CHAPTER VI

VARIATION IN ABUNDANCE OF IMPORTANT ANTS AND SOME PHYSICAL FACTORS AMONG THREE LAND USE TYPES, MIXED DECIDUOUS FOREST, TEAK PLANTATION AND AGRICULTURAL AREA

6.1 Introduction

The mechanisms of anthropogenic disturbance, including alterations in shade, vegetation structure, and plant species richness, affect the composition of ants (Hoffman et al., 2000). The areas with high number of complex habitats may provide more environmental niches and more foraging opportunities (Lassau and Hochuli, 2004). It may be possible that there is an abundance of ants in the natural habitat, which has more complexity of plant community, higher than in the anthropogenic areas. However, there is a limited information about the abundance of ants in the managed habitats. The difference in land uses among the three areas results to difference in vegetation cover. The study sites in this research consisted of a natural forest which represented by the mixed deciduous forest, and the other two monoculture land use, such as teak plantation and durian orchard, The effects of different land uses on the ant faunas in each study site could be determined.

6.2 Materials and Methods

6.2.1 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 inclusive. Four sampling methods were used to study the abundance of ants in each habitat as explained in Chapter IV.

6.2.2 Study of Physical Factors

6.2.2.1 Soil physical factors

Soil moisture content, soil pH, 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.

6.2.2.1.1 Soil moisture content (Gardner et al. 2001)

The soil moisture content was measured as explained in Chapter V.

6.2.2.1.2 Soil pH (Department of Biology, Faculty of Science, Chulalongkorn University, 2000)

The soil was mixed with distilled water with 2:1 (w/v) ratio. The soil suspension was left to stand for 30 minutes. The pH paper was immersed into the soil suspension and the changed color was compared with standard color.

6.2.2.1.3 Soil temperature

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

6.2.2.2 Relative humidity and air temperature

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

6.2.3 Ant Identification

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

6.3 Result

6.3.1 Physical Factors among Three Land Use Types

The mean of almost physical factors were significantly different among study sites (*Tamhane's T2*, $p \leq 0.05$), except the mean of soil moisture content between the mixed deciduous forest and the teak plantation were not significantly different. The relative humidity was highest in the mixed deciduous forest, followed by the orchard and the teak plantation, respectively. The air temperature and soil temperature were in similar trend, the highest values were found in the teak plantation, followed by durian orchard and the lowest values were recorded in the mixed deciduous forest. The soil moisture content was highest in the orchard, followed by the mixed deciduous forest

and the teak plantation, respectively. The soil was mildly acidic in all three study sites. The highest acidity was found in the teak plantation, followed by the orchard and the mixed deciduous forest, respectively (Table 6.1).

Table 6.1 The mean* of some physical factors within each study site at Huai Khayeng sub-district, Thong Pha Phum district, Kanchanaburi province

Physical Factors	Study site	Mean ± SE
Relative humidity (%)	Mixed deciduous forest	68.10±0.94[a]
	Teak plantation	57.54±1.24[c]
	Durian orchard	62.95±0.84[b]
Air temperature (˚c)	Mixed deciduous forest	25.67±0.25[c]
	Teak plantation	29.02±0.22[a]
	Durian orchard	27.87±0.21[b]
Soil temperature (˚c)	Mixed deciduous forest	23.25±0.15[c]
	Teak plantation	25.19±0.20[a]
	Durian orchard	24.01±0.20[b]
Soil moisture content (%)	Mixed deciduous forest	18.80±1.04[b]
	Teak plantation	17.17±0.78[b]
	Durian orchard	22.05±0.61[a]
Soil pH	Mixed deciduous forest	6.55±0.09[a]
	Teak plantation	5.24±0.06[c]
	Durian orchard	5.93±0.09[b]

* The mean of physical factors in each column with the different letter were significantly different between the study sites by *Kruskal-Wallis* test ($p \leq 0.05$) with *Tamhane's T2* ($p \leq 0.05$).

