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A Comparison of Ant Populations in Restored Forest of Different Ages and Adjacent Natural Vegetation in Northern Thailand

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ABSTRACT

The ant communities in restored forest 8, 6 and 4 years after planting with 30 native forest tree species (planted in 1997, 1999 and 2001 respectively) were compared with those of the adjacent natural vegetation in the north of Doi Suthep-Pui National Park, Chiang Mai Province, Thailand. A total of 1,486 ant specimens belonging to 6 subfamilies, 27 genera and 42 species were collected during 2003-2004. Four subfamilies of ants were recorded in all plots: Dolichoderinae, Formicinae, Myrmicinae and Ponerinae. Dorylinae and Leptanillinae were found only in the 8 year-old plots and in the natural vegetation, respectively.

Ant population on the 4 year-old plot was highest. Succession of ants appeared to occur because populations decreases with increasing maturity of the forest plots. Ant communities in all plots were similar. Cluster analysis showed that the ant communities in the 8 year-old plots and the natural vegetation were most similar, followed by the 6 year-old plot. The community in the 4 year-old plot was considerably different from the others.

Key words: ants, diversity, restored forest

INTRODUCTION

At present, deforestation is one of the most important environmental problems in Thailand. It causes loss of wildlife habitats, soil erosion and rural poverty. Protecting what remains of Thailand's forest is essential for the environmental stability of the country; but protection alone is not enough. In 1960's the first protected areas were established and Thailand's forest had been reduced from 53 % to about 22.8 % (Bhumibamon, 1986). Commercial logging was banned in 1989 and forest destruction slowed down but the deforestation rate still exceeded 1% per year due to illegal logging, agricultural expansion and urbanization. Many organizations recognize the need to reforest degraded areas. Since 1993, various projects of reforestation have been set up to celebrate the Golden Jubilee of the King. One of them is the Forest Restoration Research Unit (FORRU) of Chiang Mai University in collaboration with Doi Suthep-Pui National Park (18°15′N 98°0′E, altitude 1000 m). FORRU was established in 1994 by establishing a tree nursery and field trials at Ban Mae Sa Mai, an Hmong hill tribe village in

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the north of the national park. Plots were planted with 30 so called "framework" tree species, selected for their ability to capture the site and to attract seed dispersing wildlife. With this technique, the area has been changed from dense herbaceous vegetation to closed canopy forest within 3-4 years. The diversity of plants and animals, including ground dwelling ants increases as a result of forest restoration. Ants are the most important group of insects in tropical forest in terms of biomass, numbers of individuals and ecological impact (Holldobler and Wilson, 1990; Alonso and Agosti, 2000). They mix dead organic into the mineral soil and cycle nutrients.

The specific goals of this study were (1) to describe the ant communities in the forest restoration plots compared with an adjacent herbaceous weedy natural vegetation, (2) to study ant diversity and similarity of ant communities among the areas and (3) to assess the response of ants to restoration.

MATERIALS AND METHODS

Study plots

Three forest reforestation plots planted in 1997, 1999 and 2001 and an area of herbaceous weedy vegetation adjacent those were selected. They were called the 8, 6, 4 year-old plots (P8, P6 and P4) and NV, respectively. Trees in all plots were identified to family level. In the 8 and 6 year-old plots, trees were 8-10 m tall, but the canopy of the 8 year-old plot was denser than that of the 6 year-old plot. In the 4 year-old plot, trees were about 6 m tall and canopy closure was incomplete so light reached and grasses still remained in the ground floor. The natural vegetation plot was covered with 4 m tall grasses and soil was dry.

Ant collection

Three replicate subplots of 1600 sq m were placed randomly in each of P8, P6, P4 and NV area and 10 samples were collected from each subplot (total 30 per area) once in the rainy, cool and hot seasons of one year (2003-2004). Soil and leaf litter in the plots were collected from a quadrat of 1 sq m, 10 cm in depth and extracted by Tullgren funnels. Ants specimens were sorted and preserved in 70 % ethanol. Identification was done at the Department of Biology, Faculty of Science, Chiang Mai University and the National Science Museum, Technopolis, Khlong 5, Khlong Luang, Pathum-Thani, Thailand.

