Research article

Diversity and Community Composition of Ants in the Mixed Deciduous Forest, the Pine Forest and the Para Rubber Plantation at Chulaborn Dam, Chaiyaphum Province, the Northeastern Thailand

DUANGRAT THONGPHAK*
Entomology Section, Department of Plant Science and Agriculture Resources, Faculty of Agriculture, Khon Kaen University, Khon Kaen, Thailand
E-mail: duathg@kku.ac.th

CHITIMA KULSA
Entomology Section, Department of Plant Science and Agriculture Resources, Faculty of Agriculture, Khon Kaen University, Khon Kaen, Thailand

Received 12 October 2013 Accepted 1 March 2014 (*Corresponding author)

Abstract The species diversity of ants in three different land use types: a mixed deciduous forest, pine forest and Para rubber plantation, were studied to determine and compare the ant species diversity in these areas. Four sampling methods: handling capture over constant time, honey bait trap, leaf litter sifting and soil sifting, were conducted from September 2011 to September 2012, inclusive. The species richness of ants in the area was 40 identified species, belonging to 23 genera in five subfamilies. The Shannon-Wiener's species diversity index indicated that the diversity was the highest in the mixed deciduous forest (2.65), followed by the pine forest (2.19) and lastly the Para rubber plantation (1.48). The β-diversity, using Sorensen's similarity coefficient to determine the similarity in community composition, was highest between the mixed deciduous forest and the Pine Forest at 71%, and then between the mixed deciduous forest and Para rubber plantation at 61%, and between the pine forest and the Para rubber plantation at 53%, indicating that both ant species diversity and community composition were varied in these three sites which may relate to their different land use types. Therefore, the information from this study suggests that ant species diversity may be used to assist the conservation and management planning of agro-forestry ecosystems.

Keywords ant, community composition, species diversity, land use type

INTRODUCTION

Ants play diverse and important ecological roles. They have functions in an ecosystem as herbivores, predators, prey, detritivores, mutualists and Alonso (2000) stated that their functions are usually related to the species and genera they belong to. Mayati (1996) reported that they improved soil, assisted in the decomposition process, create mycorrhizal reservoirs, effect nutrient immobilization, water movement, nutrient cycling, soil movement and physical and chemical changes to the soil profile. Because of their ecological significance in forest ecosystems, ants are considered suitable bioindicator species for biodiversity studies (Alonso, 2000). Moreover, ants have been used as biological agents of insect pests in agriculture in many countries such as Malaysia (Khoo and Chung, 1989) and Thailand (Kritsaneeapiboon and Saiboon, 2000). Although ants have relatively low species diversity, they are the single most important arthropod group by their dominance in animal biomass (Alonso and Agosti, 2000). Environmental changes have an impact on macro-arthropod abundance (Pearson and Derr, 1986; Adis and Latif, 1996). Many ant species are highly sensitive to the micro climate fluctuations and to habitat structure, and thus respond strongly to environmental change (Anderson, 1990; Alonso, 2000). Overall, common species, most habitats are likely to have specialized species, which occur in sufficient species diversity and

abundance as to be able to serve as suitable terrestrial indicator species of habitat quality and changes. Thus, the objective of this study was to comparison between the diversity of ants at the reserve forest area of Chulaborn dam and rubber plantation.

METHODOLOGY

The study sites were located within the Chulaborn dam, Chaiyaphum province in northeast Thailand. Three areas were selected based on differences in land use types: (i) a natural habitat represented by a mixed deciduous forest and a pine forest (ii) a monoculture based Para rubber plantation. The ants were sampled two seasons which of wet season and dry season during September 2011 to September 2012. The 100 m long line transects were established at each study site. Collecting ant specimens were performed by four sampling methods; hand collecting (HC), leaf litter sampling (LL), honey bait (HB), and soil sampling (SS). Ant specimens were identified to family, genus and species using the identification guides of Bolton (1994), Hölldobler and Wilson (1990), and Wiwatwitthaya and Jaitrong (2001). The specimens were also compared with the reference collections at the Ant Museum, Faculty of Forestry, Kasetsart University. The Shannon-Wiener's diversity index (Krebs, 1999), was used to calculate the diversity of ants collected. The formula of the Shannon-Wiener's diversity index used is presented as follows:

$$H' = \sum_{i=1}^{s} (pi)(\ln pi) \quad (1)$$

Where, *H*' = Species diversity index
s = Number of species
p_i = Proportion of the total sample belonging to i_{th} species

