

Ant Species Diversity in the Establishing Area for Advanced Technology Institute at Lai-Nan Sub-district, Wiang Sa District, Nan Province, Thailand

DUANGKHAE SITTHICHAROENCHAI* AND NARATIP CHANTARASAWAT

Department of Biology, Faculty of Science, Chulalongkorn University, Bangkok 10330, THAILAND

ABSTRACT.– The research is to investigate ant species composition and to study surface ground ant species structure using pitfall traps in three habitat types; deciduous dipterocarp forest, mango plantation, and grassland in the establishing area for the *Advanced Technology Institute* in Nan Province. Forty-six species of ants found in the study area belonging to 5 subfamilies; Formicinae, Ponerinae, Dolichoderinae, Pseudomyrmecinae, and Myrmicinae. The dominant species found in this area were *Odontoponera denticulata* and weaver ants *Oecophylla smaragdina*. Among the three types of habitats studied, the similarity index between deciduous dipterocarp forest and mango plantation was highest indicating the similarity in tree structures and microhabitats. The indices of dominance of deciduous dipterocarp forest and grassland indicate that dominance of ant species occurring in these areas. Some urban ant pests such as the yellow crazy ant *Anoplolepis gracilipes*, the ghost ant *Tapinoma melanocephalum*, and the pharaoh ant *Monomorium pharaonis* including the carpenter ants *Camponotus* spp. were found scattering around the study area. The awareness of these urban pests should be considered in the land-use plan for academic building construction.

KEY WORDS: ant, species diversity, Nan Province, Thailand

INTRODUCTION

The establishing area for the *Advanced Technology Institute* is developed to increase academic opportunity for the local people in Nan Province. This area has been desolated for more than 10 years. Mostly, the area is composed of secondary deciduous dipterocarp forests. Some parts of the area were deforested and have been used for agricultural purposes

such as mango and tamarind plantations. Chulalongkorn University has planned to manage the land usage for building construction, recreation, and protection areas. The protected areas will be designated to use as *Center for Biological Diversity Research*.

Insects are one of the most diversified animals. Among all the wide varieties of insects on Earth, ants are the few forms universally recognized. They belong to Family Formicidae, Order Hymenoptera, Class Hexapoda, Phylum Arthropoda. These kinds of insects are very interesting not only because of their worldwide distribution but also because of their important roles in global ecosystem. Many ants harvest

* Corresponding author.

