ants have evolved into insects that are easily found in terrestrial ecosystems. Of the total number of insect species in the world, approximately 12.000 of them are ants, most of which are spread across tropical areas (Dong et al., 2023; Siddiqui et al., 2024). The presence of ants in a habitat is influenced by several factors including temperature, humidity, altitude, nesting sites, food availability (Herwina et al., 2021), plant structure and composition, and land topography (Withaningsih et al., 2024; Chen et al., 2015; Liao et al., 2024; Lőrincz et al., 2024). Bedengan Campsite is located in Selokerto

How to Cite:

P, N. R. R., Chasanah, R. N., Arnita, Khoirina, R., Arifika, F., Safira, A., & Fardhani, I. (2025). Diversity of Ants (*Formicidae*) in the Bedengan Camping Ground Area, Malang Regency. *Jurnal Penelitian Pendidikan IPA*, 11(6), 85-94. <https://doi.org/10.29303/jppipa.v11i6.10094>

Hamlet, Selorejo Village, Dau District, Malang Regency, East Java. Bedengan is located in a highland area which is a protected forest that is used as a tourist attraction by the local community, this area has high biodiversity of both flora and fauna including ants. The results of Camargo-Vanegas et al. (2024), Subedi et al. (2021), and Castellarini et al. (2024), showed that the diversity of ants (Formicidae) in the secondary forest of Gampong Pisang, Labuhan Haji, South Aceh Regency, as a whole was found as many as 5850 individuals (Stukalyuk & Maák, 2023).

The most commonly found species are species from the subfamilies Formicinae, Myrmicinae, Ponerinae and Dolichoderinae, while the least commonly found species are species from the subfamily Pseudomyrmicinae. The Formicinae subfamily found 13 species 3179 individuals, Myrmicinae found 8 species 1452 individuals, Ponerinae found 8 species 594 individuals. Based on previous research, the study will focus on the diversity of Formicidae ants found in the Bedengan Camping Ground, Malang Regency. The purpose of this study is to determine the diversity of ants in the Bedengan camping ground area, Malang Regency.

Method

Time and Place of Implementation

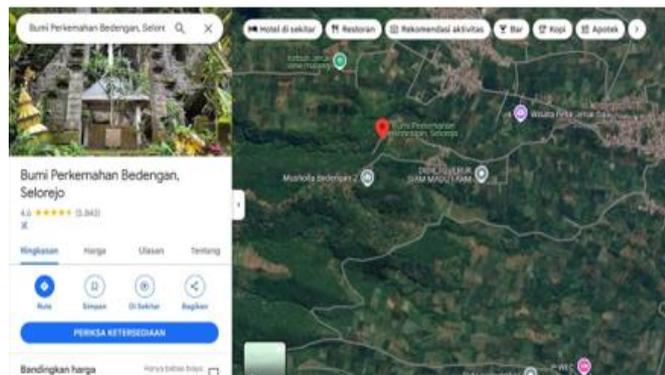


Figure 1. Bedengan



Figure 2. Map of Bedengan location



Figure 3. Mapping location

Research data collection was conducted on Sunday, November 24, 2024, between 09.00-13.00 WIB, in the prayer room area, Bumi Perkemahan Bedengan, Jalan Raya Selokerto, Godehan, Selorejo, Dau District, Malang Regency, East Java. While the identification process was carried out at the Science Education Laboratory, Faculty of Mathematics and Natural Sciences, State University of Malang.

Tools and Materials

In the study, the tools used include: Meter and rope are used to measure the distance from one point to another; Shovel is used to dig the soil; Plastic cover as a bait trap to attract ants; Plastic cup as an ant trap (fill trap); Closed container is used to store ants that have been obtained; Double tip is used as adhesive on cardboard so that ants that are already on the cardboard do not escape; Cutter or scissors to cut cardboard; Plastic is used to protect the trap from rain or other disturbances; Glass cup as a place for ants for identification; Strainer and tweezers to separate ants from dirt; Binocular and stereo microscopes; Glass slide as a place for ants to be observed under binocular microscopes, and stereo microscopes; Camera used to document ants. The materials used in this study were ants collected from the field, food ingredients in the form of bread crumbs, syrup and sweet drinks (Brichacek et al., 2024; Pérez-Lloréns et al., 2021).