The Sorensen's similarity coefficient (Krebs, 1999) was used to measure the beta diversity or the similarity between two study sites as follows:

$$S = \frac{2a}{2a + b + c} \quad (2)$$

Where, *S* = Sorensen's similarity coefficient
a = Number of species in site A and site B
b = Number of species in site B but not in site A
c = Number of species in site A but not in site B

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

$$\text{Evenness} = \frac{H'}{H'_{MAX}} \quad (3)$$

Where, *H*' = Observed index of species diversity
H'_{MAX} = Maximum possible index of diversity

RESULT AND DISCUSSION

A total of 40 ants species in 23 genera distributed among the five subfamilies were identified from three difference land use types using four sampling methods (Table 1). With the comparative ant communities between the three sites, the highest number of species was recorded in the mixed deciduous forest followed by the pine forest and the lowest in the Para rubber plantation. Twenty eight species of ants in 21 genera and five subfamilies were found in the mixed deciduous forest follow by 25 species in 20 general and five subfamilies from pine forest. The lastly, there are only 13 species in 13 genera and four subfamily from rubber plantation. Four species of ants such as *Pachycondyla luteipes*, *Pheidologeton affinis* and *Odontoponera denticulata*, were found in all

three land use types, whilst other species, such as *Philidris* sp.1, *Camponoptus singualaris Oecophylla smaragdina, Polyrhachis furcata, Aphaenogaster* sp.1, *Hypoponera* sp.1, and *Pachycondyla higrite* were found only in the mixed deciduous forest. Whereas, some species, such as *Polyrhachis cyaniventris Polyrhachis fruhstorferi*, *Polyrhachis* sp.12, *Aphaenogaster* feae, *Pheidole* sp.2, were found only in the pine forest and one species of *Aphaenogaster* sp.2 was found only in the Para rubber plantation. At the genus level of all sites, *Polyrhachis* had the highest number of 8 species.

There was a difference in the number of ants species between wet and dry seasons, where in the dry season ant species numbers were high in pine forest and in Para rubber plantation whereas slightly lower in the dry season in the mixed deciduous forest.

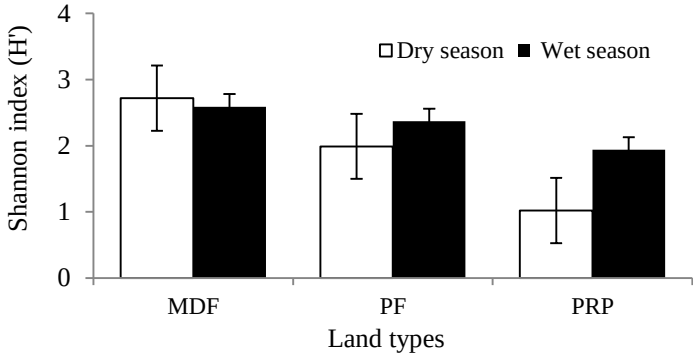
Table 1 Number of species, genera and family of ants in all sites at Chulabhorn Dam

	Number		
Subfamily	Genus	Species	Total(%)
Dolichoderinae	3	3	7.5
Formicinae	4	14	35.0
Myrmicinae	9	15	37.5
Ponerinae	6	6	15.0
Pseudomyrmercinae	1	2	5.0
Total	23	40	100

Table 2 Number of Subfamily, genera and species of ants in difference land use types at Chulaborn dam

Subfamily	Number					
	Genus			Species		
	MDF	PF	PRP	MDF	PF	PRP
Dolichoderinae	3	2	2	3	2	2
Formicinae	4	3	3	9	7	3
Myrmicinae	8	9	5	10	10	5
Ponerinae	5	4	3	5	4	3
Pseudomyrmercinae	1	2	-	1	2	-
Total	21	20	13	28	25	13

Note: MDF=Mixed deciduous forest, PF =Pine forest and PRP= Para rubber plantation

