CHAPTER V

SPECIES DIVERSITY OF ANTS BETWEEN THE WET AND THE DRY SEASONS IN MIXED DECIDUOUS FOREST, TEAK PLANTATION AND AGRICULTURAL AREA

5.1 Introduction

Activity of ants, abundance and number of colonies, can be affected by various environmental factors, both biotic and abiotic factors. In biotic factors, ant activities are usually determined by the amount of diet and prey in part due to their ability to be both herbivores and carnivores. The environmental fluctuation due to the effect of seasons may affect the nest site and the food source of ants. The food, including soil faunas and other above ground faunas, may be more available in the wet season than in the dry season. Ant activity is supposed to be limited by physical factors, such as temperature and humidity, since enzyme, hormone, and other physiological factors can be active at specific temperature and humidity. According to these reasons, the ant diversity at any time and any place can be altered by the change in environmental factor. In the fixed area, the changes in seasons seem to be the major cause of the environmental change. However, the study site was different in land use pattern, so the different in the effect of season among three study sites were interested. So, this chapter will be discussed about the differences in ant species between seasons in three different land use types which may show different response in ant diversity due to the different in land management.

This study provided the basic knowledge about both the effect of the seasons and the human practices on the ant diversity which can be used to detect the negative effect of the disturbance on the natural habitat that is an importance on the land use managements in the future.

5.2 Materials and Methods

5.2.1 Sampling Methods

In each of the three habitat types, a permanent plot of 15 × 50 m^2 was selected as a sampling area. The surveys at each site were conducted every month, from September 2007 to September 2008. Five sampling methods were used to study the species diversity and abundance of ants in each habitat as explained in Chapter IV.

5.2.2 Study of Physical Factors

5.2.2.1 Soil physical factors

Soil moisture content and soil temperature were measured for each of the soil sample collected from each sampling quadrat as the soil and leaf litter sample in each study site.

5.2.2.1.1 Soil moisture content (Gardner et al. 2001)

The soil moisture content was measured by incubating 50 g of soil in an oven at 105°C. The soil was then weighed and recorded in grams and brought back in the oven for more evaporation. The procedure was repeated every 24 hours until there were no change in the weight of the soil. It was assumed that at this point was no water left in the soil. The percentage of soil moisture content was calculated as:

$$\text{soil moisture content (\%)} = \frac{\text{fresh weight of soil sample} - \text{dry weight of soil sample}}{\text{dry weight of soil sample}} \times 100$$

5.2.2.1.2 Soil temperature

The soil temperature was measured about 10 cm depth by the thermo-hygrometer in the field.

5.2.2.2 Relative humidity and air temperature

The relative humidity and air temperature were measured, in the same sampling quadrat as the soil moisture content were measured, by the thermo-hygrometer in the field.

5.2.2.3 Monthly total rainfall

The monthly total rainfall data during the study period was obtained from the meteorological station at Thong Pha Phum district, Kanchanaburi province.

5.2.3 Ant Identification

The specimens were card mounted in standard form for identifying to the genera and species level as explained in Chapter IV.

5.2.4 Data Analysis

The species diversity and the similarity in species composition between wet and dry seasons in each study site were determined as explained in Chapter IV.

5.3 Results

5.3.1 The Determination between the Wet and the Dry Seasons

The wet and dry seasons of this study were determined by the total rainfall in each month. The months which had the total rainfall higher than 100 mm were classified as the rainy season (Whitmore, 1975), therefore, the rainy season in this study was from April to October and the dry season was from November to March (Figure 5.1).