Ant species diversity was calculated using by Simpson's diversity (1-D) (Simpson, 1949) and Shannon's Index (H¢) (Ludwig and Reynolds, 1988).

The similarity of ant fauna was computed by Sorensen's Index (Ludwig and Reynolds, 1988).

RESULTS

Ant fauna and community

A total of 1,486 ant specimens, representing 6 subfamilies 27 genera and 42 species were collected from all plots (Table 1). Ants of the subfamilies Dolichoderinae, Formicinae, Myrmicinae and Ponerinae were found in all plots, whereas Dorylinae and Leptanillinae were found only in P8 and NV, respectively (Figure 1). The 27 genera and 42 species consisted of Dolichoderinae: 2 genera, 2 species; Dorylinae: 1 genera, 1 species; Formicinae 4 genera, 6 species; Leptanillinae: 1 genus, 1 species; Myrmicinae: 10 genera, 17 species and Ponerinae: 9 genera, 15 species (Table 2). The most species-rich genus was *Pachycondyla* with 4 species, followed by *Oligomyrmex* and *Pheidole* with 3 species and *Paratrechina*, *Pseudolasius*, *Monomorium*, *Myrmicina*, *Tetramorium*, *Amblyopone*, *Hypoponera* and *Leptogenys* with 2 species.

Ant community

In the 8 year-old plot (P8), 213 ant

Table 1 Number of individuals collected from the restored forest 8, 6 and 4 year-old plots after planting (planted in 1997, 1999 and 2001) and in adjacent natural vegetation (NV).

Taxa	1997	1999	2001	NV
Subfamily Dolichoderinae				
Tapinoma melanocephalum	2	19	126	4
Technomyrmex kraepelini	1	67	8	1
Subfamily Dorylinae				
Dorylus laevigatus	4	0	0	0
Subfamily Formicinae				
Paratrechina longicornis	0	4	1	0
Paratrechina sp.	0	29	40	2
Polyrhachis (*Campomyrma*) *halidayi*	1	1	0	0
Prenolepis sp.1	0	0	15	0
Pseudolasius sp.1	3	0	32	4
Pseudolasius sp.2	26	0	108	3
Subfamily Leptanilla				
Leptanilla sp.	0	0	0	4
Subfamily Myrmicinae				
Carebara castanea	1	0	0	0
Lophomyrmex birmanua	42	31	6	1
Monomorium destructor	24	61	43	50
Monomorium pharaonis	3	3	5	5
Myrmecina sp.1	0	0	1	0
Myrmecina sp.2	0	0	1	0
Oligomyrmex sp.1	19	17	64	16
Oligomyrmex sp.2	4	1	81	21
Oligomyrmex sp.3	0	10	15	0
Pheidole sp.A (minor)	0	0	6	0
Pheidole sp.B (minor)	0	3	0	0
Pheidole pieli	4	1	17	0
Pheidologeton affinis	0	20	6	16
Rhoptromyrmex wroughtonini	1	0	0	0
Smithistruma sp.1	0	0	0	1
Tetramorium sp.1	0	0	3	0
Tetramorium sp.12	2	3	0	0
Subfamily Ponerinae				
Amblyopone sp.1	0	1	0	0
Amblyopone sp.2	0	0	0	1
Diacamma vargans	0	0	0	1
Discothyrea sp.	0	2	2	0
Gnamptogenys binbhamii	0	0	2	0
Hypoponera sp.1	13	1	9	8
Hypoponera sp.2	2	1	1	8
Leptogenys kitteli	0	0	1	0
Leptogenys sp.	0	0	0	2
Pachycondyla astuta	3	1	0	0
Pachycondyla (Brachyponera) chinensis	0	3	9	27
Pachycondyla (Brachyponera) luteipes	53	49	49	9
Pachycondyla (Mesoponera) ruba	0	1	0	0
Ponera sp.	2	13	50	16
Probolomyrmex sp.	3	0	0	0
Total	213	372	701	200