Tel: (662)-218-5259

Fax: (662)-218-5260

E-mail: duangk@sc.chula.ac.th

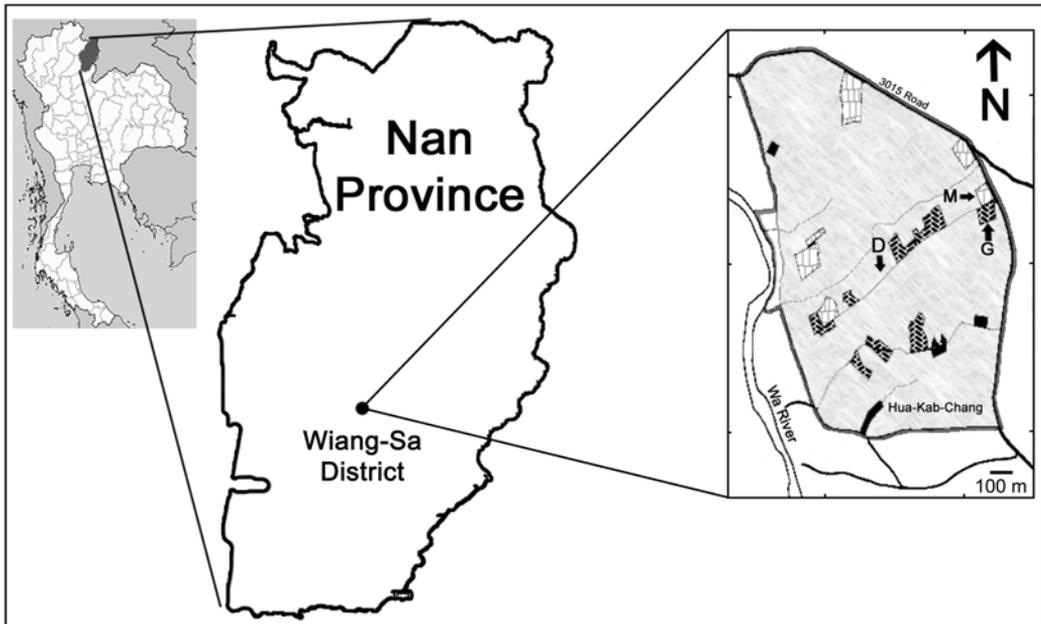


FIGURE 1. Map of Thailand illustrates the locations of Nan Province and Wiang Sa District including habitat types, sites, and routes in the study area at Lai-Nan Sub-district in Wiang Sa District (D: deciduous dipterocarp forest site, G: grassland site, and M: mango plantation site).

and eat seeds. Most of them remove the seeds to their underground nests. This behavior helps spreading the plant seeds and also turning and aerating the soil. Some ants are predators feeding on small invertebrates including other insects. However, a few of them are considered as agricultural and household pests (Agosti et al., 2000; Dunn, 2005; Hölldobler and Wilson, 1990).

The aims of this research are to investigate ant species diversity and to analyze ant species structure in the three different communities such as deciduous dipterocarp forest, grassland, and mango plantation in the establishing area. The study will provide some valuable data for both land usage planning and natural resource management in this area.

MATERIALS AND METHODS

Study Site

The study was conducted at the 3.4-km² establishing area for the Advanced Technology Institute locating in Lai-Nan Sub-district,

Wiang Sa District, Nan Province in the northern part of Thailand (Fig. 1).

Experiment

Study of Ant Species Diversity

The research was investigated from October 2003 to November 2004. The two roadsides of a trail in the middle of the study area were selected for the survey of ant diversity (Fig. 1). Hand capturing, using forceps and aspirator, and leaf litter sampling including Berlese funnel technique were used for the direct sampling of ants during the daytime from 10 am to 6 pm. The surveys were carried out seven times in October, December 2003, January, March, May, August, and November 2004.

Ants found on the ground and the trees at the two roadsides along the trail in the middle of the study area were collected by hand capturing method using forceps and aspirators. Sixteen of leaf litter bag samples each with approximately 500 gm of leaf litter were collected from the two roadsides and then brought back to the laboratory for extraction using Berlese funnel technique.

All of the ants caught were fixed in 70% ethyl alcohol. The alcohol-preserved specimens were brought back to an entomological laboratory in the Department of Biology, Faculty of Science at Chulalongkorn University for identification.

Ant Species Structure in Three Types of Habitats

The study was conducted from March to November 2004. Three types of habitats such as deciduous dipterocarp forest, grassland, and mango plantation were randomly selected from the nearby areas along the trail in the middle of the study area (Fig. 1). Each of the three habitats, five non-baiting pitfall traps were placed along a line transect by 10 m far from each other. The traps were placed for 24 hours. The ant catches were done four times in March, May, August, and November. All of the ants caught were fixed in 70% ethyl alcohol, then brought back to the entomological laboratory in the Department of Biology, Faculty of Science at Chulalongkorn University for identification. Ant species were listed and each species was counted to calculate and compare the species composition and species richness, species diversity indices, indices of dominance, including similarity indices among the three different habitat types.

Ant Identification

Bolton (1997), Hölldobler and Wilson (1990), and Jaitrong and Nabhitabhata (2005) were used for identifying the ants to genera and species. The specimens were also brought to Ant Museum at Kasetsart University for confirming to species level.

Data Analyses

Ant species listed and the complete count of the number of species presented in each habitat were done for species composition and species structure indices. The results were used to indicate the ant species structure in deciduous dipterocarp forest, grassland, and mango plantation.

