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Species diversity of subterranean ants in Rangsit Marsh, Khlong Luang District, Pathum Thani Province, Thailand

CHANATE WANNA[1,♥], NARUMON BOONMAN[1], SIRIRAT PHAKPAKNAM[1], VACHIRAPORN PIKULTHONG[1], WEEYAWUT JAITRONG[2], RUNGTIP SOI-AMPORNKUL[3]

[1]Department of Biology, Faculty of Science and Technology, Suan Sunandha Rajabhat University. 1 U-Thong Nok Rd, Dusit, Bangkok 10300, Thailand. Tel. 02-160-1143-45, fax. 02-160-1146, ♥email: chanate.wa@ssru.ac.th

[2]Office of Natural Science Research, National Science Museum. Khlong Luang, Pathum Thani, 12120, Thailand

[3]Department of Biochemistry, Faculty of Medicine Siriraj Hospital, Mahidol University. 2 Thanon Wang Lang, Siri Rat, Bangkok 10700, Thailand

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Abstract. *Wanna C, Boonman N, Phakpaknam S, Pikulthong V, Jaitrong W, Soi-Ampornkul R. 2022. Species diversity of subterranean ants in Rangsit Marsh, Khlong Luang District, Pathum Thani Province, Thailand. Biodiversitas 23: 1283-1292.* The present study aimed to compare species diversity and abundance of subterranean ants in three habitats: scrub forest, forest plantations, and glades at Rangsit Marsh, Khong Luang District, Pathum Thani Province, Thailand. The ant samples were collected twice a month during the rainy season (June-August 2019) and dry season (September-November 2019) using a pitfall trap in the soil. A total number of 6,305 individuals belonging to 4 subfamilies, 16 genera, and 16 species of ants were recorded. The subfamilies Myrmicinae comprising 6 species were the most prevalent, followed by 4 species of Formicinae, 3 species of Dolichoderinae, and 3 species of Ponerinae. The Shannon-Wiener species diversity index indicated the diversity was the highest in the glade (1.951), followed by the forest plantation (1.635), and lastly the scrub forest (0.419). Sorensen's similarity coefficient to determine the similarity in community composition was highest between the forest plantation and the glade at 63.40%, and then between the scrub forest and the forest plantation at 44.30%, and between the scrub forest and the glade at 39.60%. This indicated that both ant species diversity and community composition were distinctly varied in these three sites. The rainy season revealed higher species richness than the dry season. The highest occurrence of ant species was for *Iridomyrmex anceps* (Roger, 1863), which was recorded as uncommon and was the most abundant species in the glade, while *Anoplolepis gracilipes* (Smith, 1857) and *Carebara diversa* (Jerdon, 1851) were the most abundant species in the scrub forest and forest plantation, respectively. Therefore, this study revealed that different habitat types and seasons resulted in differences in subterranean ant species diversity.

Key words: Rangsit Marsh, species abundance, species diversity, subterranean ants, taxonomy

INTRODUCTION

Ants are well-recognized eusocial insects, characterized by cooperative brood care, overlapping generations of workers within the colony, and a highly developed caste system (Agosti et al. 2000). They are classified in the family Formicidae, included in the order Hymenoptera, placed underclass Insecta of phylum Arthropoda (Hölldobler and Wilson 1990). Worldwide there are 23 subfamilies of ants comprising 287 genera and approximately 12,000 described species, with probably a much larger number of species (Bolton et al. 2006). Beginning as lately as 1906, the first reliable records of the ant fauna of Thailand appeared in the south (Bingham 1903), where 39 species from Songkhla, Pattani, and Narathiwat were discovered. At present, 9 subfamilies of ants are recorded in Southeast Asia, and all are found to be native to Thailand, with an estimated number of 800-1,000 species (Wiwatwitaya 2003a).

Ants occupy almost all terrestrial ecosystems from the arboreal to the subterranean strata and make up their dominance of animal biomass in tropical forests, grasslands, and probably other habitats (Wilson 2000; Alonso and Agosti 2000; Jacquemin et al. 2016). However, little is known about underground ant assemblages due to sampling difficulties. Therefore, an alternative and increasingly used method are subterranean traps, such as the subterranean probe (Wilkie et al. 2007) or pitfall traps (Schmidt and Solar 2010). They play a very important role, not only because of their diversity but also their functions in ecosystems, such as improving the soil, helping with decomposition, serving as food resources, and exerting a positive effect in the regeneration process of forest trees (Maryati 1996; Watanasit et al. 2007; Johari et al. 2021). Furthermore, ants have been used as biological control agents for insect pests in agriculture in many countries such as Malaysia (Khoo and Chung 1989), Thailand (Kritsaneepaiboon and Saiboon 2000), Africa and Papua New Guinea (Way 1954). Thus, ants, well known for their significance in ecology, are being used for monitoring ecosystem quality since they are diverse, abundant, and hypersensitive to environmental changes in terrestrial habitats (Lach et al. 2010).

