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Diversity and abundance of ants (Hymenoptera: Formicidae) in Phu Luong, Thai Nguyen province, Vietnam

Sự đa dạng và độ phong phú của các loài kiến (Hymenoptera: Formicidae) ở Phú Lương, tỉnh Thái Nguyên, Việt Nam

Research article

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Three different habitats: secondary forest, acacia plantation, and mixed forests on limestone, were chosen to determine and compare the ant species diversity in these habitats. A total of 24 identified species and 11 morphology species belonging to 20 genera in seven subfamilies were collected using pitfall traps from June 2014 to May 2015. The Shannon-Wiener's species diversity index indicated that the diversity was the highest in the acacia plantation (2.08), followed by the secondary forest (1.99) and lowest in the mixed forests on limestone (1.83). There are three dominant species in the habitat (I), Pheidole noda, Odontomachus cf. monticola, and Odontoponera denticulate; four dominant species in the habitat (II), Odontoponera denticulata, Carebara diversa, Technomyrmex brunneus and Anoplolepis gracilipes; and only one dominant species in the habitat (III), Anoplolepis gracilipes. The species similarity (S) relatively low may be because of the difference vegetation and condition in the three habitats.

Đa dạng loài kiến trong ba môi trường sống khác nhau: rừng rậm thường xanh nhiệt đới, rừng keo và rừng hỗn giao trên núi đá vôi, được nghiên cứu để xác định và so sánh sự đa dạng các loài kiến trong những môi trường sống. Phương pháp nghiên cứu: sử dụng bẫy hố từ tháng 6 năm 2014 đến tháng 5 năm 2015. Đã ghi nhận được 35 loài, thuộc 20 giống, 7 phân họ. Chỉ số đa dạng loài Shannon-Wiener cho thấy rừng keo có chỉ số đa dạng cao nhất (2,08), tiếp theo là rừng rậm thường xanh nhiệt đới (1,99) và cuối cùng là rừng hỗn giao trên núi đá vôi (1,83). Có 3 loài ưu thế ở sinh cảnh (I) là Pheidole noda, Odontomachus cf. monticola và Odontoponera denticulata, bốn loài ưu thế ở sinh cảnh (II) là Carebara diversa, Technomyrmex brunneus, Odontoponera denticulate và Anoplolepis gracilipes. Ở sinh cảnh (III) chỉ có duy nhất một loài chiếm ưu thế là loài Anoplolepis gracilipes. Chỉ số tương đồng (S) tương đối thấp có thể là do sự khác nhau ở các thảm thực vật và điều kiện sống trong ba sinh cảnh.

Keywords: Formicidae, species diversity, pitfall traps, habitats, Vietnam

1. Introduction

Ants (Hymenoptera: Formicidae) are the most dominant insect group on earth, both ecologically and numerically and ants are estimated to represent 10% to 15% of the entire animal biomass in many terrestrial ecosystems (Beattie and Hughes 2002). The impact of ants on the terrestrial environment is correspondingly great. They engage in a variety of ecological roles such as: competitors, predators, prey, scavengers, mutualists, gardeners, and soil engineers. Ant is one of the important components of the ecosystem. They participate in the cyclical process of nature such as nitrogen cycle, carbon cycle, contributing to reducing climate change. Thus, ants can be used as bio-indicators to assess forest quality and environmental controls. Moreover, ants have been used as biological agents of insect pests in agriculture in many countries such as Malaysia (Khoo and Chung, 1989), Thailand (Kritsaneeapiboon and Saiboon, 2000), and Vietnam (Nguyen Thi Thu Cuc, 2005). In addition, environmental changes have an impact on macroarthropod abundance (Pearson and Derr, 1986; Adis and Latif, 1996). Many ant species are highly sensitive to the

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micro climate fluctuations and to habitat structure, and thus respond strongly to environmental change (Anderson, 1990; Alonso, 2000). The research objective is to compare the species diversity of ants at different habitats.

