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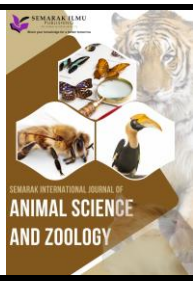

Diversity and Abundance of Ants (Hymenoptera: Formicidae) in Pineapple Plantation of Sungai Merab Bangi, Selangor

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ABSTRACT

Ants play an important role in the environment. The study on the diversity of ant species in the pineapple plantation is scarce. Saudagar Nanas Pineapple Plantation located at Sungai Merab is a monoculture pineapple plantation. Until now, no study on ant species in the plantation has been conducted and the reference of ant population is not available. Therefore, this study aimed to investigate the diversity and abundance of ant species at Saudagar Nanas Pineapple Plantation Sungai Merab, Selangor. Ants were sampled from January to March 2024 using pitfall traps and active sampling, including direct observation. Twenty-five pitfalls were set at the study site and left for a week. A total of 314 individuals of ant species have been successfully sampled, consisting of two subfamilies and six species. The subfamily Formicinae had the highest number of individuals. The genus *Camponotus* was the most abundant, totaling 297 individuals. The Shannon-Weiner diversity index (H') indicated the highest value in March (H'=0.2745) and the lowest value in February (H'=0.1217). One-way ANOVA test did not indicate any significant difference in ant species diversity between January, February and March ($p > 0.05$). This study has successfully compiled the most recent list of ant species found in Saudagar Nanas Pineapple Plantation Sungai Merab, Bangi, Selangor. Therefore, with this data, a further study on the interaction of ant species with pineapple mealybugs can be conducted.

1. Introduction

Pineapple is a significant agricultural commodity in Malaysia, with 95 % of its production earn marked for the export market, while the remaining 5 % fulfills domestic demand. The high demand for pineapple drives its export to countries like Singapore, China and West Asia. Agricultural ecosystems host a rich diversity of insects, including ants. Ants are crucial to the pineapple plant ecosystem due to their positive symbiotic relationship with pineapple mealybugs, a major insect pest

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known for causing pineapple wilt disease [1]. In Malaysia, two main species of pineapple mealybug have been reported: *Dysmicoccus brevipes* and *D. neobrevipes.*

According to Jahn and Beardsley [2], Pineapple mealybugs (*Dysmicoccus brevipes*) are known to form symbiotic relationships with ants because the ants receive a source of food, honeydew, from mealybugs and sometimes transfer pineapple mealybugs to other hosts. The big-headed ant, *Pheidole megacephala*, is a primary ant species that often forms a symbiotic relationship with pineapple mealybugs (*Dysmicoccus brevipes*) [3]. In addition, the ant species *Iridomyrmex humilis, Solenopsis geminata* and *Ochetellus glaber* have also been reported to have an association with pineapple mealybugs, depending on different environments and geography [4].

Ants are social insects with a well-organized colony structure consisting of a queen, soldier ants and worker ants. An ant colony is estimated to consist of 20 million individuals [5]. Ants have a life cycle of several weeks to several years. Additionally, the diet of ants is diverse, with some being omnivores, herbivores, eaters of seeds, nectar and honey. Worker ants usually go out looking for food and bring it back to the nest. The body size of ants is estimated to be 0.75 – 52.0 mm.

Studies on the diversity and abundance of ants in the pineapple plant ecosystem are lacking in Malaysia compared to other countries. Mamahit [6] conducted a study on the abundance and diversity of ants in Bolaang Pineapple Farm, Indonesia, while Jahn *et al.,* [7] focused on the interaction of ants and pineapple mealybugs. In Malaysia, Mohammed *et al.,* [8] conducted a DNA barcode study of pineapple mealybugs species and ants associated with pineapple plants in Sarawak. Detailed studies on ants within agricultural ecosystems in Malaysia, particularly in the context of their interactions with other species, have not been extensively conducted. This study aims to document the diversity and abundance of ant species in the pineapple ecosystem of Sungai Merab Bangi, Selangor. This study is a pioneering effort in understanding the ant species within the pineapple ecosystems in Malaysia. This study provides a crucial baseline for future studies by documenting the species diversity and abundance. The data collected in this study could be instrumental in developing sustainable agricultural practices and enhancing biodiversity conservation in the pineapple ecosystem.

2. Methodology

2.1 Study Location

This research was carried out at Saudagar Nanas Pineapple Plantation in Selangor, located at coordinates 2° 9' 4" North, 101° 74' 0" East, over three months from January to March 2024 (Figure 1). The Saudagar Nanas Pineapple Plantation is a privately-owned pineapple farm operated by Mr. Hardy. The farm covers an area of 8 acres and specializes in cultivating MD2 type pineapples. In this region, mineral soil is indeed used for pineapple cultivation.