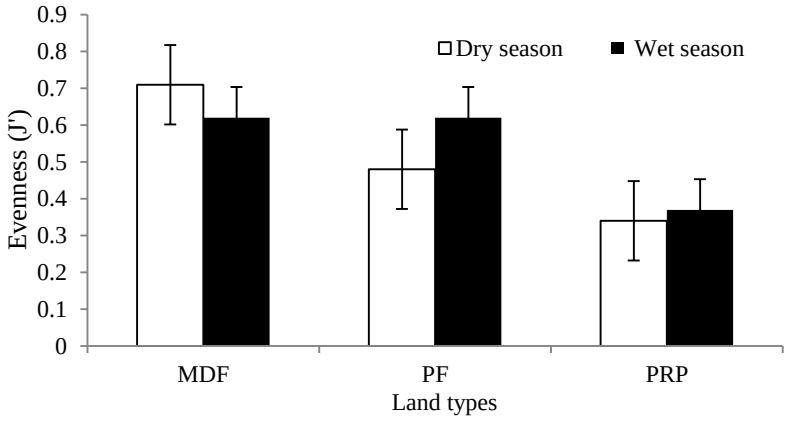


MDF=Mixed deciduous forest, PF =Pine forest and PRP= Para rubber plantation

Fig. 1 Comparison between Shannon index (H') of ant species in each land type at Chulaborn dam

The Shannon-Wiener's species diversity index (Fig. 1) indicated that the year round, diversity was the highest in the mixed deciduous forest, followed by the pine forest and lastly the rubber plantation. Moreover, the highest value of the evenness index of ants was in the mixed deciduous forest, followed closely by the pine forest, whereas that for the Para rubber plantation was markedly lower (Fig. 2). This indicates that a relatively equal abundance of each ant species

was present in the mixed deciduous forest and the pine forest whereas the Para plantation had an unequal abundance of some ant species.



MDF=Mixed deciduous forest, PF =Pine forest and PRP= Para rubber plantation

Fig. 2 Comparison between Evenness (J') of ant species in each land type at Chulaborn dam

Table 3 The Sorensen's similarity coefficient ants from the three sites

Types of land	Sorensen's similarity (%)		
	MDF	PF	PRP
MDF	1	-	-
PF	0.71	1	-
PRP	0.61	0.53	1

Note: MDF=Mixed deciduous forest, PF =Pine forest and PRP= Para rubber plantation

The species similarity between the mixed deciduous forest and the pine forest, as evaluated by Sorensen's similarity coefficient, was the highest whilst that between the mixed deciduous forest and the Para rubber plantation and between the pine forest and the Para rubber plantation were intermediate and the lowest, respectively (Table 3). The relatively high ant species diversity in the mixed deciduous forest may be caused by the correspondingly high diversity in the plant community and as such would potentially reflect the differences in the canopy cover and leaf shedding. Hasin (2008) reported that the leaf litter, soil moisture content, and leaf litter biomass in each study site would likely be affected by differences in each plant community. The leaf litter provides both food and nest sites to many ant species, so it might be expected that an addition of both resources will produce a stronger response from litter-nesting ants (Armbrecht et al., 2006). The higher species richness of ants in the natural forest than in the Para rubber plantation was similar to the reported trend for ant diversity at Sabah, Malaysia, which was higher in the primary and secondary forests than in the oil palm plantation (Yahya, 2000). Similarly with our report that the highest ant species richness was in the mixed deciduous forest followed by the pine forest and the Para rubber plantation, respectively, supporting that the forest is a more suitable habitat than the Para rubber plantation, all year round.

In the dry season, there were lower soil and litter moisture contents and a high temperature, conditions which are unsuitable for ants and their prey leading to a lower ant biodiversity and population levels and so a lower species number being recorded except in this study the mixed deciduous forest was slightly higher in dry season. In the wet season, there is more soil and litter moisture contents which are hence more suitable for many soil faunas that serve as ant prey. Thus, with an increase in the population size and potential biodiversity, a higher of predatory ants were found in this period. The similarity indices indicated that the species composition of ants between the natural forest and the pine forest was higher than that between the pine forest and Para rubber plantation. Compared with the primary land use as a natural forest, this result suggests that these a modified land usages reduce the ant diversity, meanwhile the Para rubber plantation can support a lower ant biodiversity than the forests. This may be due to the fact that the tree canopy of the Para

rubber was treated all year round by some chemicals such as the herbicide that can also affect some arthropods and other food sources.