Deforestation causes a loss of taxonomic diversity in a wide range of plants as well as animals. This disturbance may have a negative effect on leaf litter-associated and canopy ants (Laurance and Bierregaard 1997). Previous studies have shown that low species richness and evenness are typical for ground-foraging ant communities in disturbed forests (Brühl et al. 2003; Bickel and Watanasit 2005; Fayle et al. 2010; Wang and Foster 2015). With the increasing loss of habitats and biodiversity, there is an urgent need for biodiversity assessment (Agosti et al. 2000). Ants are considered suitable bioindicator species for biodiversity studies and ecological niches, especially soil systems (Alonso 2000) because of their high diversity and biomass, ecological importance at all trophic levels, ease of sampling, and their well-understood community dynamics (Andersen and Sparling 1997). Furthermore, ants consistently show strong successional patterns in ecosystems, and their functional diversity and composition are related to land management practices and disturbances, including forest management (Andersen and Sparling 1997; Vanderwoude et al. 2000; Willett 2001; Stephens and Wagner 2006). Along with other soil-dwelling fauna, ground-nesting ants play a crucial role in soil structure by increasing moisture, water infiltration, aeration, and organic matter (Lal 1988). Additionally, ants possess numerous mutualistic and symbiotic relationships and shape the abiotic and biotic matrices of community interactions (Kaspari 2000).

Many ant species are highly sensitive to microclimate fluctuations and habitat structure and thus respond strongly to environmental changes (Andersen 1990; Alonso et al. 2001). The biodiversity assessments were carried out during the conservation planning process (Alonso 2000), considering factors influencing biodiversity variation such as habitats or land-use types. However, to date, there have been few studies on ant species diversity in Thailand and thus, the status of ant biodiversity in this country is largely unknown or out of date compared to other areas. Thus, the present study aims to examine the diversity, abundance, and distribution of subterranean ant species in three different land-use types and through seasonal change during the rainy and dry seasons within the same broad area along with the Rangsit Marsh, Khlong Luang District, Pathum Thani Province, Thailand. As a minimum, this study will provide baseline data of ant species diversity and composition in different land usage habitats for reference collections of ants in the central region of Thailand. These data are expected to create a new understanding or further develop knowledge about ants in Thailand and will be useful in other research areas, including taxonomy, ecology, and diversity. Consequently, the findings will be of value in evaluating and planning for biodiversity conservation management.

MATERIALS AND METHODS

Study sites

The study was carried out in Rangsit Marsh, Khlong Luang District, Pathum Thani Province, in the central part of Thailand (Figure 1). Three habitats were selected based on differences in land usage types: (i) Scrub forest: This site represents a natural habitat type and is located at 14◦3'32.9796" N, 100◦42'34.2972" E. It provided 10% canopy coverage with larger, densely covered trees. The ground area was covered with dense foliage and twigs and some places had very high humidity and waterlogging (Figure 1A). (ii) Forest plantation: This site represented an area that collects plants from different areas comprising about 10 rai and located at 14◦2'57.1128" N, 100◦42'52.7436" E near the community. It had approximately 60 canopy trees and was planted in rows. The soil was loam and clay mixed together and some areas had humidity (Figure 1B). (iii) Glade area: This site represented an area that is not covered by large trees and is located at 14◦2'54.5424" N, 100◦42'44.5032" E. The sunlight could reach the ground throughout the area. The soil was clay soil and small grasses were covering some spots, while rocks and pebbles were inserted in the soil layer (Figure 1C).

Ant survey and sampling method

This study was conducted to assess the species diversity and abundance of subterranean ants in the three habitat types at Rangsit Marsh. The examinations were carried out twice monthly from June to November 2019. The rainy season in this study period occurred from June to August and the dry season ran from September to November. The sampling method uses the pitfall trap. In each habitat area, the surveys were arranged in 3 lines, 5 meters apart, while 7 pitfall traps were dug to serve as ant traps, 3 meters apart, and were buried in each line. Vertical ant traps were placed under soil cover at a depth of 10 cm from the soil surface (Figure 2). A plastic container (8 cm diameter x 12 cm height) was placed in each hole with the lip of the trap at the same level as the soil surface. Petroleum gel was coated around the trap’s inner lip and some detergent solution was poured into the trap to a depth of about 2 cm. Samples were collected after 24 hours and taken to the laboratory for sorting.

Ant preservation and identification

The ant specimens were preserved in microtubes containing 80% ethanol and taken back to the laboratory for classification to (morpho-) species level and for counting the numbers of each (morpho-) species. The specimens were identified to subfamily, genera, and species levels based on the taxonomic keys using stereo microscope Olympus SZ2 series (Bolton 1997; Wiwatwitaya and Jaitrong 2001; Jaitrong and Nabhitabhata 2005). The specimens were also compared with the reference collections at the Natural Science Research, National Science Museum, Khlong Luang, Pathum Thani, and the National Science Museum, Thailand, and re-examined carefully by Dr. Weeyawut Jaitrong (the ant expert from the Natural Science Research, National Science Museum, Khlong Luang, Pathum Thani). Finally, the subterranean ant specimens were deposited in the Department of Biology, Faculty of Science and Technology, Suan Sunandha Rajabhat University, Thailand.