Shannon-Wiener function (Krebs, 1999) was also used to calculate the species diversity

indices of the ants living in each type of habitats as follow:

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

where. H = Species diversity index

s = number of species

p_i = proportion of the total sample belonging to i^{th} species

The measurement of dominance species index (Odum, 1971) in each habitat, was calculate using the equation as follow:

$$C = \sum (p_i)^2$$

where C = Index of dominance

p_i = proportion of the total sample belonging to i^{th} species

To measure the similarity between two community samples, coefficient of Sorensen (Krebs, 1999) was used as the following equation:

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

where S_s = Sorensen's similarity coefficient

a = number of species in sample A and sample B (joint occurrences)

b = number of species in sample B but not in sample A

c = number of species in sample A but not in sample B

RESULTS

Forty-six species of ants were found in the establishing area for the *Advanced Technology Institute*. All of ants collected were identified into 5 subfamilies. There were 15 species in 5 genera of subfamily Formicinae, 7 species in 5 genera of subfamily Ponerinae, 5 species in 5 genera of subfamily Dolichoderinae, 2 species in 1 genus of subfamily Pseudomyrmecinae,

TABLE 1. List of ants collected by hand capturing, using forceps and aspirators, and leaf litter sampling from October 2003 to November 2004 along the two road sides in the middle of the study area at Lai Nan Sub-district, Wiang Sa District, Nan Province.

Scientific Name	Tribe	Site Found	Remarks (general characters of each genus from Agosti et al. 2000)
Subfamily Formicinae			
<i>Anoplolepis gracilipes</i> Fr. Smith, 1857	Plagiolepidini	tree trunk	living or foraging above the ground
<i>Camponotus arrogans</i> (Fr. Smith, 1858)	Camponotini		
<i>Camponotus rufoglossus</i> (Jerdon, 1851)	Camponotini	tree trunk, ground surface	nesting in ground, in dead wood, in or on tree
<i>Camponotus sericeus</i> (Fabricius, 1798)	Camponotini		
<i>Camponotus</i> sp.1 (<i>Camponotus</i> sp.7 of AMK)	Camponotini		
<i>Oecophylla smaragdina</i> Fabricius, 1775	Oecophyllini	tree trunk	arboreal, silk woven leaf nests
<i>Paratrechina longiconis</i> Latreille, 1802	Lasiini	ground surface	
<i>Paratrechina</i> sp.1 (<i>Paratrechina</i> sp.5 of AMK)	Lasiini		generalized foragers
<i>Paratrechina</i> sp.2 (<i>Paratrechina</i> sp.8 of AMK)	Lasiini	tree trunk	
<i>Polyrhachis armata</i> (Le Guillou, 1842)	Camponotini		
<i>Polyrhachis illaudata</i> Walker, 1895	Camponotini		
<i>Polyrhachis proxima</i> Roger, 1863	Camponotini	ground surface	many arboreal, others nesting on the ground
<i>Polyrhachis tibialis</i> Fr. Smith, 1857	Camponotini		
<i>Polyrhachis</i> sp.1 (<i>Polyrhachis</i> sp.2 of AMK)	Camponotini		
<i>Polyrhachis</i> sp.2 (<i>Polyrhachis</i> sp.11 of AMK)	Camponotini		
Subfamily Ponerinae			
<i>Diacamma vagans</i> (Fr. Smith, 1860)	Ponerini	ground surface	predators
<i>Hypoponera</i> sp.1 (<i>Hypoponera</i> sp.5 of AMK)	Ponerini	ground surface, under leaf litter	nesting in leaf litter
<i>Hypoponera</i> sp.2	Ponerini		
<i>Leptogenys diminuta</i> Fr. Smith, 1857	Ponerini	ground surface	predators of isopods and mass foraging predators, especially of termites
<i>Odontoponera denticulata</i> Fr. Smith, 1858	Ponerini	ground surface	predators, living or foraging above the ground
<i>Pachycondyla astuta</i> Fr. Smith, 1858	Ponerini	ground surface	predators
<i>Pachycondyla rufipes</i> (Jerdon, 1851)	Ponerini		
Subfamily Dolichoderinae			
<i>Dolichoderus thoracicus</i> Fr. Smith, 1860	Dolichoderini	tree trunk	arboreal, generalized foraging
<i>Iridomyrmex anceps</i> Roger, 1863	Dolichoderini	tree trunk	generalized foraging
<i>Pholidris</i> sp.1 (<i>Pholidris</i> sp.1 of AMK)	Dolichoderini	tree trunk	mainly arboreal, most nesting in plants
Subfamily Dolichoderinae (cont')			
<i>Tapinoma melanocephalum</i> (Fabricius, 1793)	Dolichoderini	tree trunk	generalized foragers
<i>Technomyrmex butteli</i> Forel, 1913	Dolichoderini	tree trunk	generalized foragers
Subfamily Pseudomyrmecinae			
<i>Tetraponera difficilis</i> (Emery, 1900)	Pseudomyrmecini	ground surface, under leaf litter	arboreal, nesting in plant cavities
<i>Tetraponera rufonigra</i> Jerdon, 1851	Pseudomyrmecini	tree trunk, ground surface	
Subfamily Myrmicinae			
<i>Cardiocondyla emeryi</i> Forel, 1881	Leptothoracini	tree trunk	
<i>Carebara lianata</i> Westwood, 1840	Pheidologetonini	ground surface, in soil	ground-dwelling ant, found remains only