2.2 Ants Sampling

The ant sampling was conducted from January to March 2024. A total of 25 pitfall traps were employed to monitor the ant community in a 10m x 10m plot at the Sungai Merab pineapple plantation. The pitfall traps consisted of plastic cups placed at ground level and filled with soapy water to prevent ants from escaping and acts as a preservative (Figure 2). The traps were left for one week. The active sampling was conducted at two different times: (10 am - 11 am) and (2 pm - 3 pm). The visual inspections for ants on the ground, on plants and around nests were also conducted (Figure 3).

Fig. 1. Location of the study at Saudagar Nanas Pineapple Plantation, Bangi Malaysia

Fig. 2. Passive sampling method using pitfall traps

Fig. 3. Active sampling method through direct observations and search in the field

2.3 Data Analysis

2.3.1 Species identification

The ant samples were pinned and dried for long-term preservation. The ant's identification was done referring to Bolton (1994) and online databases such as http://www.antbase.net and www.antwiki.org.

2.3.2 Statistical analysis

The ant's abundance was analyzed using one-way ANOVA followed by Tukey's test for post hoc comparisons, with a significance level set at $p < 0.05$. The species diversity index, species richness index and species evenness index were calculated using Paleontological Statistics Software (PAST).

3. Results and Discussions

3.1 Overall Results

Two subfamilies and six species / morphospecies were successfully recorded at Sungai Merab Bangi Selangor Pineapple Plantation, comprising 314 individuals (Table 1). The subfamilies represented only 10 % of the 21 subfamilies of ants described worldwide. The subfamily Formicinae had the highest abundance with 298 individuals, while Myrmicinae had only 16 individuals. The six recorded species were *Camponotus japonicus, C. irritans, C. tenuipes* and *Polyrhachis armata* in the subfamily of Formicinae, and *Crematogaster sp. 1* and *Solenopsis invicta* in the subfamily *Myrmicinae*.

Table 1
Total number of individuals sampled in January, February and March

Subfamily	Species	January	February	March	Total	%
Formicinae	*Camponotus japonicus*	45	37	213	295	75
	Camponotus irritans	0	0	1	1	
	Camponotus tenuipes	0	0	1	1	
	Polyrhachis armata	1	0	0	1	
Myrimicinae	*Crematogaster* sp. 1	2	0	0	2	25
	Solenopsis invicta	0	1	13	14	
Total species		48	38	228	314	100

3.1.1 Overall distribution

According to Table 2, *Camponotus* was the most dominant and abundant, with 297 individuals successfully recorded. According to Trible & Kronauer [9] and Williams *et al.,* [10], *Camponotus*, commonly known as carpenter ants, is one of the most dominant and abundant ant genera worldwide. There are three species within this genus*: Camponotus japonicus* (295 individuals), *C. irritans* (1 individual) and *C. tenuipes* (1 individual). *Camponotus japonicus* is the common species in this study. *Camponotus japonicus* is an important species in the ecosystem, playing a role in the decomposition of wood and the regulation of insect populations. They are omnivorous, feeding on a variety of substances including honeydew from aphids, plant exudates and other insects [11]. *Polyrhachis* records only one species, ie. *Polyrhachis armata* (1 individual). *Polyrhachis* are primarily found in the Old World. *Polyrhachis* are known for their complex social behaviors and varied nesting strategies. As arboreal ants, they are often involved in mutualistic relationships with plants, such as tending to aphids or other sap-sucking insects in exchange for honeydew [12]. The genus *Crematogaster* records only 1 species, *Crematogaster* sp. 1 (2 individuals), while the *Solenopsis* genus also recorded only 1 species, *Solenopsis invicta* (14 individuals). *Crematogaster* are known for their aggressive behavior and are effective predators. In some species, *Crematogaster* engage in mutualistic relationships with plants, where they protect the plant from herbivores in exchange for shelter or food [13].

Table 2
List and number of ant species in Pineapple Plantation based on subfamilies

Subfamily	Genus	Species	Total
Formicinae	*Camponotus*	*Camponotus japonicus*	295
		Camponotus irritans	1
		Camponotus tenuipes	1
	Polyrhachis	*Polyrhachis armata*	1
Myrmicinae	*Crematogaster*	*Crematogaster* sp. 1	2
	Solenopsis	*Solenopsis invicta*	14
Total individual			314
Number of species			6
Number of subfamilies			2

3.2 Index Value of Diversity, Evenness and Richness of Ant's Species

The Shannon-Weiner diversity index (H') was highest in March at H' = 0.2745, followed by January at H' = 0.2736 and February at H' = 0.1217 (Table 3). The value of H' was quite low compared to typical Shannon-Weiner index values, which often ranged from 1.5 to 3.5 in more diverse ecosystems. This suggests that the overall species diversity in the community was relatively low. This could be due to a limited number of species or a community where a few species dominate in numbers, reducing the evenness.