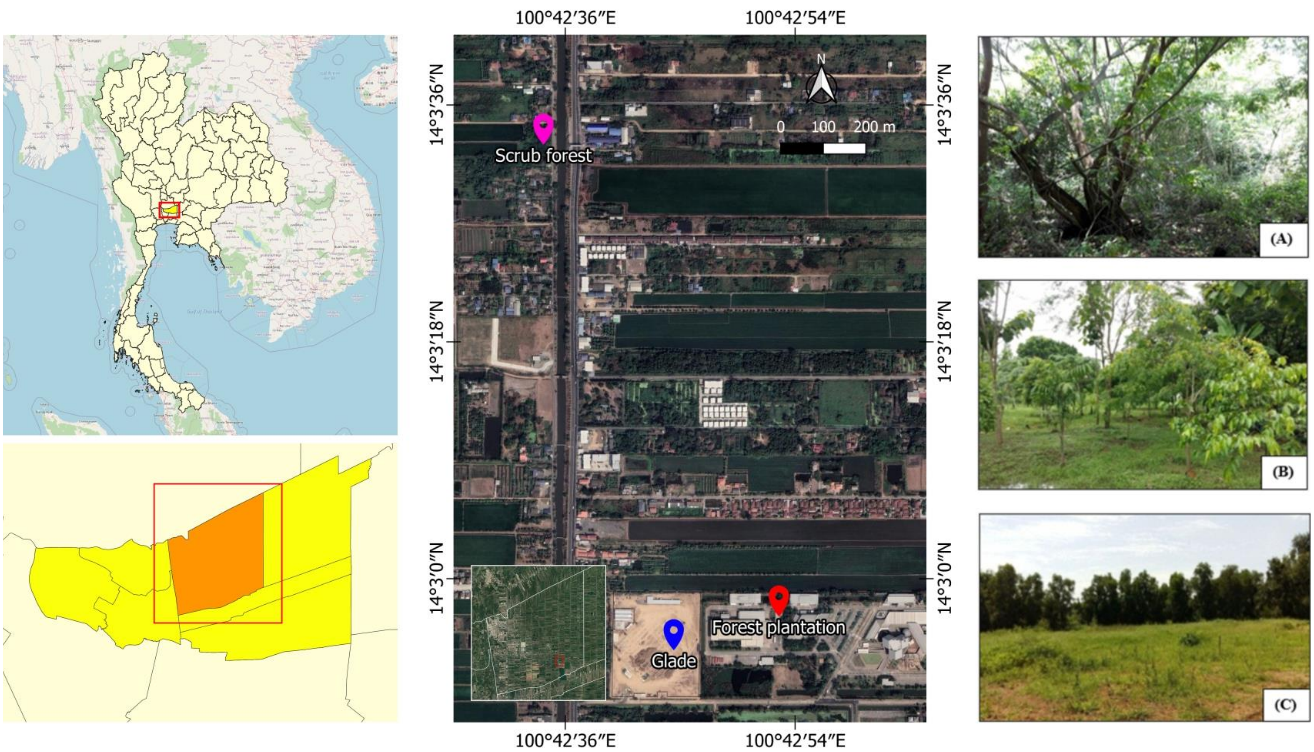

Figure 1. The location map of the three study sites in Rangsit Marsh, Khlong Luang District, Pathum Thani Province, Thailand, created using the ArcMap 10.5 program: A. Scrub forest; B. Forest plantation; C. Glade

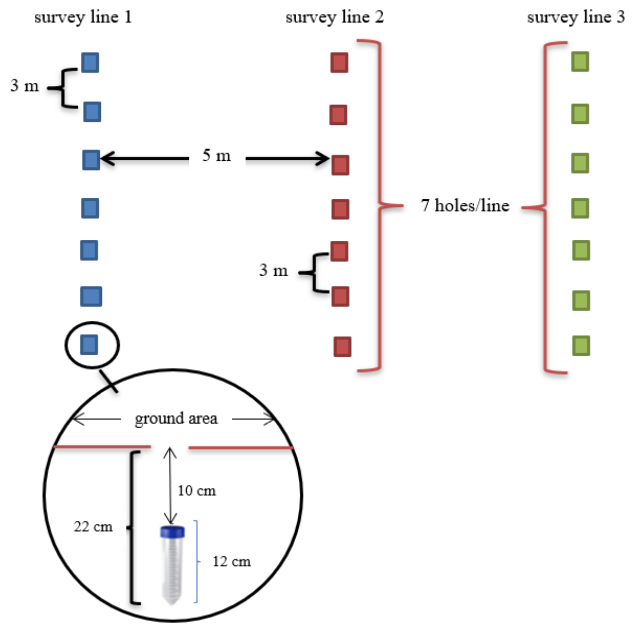

Figure 2. Survey line and pitfall trap model for collecting ant samples in each habitat in Rangsit Marsh, Khlong Luang District, Pathum Thani Province, Thailand