TABLE 1. Continued

Scientific Name	Tribe	Site Found	Remarks (general characters of each genus from Agosti et al. 2000)
Subfamily Myrmicinae			
<i>Cataulacus granulatus</i> Latreille, 1802	Cataulacini	tree trunk	arboreal, nesting in plant cavities
<i>Crematogaster inflata</i> Fr. Smith, 1857	Crematogastrini	tree trunk	arboreal, nesting in hollow tree trunks, general foragers
<i>Crematogaster rogenhoferi</i> Mary, 1879	Crematogastrini		
<i>Crematogaster</i> sp.1 (<i>Crematogaster</i> sp.9 of AMK)	Crematogastrini		
<i>Crematogaster</i> sp.2	Crematogastrini		
<i>Monomorium chinense</i> Santachi, 1925	Solenopsidini	tree trunk, in soil	generalized foragers, harvesters
<i>Monomorium destructor</i> Jerdon, 1851	Solenopsidini		
<i>Monomorium floricola</i> (Jerdon, 1851)	Solenopsidini		
<i>Monomorium pharaonis</i> (Linnaeus, 1758)	Solenopsidini		
<i>Monomorium</i> sp.1 (<i>Monomorium</i> sp.1 of AMK)	Solenopsidini		
<i>Pheidole bugi</i> Wheeler, 1881	Pheidolini	ground surface, under leaf litter	most nesting in soil, some in rotten wood, many seed harvesters, many omnivorous
<i>Pheidole platifrons</i> Santschi, 1920	Pheidolini	ground surface	generalized and mass foragers
<i>Pheidole</i> sp.1	Pheidolini		
<i>Pheidologeton diversus</i> (Jerdon, 1851)	Pheidologetonini	ground surface	
<i>Tetramorium</i> sp.1	Tetramoriini	round surface, under leaf litter	generalized foragers

AMK: Ants Museum of Kasetsart University

and 17 species in 7 genera of subfamily Myrmicinae. Of the 46 ant species collected, 14 species were identified only into generic level. The detail of ant species was listed in 'Table 1'.