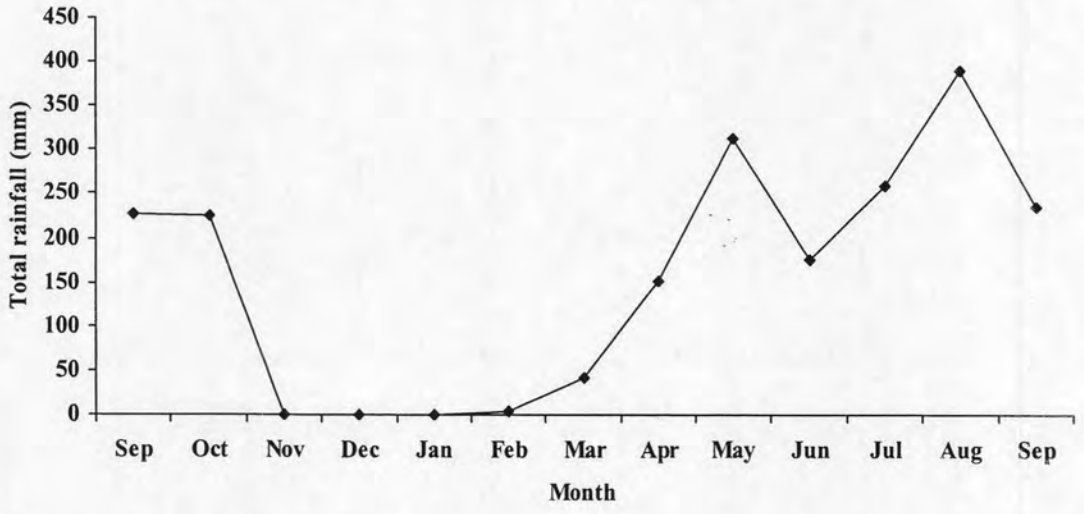

Figure 5.1 The total rainfall (mm) of each month from September 2007 to September 2008 at Huai Khayeng sub-district, Thong Pha Phum district, Kanchanaburi province

5.3.2 Comparisons of Environmental Factors between the Wet and the Dry Seasons in each Study Site

The relative humidity, air temperature, soil temperature, and soil moisture content were significantly higher in the wet season than in the dry season in all study areas, except the soil temperature in the teak plantation was not significantly different between the two seasons. The highest relative humidity in both seasons was found in the forest, followed by the durian orchard and the teak plantation, respectively. In contrast, the teak plantation was the highest value of air temperature in both seasons, followed by the orchard and the forest, respectively. The soil temperature in the wet season in all study sites was similar, but the highest in the dry season was found in the teak plantation. The soil moisture content found the distinct highest in dry season in the durian orchard, but the teak plantation was lowest of soil moisture content in the wet season (Table 5.1).

Table 5.1 The mean* of environmental factors comparison between the wet and the dry seasons among three study sites at Huai Khayeng sub-district, Thong Pha Phum district, Kanchanaburi province

Environmental factors (mean±SE)	Seasons	Mixed deciduous forest	Teak plantation	Durian orchard
Relative humidity (%)	wet	72.44±0.81[a]	64.56±1.27[a]	67.99±0.54[a]
	dry	61.16±1.67[b]	46.30±1.44[b]	54.90±1.36[b]
Air temperature (˚c)	wet	27.00±0.13[a]	29.29±0.16[a]	28.77±0.08[a]
	dry	23.56±0.48[b]	28.57±0.50[b]	26.42±0.47[b]
Soil temperature (˚c)	wet	24.09±0.06[a]	25.53±0.12	25.42±0.08[a]
	dry	21.91±0.31[b]	24.65±0.47	21.76±0.28[b]
Soil moisture content (%)	wet	26.43±0.92[a]	23.62±0.45[a]	24.46±0.71[a]
	dry	6.61±0.50[b]	6.84±0.39[b]	18.18±0.89[b]

* The mean of environmental factors in each column with the different letter were significantly different between seasons in each study site by *Mann-Whitney U*-test at $p \leq 0.05$, except the soil moisture content in the orchard was significantly different between seasons by *t*-test at $p \leq 0.05$.

5.3.3 The Species Diversity between the Wet and the Dry Seasons in each Site

The highest species richness of ants was found in the mixed deciduous forest, both in the wet season and the dry season, followed by the teak plantation, and the durian orchard, respectively. The Shannon-Wiener's species diversity indices, both during the two seasons, were highest in the mixed deciduous forest (2.213 and 2.520) followed by the durian orchard (1.958 and 1.771) and the teak plantation (1.535 and 1.300), respectively. The species diversity indices in the teak plantation and the durian orchard were higher in the wet season than in the dry season, whereas in the natural habitat, the species diversity index in the dry season was higher than the wet season (Table 5.2).

