Research article

Ant Biodiversity under Different Fruit Agro-ecosystem in Nam Phong Watershed, Thailand

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Abstract Ants are one of significant components of ecosystems. They play important roles in agro-ecosystem functioning and provide ecological services as bioindicator, pollinator and biological control. Ants are diverse taxonomic groups. The study of ant diversity in economic crop areas including guava, mango, custard apple and banana gardens in Nam Phong Watershed, Khon Kaen province was conducted during November 2017 to August 2018. Ants were collected using three random sampling methods: manual catching, plant litter sifting and syrup trapping. The result revealed that 5 subfamilies, 13 genera of ants were found in this study. Five subfamilies found in the studied sites comprised of Dolichoderinae, Formicinae, Myrmicinae, Ponerinae and Pseudomyrmecinae. The most common species of ant with wide distribution in the study area were Anoplolepis and Diacamma. The Shannon-Wiener's species diversity index revealed that the diversity was highest in guava (0.36) followed by mango (0.35), custard apple (0.34) and lastly the banana garden (0.26). There was no dominant species of ant in the study areas. The β-diversity score, using Sorensen's similarity coefficient to determine the similarity in community composition, was found highest between guava and custard apple garden at 62%, follow by between mango and guava garden at 46%, and between mango and the banana garden at 38%, the results indicated that ant species diversity was varied in the four studied sites. Therefore, the results from this study suggests that ant species diversity can be used to support agro- ecosystems management.

Keywords ant diversity, ecosystem service, economic crops, Nam Phong Watershed

INTRODUCTION

Ants may function as bio-indicators, due to their complex ecological interaction within their, and to their sensitivity to disturbances (Read and Andersen, 2000). It is possible to analyze variations in the community of ants under the concept of functional groups, defined in accordance with their tolerance to disturbance and environmental stress, as well as with their ability for competitive interactions (Andersen, 1995). Ants play diverse and important ecological roles. Because of their ecological significance in ecosystems, ants are considered to be the suitable bio-indicator species for biodiversity studies (Alonso, 2000). Moreover, ants have been used as biological agents of insect pests in agriculture in several countries include 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). 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.

OBJECTIVE

The objective of this research was to investigate biodiversity of ants in four different agro-ecosystems; guava, custard apple, mango and banana gardens in Nam Phong Watershed, Khon Kaen Province, Thailand.

METHODOLOGY

Study sites were located at Namphong Watershed, Khon Kaen, Thailand. Four different fruit agroecosystem included guava, custard apple, mango and banana gardens were chosen to investigate ant diversity. Guava garden with the area of 6 Rai (0.96 ha) was located at Kok Tah Village, Mueang District, (16.5° 38' 81.3" N, 102.90° 12' 75" E). There was not any management system in this garden. Custard apple garden in area of 2 Rai (0.32) was located at Tha Kra Some Village, Nam Phong District, (16.62° 22' 47" N, 102.87° 73' 75" E. Mango garden in area of 2.5 Rai (0.4 ha) was located at the same village of the custard apple garden (16.60° 59' 83" N, 102.87° 61' 40" E), both gardens had no management system. Banana garden in area of 3.7 Rai was located at Nong Ngu Luam Village, Mueang District, (16.5° 149' 74" N, 102.93° 11' 17" E), herbicide and chemical fertilizer (N-P-K-15-15-15) were applied in banana garden. All four studied sites were in Khon Kaen Province.

Fig. 1 Study sites

Ant samples were collected from November 2017 to August 2018. The seasons of collecting data were divided into wet season and dry season. Ant specimens were collected by using three random sampling methods: manual catching, plant litter sifting and syrup trapping. The ecological factors were measured at the same time. Identification of ants to family, genus and species was based on the keys by Bolton (1994), Hölldobler and Wilson (1990), and Wiwatwitaya and Jaitrong (2001). The Shannon-Wiener’s diversity index (Krebs, 1999), was used to calculate ants diversity collected. The formula of the Shannon-Wiener’s diversity index used is presented below

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

where H' = species diversity index, s = number of species, pi = proportion of the total sample belonging to ith species.

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

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

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:

$$\text{Evenness} = \frac{H'}{H'\text{MAX}}$$

where H' = observed index of species diversity, H'MAX = maximum possible index of diversity.

RESULTS AND DISCUSSION

Table 1 Number of genera and family of ants in all sites at Nam Phong Watershed

Subfamily	Genus	Study area				Total
		Guava	Custard apple	Mango	Banana	
Amblyoponinae	*Amblyopone*	7	0	2	0	9
Dolichoderinae	*Ochetellus*	1	0	1	0	2
	Iridomyrmex	0	0	0	1	1
Formicinae	*Anoplolepis*	329	112	8	11	460
	Camponotus	3	16	0	0	19
	Nylanderia	7	5	1	10	23
	Oecophylla	76	43	195	4	318
Ponerinae	*Diacamma*	10	26	0	1	37
	Odontoponera	3	33	0	0	36
Myrmicinae	*Pheidole*	9	11	0	0	20
	Cardiocondyla	0	0	0	1	1
	Monomorium	23	42	136	130	331
	Crematogaster	25	0	0	0	25
Number of genus		10	8	6	7	13
Number of specimens		503	296	349	165	1295