6.3.2 High Abundant Ant Species in each Different Land Use Types

6.3.2.1 The mixed deciduous forest

The total abundance of all ant species found in the mixed deciduous forest was 19,145 individuals in overall study period. The mixed deciduous forest had communities that were numerically dominated by *Pheidologeton affinis* (Figure 6.1 A-B), which accounted for 7,540 individuals of all ants in this site, followed by *Monomorium* sp.1 of AMK (Figure 6.1 C), *Anoplolepis gracilipes* (Figure 6.1 D), and *Pheidole* eg. 101 (Figure 6.1 E-F) (Table 1-B Appendix B).

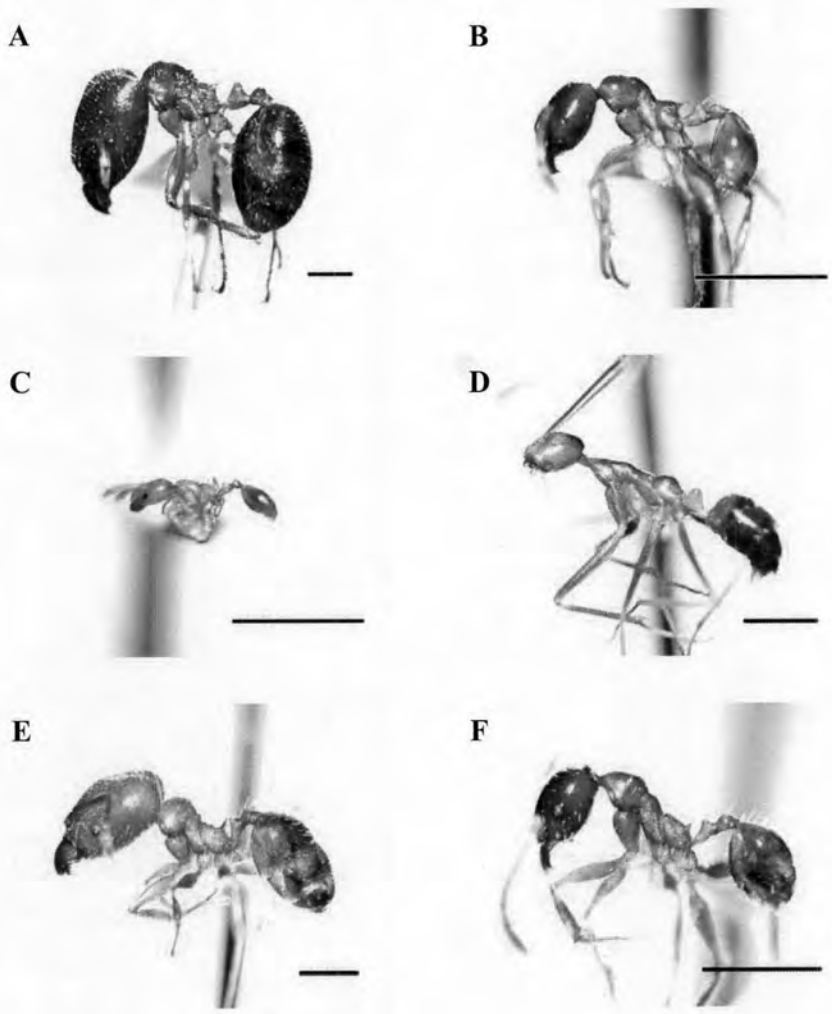

Figure 6.1 Dominant ant species in the mixed deciduous forest, **A.** *Pheidologeton affinis* (major), **B.** *Pheidologeton affinis* (minor), **C.** *Monomorium* sp.1 of AMK, **D.** *Anoplolepis gracilipes*, **E.** *Pheidole* eg. 101 (major), and **F.** *Pheidole* eg. 101 (minor), Scale bars = 1 mm

6.3.2.2 The teak plantation

The total abundance of all ant species found in the teak plantation was 42,818 individuals in overall study period. The teak plantation had communities that were numerically dominated by *Pheidologeton diversus* (Figure 6.2 A-B), which accounted for 22,076 individuals of all ants in this site, followed by *Philidris* sp.1 of AMK (Figure 6.2 C), *Pheidologeton affinis* (Figure 6.1 A-B), *Oecophylla smaragdina* (Figure 6.2 D), and *Tetramorium kheperra* (Figure 6.2 E) (Table 2-B Appendix B).