Figure 4. Tools and materials

Methods and Data Analysis

The method used in this study was field research with direct location surveys. The method used was by tracing through the paths around the prayer room area at Bumi Perkemahan Bedengan. Observations were made by taking direct photos of ants that matched the characteristics of the book and journal guides. Insect sampling was carried out using two techniques, namely bait traps (bait traps) which utilize the attraction of food to attract ants, and fill traps (fill traps) which are designed to trap ants moving on the ground surface. Sampling using the bait trap technique was carried out by placing 17x12cm plastic caps at six predetermined points in the prayer room area with a distance between points of about 5 meters. Each plastic cap was coated with double tape to prevent the trapped ants from escaping. As bait, pieces of bread crumbs, syrup and sweet drinks were used which were placed on cardboard. The traps were set at 09.00 WIB and collected again at 13.00 WIB. During the data collection period, the traps were observed periodically and documented.



Figure 5. Bait trap

The captured ants were then collected in a closed container containing 70% alcohol for preservation and further identification. Identification of ant species was carried out in a science laboratory using a binocular microscope, stereo microscope, determination key, previous research journals and assisted by image recognition applications such as Google Lens as additional references. The second technique is the fill trap technique, where collecting ants with a fill trap is an effective trap for collecting ants because it can describe the abundance of individuals in a habitat. Sampling using a fill trap was carried out by digging a hole measuring 5 cm in diameter and 5 cm deep at six predetermined points in the prayer room area with a distance between points of about 5 meters. The hole was dug slightly wider than the diameter of the trap container so that the container could be inserted easily. As bait, bread crumbs, syrup and sweet drinks were poured into the trap container. The trap was set at 09.00

WIB and collected again at 13.00 WIB. During the data collection period, traps were periodically observed and documented.



Figure 6. Fill trap

The captured ants were then transferred to a closed bottle containing 70% alcohol for preservation and further identification. Identification of ant species was carried out in a science laboratory using a binocular microscope, stereo microscope, determination key, previous research journals and assisted by image recognition applications such as Google Lens as additional references. So that the total number of bait traps and fill traps is twelve. The data analysis in this study is qualitative and descriptive. The qualitative method is a method with a research procedure that produces descriptive data in the form of sentences or words written or spoken from people or behavior that can be observed. The data obtained were analyzed in depth by comparing samples with journals and previous studies with the aim of determining the diversity of ants that exist. Descriptive analysis is used to analyze data by describing the data that has been obtained as it is without intending to make conclusions that apply to the public or generalizations.

Result and Discussion

Observations of ant species identification were carried out in the beds through a descriptive qualitative approach with direct observation at the location. Observations lasted for 4 hours through 2 different methods, namely the trap method, including fill traps and bait traps. (Explanation of fill traps and bait traps + pictures). The second technique is the fill trap technique, where ants are collected using fill traps which are effective traps for collecting ants because they can describe the abundance of individuals in a habitat (Hacala et al., 2021). The method of collecting ants through fill traps is a method by making traps by making holes in the ground area using a shovel, then the

holes are given plastic cup containers. The cup container is given a sweet drink and on the walls of the container there is syrup liquid. The fill trap hole is used to trap ants that are active on the ground surface. The ants that are caught are immediately put into 70% alcohol to maintain the integrity of the ant's body and avoid decay.



Figure 7. Filltrap trap

The Bait Trap uses a container that can be a flat plate, researchers use a used food lid measuring 17 x 12 cm with food placed on the base. Ants that approach the food area will be immediately observed and put in 70% alcohol so that they are not damaged.