Data analysis

The relative abundance (RA) of ants in each area was assessed using the formula of Krebs (1999), dividing the number of individuals of a species by the total number of ants observed and multiplying the quotient by 100 to make it a percentage. The relative abundance in the study area was grouped into 5 categories: Very common (>81%), Common (61-81%), Uncommon (41-60%), Rare (20-40%), and Very rare (<20%) (Krebs 1999).

The Shannon-Weiner species diversity index (H') was calculated to determine the diversity of ants in each study site using the formula of Krebs (1999) as presented below:

$$H' = -\sum_{i=1}^{N} [p_i (\ln p_i)]$$

Where
H' : Species diversity index
N : Number of species
p_i : Proportion of the total sample belonging to the i^{th} species

To determine the equal abundance of ants in each study site, the evenness index (Krebs 1999) was calculated as follows:

$$E = H'/\ln N$$

Where
H' : Species diversity index
N : Number of species in each area

The Sorensen similarity coefficient (S) (Krebs 1999) was used to determine the similarity of ant species between two study sites as follows:

S = 2a/)2a+b+c(

Where
a : Number of ant species found in both sites
b : Number of ant species in site B but not in site A
c : Number of ant species in site A but not in site B

The data was analyzed with the SPSS program version 26.0. Analysis of variance (ANOVA) and Duncan's new multiple range test (*p*<0.05(were used to detect the significant differences among treatment means.

RESULTS AND DISCUSSION

Species diversity of subterranean ants in the Rangsit Marsh

In the study sites, a total of 6,305 individual ants were recorded, which represented 16 species comprising 16 genera in 4 subfamilies: Myrmicinae, Formicinae, Dolichoderinae, and Ponerinae. The proportion of species richness in each subfamily is shown in Table 1. The highest number of ant species was found belonging to the subfamily Myrmicinae)6 genera, 6 species, 37.50%(, followed by the subfamily Formicinae)4 genera, 4 species, 25.00%(, Dolichoderinae (3 genera, 3 species, 18.75%), and Ponerinae (3 genera, 3 species, 18.75%(. Although the subfamilies Dolichoderinae and Ponerinae were found to have the same number of ant species, however, the number of Dolichoderinae ant individuals was much higher.

From this study of the comparative subterranean ant communities examining three different distinctive areas, it was found that the highest number of subfamilies were found in the forest plantation (4 subfamilies) followed by the glade and scrub forest. Most of the ant genera were found in the forest plantation (10 genera), followed by the glade (8 genera) and the scrub forest (7 genera). The ant species showed similar trends; the highest number of ant species was recorded in the forest plantation (10 species), followed by the glade (8 species) and the scrub forest (7 species) (Table 2). When considering the Shannon-Weiner species diversity index (H'), it was found that the species diversity index of ants was the highest at 1.951 in the glade, followed by the forest plantation at 1.635, and lastly, the scrub forest at 0.419. Moreover, the species evenness index (E), which determines the equal abundance of ants in each habitat, showed that the highest value for E of ants was in the glade (0.888), followed closely by the forest plantation (0.682), whereas the score for the scrub forest was markedly lower (0.202). This indicated that a relatively unequal abundance of each ant species was present, and this was significantly different among habitats (Table 2). The same behavior is presented by frequency values, showing that the glade has more abundance species than other areas (Table 4).

When considering Sorensen's similarity coefficient for subterranean ants, the tools for comparing the similarity between the two communities indicated that the difference in habitat types influences the kinds of ant species found in these habitats. By the similarity measurement in the three different habitats of this study, it was found that the forest plantation (FP) and glade (G) areas had the greatest similarity in ant species composition with a value of 0.634. Of the 19 ant species found, 6 species were the same. The scrub forest (SF) and forest plantation (FP) had similarities with a value of 0.443. Of the 18 ant species found, 4 species were the same. The areas with the least similarity were the scrub forest (SF) and glade (G) with a value of 0.396, which had 15 species of ants, of which 3 species were the same (Table 3).