individuals representing 22 species were collected. The dominant species was *Pachycondyla luteipes*. In the 6 year-old plot (P6), 372 individuals representing 24 species were collected with *Technomyrmex kraepelini* was dominant. The most species rich plot was the 4 year-old plot (P4), with 701 ant individuals collected representing 27 species. *Tapinoma melanocephalum* was dominant. In the herbaceous weedy vegetation (NV), only 200 ant individuals representing 20 species with *Monomorium destructor* dominant (Table 3).

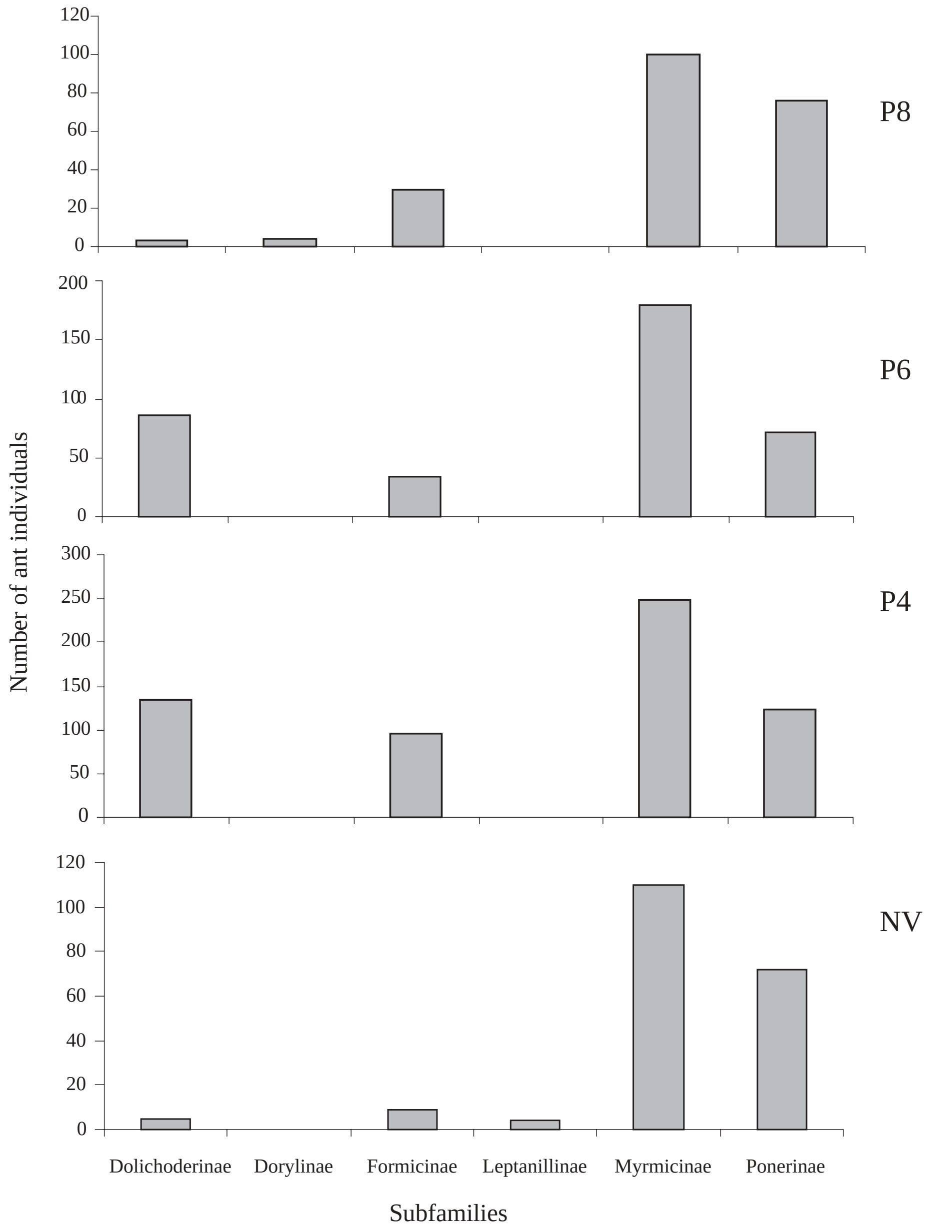

Figure 1 Comparison of ant populations on plots of various ages on restoration areas with population in the natural vegetation.