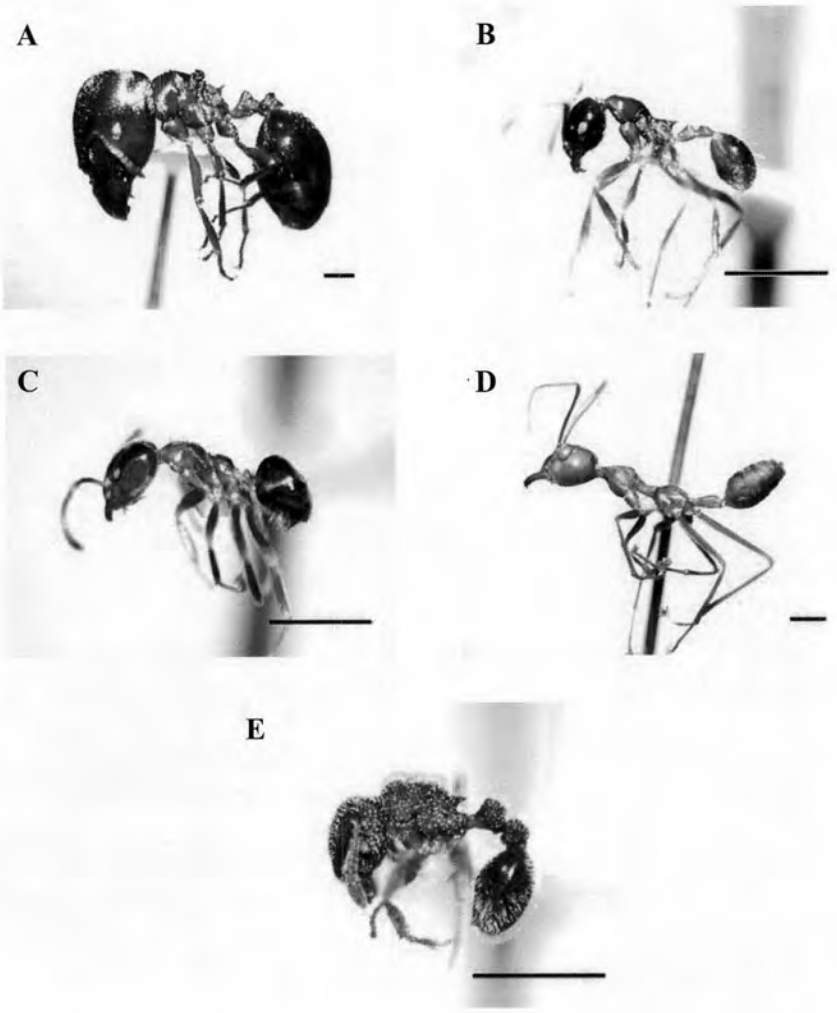

Figure 6.2 Dominant ant species in the teak plantaton **A.** *Pheidologeton diversus* (major), **B.** *Pheidologeton diversus* (minor), **C.** *Philidris* sp.1 of AMK, **D.** *Oecophylla smaragdina*, and **E.** *Tetramorium kheperra,* Scale bars = 1 mm

6.3.2.3 The durian orchard

The total abundance of all ant species found in the durian orchard was 15,691 individuals in overall study period. The durian orchard had communities that were numerically dominated by *Pheidole* eg. 101 (Figure 6.1 E-F), which accounted for 4,685 individuals of all ants in this site, followed by *Pheidologeton affinis* (Figure 6.1 A-B), *Oligomyrmex* sp.1 of CUMZ (Figure 6.3 A-B), and *Solenopsis geminata* (Figure 6.3 C-D) (Table 3-B Appendix B).