Table 1. The total number of subfamilies, genera, and species of subterranean ants

Subfamily	Genera	Species	No. of individuals	Total of no. of species (%)
Myrmicinae	6	6	1,292	37.50
Formicinae	4	4	1,264	25.00
Dolichoderinae	3	3	3,708	18.75
Ponerinae	3	3	41	18.75
Total	16	16	6,305	100

Table 3. The Sorensen similarity coefficient of subterranean ants among three different habitats in Rangsit Marsh, Thailand

Study sites	SF	FP	G
SF	1	0.443	0.396
FP	-	1	0.634
G	-	-	1

Note: SF: Scrub forest; FP: Forest plantation; G: Glade

Table 2. The biological diversity of subterranean ants from the three habitats

Biological diversity index	Scrub forest	Forest plantation	Glade
Subfamilies	3	4	3
Genera	7	10	8
Species richness	7	10	8
Species diversity index (H')	0.419^{a}	1.635^{b}	1.951^{c}
Species evenness index (E)	0.202^{a}	0.682^{b}	0.888^{c}

Note: Different letters in the row indicate significant differences at *p*<0.05

Species abundance of subterranean ants

The results for species abundance showed 16 subterranean ants in 4 subfamilies in terms of frequency or percentage of occurrence, revealing that *Iridomyrmex anceps* (Roger, 1863) was found to be by far the most ant species with 41.26% of occurrences and 1,522 individuals collected by the pitfall trap. Their frequency was the highest, with presence in all three habitats. Even though its presence across the three areas of the collection was similar, significant differences (p<0.05) between the areas were recorded in terms of the dominance in the respective collections: *I. anceps* were found in over 50% of all areas examined; this value was much higher in the glade (37.30%) and the lowest in the scrub forest (0.79%). The second most frequent genera was *Bothriomyrmex* sp. in all areas. *Anoplolepis gracilipes* (Smith, 1857) was more frequent in the scrub forest, followed by *Ochetellus glaber* (Mayr, 1862), also predominantly in the glade. Moreover, *Carebara diversa* (Jerdon, 1851) had the highest percentage of occurrences in the forest plantation. Therefore, the five species were assumed to be the dominant species from the percentage of occurrences. From these results, we compared species abundance of the five dominant ant species among habitat types to evaluate colonization. There are 12 ant species which were very rare based on frequency occurrences such as *Lophomyrmex bedoti* (Emery, 1893), *Meranoplus bicolor* (Guérin-Méneville, 1844), *Solenopsis geminata* (Fabricius, 1804), *C. diversa*, *Myrmicaria birmana* (Forel, 1902), *Pheidole* sp., *Paratrechina longicornis* (Latreille, 1802), *Camponotus rufoglaucus* (Jerdon, 1851), *Nylanderia* sp., *Odontomachus simillimus* (Smith, 1858), *Diacamma rugosum* (Le Guillou, 1842), and *Odontoponera denticulata* (F.Smith, 1858) (Table 4 and Figures 1-4).

Seasonal changes in subterranean ants

When comparing the species diversity index of ants in two seasons, the rainy season during June to August, and the dry season from September to November, it was found that the species diversity indices determined by pitfall trap were not significantly different (p>0.05) between the rainy and dry seasons. The species diversity indices were 1.901 and 1.722, respectively (Figure 5). In the rainy season, there was a higher species richness of ants than in the dry season (Table 4) and consequently, the species diversity in the rainy season was found to be higher. Five dominant species, including *I. anceps*, *Bothriomyrmex* sp., *A. gracilipes*, *C. diversa*, and *O. glaber* had the highest prevalence in November, October, August, August, and July, respectively (Figure 6).

In this study, there were found 15 ant species in the rainy season and 9 ant species in the dry season. However, when analyzing the similarity of ants in both seasons, there were similarities of all 8 ant species, namely *L. bedoti*, *M. bicolor*, *C. diversa*, *A. gracilipes*, *I. anceps*, *Bothriomyrmex* sp., *O. glaber*, and *O. simillimus* (Table 4 and Figures 7-8).

Table 4. Taxonomic list, frequency occurrence, and abundance status of subterranean ants recorded among three habitats in the rainy and dry seasons

Subfamily	Scientific name	Individuals	Frequency (% occurrence)			Abundance	Season	
			SF	FP	G		R	D
Myrmicinae	*Lophomyrmex bedoti* (Emery, 1893)	76	-	-	2 (1.59)	VR	✓	✓
	Meranoplus bicolor (Guérin-Méneville, 1844)	83	-	9 (7.14)	4 (3.17)	VR	✓	✓
	Solenopsis geminata (Fabricius, 1804)	2	-	1 (0.79)	-	VR	✓	-
	Carebara diversa (Jerdon, 1851)	877	-	18 (14.29)	6 (4.76)	VR	✓	✓
	Myrmicaria birmana (Forel, 1902)	105	-	1 (0.79)	-	VR	✓	-
	Pheidole sp.	149	-	1 (0.79)	-	VR	✓	-
Formicinae	*Paratrechina longicornis* (Latreille, 1802)	90	2 (1.59)	3 (2.38)	-	VR	✓	-
	Anoplolepis gracilipes (Smith, 1857)	1,167	35 (27.78)	-	-	R	✓	✓
	Camponotus rufoglaucus (Jerdon, 1851)	2	1 (0.79)	-	-	VR	✓	-
	Nylanderia sp.	5	1 (0.79)	-	-	VR	✓	-
Dolichoderinae	*Iridomyrmex anceps* (Roger, 1863)	1,522	1 (0.79)	4 (3.17)	47 (37.30)	UC	✓	✓
	Bothriomyrmex sp.	816	3 (2.38)	8 (6.35)	25 (19.84)	R	✓	✓
	Ochetellus glaber (Mayr, 1862)	1,370	-	1 (0.79)	32 (25.40)	R	✓	✓
Ponerinae	*Odontomachus simillimus* (Smith, 1858)	23	2 (1.59)	-	3 (2.38)	VR		✓
	Diacamma rugosum (Le Guillou, 1842)	4	-	2 (1.59)	-	VR	✓	-
	Odontoponera denticulata (F.Smith, 1858)	14	-	-	4 (3.17)	VR	-	✓
	Total	6,305	45	48	123			