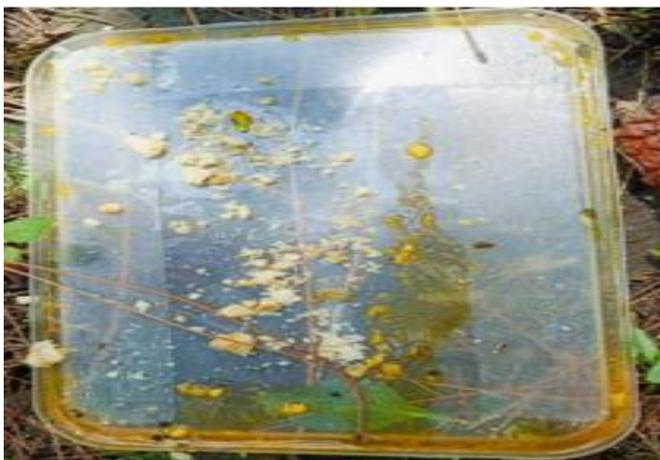


Figure 8. Bit trap

The provision of 2 types of trap methods is spread at 6 points with a distance between each point of 5 meters (Dhanaraju et al., 2022; Rother et al., 2025). At each point, 2 types of traps are given so that 12 trap results will be obtained at the 6 points. The results of the trap distribution show that each point has different species, but there are also the same types of ants at other points (Leahy et al., 2020; Houadria & Menzel, 2021). The species results obtained consist of 9 different species. The species identified after observation are paratrechina

longicornis, camponotus atriceps, polyrhachis dives, solenopsis sp, pachycondyla crassinoda, formica sanguinea, solenopsis geminata, odontoponera transversal, and monomorium pharaonis.



Figure 9. Bed ants table 1. bed ant species

Based on 6 points where traps were given, various types of ants were found. At point 1 which is closest to the prayer room area, it shows that the types of ants *Solenopsis* sp and *Paratrechina longicornis* were found.



Figure 10. Paratrechina longicornis

Solenopsis spp ants were found in fill traps, the body of this type of ant is not intact but can be identified as a type of queen ant, because it has wings and a large reddish-brown body. According to Ranny et al. (2015), the body of *Solenopsis* spp is reddish brown. Generally, these ants live in colonies of up to 100,000 individuals. Each colony of *Solenopsis* sp. led by a queen ant produces between 150 and 200 eggs every day. *Solenopsis* sp. makes mounds in open areas and is exposed to sunlight. According to (Abdullah et al., 2021), also stated that the nest of *Solenopsis* sp. ants is in the form of dynamic mounds located in agricultural land and the surrounding environment. The taxonomy of the species is:

Kingdom: Animalia
 Phylum: Arthropoda
 Class: Insecta
 Order: Hymenoptera
 Family: Formicidae
 Subfamily: Myrmicinae
 Genus: Solenopsis
 Species: Solenopsis spp

The second ant, *Paratrechina longicornis*, was found in both traps, namely fill trap and Bait Trap, but was more numerous in Bait trap. This ant appears to emerge from the ground area and crawl through small grass (Bollazzi & Roces, 2011). This ant has a small body shape with a black color all over from the head to the abdomen when observed from a distance. When observed closely, this ant has a dark brown and black body color surrounded by many fine hairs all over its body. This ant is also known as a smelly ant, usually found near trees or rotten wood and moist soil conditions. At post 1 the trap is placed near a tree and the soil conditions in the area are moist and easy to dig. The taxonomy of the species is:

Kingdom: Animalia
 Phylum: Arthropoda
 Class: Insecta
 Order: Hymenoptera
 Family: Formicidae
 Subfamily: Formicinae
 Genus: Paratrechina
 Species: *P. longicornis*

At point 2, only one type of ant was found, namely *Paratrechina longicornis*. At point 2, the environmental conditions and traps provided were on the same type of soil and were both under the same tree as post 1. These almost the same environmental conditions caused the similarity of species, namely the crazy black ant. Then at point 3, one type of ant was found, namely *Polyrhachis dives*. This ant is much larger in size when compared to the ants at posts 1 and 2. This ant has long antennae with a black body color that has a white line on the upper abdomen area. This ant was found near lush grass. This ant is easy to find because it appears on the surface and its habitat is easily accessible so that it is rare to find only one ant in the area but directly in groups. According to Yaherwandi et al. (2019), *Polyrhachis dives* are shiny black ants covered in fine hairs, have a pair of antennae and three pairs of legs. Have convex eyes on the side. Have a short rounded abdomen and have rough skin segments and surfaces. *Polyrhachis* ants are known for their habit of nesting in the ground, under rocks, or in rotten wood (George et al., 2018). In addition, they can

also be found nesting between plants or in small holes in trees. This nesting behavior helps them protect the colony from predators and maintain stable environmental conditions (Roshnath et al., 2019). The taxonomy of these ants is:

Kingdom: Animalia
 Phylum: Arthropoda
 Class: Insecta
 Order: Hymenoptera
 Family: Formicidae
 Subfamily: Formicinae
 Genus: *Polyrhachis*
 Species: *Polyrhachis dives*



Figure 11. *Polyrhachis dives*

At point 4, three different types of ants were found, namely *Monomorium pharaonis*, *Paratrechina longicornis*, *Camponotus atriceps*.