Species diversity indices

Ant species diversity, as calculated by Simpson's index (1-D) and Shannon (H¢), also did not differ significantly among plots, but the diversity was highest in the 4 year-old plot (P4) (Table 4)

Similarity

The similarity of ant fauna in the plots was computed by Sorensen's index as shown in Table 5. It was found that ant fauna were similar in all plots.

Table 2 Number of species (S) and genera (G) for subfamilies collected in all plots (pooled data for each area).

Subfamily	P8		P6		P4		NV	
	S	G	S	G	S	G	S	G
Dolichoderinae	2	2	2	2	2	2	2	2
Dorylinae	1	1	-	-	-	-	-	-
Formocinae	3	2	3	3	5	4	3	2
Leptanillinae	-	-	-	-	-	-	1	1
Myrmicinae	9	7	10	6	12	7	7	5
Ponerinae	6	4	9	5	8	6	8	4

Table 3 Dominant species, number of individuals and species found in each plot.

Plot	Dorminant species	Number of ants in plots	
		Individuals	Species
P8	*Pachycondyla luteipes*	213	22
P6	*Technomyrmex kraepelini*	372	24
P4	*Tapinoma melanocephalum*	701	27
NV	*Monomorium destructor*	200	20

Table 4 Species diversity of ant fauna in the 8, 6, 4 year-old plots (P8, P6, P4) and the natural vegetation (NV) (pooled data from all replicates in each area)

Plot Indices.	P8	P6	P4	NV
Simpson. (1-D)	0.861	0.891	0.902	0.885
Shannon (H′)	2.295	2.444	2.593	2.471

Table 5 Computed value of similarity of ant fauna in the 8, 6, 4 year-old plots (P8, P6, P4) and the natural vegetation (NV).

	P6	P4	NV
P8	0.67	0.58	0.62
P6		0.67	0.62
P4			0.67

Comparison of plots based on ant fauna

Cluster analysis of the plots (Figure 2) demonstrated that the 8 year-old plot and the natural vegetation were the most similar in regards to the ant community, followed by the 6 year-old plot. The community of the 4 year-old plot was considerably different from the others.

DISCUSSION

Subfamilies of ant from studied plots were not the same in both species snd numbers (Figure1) because the conditions were slightly different. Dorylinae usually settles deeply into the soil, engulfs all of the ground and low vegetation in its path (Holldobler and Wilson, 1990). Our observations indicated that, Dorylinae (*Dorylus* sp.) nested in the moderately moist soil. Therefore, the soil of the 8 year-old plot was moister than the other plots because of the tall trees and shade. The situation of the plot was suitable for these ants. Letanillinae ants are centered in the Oriental region (Snelling, 1981) and they are found in dry natural vegetation. *Leptanilla* was collected from rainforest to dry broadleafed forest (Holldobler and Wilson, 1990; Shattuck,1999), so the condition of the natural vegetation was suited. Myrmicinae is most abundant in all plots because it is the largest and the most diverse group of the ants (Snelling, 1981) with a worldwide distribution (Shattuck, 1999).