Note: SF: Scrub forest; FP: Forest plantation; G: Glade; R: Rainy season (June-August); D: Dry season (September-November); VC: Very common; C: Common; UC: Uncommon; R: Rare; VR: Very rare

Figure 1. Subterranean ant species in the subfamily Myrmicinae were collected from Rangsit Marsh, Thailand. A. *Lophomyrmex bedoti*; B. *Meranoplus bicolor*; C. *Solenopsis geminata*; D. *Carebara diversa*; E. *Myrmicaria birmana*; F. *Pheidole* sp.

Figure 2. Subterranean ant species in the subfamily Formicinae were collected from Rangsit Marsh, Thailand. A. *Anoplolepis gracilipes*; B. *Paratrechina longiconts*; C. *Camponotus rufoglacus*; D. *Nylanderia* sp.

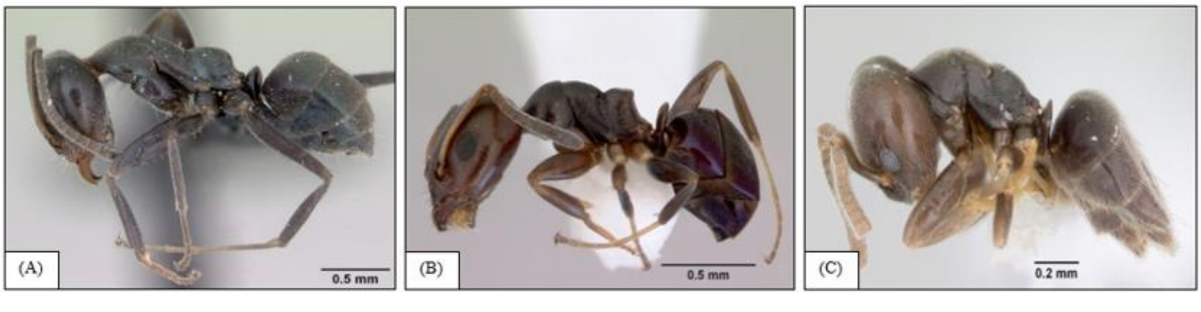

Figure 3. Subterranean ant species in the subfamily Dolichoderinae were collected from Rangsit Marsh, Thailand. A. *Iridomyrmex anceps*; B. *Bothriomyrmex* sp.; C. *Ochetellus glaber*

Figure 4. Subterranean ant species in the subfamily Ponerinae were collected from Rangsit Marsh, Thailand. A. *Odontomachus simillimus*; B. *Diacamma rugosum*; C. *Odontoponera denticulata*

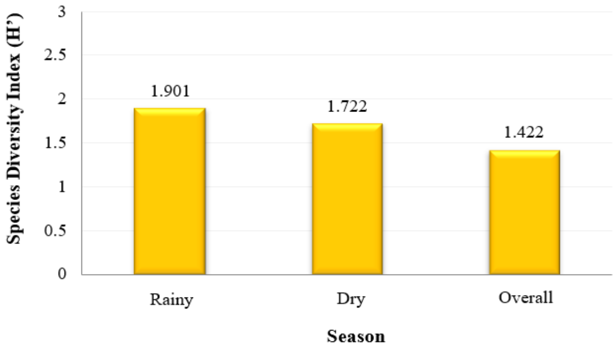

Figure 5. The average of the species diversity index of subterranean ants in each season and in the overall six-month period