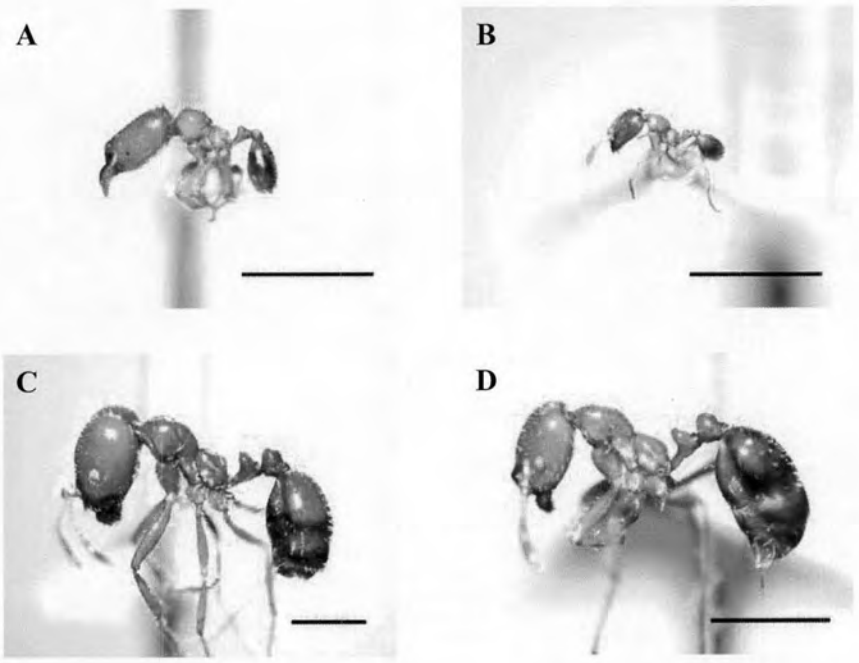

Figure 6.3 Dominant ant species in the durian orchard, **A.** *Oligomyrmex* sp.1 of CUMZ (major), **B.** *Oligomyrmex* sp.1 of CUMZ (minor), **C.** *Solenopsis geminata* (major), and **D.** *Solenopsis geminata* (minor), Scale bars = 1 mm

6.3.3 The Important Ant Species in each Study Site

The mixed deciduous forest was referred to a natural habitat, so the important ant species were selected from this habitat and were used to compare to the other two land use types. The important ant species were also selected by the abundance of ants in the mixed deciduous forest. Therefore, the first 4 ant species with highest in abundance were selected. *Pheidologeton affinis* was the highest in abundance, followed by *Monomorium* sp.1 of AMK, *Anoplolepis gracilipes*, and *Pheidole* eg. 101 (Table 1-B Appendix B). Moreover, *P. affinis* and *Pheidole.* eg. 101 were found in all habitats throughout the year.

In the teak plantation, *P. affinis* was the third rank in ant abundance (*Pheidologeton diversus* and *Philidris* sp.1 of AMK were the first and second, respectively). The abundance of *Monomorium* sp.1 of AMK, *Anoplolepis gracilipes*, and *Pheidole* eg. 101 in the teak plantation were found lower than in the mixed deciduous habitat. *Monomorium* sp.1 of AMK was yielded 393 individuals, followed closely by *A. gracilipes* (390 individuals) and the lowest was *Pheidole.* eg. 101 (20 individuals) (Table 2-B Appendix B).

In the durian orchard, *Pheidole* eg. 101 was found the highest catch (4,685 individuals), followed by *Pheidologeton affinis* (4,162 individuals). There was no *Monomorium* sp.1 of AMK and *Anoplolepis gracilipes* found in any methods in this area (Table 3-B Appendix B).