Ant populations were relatively low in the 8 and 6 year-old plots and in the natural vegetation, but were higher in the 4 year-old plot (Table 3). In addition, the two separate estimates of diversity for each plot were very similar (Table 4). The highest diversity was found in the 4 year-old plot. Diversity increased with maturity of the planted trees (Kreb, 1972; Rosenzweig,1995) and decreased before reaching the climax vegetation

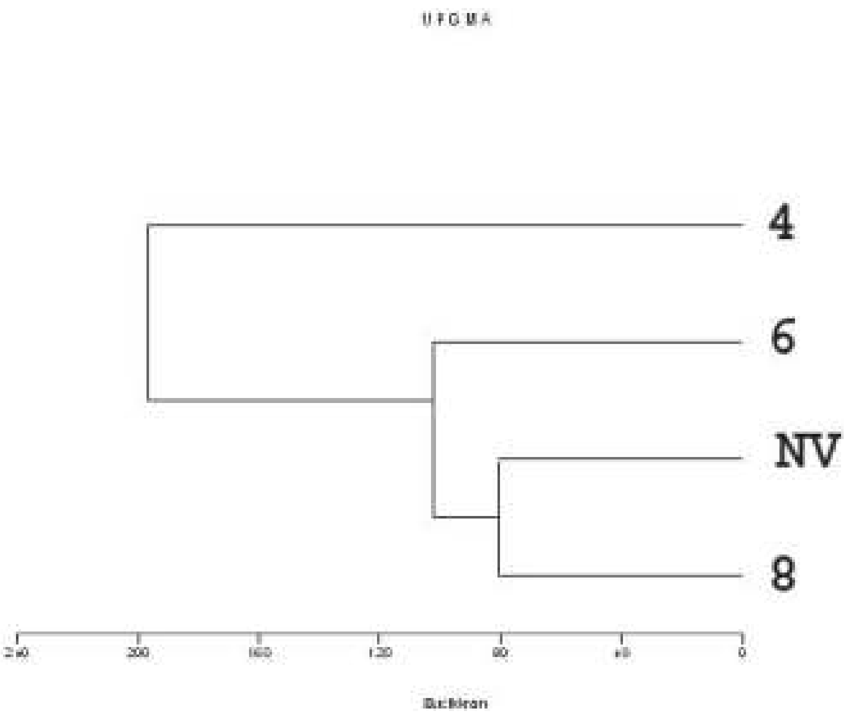

Figure 2 Cluster analysis tree diagram comparison of the 4 plots. The numbers refer to the years planted, NV refers to the natural vegetation. The distance metric is Euclidean.

type.(Whittaker and Woodwell, 1969). Therefore, the 8 year-old plot diversity was lower than the other, but it might have canopy ants which was not accounted for.

The number of individuals and species of ant in the natural vegetation, which was covered with tall grasses, was lowest because the area was dry and *Monomorium destructor* was dominant. In general, *Monomorium destructor* is a seed harvester (Shattuck, 1999). It is possible that *M. destructor* helps disperse grass seeds into the area because most of ants are found in the rainy season. *Pachycondyla luteipes* was the dominant species in the 8 year-old plot. They are general predators or scavengers and forage on the ground surface. Some are limited to leaf litter or under objects on the ground (Shattuck,1999). Most of *Pachycondyla luteipes* were collected in the hot season, where there were fallen leaves and twigs for ants hiding and group raiding.

In the 6 year-old plot, *Technomyrmex kraepelini* was dominant and most often occurred in the hot season. *Technomyrmex* is a pest on vegetation which has become highly spread in tropical region by the activities of human. It is common in disturbed habitats (Shattuck, 1999) such as this plot. The ant community in P6 was not high (Table 3) because the spider community was high, especially the spider family Zodariidae which is an ant eater (Harkness, 1977).

Tapinoma melanocephalum forages on low vegetation and is a scavenger. It was a major species in the 4 year-old plot. *T. melanocephalum* occurs in association with humans in the tropics and subtropics. They frequently nest in unstable and temporary habitats, i.e. plant stems, clumps of dried grass, debris and change sites when conditions become unfavorable (Passera, 1994), which is exactly the condition of 4 year-old plot.