Figure 12. *Monomorium pharaonis*

Monomorium pharaonis ants are in bait traps that appear on the ground. These ants are very small and tend to be reddish brown with a slightly dark abdomen. These ants are easy to find anywhere, either at home or in the garden. According to Karolak et al. (2024), *Monomorium pharaonis* ants (Pharaoh Ants) are found in open habitats, under rocks, trash cans, on tables, and on walls. Their food sources based on the field are obtained from meat, vegetables, and fruit. *Monomorium*

pharaonis (Pharaoh Ants) are about 1 mm long, a little more than 1/16 inch. *Monomorium pharaonis* (Pharaoh Ants) are light yellow to reddish brown with a darker abdomen. The leaf stalk (narrow waist between the thorax and abdomen) has two nodes and the thorax has no thorns. The taxonomy of these ants is:

Kingdom: Animalia
 Phylum: Arthropoda
 Class: Insecta
 Order: Hymenoptera
 Family: Formicidae
 Genus: *Monomorium*
 Species: *Monomorium pharaonis*

The ants found in post 4 are *Camponotus atriceps* found in Fill traps and Bait traps. These ants are medium-sized with reddish brown bodies. The head or thorax and abdomen of the ants are dark brown and the chest area of the ants is reddish brown. These ants can be found in areas of land adjacent to large rocks. According to Rakotonirina et al. (2016), The characteristics of the *Camponotus* genus are antennas consisting of 12 segments; mandibles with a subtriangular type; antennal sockets separate from the clypeus; compound eyes located at the top of the midline of the head; petiole with an upright node; tergite on the first segment of the gaster is usually slender and longer than the second segment. The Taxonomy of Ants is:

Kingdom: Animalia
 Phylum: Arthropoda
 Class: Insecta
 Order: Hymenoptera
 Family: Formicidae
 Subfamily: Formicinae
 Genus: *Camponotus*
 Species: *C. atriceps*



Figure 13. *Camponotus atriceps*

At point 5, four different types of ants were found, namely *Pachycondyla crassinoda*, *Solenopsis geminata*, *Camponotus atriceps*, *odontoponera transversa*.



Figure 14. *Solenopsis geminata*

Solenopsis geminata ants are found in areas of land with lots of grass that are close to rocks. These ants are reddish brown from a distance and can be identified from fill traps and bait traps, but are more numerous in fill traps. The habitat of these ants is in soil with humid conditions and is close to plants and rocks. According to (Dhadwal & Bharti, 2024), *Solenopsis geminata* has characteristics that are reddish brown with a brown head, a rectangular head, a convex posterior margin, large and upright mandibles. Has four teeth. Clypeus with a pair of longitudinal carinae. Relatively small eyes consisting of approximately 20 ommatidia. There are ocelli on the anterior part of the head. Short scape, club antenna is the same length as the combination of the 3rd to 9th antenna segments. On the mesosoma and gaster there are many erect hairs. The mandible consists of four teeth. The scape on the antenna reaches the posterior part of the head. The taxonomy of these ants is:

Kingdom: Animalia
 Phylum: Arthropoda
 Class: Insecta
 Order: Hymenoptera
 Family: Formicidae
 Genus: *Camponotus*
 Species: *Camponotus atriceps*