6.3.4 Comparison in Abundance of Important Ants Species among Three Study Sites

The mean abundance of *P. affinis* was significantly different between the mixed deciduous forest and the teak plantation (*Tamhane's T2*, $p \leq 0.05$). The highest abundance of *P. affinis* caught was in the mixed deciduous forest, followed by the durian orchard and the lowest was in the teak plantation. *Monomorium* sp.1 of AMK and *A. gracilipes* were in similar trend. Their mean abundances were significantly different among the study sites (*Tamhane's T2*, $p \leq 0.05$). Both species were found in the mixed deciduous forest higher than in the teak plantation, whereas they did not be found in the orchard. The mean abundance of *Pheidole* eg. 101 was also significantly different among the study sites. The abundance of this ant species was highest in the

agricultural area, followed by in the mixed deciduous forest and lowest in the teak plantation (Table 6.2).

Table 6.2 Mean* abundance of important ant species in each study site at Huai Khayeng sub-district, Thong Pha Phum district, Kanchanaburi province

Important ants species	Mean abundance (±SE)		
	Mixed deciduous forest	Teak plantation	Durian orchard
Pheidologeton affinis	580±281.8[a]	91.69±62.45[b]	320.15±196.07[ab]
Monomorium sp.1 of AMK	222.77±90.94[a]	30.23±11.04[b]	0[c]
Anoplolepis gracilipes	124.54±20.52[a]	30±10.35[b]	0[c]
Pheidole eg. 101	90.54±15.71[b]	1.54±0.56[c]	360.38±153.23[a]

* The mean abundances of important ant species in each row with the different letter were significantly different between the study sites by *Kruskal-Wallis* test ($p \leq 0.05$) with *Tamhane's T2* ($p \leq 0.05$).

6.3.5 Correlation between the Abundance of Important Ant Species and some Physical Factors in each Study Site

In the mixed deciduous forest, the abundance of three ant species, *Pheidologeton affinis*, *Monomorium* sp.1 of AMK, and *Anoplolepis gracilipes*, correlated with some physical factors. *P. affinis* was highly positive correlated with the relative humidity (p-value = 0.0003, r = 0.84) and correlated with the soil moisture content (p-value = 0.042, r = 0.569). *Monomorium* sp.1 of AMK was highly negative correlated with the relative humidity (p-value = 0.005, r = - 0.731), whereas positively correlated with the soil temperature (p-value = 0.029, r = 0.604). *A. gracilipes* negatively correlated with the relative humidity (p-value = 0.031, r = - 0.599) and positively correlated with the soil temperature (p-value = 0.025, r = 0.615) (Table 6.3).

In the teak plantation, only *Monomorium* sp.1 of AMK was found positively correlated with the air temperature (p-value = 0.024, r = 0.621) and highly positive correlation with soil temperature (p-value = 0.005, r = 0.726) (Table 6.3).

In the durian orchard, there was the abundance of only one species correlated with the physical factors. *P. affinis* was found positively correlated with relative humidity and soil moisture content (p-value = 0.035, r = 0.586 and p-value = 0.024, r = 0.621, respectively) (Table 6.3).

Table 6.3 Correlation coefficient* between some physical factors and abundance of important ant species in each study site at Huai Khayeng sub-district, Thong Pha Phum district, Kanchanaburi province

Study site	Species	Physical factor	r
Mixed deciduous forest	*Pheidologeton affinis*	Relative humidity	0.84
		Soil moisture content	0.569
	Monomorium sp.1 of AMK	Relative humidity	-0.731
		Soil temperature	0.604
	Anoplolepis gracilipes	Relative humidity	-0.599
		Soil temperature	0.615
	Pheidole eg. 101	-	-
Teak plantation	*Pheidologeton affinis*	-	-
	Monomorium sp.1 of AMK	Air temperature	0.621
		Soil temperature	0.726
	Anoplolepis gracilipes	-	-
	Pheidole eg. 101	-	-
Durian orchard	*Pheidologeton affinis*	Relative humidity	0.586
		Soil moisture content	0.621
	Monomorium sp.1 of AMK	-	-
	Anoplolepis gracilipes	-	-
	Pheidole eg. 101	-	-

*The r value in each row was correlation coefficient between the physical factors and the abundances of ants in each study site by *Spearman's* rank correlation at $p \leq 0.05$.