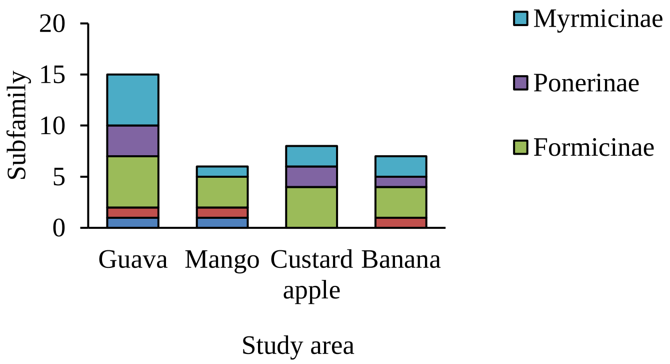

Fig. 2 Comparison of ant diversity in each crop areas

Total of 23 ant genera distributed among five subfamilies were identified from four difference agro-ecosystems (Table 1, Fig. 2). With the comparative ant communities between the four agro-ecosystems, the highest number of specimens was recorded in guava garden followed by custard apple, banana and the lowest in mango garden. Ten genera and five subfamilies were found in guava garden follow by eight general and four subfamilies from custard apple, seven genera and four subfamilies from banana garden. Meanwhile there are only six genera and four subfamilies from mango garden. Four species of ants included *Anoplolepis, Nylanderia, Oecophylla, Monomorium* were found in all four agro-ecosystems, whilst other species, *Iridomyrmex* and *Cardiocondyla* were found only in banana garden and one species of *Crematogaster* was found only in guava garden. At the subfamily level of all sites, Formicinae and Mymicinae had the highest number of four genera. The richness of genera found in the study is lower compared to the richness recorded in other studies carried out in crop area in central Thailand (Weerapadtra et al., 2018).

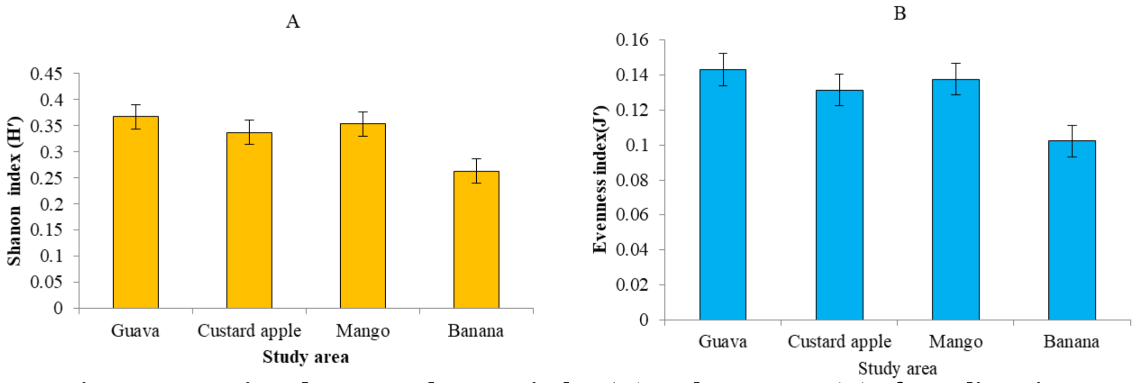

Fig. 3 Comparison between Shannon index (A) and Evenness (B) of ant diversity in each plantation

The Shannon-Wiener's species diversity index (Fig. 3A) indicated that the year-round diversity was the highest in guava garden, followed by mango, custard apple and lastly in banana garden. Moreover, the highest value of the evenness index was found in guava garden followed closely by mango and custard apple gardens, whereas those for banana garden was markedly lower (Fig. 3B). This result indicates that a relatively equal abundance of each ant species was present in guava and mango gardens whereas banana garden had an unequal abundance of some ant species.

The species similarity between guava and custard apple gardens, as evaluated by Sorensen's similarity coefficient was the highest, whilst that of between guava and mango gardens was intermediate and the lowest similarity was found between in custard apple and banana garden (Table 2). The relatively high ant species diversity in guava garden 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).

Table 2 The Sorensen's similarity coefficient ants from the four sites

Study area	Sorensen's similarity			
	Guava	Mango	Custard apple	Banana
Guava	1	-	-	-
Mango	0.46	1	-	-
Custard apple	0.62	0.31	1	-
Banana	0.38	0.38	0.31	1

CONCLUSION

In conclusion, diversity of ants was different in four crop gardens, which may reflect the different ecological service they provide in different land uses of the studied sites. However, more detailed study needs to be done to confirm include potentially factors influenced ant community species, diversity, and composition, as somewhat intuitively expected but not to date ascertained for these habitats. Some species were found in all four crop areas, whilst other species were more specifically being found only in specific microhabitats in the studied areas. If the 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. Future research on the roles of ants in an ecosystem and their contribution to ecosystem service need to be investigated.

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