Table 3
Index values for diversity, evenness and richness of ant species by month

	January '24	February '24	March '24
Shannon_H'	0.2736	0.1217	0.2745
Evenness_E'	0.4382	0.5647	0.329
Margalef_R'	0.5166	0.2749	0.5526

3.3 Accumulation Curve of Ant Species

The accumulation curve in all three months has not reached an asymptote or a flat line, indicating that our sampling efforts are still not sufficient. There's a high possibility of finding more species and individuals that were not recorded in this study. The graph for March almost reaches a horizontal line compared to January and February, indicating that March has the most abundant distribution of species (Figure 4).

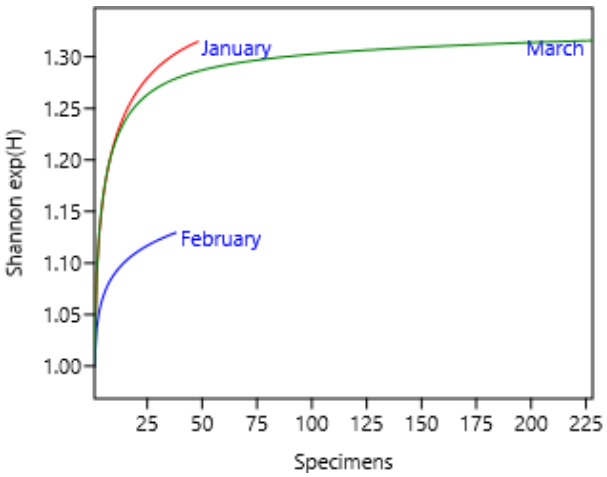

Fig. 4. Accumulation curve of ant species by month

3.4 Comparison of the Abundance of Ant Species in January, February and March 2024

The distribution of ants based on the month of sampling shows a fluctuating pattern, with the number of ants recorded being inversely proportional to rainfall (Figure 5). The high rainfall can impact ant populations, often leading to a decrease in their numbers. The weather greatly influences the growth and behavior of insect populations [14]. Specifically, humidity levels in the environment can impact the water content in insects' bodies, leading to changes in their development and overall population abundance [15]. Fluctuations in environmental humidity can physically alter the dynamics of insect populations.

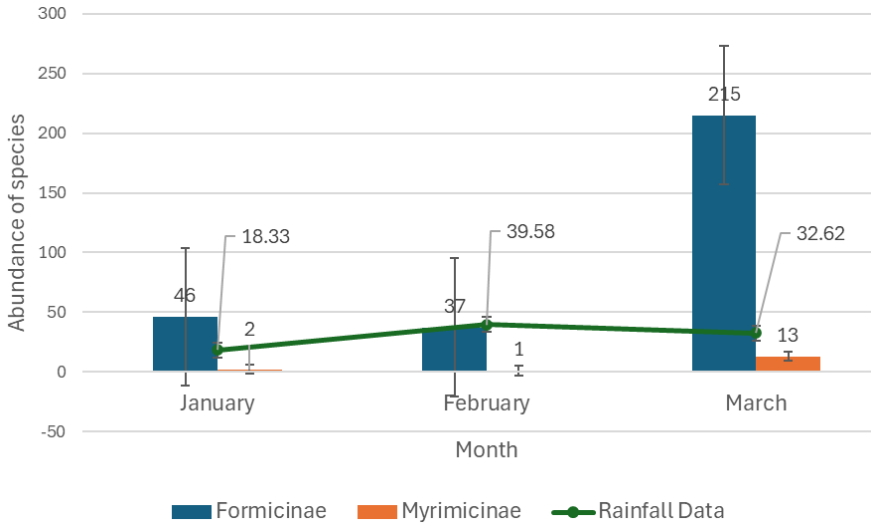

Fig. 5. The abundance of ant species in January, February and March 2024

This study has found that the highest number of ant individuals was recorded in March (228 individuals), followed by January (48 individuals) and February (38 individuals). The average rainfall data shows that the highest value was in February (39.58 mm), followed by March (32.62 mm), and the lowest recorded in January (18.33 mm). It can be concluded that an increase in individual ant species occurs when the average rainfall is low. This indicates that the temporal distribution significantly affects the ant population. This is because the activity of searching for food and the movement of ants will be hindered when the raindrops close or block the path between the leaves. Additionally, heavy rain will cause flooding in ant nests located on the ground, prompting the ants to seek new shelter [15].

4. Conclusions

In this study, 314 individual ants from two subfamilies, Formicinae and Myrmicinae, were recorded. Formicinae were the most abundant subfamily, with the genus *Camponotus* being the most dominant. This study is important to improve our knowledge of ant ecology and can be useful in develop effective and sustainable methods for managing pests and promoting healthy agricultural practices in pineapple plantations. However, the low Shannon-Weiner diversity index indicateed that the sampling efforts were insufficient to capture the ant community's full diversity. Further studies on the symbiotic relationship between ants and pineapple mealybugs and a comprehensive listing of ant species in the pineapple ecosystem in Malaysia are important.

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