Table 5.2 The species richness, species diversity index, and evenness index between seasons among three study sites at Huai Khayeng sub-district, Thong Pha Phum district, Kanchanaburi province

Study site	Mixed deciduous forest		Teak plantation		Durian orchard	
	wet	dry	wet	dry	wet	dry
Species richness	95	61	74	42	42	35
Species diversity index	2.213	2.520	1.535	1.300	1.958	1.771
Evenness index	0.526	0.658	0.389	0.372	0.551	0.521

In both the wet and the dry seasons, the highest of total ant species richness was in the mixed deciduous forest (95 and 61 species, respectively), followed by the teak plantation (74 and 42 species, respectively) and the lowest was in the durian orchard (42 and 35 species) (Table 5.2). As showed in Figure 5.2, the highest ant species richness was in the mixed deciduous forest for all of sampling months, followed by the teak plantation and the orchard, respectively. The species richness of ants among sampling months in the forest and the teak plantation showed highly correlated trend (*Pearson's correlation*, p-value = 0.0000, r = 0.89), whereas the constantly richness was found in the durian orchard. There was the difference in ant

species number between the wet and dry seasons. In the wet season (from April to October), ant species numbers were high in all study sites and then lower in dry season (from November to March). Additionally, in the natural forest and the teak plantation, the species richness was increased when the rain began in April 2008. In the forest and the teak plantation, the highest of ant species numbers was in May 2008, whereas the lowest of the forest was in January and March 2008 and in the teak plantation was in March 2008. On the other hand, in orchard, the highest of ant species numbers was in September and October 2007 whereas the numbers of ant species were low in the vicinity from January to April 2008.

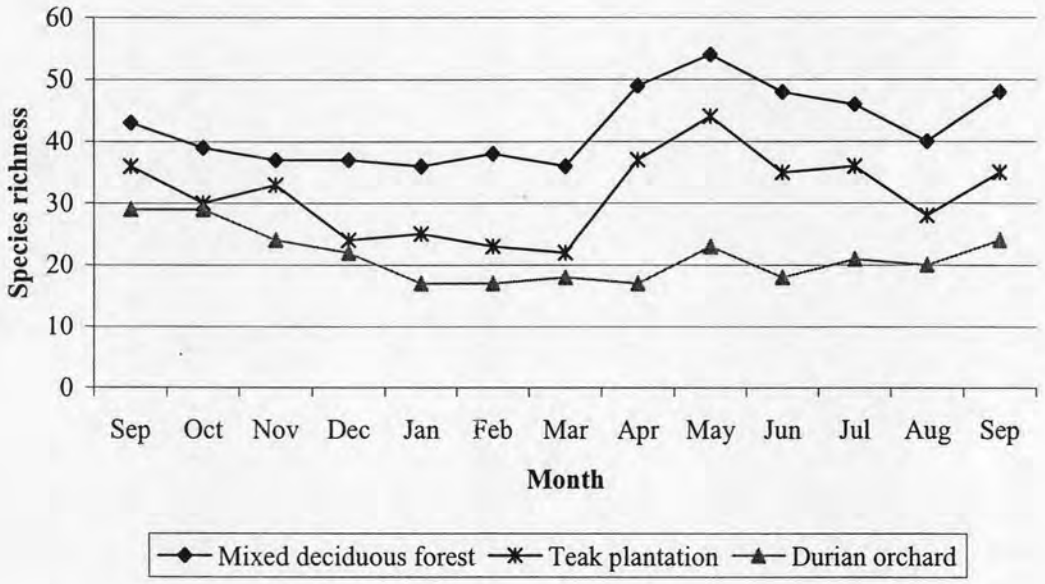

Figure 5.2 The seasonal variation of species richness of ants in each month from September 2007 to September 2008 in the three habitats at Huai Khayeng sub-district, Thong Pha Phum district, Kanchanaburi province

5.3.4 The Species Similarity between Seasons in each Site

The Sorensen's similarity coefficient was used to indicate the species similarity between the wet and dry seasons in each habitat. The highest similarity between the wet and the dry seasons in each study site was found in the durian orchard (0.805), followed by the teak plantation (0.672) and the mixed deciduous forest (0.647), respectively. The similarity index in the wet season was highest between the mixed deciduous forest and the teak plantation (0.659), followed by

between the teak plantation and the durian orchard (0.439) and the lowest was between the mixed deciduous forest and the durian orchard (0.361). Similar trend as the wet season, the similarity index in the dry season was highest between the mixed deciduous forest and the teak plantation (0.524), followed closely by between the teak plantation and the durian orchard (0.519) and the lowest was between the mixed deciduous forest and the durian orchard (0.375) (Table 5.3).