The total numbers of ant species caught by pitfall traps were equal in deciduous dipterocarp forest (14 species) and grassland sites (14 species), but lower in mango plantation site (9 species). The detail of species list was in Table 2. The species diversity indices among the three types of habitats were slightly different. The index was the highest in deciduous dipterocarp forest (2.14), following by grassland (1.94) and mango plantation (1.72). The dominance indices were similar in deciduous dipterocarp forest (0.93) and grassland (0.84), but much lower in mango plantation (0.23). For the similarity measurement, the highest similarity index was in between deciduous dipterocarp forest and mango plantation (0.70). The detail of ant species structure index values from the three habitat types was showed in Table 3.

DISCUSSION

Of all ant species collected from the two roadsides of a trail in the middle of the study area at Lai-Nan Sub-district from October 2003 to November 2004, ants in subfamily Myrmicinae showed the highest species composition. The reasons that may explain the highest number of ant species may be because Myrmicinae is one of the large subfamilies of ants, which has extremely wide distributions and is found in all zoographic regions. This subfamily is also commonly found in the Indo-Australian region and the Oriental region including Thailand (Bolton 1997; Hölldobler and Wilson 1990).

Of 46 ant species caught from the two roadsides, the most ant species caught are *Odontoponera denticulata* and weaver ant *Oecophylla smaragdina*. These two species were found in most study sites and also in every season. *Odontoponera denticulata* is ground

TABLE 2. Species composition and species richness of ant species collected from three different habitats: deciduous dipterocarp forest (D), grassland (G), and mango plantation (M) in the study area at Lai Nan Sub-district, Wiang Sa District, Nan Province by pitfall traps from March to November 2004.

Species Composition	Dipterocarp Forest (D)	Grassland (G)	Mango Plantation (M)
<i>Anoplolepis gracilipes</i>	/	/	/
<i>Camponotus arrogans</i>		/	
<i>Camponotus rufogloucus</i>	/	/	
<i>Camponotus</i> sp.1	/		/
<i>Cardiocondyla emeryi</i>		/	
<i>Crematogaster inflata</i>	/		
<i>Crematogaster</i> sp.3	/		
<i>Diacamma vagas</i>		/	/
<i>Iridomyrmex anceps</i>		/	
<i>Monomorium chinense</i>	/	/	/
<i>Monomorium destructor</i>		/	
<i>Monomorium pharaonis</i>	/		/
<i>Monomorium</i> sp.1	/	/	
<i>Odontoponera denticulata</i>	/	/	/
<i>Oecophylla smaragdina</i>	/		/
<i>Paratrechina</i> sp.1	/		/
<i>Pheidole</i> sp.1	/	/	/
<i>Philidris</i> sp.1	/	/	
<i>Tapinoma melanocephalum</i>	/	/	
<i>Tetramorium</i> sp.1		/	
Species richness	14	14	9

dwelling ants. They dig the surface ground to make small holes as their nests. They are predators, living and foraging for small animals above the ground. The weaver ants are arboreal, nesting on trees, and they use living leaves to build their nests. The weaver ants normally feed on small creatures and also nectar. These ants do not sting but they will bite aggressively when disturbed. They will release formic acid from the end of the gaster and hurt the intruders (Lee and Tan, 2004). The weaver ants are also used as a biological indicator for the secondary forest.

During dry season, usually from November to April, villagers in Lai-Nan Sub-district enter into the study area to gather the weaver ant's eggs for food and selling. In order to get the ant's eggs, the villagers will burn the deciduous dipterocarp forest floor and tree trunks for forcing the evacuation of weaver ant workers and then bring their eggs. Even in May, the

early rainy season, the weaver ants are still the dominant species found scattering everywhere in the study area. In this period the ants usually are very aggressive because this time is their breeding season. It is a time for mating, building nests, laying eggs, and increasing their populations. The ant's egg is a kind of favorite food for the local people; and the queen ant, called in Thai that "Mae Peng", is also a popular food choice.