2. Methodology

The study sites were located within the Phu Luong district, Thai Nguyen province in north-eastern Vietnam. Three habitats were selected to set up pitfall traps: (I) secondary forest, (II) acacia plantation, (III) mixed forests on limestone. The ants were sampled in four seasons, from June 2014 to May 2015.

Sampling method: Ants were primary collected by pitfall traps, which are made from plastic cups (diameter of 10cm, height of 13cm), each cup containing 10 mL alcohol with 4% formaldehyde. The cup was set on the ground so that its rim was flush with the ground surface. A total of 15 traps were set at each habitat. Ant specimens were collected after 10 days since the trap was set with study liquid (alcohol and formaldehyle), then the trap was left empty 10 days, filled with study liquid again and left for another 10 days to the next collected time. Ant specimens were identified using the identification guides of Bolton (1994), Eguchi et al. (2011, 2014). In addition, Dr. Yamane from Kagoshima University and Dr. Eguchi from Tokyo Metropolitan University also helped to identify ant specimens.

The Shannon-Wiener's diversity index (*H'*) (Krebs, 1999) and Bray-Curtis similarity (S) were used in this study, with formulae as below:

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

Where, H' = Species diversity index
s = Number of species
pi = Proportion of the total sample belonging to i*th* species

$$S = 100 \left(1- \frac{\sum_i |yij - yik|}{\sum_i yij + \sum_i yik} \right)$$

Where, S = Bray-Curtis similarity
y = Number of specimen
j, k = habiatas j and k
i = species i
yij, yik = Number specimen at habitat j and habitat k.

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

$$J' = \frac{H'}{H'MAX}$$

Where, H' = Observed index of species diversity
H'MAX = Maximum possible index of diversity

The software used in this study is Primer 6.

3. Results and discussion

A total of 35 ant species in 20 genera distributed among seven subfamilies were collected from three different habitats using pitfall trap (Table 1). Seven species were added to the list publish by Nguyen 82015): *Monomorium destructor* (Jerdon), *Pheidole laevicolor* Eguchi, *Pristomyrmex punctatus* (Smith), *Pachycondyla nigrita* (Mayr), *Nylanderia* sp1 of LD, *Crematogaster* sp3 of LD, and *Tetraponera* sp5 of LD. With the comparative ant communities between the three habitats, the highest number of species was recorded in the habitat (II), followed by the habitat (I), and the lowest in the habitat (III). Twenty-eight species of ants in 20 genera and seven subfamilies were found in the habitat (II), follow by 22 species in 15 general and five subfamilies in habitat (I), and there are only 13 species in 10 genera and five subfamily were found in habitats (III). Eight species, *Aenictus binghamii* Forel, *Technomyrmex brunneus* Forel, *Anoplolepis gracilipes* (F. Smith), *Carebara diversa* (Jerdon), *Crematogaster* sp2 of LD, *Leptogenys peugueti* (Andre), *Odontoponera denticulata* F. smith, *Pachycondyla rufipes* (Jerdon), were found in all three habitats. Ten species, *Gnamptogenys bicolor* (Emery), *Polyrhachis proxima* Roger, *Polyrhachis* sp2 of LD, *Crematogaster* sp3 of LD, *Monomorium destructor* (Jerdon), *Pheidole laevicolor* Eguchi, *Pristomyrmex punctatus* (Smith), *Anochetus cf. qraeffei* Mayr, *Tetraponera attenuata* (F. Smith), *Tetraponera*sp5 of LD, were found only in the habitat (II). Two species *Aenictus paradentatus* Jaitrong & Yamane and *Leptogenys kitteli* (Mayr) were found only in the habitat (I). And two species *Camponotus* sp.3 of LD and *Pachycondyla nigrita* (Mayr) were found only in the habitat (III). At the genus level of all sites, *Pachycondyla* has the highest number of species, with 5 species.