Figure 15. *Odontoponera transversa*

Odontoponera transversal ants are found in areas around rocks, these ants are also often found on trees near post 5. These ants have quite strong bites (Pulagura et al., 2024). These ants have a black body color from head to abdomen. These ants have a rather short antenna shape with a large body and there is a thin sting at the tip of the ant's abdomen. According to Hasan et al. (2023), the *Odontoponera transversa* species is known to local residents as 'jetet ants'. These ants have the characteristic of mesosoma connected to only one gaster, namely the petiole. It has a sting on the ovovisitor, petiole and gaster which are separated by a deep groove. The antenna sockets are more forward hanging from the mandibles (Paraskevopoulos et al., 2023). The mandibles are triangular and the outer surface of the tibiae on the middle legs have few and thin hairs. *Odontoponera* species have the characteristics of a wide and long head, weak and convex sides. The mandibles, clypeus and appendages (limbs) are ferruginous or brownish black. The taxonomy of these ants is:

Kingdom: Animalia
 Phylum: Arthropoda
 Class: Insecta
 Order: Hymenoptera
 Family: Formicidae
 Subfamily: Ponerinae
 Genus: *Odontoponera*
 Species: *Odontoponera transversal*



Figure 16. *Pachycondyla crassinoda*

Pachycondyla crassinoda ants are found in fill traps with black body color from the head to the abdomen. Their body shape is rather slender with longer antennae. These ants are also often found on rocks at post 5. The taxonomy of these ants is:

Kingdom: Animalia
 Phylum: Arthropoda
 Class: Insecta
 Order: Hymenoptera
 Family: Formicidae
 Subfamily: Ponerinae

Genus: *Pachycondyla*
 Species: *P. crassinoda*

At point 6, one type of ant was found, namely *Formica sanguinea*.



Figure 17. *Formica sanguinea*

These ants were found in Fill traps with body characteristics that are almost similar to spiders because of the circular abdomen shape and larger size compared to the upper body area (Schroeder et al., 2018). These ants have a body color of the thorax, chest, and legs that are red. These ants are found near grass and tend not to colonize when looking for food. The taxonomy of these ants is:

Kingdom: Animalia
 Phylum: Arthropoda
 Class: Insecta
 Order: Hymenoptera
 Family: Formicidae
 Subfamily: Formicinae 1 Genus: *Formica*
 Species: *Formica sanguinea*

The results of the study showed that the beds have many different species of ants, especially in the area behind the prayer room. This diversity is influenced by several factors such as soil moisture conditions, rocks, trees, grass and so on. The area behind the prayer room in the beds has various areas, ranging from areas close to rivers, rocks, pine tree areas, grass, and also other types of trees. The diversity of flora is also a major factor in the ants in the area being different (Harahap et al., 2022; Paraskevopoulos et al., 2023). In addition, it can also be influenced by the type of food that is adapted to the species of the ant. The traps used also affect certain species, there are ants that like the type of leftover food or animal carcasses.

Conclusion

Observations of ant species identification conducted in the beds with a qualitative descriptive

approach through the fill trap and bait trap methods and direct observation successfully identified nine ant species, namely *Paratrechina longicornis*, *Camponotus atriceps*, *Polyrhachis dives*, *Solenopsis* sp., *Pachycondyla crassinoda*, *Formica sanguinea*, *Solenopsis geminata*, *Odontoponera transversal*, and *Monomorium pharaonis*. The trapping methods used included fill traps and bait traps with bait in the form of syrup and bread crumbs. Each method showed advantages in catching certain types of ants. The diversity of species found was influenced by the location of the soil structure, flora around the trap, humidity, and surrounding rocks. The results also showed that the ant species diversity index at this location tended to be low, which may be caused by land conversion and differences in food availability. This study provides an illustration that the approach using a combination of trapping methods is able to document the presence of ant species in a habitat effectively, but the results are highly dependent on environmental factors and sampling techniques.

Acknowledgments

We would like to thank all parties who have supported this research, especially the managers of the observation area and the research team who have worked hard in collecting data in the field. Thanks also to the previous researchers whose study results became references and foundations in this research. Hopefully the results of this research can provide benefits and positive contributions to the development of science on biodiversity, especially in ant ecology.

Author Contributions

Conceptualization; N. R. R. P.; methodology; R. N. C.; validation; A.; formal analysis; R. K.; investigation; F. A.; resources; A. S.; data curation; I. F.; writing—original; N. R. R. P.; draft preparation. R. N. C.; writing—review and editing; A.; visualization; R. K. All authors have read and agreed to the published version of the manuscript.

Funding

Researchers independently funded this research.

Conflicts of Interest

The authors declare no conflict of interest.

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