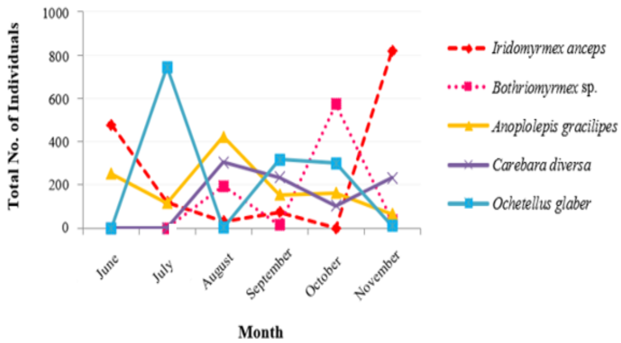

Figure 6. The occurrence of common subterranean ants in each month

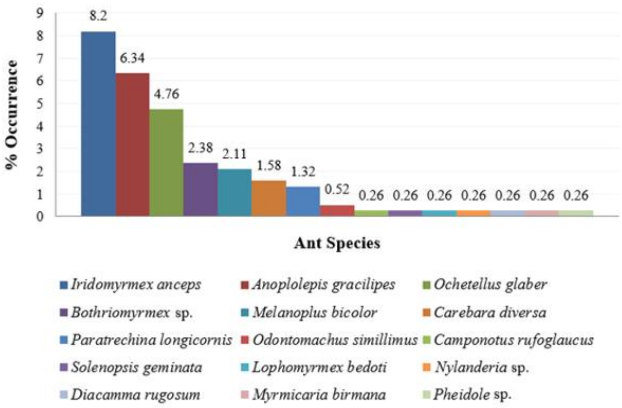

Figure 7. The frequency of subterranean ant species during the rainy season

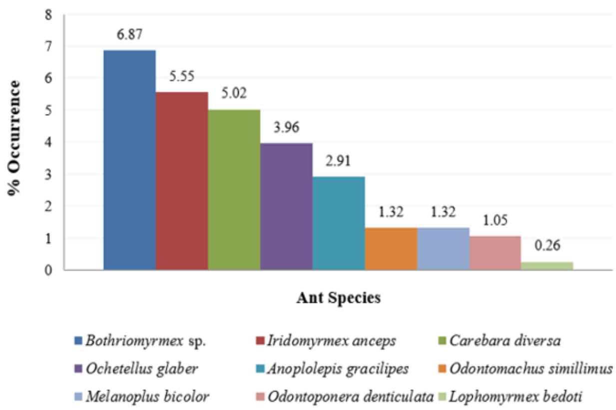

Figure 8. The frequency of subterranean ant species during the dry season

Discussion

Of all the subterranean ant species were collected from the three study sites in the Rangsit Marsh, Khlong Luang District, Pathum Thani Province, Thailand, from June to November 2019, the majority of the ant species belonged to the subfamily Myrmicinae. For instance, these findings were supported in many previous studies even though the methodology was different (Wiwatwitaya 2003b; Noon-anant et al. 2005; Sitthicharoenchai and Chantarasawat 2006; Narvaez-Vasquez et al. 2021). The reason that might explain the highest species composition may be because Myrmicinae is one of the largest subfamilies of ants containing diverse genera and species, which have extremely wide distributions and can be found in all zoographic regions. This subfamily is also commonly found in the Indo-Australian and the Oriental regions, including Thailand (Hölldobler and Wilson 1990; Bolton 1997). This study makes up 37.50% of the total ant species collected, so it is not surprising that Myrmicinae is dominant in this study.

Both genera and species richness differed in the occupancy of the three habitats due to the nature of the ground moisture content and the food sources of ants in each area, including the use of different soils. These marked differences might be because ant communities are highly influenced by habitat type)Costa-Milanez et al. 2014(and vegetation structure)Luke et al. 2014; Sanabria et al. 2014(. It can be seen that the greatest number of ant species were found in the forest plantation area. The Shannon-Wiener species diversity index of ants showed a slight difference between the glade and forest plantation, while the species diversity of the scrub forest was quite diverse compared to the previous two areas. The factors that may affect the species diversity of ants include parameters such as soil moisture. The scrub forest sometimes has flooded on the ground that can prevent ants from living in the area, whereas the soil condition in the forest plantation usually remains free of flooding, allowing ants to live in the soil all year round. The high levels of soil moisture affected the foraging behavior and were correlated with decreases in many activities)Agosti et al. 2000(. Furthermore, the drier microclimate and the removal of understory vegetation could support greater ant species diversity)Turner and Foster 2006; Fayle et al. 2010; Wang and Foster 2015; Hood et al. 2020(. This result would be more consistent with a previous study that indicated that the glade and forest plantation had greater complexity of ants than disturbed areas such as scrub forest and depending on the habitat (Schmidt and Diehl 2008). The highest species richness and species diversity were found in the forest plantation and glade, respectively, which might be caused by the slightly higher tree canopy, herb cover, and soil moisture content. Moreover, the forest plantation and glade areas have various microhabitats and food sources created by human activities. The lowest species richness and diversity in the scrub forest might be because this area was burned. The fire might have a negative impact on litter dwelling species)Arnan et al. 2006(. Some ant species were found in grasslands rather than sloping areas and areas near water sources, possibly because the condition of the sloping area has a gradient on the ground and there are differences in habitats and food, as well as physical factors such as humidity, amount of light, and temperature levels. These factors also affect soil conditions)Lindsey and Skinner 2001). Most ant species were found in grasslands rather than in natural forests due to different vegetation and other animals in their habitats, noting that the grassland area is an open area)Fisher and Robertson 2002(.