Table 5.3 The Sorensen's similarity coefficient of ants between the wet and the dry seasons among study sites at Huai Khayeng sub-district, Thong Pha Phum district, Kanchanaburi province

Similarity index		Mixed deciduous forest		Teak plantation		Durian orchard	
		wet	dry	wet	dry	wet	dry
Mixed deciduous forest	wet	1	-	-	-	-	-
	dry	0.647	1	-	-	-	-
Teak plantation	wet	0.659	0.593	1	-	-	-
	dry	0.467	0.524	0.672	1	-	-
Durian orchard	wet	0.361	0.350	0.439	0.429	1	-
	dry	0.354	0.375	0.495	0.519	0.805	1

5.3.5 Presence of ants between the wet and the dry seasons in each site

There were twelve ant species, such as *Paratrechina* sp.4 of AMK, *Oligomyrmex* sp.1 of CUMZ, *Pheidologeton affinis*, *Odontoponera denticulata*, and *Pachycondyla luteipes*, were found in both the wet and the dry seasons including in all habitat as showed in Table 1-A Appendix A whereas most ant species were found only in the wet season or the dry season in each habitat type. For example, in the mixed deciduous forest, *Polyrhachis (Myrmhopla) furcata*, *Leptanilla* sp.2 of AMK, *Crematogaster (Orthocrema)* sp.1 of AMK, and *Oligomyrmex* sp.11 of AMK were found only in the wet season whereas *Paratrechina opaca*, *Polyrhachis (Myrmhopla)* sp.5 of AMK, and *Amblyopone* sp.4 of AMK were found only in the dry season. In

the teak plantation, many species, such as *Aenictus laeviceps*, *Myrmicaria brunnea*, and *Myrmicaria* sp.1 of CUMZ were found only in the wet season whereas *Cerapachys* sp.3 of AMK, *Crematogaster* sp.2 of AMK, and *Tetraponera rufonigra* were found only in the dry season. In the durian orchard, *Tapinoma indicum*, *Cardiocondyla emeryi,* and *Hypoponera* sp.3 of AMK were found only in the wet season whereas *Strumigenys* sp.7 of AMK and *Ponera* sp.7 AMK were found only in the dry season. There were no more than 5 of ant species found only in the dry season in each area. The ant species which found only in the wet season was highest in the forest (39 species), followed by the teak plantation (35 species) and the lowest in the durian orchard (11 species) (Figure 5.3).