6.4 Discussion

6.4.1 Influence of the Habitat Characteristics on the Physical Factors in Three Land Use Types

The differences of the physical factors occurred in the study areas may be because of land use management. The highest of relative humidity in the mixed deciduous forest may be due to the higher canopy cover than those in the other two habitats. The ground covers protected this area from heat and resulted it less in water loss. Moreover, the soil moisture content in the mixed deciduous forest site was in the second rank, and the air and soil temperature were the lowest. These physical factors represented the low temperature in this area. It may be because percentages of tree canopy covers and tree density in the mixed deciduous forest were higher than in the teak plantation. The sunlight could not penetrate and contact directly to the soil surface except in the dry season when the trees shaded their leaves. The complexity of plant community might play an important factor affecting in these different land use types. The mixed deciduous forest was covered by at least 20 species of native plant species. The surface ground was covered by the understory in the family Zingiberaceae and the tree trunks were covered by epiphytics, climbers, moss, and lichens. These natural plants did not be found in the other two monoculture areas. In the teak plantation, the understory can be found but less than those in the mixed deciduous forest. In the orchard, grass and weeds were found in rainy season when the farmers did not apply herbicides to their crops. After the herbicides were used, there were no alive weeds left in this area. This may increase the chance of the orchard, which had low percentage of crowd cover, to contact to sunlight directly. Therefore, the orchard was the second highest in soil and air temperature. The highest in the soil and air temperature was in the teak plantation that was also the monoculture area. Despite, in the teak plantation, there was more understory in the teak plantation than in the orchard and it can be found some epiphytes were found in the area. The teak trees shaded their leaves in dry season and there was forest fired in March 2008. During that time, the teak plantation became the open area which very differed from the orchard (evergreen durian trees). This resulted the teak plantation area had the highest temperature.

In contrast, the durian orchard was under the conventional farmer practice, and all year round soil moisture content was expected to be constant. There was the water irrigation at the durian orchard in the dry season. This was a reason to explain the highest soil moisture content in the area all the year, and resulted to the significantly different between the mean of soil moisture content in this area and the other two land use types (*Tamhane's T2*, $p \leq 0.05$).

One of the important problems in the monoculture plantation in the tropical ecosystem is the soil acidity. The majority of the soil acidity was found about two years after removing the natural plant community. The soil acidity usually increased without any treatment and the soil become neutral after the natural plants recover (Gajaseni, 2001). Therefore, this may lead the lower pH values in both teak plantation and durian orchard than the mixed deciduous forest.

6.4.2 High Abundant Ant Species in each Different Land Use Type

In overall areas, *Pheidologeton diversus* was the highest in abundance (Table 2-B Appendix B). It may be because they form large colonies and contain large number of workers. However, this species was found only 2 individuals in the mixed deciduous forest and did not be found in the orchard. In contrast, *Pheidologeton affinis* was found in all study sites, both the wet and the dry seasons, and all methods (Table 1-A Appendix A). This evidence indicated more distribution range than *P. diversus* which was the highest abundance in the teak plantation. The abundance of *P. affinis* was the highest in the mixed deciduous forest, followed by the orchard and the teak plantation, respectively. The high abundance of this species was similar to previous report in Huai Khayeng sub-district. Bourmas (2005) reported that this species could be found in all habitats in the Golden Jubilee reserve forest and also discussed that *P. affinis* was generalist forager which could adapt to the different environments in each plant community. However, there were no *P. diversus* found in the 4 forest types (a dry evergreen, lower mixed deciduous, dry upper mixed deciduous and disturbed mixed deciduous forests) as in Bourmas' report. Meanwhile, *P. diversus* was reported in the open area, such as urban community in Bangkok (Senthong, 2003) and surrounding Ratchaburi Power Plant, Ratchaburi province (Thienthaworn, 2004). *P. diversus* was also reported in the four forest types at

Sakaerat Environmental Research Station, Nakhon Ratchasima province (Hasin, 2008), but was not found in Bala forest at Hala-Bala Wildlife Sanctuary, Narathiwat province (Noon-anant, 2003). Thus, from Bourmas' report and this study, it may be possible that in Huai Khayeng sub-district this species may prefer the open area like the teak plantation. This confirms that *P. diversus* may prefer disturbed habitats. However, there was no reported about the difference in foraging behavior of these 2 species.