CONCLUSION

In conclusion, the difference in land use types, which may reflect the different land usages of these sites but that awaits more detailed studies to confirm, potentially influenced the ant community species diversity and composition, as somewhat intuitively expected but not to date ascertained for these habitats. Some species were found in all three land use types, whilst other species were more specialized being found only in specific microhabitats in the forest. If an understanding of microhabitats used by specific ant species can be developed, along with the key trophic interactions, then the potential of using ants as terrestrial indicator species for detecting environmental changes can potentially be reliably and easily (low cost and time) performed compared to some other indicator species.

ACKNOWLEDGEMENTS

This research was supported by the Khon Kaen University funding 2012. The authors thank to the Plant Genetics Conservation Project under The Royal Initiative of Her Royal Highness Princess Maha Chakri Sirindhorn for permission of conducting the research. Special thanks to Integrated Water Resource Manegiment and Development Central Northeast Thailand.

REFERENCES

Adis, J. and Latif, M. 1996. Amazonian arthropod respond to El Nino. Biotropica, 28, 403-408.

Alonso, L.E. 2000. Ants as indicators of diversity. In: Ants: Standard method for measuring and monitoring biodiversity. Agosti, D., Alonso, L.E., Majer, J.D. and Schultz, T.R. (Eds). Smithsonian Institution Press, Washington, D.C., USA, 80-88.

Alonso, L.E. and Agosti, D. 2000. Biological studies, monitoring, and ants: An overview. In: Ants: Standard method for measuring and monitoring biodiversity. Agosti, D., Alonso, L.E., Majer, J.D. and Schultz, T.R. (Eds). Smithsonian Institution Press, Washington, D.C., USA, 1-8.

Anderson, A.N. 1990. The use of ant communities to evaluate change in Australian terrestrial ecosystems: A review and recipe. Proceedings of Ecological Society Australia, 16, 347-257.

Armbrecht, I., Perfecto, I. and Silverman, E. 2006. Limitation of nesting resources for ants in Colombian forest and coffee plantations. Ecological Entomology, 31, 403-410.

Bolton, B. 1994. Identification guide to the ant genera of the world, Harvard University Press, Cambridge, USA, 222.

Hasin, S. 2008. Diversity and community structure of ants at Sakaerat Environmental Research Station, Nakhon Ratchasima province. Department of Forest Biology, Faculty of Forestry, Kasetsart University. Thailand. 94, (in Thai).

Hölldobler, B. and Wilson, E.O. 1990. The ants. Belknap Press, Cambridge, USA, 732.

Krebs, C.J. 1999. Ecological methodology. Addison- Educationall Publishers, California, USA, 581.

Khoo, K.C. and Chung, G.F. 1989. Use of black cocoa ant to control mirid damage in cocoa. The Planter, Kuala Lumpur, 65, 370-383.

Kritsaneepaiboon, S. and Saiboon, S. 2000. Ant species (Hymenoptera:Formicidae) in longkong (Meliaceae: Aglaia dookkoo Griff.) plantation. Songklanakarin Journal of Science and Technology, 22(3), 393-396.

Maryati, M. 1996. A review of research on ants in Malaysia. In: Biodiversity and the Dynamics of Ecosystems. I.M. Turner, C.H. Diong, S.S.L. Lim and P.K.L. Ng, (eds.). Diversitas in the Western Pacific and Asia series 1, 373-383.

Pearson, L.D. and Derr, A.J. 1986. Seasonal patterns of lowland forest floor abundance in southern Peru. Biotropica, 18, 244-256.

Wiwatwitaya, D. and Jaitrong, W. 2001. Identification guide to the ant genera of Khao Yai National Park. Kasetsart University, Bangkok, Thailand. 110, (in Thai).

Yahya, B.E.B. 2000. The use of three insect groups as biological indicators in three ecohabitats of Sabah. School of Science and Technology, University Malaysia Sabah, Malaysia, 182.