Table 1. Species composition and their individuals at three habitats in Phu Luong, Thai Nguyen

No	Composition	Number of individuals in each habitat		
		(I)	(II)	(III)
	Subfamily Dorylinae			
1	*Aenictus binghamii* Forel	12	2	27
2	*Aenictus paradentatus* Jaitrong & Yamane	5		
	Subfamily Dolichoderinae			
3	*Dolichoderus thoracicus* F. Smith	3	7	
4	*Dolichoderus* sp1 of LD	1		
5	*Technomyrmex brunneus* Forel	37	244	8
	Subfamily Ectatomminae			
6	*Gnamptogenys bicolor* (Emery)		1	
	Subfamily Formicinae			
7	*Anoplolepis gracilipes* (F. Smith)	2	111	122

No	Composition	Number of individuals in each habitat		
		(I)	**(II)**	**(III)**
8	*Camponotus* sp1 of LD		35	22
9	*Camponotus* sp2 of LD	1		2
10	*Camponotus* sp3 of LD			2
11	*Nylanderia* sp1 of LD	1	30	
12	*Polyrhachis proxima* Roger		1	
13	*Polyrhachis* sp2 of LD		3	
	Subfamily Myrmicinae			
14	*Carebara diversa* (Jerdon)	63	561	84
15	*Crematogaster* sp2 of LD	2	44	5
16	*Crematogaster* sp3 of LD		7	
17	*Monomorium destructor* (Jerdon)		1	
18	*Pheidole laevicolor* Eguchi		3	
19	*Pheidole noda* Smith	113	8	
20	*Pheidole plainfrons* Santschi	4	6	
21	*Pheidole yeensis* Forel	1	20	
22	*Pristomyrmex punctatus* (Smith)		41	
	Subfamily Ponerinae			
23	*Anochetus cf. qraeffei* Mayr		8	
24	*Diacamma* sp1 of LD	13	2	
25	*Leptogenys kitteli* (Mayr)	5		
26	*Leptogenys peugueti* (Andre)	10	9	36
27	*Odontomachus cf. monticola* Emery	160	24	
28	*Odontoponera denticulata* F. smith	163	157	68
29	*Pachycondyla cf. astuta* F. Smith	1		1
30	*Pachycondyla cf. nakasujii* Yashiro et al	6	1	
31	*Pachycondyla nigrita* (Mayr)			1
32	*Pachycondyla rufipes* (Jerdon)	9	58	1
33	*Pachycondyla* sp1 of LD	1	3	
	Subfamily Pseudomyrmecinae			
34	*Tetraponera attenuata* (F. Smith)		19	
35	*Tetraponera*sp5 of LD		2	
	Total	**613**	**1408**	**379**

Note: LD is abbreviation of collection of Nguyen Dac Dai and Nguyen Thi Phương Lien.
*Note: **(I)** = secondary forest, **(II)** = acacia plantation, **(III)** = mixed forests on limestone*

Dominant species is the species which have more than 100 individuals in the habitat. Their list is shown in Table 2. There are three dominant species in the habitat (I), *Pheidole noda*, *Odontomachus cf. monticola*, and *Odontoponera denticulate*; four dominant species in the habitat (II), *Odontoponera denticulata*, *Carebara diversa*, *Technomyrmex brunneus* and *Anoplolepis gracilipes*; and only one dominant species in the habitat (III), *Anoplolepis gracilipes*. The reasons may be due to bioecological traits of the most abundant species as well as stochastic impacts. The more dominant species, the fewer amounts of resources goes to concomitant species, therefore, the lower value in community species richness. The part of community resources used by the dominant species may be not a special case but can be a reflection of general pattern of resources distribution among species under specific environmental conditions. Correspondingly, in communities with higher dominance species, there might be more "strict" distribution of resources among concomitant species, which, in turn, might influence community species richness.