Ants in all the plots were similar (Table 5) because most nested in soil (*Dorylus, Leptanilla, Oligomyrmex, Pheidole, Pheidologeton, Tetramorium, Amblyopone, Discothyrea, Ponera* and *Probolomyrmex)* or in loose debris (*Diacamma, Leptogenys*) or in leaf litter (*Pseudolasius, Rhop*tromyrmex) (Shattuck, 1999). Some are predators, both generalists and specialists, i.e. *Pseudolasius* is known to attend Hemiptera on the roots of plants, *Rhoptromyrmex wroughtonini* and *Leptanilla* feed on small arthropods (Shattuck, 1999). Some are scavengers, such as *Technomyrmex kraepelini* and *Pheidologeton affinis*.

The plots could be distinguished into 3 groups based on ant fauna (Figure 2). The 8 year-old plot and the natural vegetation were most similar, both containing 5 subfamilies. Dorylinae was found in the 8 year-old plot whereas Leptanillinae was found in the latter. The second group was the 6 year-old plot which was not very different from the first group. The last group was the 4 year-old plot, which was greatly different from the others.

Most of ants in the restoration forest plots were ground dwelling. It was suggested that if the forest structure changes with tree growth, the diversity of ground dwelling ant will decrease because of maturity or some will be in the canopy. Therefore, canopy ants should be studied together and ant population can be an indicator of forest succesion.

CONCLUSION

Ants of the subfamilies Dolichoderinae, Formicinae,Myrmicinae and Ponerinae were found in the restored forest of different ages and adjacent natural vegetation, whereas Dorylinae and Lepanillinae were found in the oldest restored forest (8 year planting) and in the natural vegetation, respectively. Myrmicinae was the most abundant in all plots. The ant populations were similarly because they were ground dwelling. The diversity of ant will decreases with the maturity of forest or the ant may be in the canopy. If the canopy ants were included in this study, ant populations might be an indicator of forest succession.

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LITERATRE CITED

Alonso, L.E. and D. Agosti. 2000. Biodiversity studies, monitoring, and ants: an overview, pp. 1-8. *In* D.Agosti, J.D.Majer, L.E. Alonso and T.R. Schultz (eds.). **Ants: Standard Methods for Measuring and Monitoring Biodiversity.** Smithsonian Institution Press, Washington.

Bhumibamon, S. 1986. **The Environmental and Socio-Economic Aspects of Tropical Deforestation: a Case Study of Thailand.** Department of Silviculture, Faculty of Forestry, Kasetsart University. 102 p.

Harkness, R.D. 1977. Further observations on the relation between an ant, *Cataglyphis bicolor* (F.) (Hym., Formicidae) and a spider, *Zodarium frenatum* (Simon) (Araneae, Zodariidae). **Entomologist's Monthly Magazine** 112: 111-121.

Holldobler, B. and E.O. Wilson. 1990. **The Ants.** Harvard University Press, Massachusetts. 732 p.

Kreb, C.J. 1972. **Ecology, the Experimental Analysis of Distribution and Abundance,** 2nd ed. Harper & Row, Publisher, London. 624 p.

Ludwig, J.A. and J.F. Reynold. 1988. Statistical ecology a primer on the methods and computing, pp.85-103. *In* J.A. Ludwig (ed.). **Diversity Indices.** A Wiley Interscience Publication, New York.

Passera, L. 1994. Characteristics of tramp species, pp. 23-43. *In* D.F. Williams (ed.). **Exotic Ants.** Westview Press, Oxford.

Rosenzweig, M.L. 1995. **Species Diversity in Space and Time.** Cambridge University Press. Cambridge.

Shattuck, S.O. 1999. **Australian Ants.** CSIRO Publishing, Collingwood, VIC 3066 Australia. 226 p.

Simpson, E.H. 1949. Measurement of Diversity. **Nature** 163: 163-168.

Snelling, R.R. 1981. Systematics of Social Hymenoptera. **Social Insects** II: 369-453 Academic Press Inc., London.

Whittaker, R.H. and G.M. Woodwell.1969. Structure, production and diversity of the oak-pine forest at Brookhaven, New York. **J. Ecol.** 57: 155-174.