There are three more kinds of ants found often in the study area such as yellow crazy ant *Anoplolepis gracilipes*, ghost ant *Tapinoma melanocephalum*, and pharaoh ant *Monomorium pharaonis*. These three species have been reported as the important urban pests associated with human communities. Yellow crazy ants are omnivorous, feeding on broad diet. They live and nest under leaf litter, in cracks, and crevices in soil. These ants do not bite or sting. Ghost ants are predators. They feed on small insects such as aphids and insect larvae including insect eggs. They do not bite or sting. Usually they live outdoors nesting in soil at the base of trees, rotten wood, decayed tree parts, or beneath leaf litter. The pharaoh ants are omnivorous feeding on wide varieties of food. They are found living outdoors, sometimes, locating near rotten logs or in piles of lumber. These ants may bite but rarely sting. Both the ghost and the pharaoh ants infest into buildings and become nuisances (Hedges, 1997; Lee and Tan, 2004).

Along the trail that cut through the study area, the ants in the genus *Camponotus* were found. These ants are called carpenter ants because of their nesting behavior. They dwell in the tree trunks, living and making galleries inside, but do not feed on the wood. Tree hollow, tree holes, and dead limbs are the most common nesting sites. They prefer to feed on aphids, other honeydew secreting insects, and dead insects for protein sources including sugar-based food such as nectar for carbohydrate source. The carpenter ants are important insect pests causing damages in building structures and forest tree industry (Hedges, 1997).

TABLE 3. Ecological indices of ant species structure in the three different habitats: deciduous dipterocarp forest (D), grassland (G), and mango plantation (M) in the study area at Lai Nan Sub-district, Wiang Sa District, Nan Province by pitfall traps from March to November 2004

Ecological Indices of Species Structure	Dipterocarp Forest (D)	Grassland (G)	Mango Plantation (M)
Species diversity index	2.14	1.94	1.72
Index of dominance	0.93	0.84	0.23
Similarity index between D and G = 0.57			
Similarity index between D and M = 0.70			
Similarity index between G and M = 0.43			

Remains of adult *Carebara lianata*, called in Thai that “Malaeng Mun” or “Maeng Mun”, were found around the office building of Lai Nan Sub-district in the middle of May 2004. The remains indicated that the peak of reproductive period for this kind of ants just had passed by a few days ago. Normally, the reproductive class of the male and female ants in this species will fly from their nests locating deeply down under the ground for mating outside. There is only one peak of a short reproductive period in a year for these ants. This is a reason that makes Malaeng Mun price become high in the markets. Malaeng Mun is a famous food for local people. The adult ants are cooked by frying with salt and chili sauce. The villagers usually catch the ants using light traps. Digging for the ant nests will disturb the ants and makes them migrate to another place. Additionally, there are two species of ants found only in the areas that used to occupy as a waterfall nearby the trail in the middle of the study area. They are *Pachycondyla rufipes* and *Polyrhachis armata*. The first species has an interesting behavior. When disturbed, they will secrete bubble acid foam from the tip of abdomens to defend themselves.

The study of species structure indices compared among the three types of habitats such as deciduous dipterocarp forest, grassland, and mango plantation indicates that the difference in habitat types influences the kinds of ant species inhabiting in these habitats. The similarity indices, tools for comparing the similarity between two community samples, vary from approximately 40% to 70% among those three habitat sites. By the similarity

measurement, deciduous dipterocarp forest and mango plantation show the most similar ant species structure. The highest similarity index between them indicates the highest number of ant species coexistence in both sites. It is possible that the mango plantation may consist of some similar microhabitat types occurring in the deciduous dipterocarp forest. Although grassland and dipterocarp forest sites have the same number of ant species, the similarity index between both of them is low. The lower index value indicates the microhabitats between the two areas are more different.

The deciduous dipterocarp forest and grassland sites also have similarly high indices of dominance. The high dominance index values reveal that there are dominant species of ants occurring in these areas. Yellow crazy ant *A. gracilipes*, carpenter ant *Camponotus* spp., and pharaoh ant *M. pharaonis* are the dominant species in the deciduous dipterocarp forest site whereas yellow crazy ant is the only dominant species in grassland site.