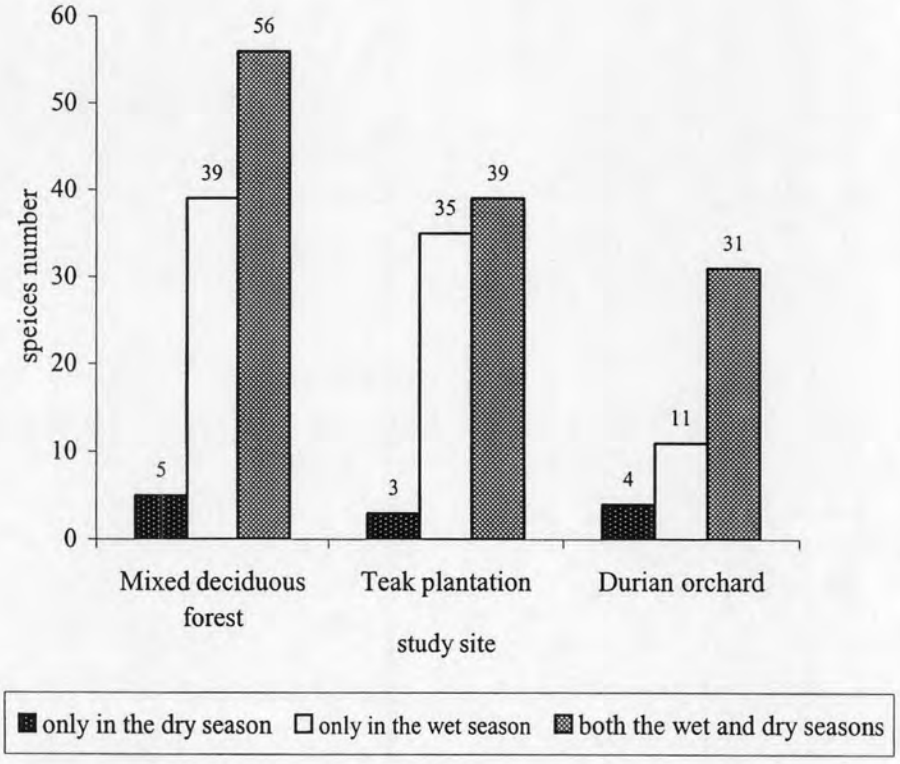

Figure 5.3 The species number of ants that was found only in the dry season, only in the wet season, and found in both seasons in each study site at Huai Khayeng sub-district, Thong Pha Phum district, Kanchanaburi province

5.4 Discussion

5.4.1. The Species Richness of Ants between the Wet and the Dry Seasons in each Study Site

In all areas, the species richness was higher in the wet season than in the dry season. The highest of ant species richness was in the mixed deciduous forest in both seasons followed by the teak plantation and the durian orchard, respectively. This might be due to more nest site availability in the mixed deciduous forest, such as leaf litters, logs, or epiphytes that could support functional types of ants (Andersen, 2000). Moreover, the food supply was also an important factor. Food availability was obviously a critical determinant of the distributions of species with specialized diets, such as seed harvesters and specialist predators (Andersen, 2000). In dry season, the mixed deciduous forest had low soil and litter moisture contents with high temperature. These conditions were not suitable for ants and their preys, so lower ant species were found. In the wet season, soil and litter moisture content were high. The condition was suitable for many soil faunas which prey for ants. The present of predatory ants, such as *Amblyopone reclinata*, *Amblyopone* sp.5 of AMK, *Leptanilla* sp.1 of AMK, and *Leptanilla* sp.2 of AMK, were found in this period. Additionally, the army ants, *Aenictus* spp., were occasionally collected in only wet season, affecting the increase of the species richness of ants in the mixed deciduous forest (5 species), the teak plantation (4 species), and the durian orchard (1 species). Their action as mobile generalist predators in the litter layer could influence the composition of the faunas (Delabie, Agosti, and Nascimento, 2000). The army ant activity has been changed seasonally, in correlation with moisture (Levings, 1983). In the Narathiwat province study, Noon-anant (2003) reported that the species number of ant in subfamily Aenictinae was significantly higher in the wet season than in dry season. The more number of these ant species in this area confirmed that the natural forest supported factors that were not available in other land use types.

Additionally in the dry season, the various plants in the mixed deciduous forest and the teak trees in the plantation shed their leaves, which did not occur to the same extent with the evergreen durian trees. However, there was a fire in the teak plantation in March 2008 which removed the leaf litter. Therefore, consequentially, the mixed deciduous forest had leaf litter higher than the other sites, and the area was

covered by the leaf litter all year round. The leaf litter has provided both food and nest sites to many kinds of ant species. It may be expected that both resources will produce a stronger response to litter-nesting ants (Armbrecht et al., 2006). Thus, there were more leaf litter ant species in the forest than the teak plantation, such as *Paratrechina* sp.1 of AMK, *Paratrechina* sp.9 of AMK, and *Odontomachus rixosus*.

The rainfall and temperature may also be important factors in tropical areas (Levings, 1983). In the natural forest and the teak plantation, the species richness was increased when the rain began. The highest value of total rainfall was found in August (389.8 mm) (Figure 5.1). As shown in Figure 5.2, the species richness of ants in the mixed deciduous forest and teak plantation dropped off in this month. This may be because of the heavy rains which inhibit the foraging in most species (Levings, 1983). Bourmas (2005) reported that the mean of rainfall period in wet season was 20 days per month. In this study, the mean of the rainfall period was 22.25 days ranging from 14-28 days in each month. These showed the effect of the variation in the amount of rain fall on the ants in the mixed deciduous forest and teak plantation whereas this effect did not found in the durian orchard which was irrigated by the farmers. In the dry season, the air temperature and soil temperature were highest at the teak plantation. The drought condition strongly reduced foraging activity and some activities of ant species (Levings, 1983). This may be an explanation for the lower numbers of ant species in teak plantation comparing to the forest.