Monomorium sp.1 of AMK was found as the second dominant in the mixed deciduous forest. In the teak plantation, it was found at 0.92% (Table 2-B Appendix B) in relative abundance, but it could not be found in the orchard. This may be because of the difference in amount of the leaf litter that was highest in the mixed deciduous forest, followed by the teak plantation because of the mixed deciduous forest fire in March 2008. Bourmas (2005) reported about the correlation of the occurrence of this species and the amount of the leaf litter. Thienthaworn (2004) noted that *Monomorium* sp.1 of AMK was rare in the open area surrounding Ratchaburi Power Plant, Ratchaburi province. Hasin, 2008 reported that this species nested in the soil in all habitats (mixed deciduous forest, dry evergreen forest, deciduous dipterocarp forest, and 40 years old Acacia plantation) where had much in the amount of leaf litter, at Sakaerat Environmental Research Station, Nakhon Ratchasima province. So, it may be possible that the high abundance of this species in this study was associated with the amount of leaf litter.

Anoplolepis gracillipes, an exotic ant species, is one of leaf litter ants that generalist forager (Brown, 2000), high reproductive rate, and more ability in foraging competition than other species. Therefore, this species was found in the high abundance in the mixed deciduous forest, whereas there was found only 0.91% (Table 2-B Appendix B) in relative abundance in the teak plantation. It may be caused by of the low amount of leaf litter in this area. However, this species did not find in the orchard that may be because the insecticide application was often used in this area.

Pheidole is the one of the prevalent ground-dwelling genus (in both species richness and abundance) in world tropics (Ward, 2000). *Pheidole* was classified in the generalized Myrmicinae functional group (Andersen, 2000). It may be possible that in the areas which high species number of the ants in the same functional group, like

forest and teak plantation, can lead to the high competition among them. Therefore, the abundance of *Pheidole* eg. 101 was supposed to be high in the durian orchard where had the low of the other ant species number in the same functional group.

Philidris sp.1 of AMK was found the second in abundance (the first was *Pheidologeton diversus*) in the teak plantation and was found only 7 individuals in the mixed deciduous forest area. However, this species was commonly found in the plantation throughout the year. It could be found in wide distribution in the teak plantation plot. This species was found at 100 % of occurrence throughout the year whereas *P. diversus*, which the highest in abundance, was found at 84.62 % (Table 2-B Appendix B). This may be because *Philidris* sp.1 of AMK nest in the bark of the teak trees and forage on the ground in the area. The bark of the teak tree may suitable for nesting behavior of this species, so it can nest in this area and increase their sub-nest in wide range. Moreover, it is classified into dominant Dolichoderine functional group. It is arboreal and behaviorally dominant in the tropics (Andersen, 2000). Hasin (2008) found that in Sakaerat Environmental Research Station, Nakhon Ratchasima province, this species was found under the leaf litter and around the tree trunks in the dry evergreen forest. Its microhabitat was in twig cavity, under bark, and in epiphytics. Moreover, it existed at high population that was similar to this study.

Oligomyrmex sp.1 of CUMZ nest in the soil and feed on soil arthropods which were found the abundance positive correlated with the soil moisture content (Chikoski, Ferguson, and Meyer, 2006). The humidity in the durian orchard was controlled by conventional agricultural practice with irrigation, especially in the dry season, so the arthropod populations in this area should more available than in the other habitats. This may lead the abundance of *Oligomyrmex* sp.1 of CUMZ in the durian orchard to be higher than in the other two habitat types.