Mango plantation has the lowest dominance index. The low index value implies that there is no dominant ant species exist in the mango plantation site. In summer, local people burn the deciduous dipterocarp forest floor and tree trunks to collect weaver ant's eggs. The burning suddenly changes the tree structure and microhabitats. The changes may allow some special ant species to live in at the summer time. The similar situation also occurs in the open area such as grassland. The climatic changes may affect violently on the grassland ground surface and can create microhabitat changes. These conditions select only suitable

ant species to live in the area at any violent duration. On the other hand, in the mango plantation site, its ground surface is always covered with mango-leaf litter, shaded by the mango tree canopy, and is not disturbed by the local people. The habitat surrounding has been slightly changed over the time. It seems that the microhabitats in the desolated mango plantation are more stable than in the deciduous dipterocarp forest and grassland.

Another interesting data is that the weaver ants *Oecophylla smaragdina* were found only in deciduous dipterocarp forest and mango plantation sites, but not in grassland. Weaver ant nests are formed basically of living leaves and stems bound together with larval silk (Hölldobler and Wilson, 1990). In this study we found a lot of weaver ant nests hanging on the trees in the deciduous dipterocarp forests and mango plantations along the roads around the study area especially in summer season. Because of being an aggressive predator and territory defense, they sometimes drop down from their nests and tree branches onto the ground for foraging and defense. The ants usually prefer small animals such as small insects and insect larvae; and their foraging for food is not far from the nests. Therefore, it is possible to find and catch more weaver ants by pitfall trapping in the forest floor and plantation surface ground due to tree structure similarity than in the grassland.

By the survey, most habitats in the establishing area are secondary deciduous dipterocarp forests with scattering grassland. Some habitats are abandoned orchards such as mango and tamarind plantations. There is a small mixed deciduous forest occur around the area that used to be a waterfall. The results indicate that although both deciduous dipterocarp forest and mango plantation areas are different in ant species richness, they might have similar tree structure and microhabitat types because of the high similarity index. Human activities in burning the deciduous dipterocarp forest floor in summer not only will

disrupt the forests from natural succession to be the mixed deciduous forests but also will increase the extension of deciduous dipterocarp forest boundaries into the nearby areas.

ACKNOWLEDGEMENTS

This research was supported by the Asia Research Center of Korea Foundation for Advanced Studies at Chulalongkorn University. We would like to thank Assoc. Prof. Chariya Lekprayoon, Head of Center of Excellence in Biodiversity for providing research facilities.

LITERATURE CITED

- Agosti, D., Majer, J.D., Alonso, L.E., and Schultz, T.R. 2000. *Ants: Standard Methods for Measuring and Monitoring Biodiversity*. Smithsonian Institution. Washington. 280 pp.
- Bolton, B. 1997. *Identification Guide to the Ant Genera of the World*, 2nd ed. Harvard University Press. London. 222 pp.
- Dunn, R.R. 2005. *Jaws of Life*. *Natural History* 114: 30-35.
- Hedges, S.A. 1997. *Ants*, In: Mallis, A. (Ed.). *Handbook of Pest Control: The Behavior, Life History, and Control of Household Pests*, 8th ed. Mallis Handbook & Technical Training Company, 123-202 pp.
- Hölldobler, B. and Wilson, E.O. 1990. *The Ants*. Harvard University Press, Cambridge. 732 pp.
- Jaitrong, W. and Nabhitabhata, J. 2005. A list of known ant species of Thailand (Formicidae: Hymenoptera). *The Thailand Natural History Museum Journal* 1: 9-54.
- Krebs, C.J. 1999. *Ecological Methodology*. Benjamin/Cummings. Menlo Park, CA. 620 pp.
- Lee, C.Y. and Tan, E. 2004. *Guide to Urban Pest Ants of Singapore*. SPMA. Singapore. 40 pp.
- Odum, E.P. 1971. *Fundamentals of Ecology*. 2nd ed. W. B. Saunders Comp. London. 574 pp.

Received: 21 February 2006

Accepted: 14 July 2006