In the durian orchard, the species richness of ants in wet and dry seasons were similar. It may be because the soil moisture content in this area was relatively constant in both seasons. Therefore, when comparing to the ant species that prefer moist condition, the species that prefer dry condition could have low ability to survive in this habitat.

5.4.2. The Species Diversity Index of Ants between Seasons in each Study Site

In the teak plantation and the durian orchard, the Shannon-Wiener's species diversity indices were higher in the wet season than in the dry season, but the alternative result was found in the mixed deciduous forest. The low species diversity index in the wet season of the forest was reflected from the relative abundance of an

ant species, *Pheidologeton affinis*, which strongly high number of catches both in pitfall trap and sugar-protein baiting trap (Figure 5.4). The high activity at baits of the ant may be a function of increased competition for food when the physical environment is favorable for foraging, such as after raining, but less in food source available. Food requirements may also be high, depending upon the pattern of brood development. High catches were usually associated with large numbers of a few mass-recruiting species, which recruit large numbers of fellow workers to a newly discovered food source. These species had been collected while recruiting to a food source or a part of a nest (Levings, 1983). Moreover, in dry season at the forest site, a few plants were either fruiting or flowering that might become to other food sources for the ground ants.

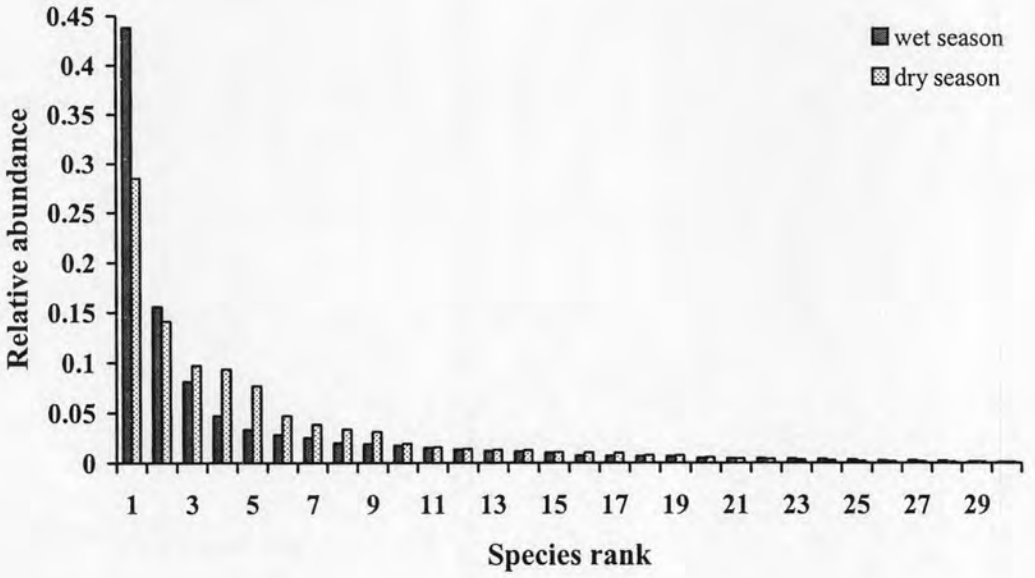

Figure 5.4 The relative abundance of ant species in the wet and dry seasons in the mixed deciduous forest at Huai Khayeng sub-district, Thong Pha Phum district, Kanchanaburi province

The lowest species diversity index in the wet season of the teak plantation was reflected by the high relative abundance of some ant species, *Pheidologeton diversus*. In the wet season, this species was highest in abundance that caused the distinctive

difference of abundance to other ant species in the area thus the evenness value in the teak plantation was low (0.389). The *P. diversus* behavior was similar to the *Pheidologeton affinis* in the forest. Because of their active in mass number of workers, so they were found in pitfall trap and baiting methods (Figure 5.5).