Table 2. Dominant species in three habitats in Phu Luong, Thai Nguyen

No	Species name	Number of individuals in each habitat		
		(I)	**(II)**	**(III)**
1	*Anoplolepis gracilipes* (F. Smith)	-	111	122
2	*Carebara diversa* (Jerdon)	-	561	-
3	*Pheidole noda* Smith	113	-	-
4	*Odontomachus cf. monticola* Emery	160	-	-
5	*Odontoponera denticulata* F. smith	163	157	-
6	*Technomyrmex brunneus* Forel	-	244	-
	Total	**436**	**1073**	**122**
	D (%)	**71.1**	**76.2**	**32.2**

Note: (I) = secondary forest, (II) = acacia plantation, (III) = mixed forests on limestone

The Shannon-Wiener's species diversity index (H') (Table 3) indicated that in the year round, diversity was the highest in the habitat (II), followed by the habitat (I) and lowest in the habitat (III). Moreover, the highest value of the Evenness index (J') of ants was in the habitat (III), followed closely by the habitat (I), and lowest in the habitat (II). This indicates that a relatively equal abundance of species was present in the three habitats.

Table 3. Shannon-Wiener's species diversity index (H') and Evenness index (J') of ant in each habitat in Phu Luong, Thai Nguyen

Habitats	Number species	Number specimen	J'	H'
Natural evergreen raining forest (I)	22	613	0.64	1.99
Acacia plantation (II)	28	1408	0.62	2.08
Mixed forests on limestone (III)	13	379	0.71	1.83

Figure 1 showed that the similarity, using Bray-Curtis similarity coefficient (S) to determine the similarity in community composition, was highest between the mixed forests on limestone and the acacia plantation (35%), and then between the natural evergreen raining forest and the other two habitats, acacia plantation and mixed forests on limestone (32%), indicating that both ant species diversity and community composition were varied in these three sites which may relate to their different habitats.

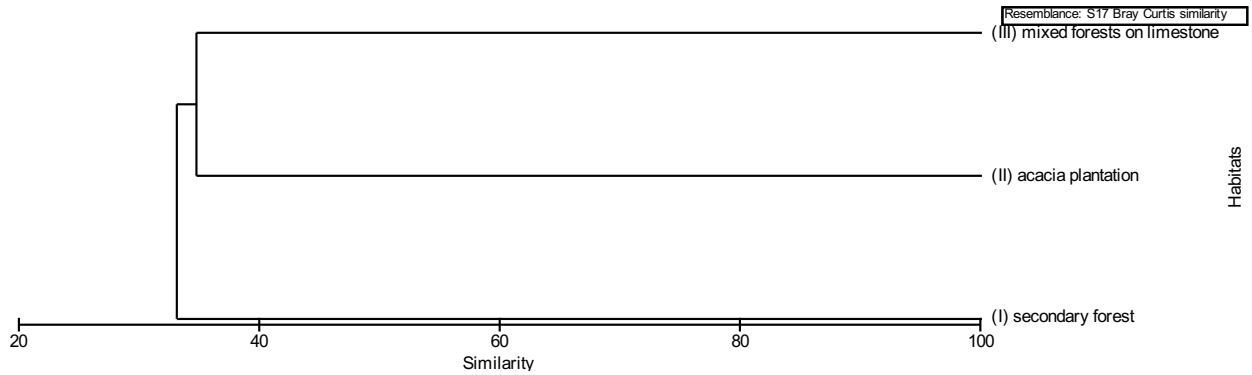

Figure 1. The Bray-Curtis similarity coefficient of ants from three habitats in Phu Luong, Thai Nguyen

4. Conclusion

The difference in habitats may reflect the different of species composition. Some species were found in all three habitats, while other species were more specialized being found only in a specific habitat. Each habitat has different number of dominant species. In this study, there are six dominant species recorded, in which three dominant species were found in the habitat (I), four dominant species were found in the habitat (II), and only one dominant species found in the habitat (III). The Shannon-Wiener's species diversity index (H') was the highest in the habitat (II) and lowest in the habitat (III). Therefore, species diversities in the habitats are different: habitat (II) has the highest number of species, followed by the habitat (I), and the lowest number of species is in the habitat (III). The species similarity coefficients (S) of ants in each habitat are relatively low. The reason may be the difference vegetation and condition in each habitat. In addition, this is only a comparative assessment of diversity and abundance of research subjects.

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