Solenopsis geminata was the fourth rank in abundance in the orchard. *S. geminata* was reported once to occur in a wide variety of habitat, including disturbed sites as roadsides, pastures, and recently cleared land (Tschinkel, 1988). Perfecto and Vandermeer (1996) reported that in monoculture-coffee agroecosystem of Costa Rica, the open area was dominated by *S. geminata.* Moreover, this species is especially efficient at foraging on large and defensible resource and rapid recruitment. This kind of ant is very aggressive against other ant species. The behavior resulted the kind of

ant to be high abundance in the orchard and not be found in other study areas. In addition, this ant species never had been reported in any forest habitat (Wiwatwitaya and Jaitrong, 2001; Phoonjumpa, 2002; Noon-anant, 2003; Bourmas, 2005; Hasin, 2008). However, its abundance was the highest in urban community in Bangkok (Senthong, 2003). It was also found in the open area like the surrounding area near Ratchaburi Power Plant, Ratchaburi province (Thienthaworn, 2004).

6.4.3 The Comparison in Abundance of Important Ants among Three different Land Use Types

Table 6.2 showed the difference in mean abundance of some important ant species among three study sites. The mean abundances of *Monomorium* sp.1 of AMK and *Anopolepis gracillipes* were similar in the pattern. Their abundances were the highest in the mixed deciduous forest, followed by the teak plantation and both of them were not found in the orchard. It may be because these two species may prefer to nest under the leaf litter and they may be sensitive to the insecticides used in the agricultural area.

The *Pheidologeton affinis* was found the first highest in mean abundance in the mixed deciduous forest, second rank of the durian orchard, and in the third rank of the teak plantation. Among these three study sites, this species was lowest in the teak plantation (2.78% in relative abundance). This may be because of the high abundance of *Pheidologeton diversus* and *Philidris* sp.1 of AMK in the teak plantation (Table 2-B Appendix B). The first species was mass recruitment which may prefer the open area. The second species, *Philidris* sp.1 of AMK, was widely distributed in this area throughout the year. The abundance of these two mass of workers species might affect to the number of workers of *P. affinis* with the competition in food source and nest site. In the durian orchard, *P. affinis* was recorded at 27% (Table 3-B Appendix B) in relative abundance that was secondly in the area. The number of individuals of this species could be more than the recorded number, but may be because the orchard was treated by insecticides and herbicide which may reduce the population of this species.

The mean abundance of *Pheidole* eg. 101 was highest in the durian orchard. This may be because of the high species richness in this genus in the other two sites. In the mixed deciduous forest and the teak plantation, there were 8 species of

Pheidole, but there was only 4 species in the orchard (Table 1-A Appendix A). Therefore, in the mixed deciduous forest and the teak plantation, the ants in the same functional group had higher competition than in the durian orchard. This may be a reason of lower number of individuals of this species in the mixed deciduous forest and teak plantation.

6.4.4 Correlation between the Abundance of Important Ant Species and some Physical Factors in each Land Use Type

The correlation of the abundance of *P. affinis* and relative humidity and soil moisture content was similar to the previous study by Noon-anant (2003) which reported the positive correlation of air temperature and the number of workers of *Pheidologeton*. However, he discussed that soil temperature and soil moisture content might be more correlated with this genus than air temperature.

Monomorium sp.1 of AMK was negatively correlated with relative humidity, but positively correlated with soil temperature in the mixed deciduous forest and air temperature in the teak plantation. This was similar to the previous study of Bourmas (2005) which reported that the abundance of *Monomorium* sp.1 of AMK was highly negative correlation with soil and leaf litter humidity and positive with the soil temperature.

Anoplolepis gracilipes was found negatively correlated with relative humidity, whereas positively correlated with soil temperature. This may be because in the rainy season almost species were increased, so the competition was high. In the dry season, most species decreased in population, so the low competition induced this generalized forager to increase the number of workers.

Although there was none of correlation of *Pheidole* eg. 101 with any physical factor, this showed non-specific to the environmental factors that was similar to the previous study in Huai Khayeng sub-district (Bourmas, 2005). This species was found in all three habitats and also found in all 4 forest types (dry evergreen, lower mixed deciduous, dry upper mixed deciduous and disturbed mixed deciduous forests) in previous study. This might expect that this species can adapt to various habitats and wide spread in Huai Khayeng sub-district.