In the dry season, the species diversity index was lowest in the teak plantation comparing to other sites because there was difference in the relative abundance of some species. The *Pheidologeton diversus* and *Philidris* sp.1 of AMK were the first and second in relative abundance in the dry season. Their abundances were similar, but both of them were very different to the abundance of other species. Thus, the evenness value in the dry season at the teak plantation was low (0.372) (Figure 5.5). These dominant species may be a function of competition for food when the physical environment is suitable for foraging, but small amount of food is available. Food requirements may be also high, depending upon the pattern of brood development (Levings, 1983).

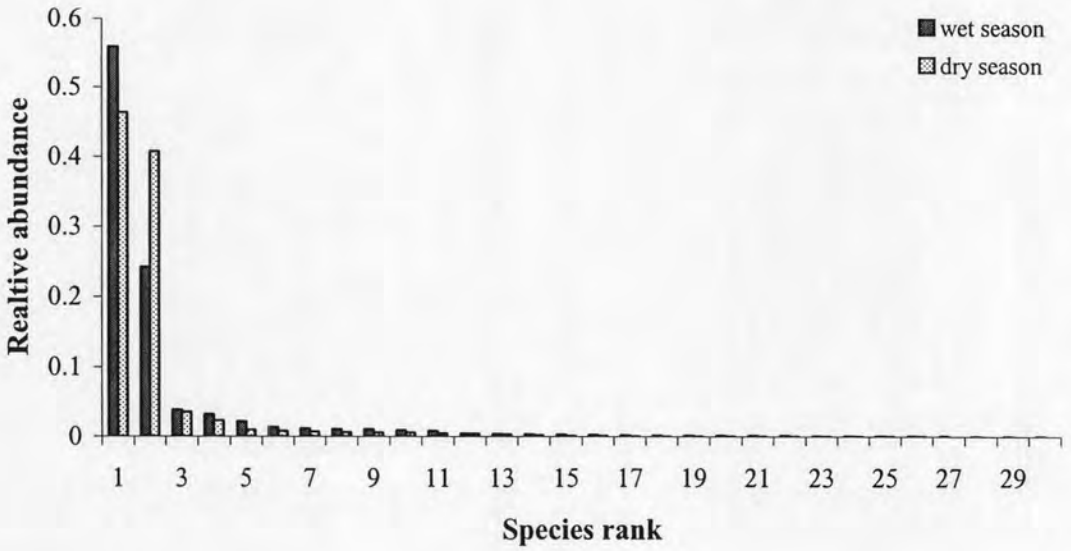

Figure 5.5 The relative abundance of ant species in the wet and dry seasons in the teak plantation at Huai Khayeng sub-district, Thong Pha Phum district, Kanchanaburi province

5.4.3 The Similarity of Ant Species between Seasons in each Study Site

In the durian orchard, the highest similarity indices in the two seasons may be due to the constant soil moisture content thought out the year (Table 5.1) because the durian orchard was irrigated all year round, especially in the dry season. These activities made the orchard had soil moisture content higher than in the other areas, leading to a relative abundance of soil arthropods, such as springtails, symphylans and diplurans, which being found all year round and in the areas where presence of those predatory ant species. Because the soil arthropods in the moisture areas may remain active for longer periods than individuals in dry areas (the mixed deciduous forest and the teak plantation), the soil arthropods in the durian orchard may be more abundance than other areas at the same time. This may increase the prey available to the predatory ants in the durian orchard.

5.4.4 Presence of ants between the wet and the dry seasons in each site

The 12 ant species found in both wet and dry seasons and in all three habitats depict the adaptability of these species to the environmental changes influenced by the seasons in all three study areas. Temperature, relative humidity, and total rainfall in each month were the important physical factors affecting on the increase and decrease or the stability of ant population in the ecosystem. These physical factors also affected on the differences in foraging behavior of the workers in the each species. Moreover, some species were specific to temperature period, moisture, and rainfall (Hölldobler and Wilson, 1990; Andersen, 2000). Moreover, in the durian orchard, the proportion of the number of ant species found in both wet and dry seasons was very high. This may indicate that in the durian orchard, the irrigation by the farmer can cause the lower variation in ant species between wet and dry seasons than those in the other two land use types.