The similarity indices of these findings indicated that the species composition of ants between the forest plantation and glade was higher than that between the scrub forest and glade. A higher similarity index between these areas indicated the higher number of ant species coexisting in both sites. On the other hand, a lower index value revealed the microhabitats between the two areas show greater differences. The forest plantation may consist of some similar or specific microhabitat types (Charoenpokaraj and Chitman 2021) and offer conditions that favor greater ant abundance, in which nest sites and food supply are available occurring in the glade (Shattuck 1999; Kaspari and Majer 2000). Several factors such as the high structural complexity of foraging habitats, lack of nest sites, and poor food supply served as the main stressors limiting ant populations (Andersen 2000).

From the percentage of occurrences, some species were dominant over others, such as *I. anceps*, *O. glaber*, *A. gracilipes*, *C. diversa*, and *Bothriomyrmex* sp. that were found to have very high numbers of individual ants and a high percentage of occurrences. This result suggested having either highly competitive capabilities or a broad niche. Two of these five species, *I. anceps* and *Bothriomyrmex* sp., were found in all habitat types but *I. anceps* was significantly different (p<0.05) only in the glade, which meant these species have high colonization. It might be because these species prefer to live in dry habitats under the soil or leaf litter or under dead logs and rocks. Some ant species were adapted to building nests in open areas and could withstand drought (Hölldobler and Wilson 1990; Jaitrong and Ting-Nga 2005; Torchote et al. 2010). It is apparent that *I. anceps* can move very quickly and is common in open areas, agricultural areas, paddy fields, and parks. Moreover, most of these ants are predators and eat carrion, so this species was found in large numbers and with a high distribution.

This study found that the seasonal changes did not result in significant changes in the ant species collected. However, there was a difference in the number of ant species between the rainy and dry seasons, while the species diversity index in the rainy season was higher than in the dry season. The reason is that the environmental factors in this area did not fluctuate very much. Moreover, the nests of the ant species concerned are not temporary nests like some species of army ants and driver ants (Hölldobler and Wilson 1990). This finding corresponds with Gurevitch et al.'s (2002) study, which reported that ant diversity depends on food diversity and physical factors such as temperature, humidity, and precipitation. These factors can also increase or decrease ants in foraging. Hölldobler and Wilson (1990) found that dry winters will cause ants living on organic matter to move into the soil because it has a higher moisture level. Consistent with a study by Sakchoowong et al. (2015), a study of the low prevalence of ants in the rainforest found that ants forage more during the rainy season than in the dry season because there is lower soil and litter moisture content and a higher temperature in the dry season. These conditions are unsuitable for ants and their prey, leading to lower ant biodiversity and population levels, and therefore a lower number of species being recorded (Bestelmeyer 1997).

Our results showed that *I. anceps* is abundant in November, which is during the dry season, making it known that this species is rarely found during periods of high humidity but is more common during periods of drought or low humidity. Moreover, the low density canopy in glade areas allowed sunshine penetration to the ground and the leaf litter, causing low moisture humidity in the soil and dry leaf litter, resulting in a suitable habitat for *I. anceps*. In comparison, *A. gracilipes* is an exotic species in Thailand; it might be native to tropical Africa. Its distribution has clearly been expanded by the human agency so that it is now widespread in tropical and subtropical regions of the globe (Wilson and Taylor 1967). It is abundant in August, during the rainy season, making it a type of ant that can often be found during periods of high humidity but less common during periods of lower humidity or dry weather. In our study sites, we found that *A. gracilipes* was the dominant species in scrub forest with high relative humidity and soil moisture in the rainy season with a lot of rain and high humidity in the air. Therefore, abiotic factors such as relative humidity and soil moisture in the scrub forest might be more suitable for *A. gracilipes*. Our result is similar to the reports of Hölldobler and Wilson (1990) and Agosti et al. (2000), who suggested that the effects of temperature and rainfall on quantity and population stability in the ecosystem and the foraging behavior of ant workers in each species were different.

In summary, the distribution of sixteen subterranean ant species collected by pitfall traps at the Rangsit Marsh, Khlong Luang District, Pathum Thani Province, Thailand, showed that ant communities in terms of species richness and species composition were different among the three studied sites. Moreover, the greater abundance of ant species occurred in habitats providing food in the glade and forest plantation. The most important factors influencing ant communities in this area are soil temperature, and water content in soil and litter. Nevertheless, other physical factors can also influence the ant species composition, such as precipitation and humidity, along with other resources such as food and microhabitats. These factors affected feeding behavior, foraging activities, and nest-building. Thus, it was found that several ants can be found only in particular areas. Furthermore, some species were found in all three land-use types, while other species were more specialized and could be found only in specific microhabitats in the forest. Regarding the study sites, subterranean ants can be used as bioindicators or bioturbators and have been claimed to be a suitable taxon for monitoring environmental change.

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