CHAPTER II

LITERATURE REVIEW

2.1 Diversity of Ants

Ants are classified in a single family, the Formicidae, in the order Hymenoptera (Hölldobler and Wilson, 1990). There are 23 subfamilies of ants comprised of 287 genera and approximately 12,000 described species, with a likely much larger number of species yet to be described worldwide (Bolton et al., 2006). Despite the fact that tropical forests are among the poorest surveyed areas, they still have the highest recorded species diversity, for example, approximately 2200 species were recorded in Asia (Hölldobler and Wilson, 1990). In Thailand, there are nine recorded subfamilies: Aenictinae, Cerapachyinae, Dolichoderinae, Dorylinae, Formicinae, Leptanillinae, Myrmicinae, Ponerinae, and Pseudomyrmecinae (Wiwatwitaya and Jaitrong, 2001).

The local diversity of ants is also very high. In wet tropical forests in eastern Madagascar, 471 species in 36 genera were found (Fisher, 2000). A survey of a primary rain forest in the Kinabalu National Park, Sabah, Borneo yielded 524 species belong to 7 subfamilies and 73 genera (Brühl, Gunsalam, and Linsenmair, 1998), while 120 species belong to 5 subfamilies and 49 genera were recorded in the Pasoh Forest Reserve, west Malaysia (Malsch, 2000).

Ant species diversity was studied in many parts of Thailand. Wiwatwitaya and Jaitrong (2001) reported 9 subfamilies, 73 genera, and 246 species; and Phoonjumpa (2002) reported 9 subfamilies, 59 genera, and 224 species in Khao Yai National Park. In Bala Forest at Hala-Bala Wildlife Sanctuary, Narathiwat province, 255 species in 63 genera belong to 8 subfamilies were found (Noon-anant, 2003). Hasin (2008) reported 9 subfamilies, 56 genera, and 131 species at Sakaerat Environmental Research Station, Nakhon Ratchasima Province. These studies showed high diversity of ant in Thailand. In contrast, there are lacks of the information on the ant diversity in most habitats including the changing forest land usage.

2.2 The Role of Ant in Ecosystem

Although the proportion of biomass represented by ground-dwelling ants in comparison with other soil macrofauna (e.g. termites and earthworms) in the tropics varied from relatively low (0.02-5%) to high (80%) (Hölldobler and Wilson, 1990), in terms of population density, when at a low relative biomass ants make a far larger contribution ranging typically from 7-53% (Lavelle and Pashanasi, 1989). One third of the entire animal biomass of the Amazonia terra firme rain forest was composed of ants and termites, with each hectare of soil containing in excess of 8 million ants and 1 million termites (Hölldobler and Wilson, 1990). Indeed both arboreal and ground-dwelling ants play diverse and important ecological roles. Coupled with the abundance of ants, this behavioral diversity has produced a spectacular array of interactions between ants and other organisms. They may function in an ecosystem as predators, prey, detritivores, mutualists, herbivores, or in combinations, and their functions are usually related to the species and genera they belong to (Alonso, 2000; Schultz and McGlynn, 2000). In addition, they create mycorrhizal reservoirs, effect nutrient immobilization, water movement, nutrient cycling, soil movement, and other physical and chemical changes to the soil profile (Folgarait, 1998; Philpott and Armbrecht, 2006).

2.3 Advantages to Use the Ant as a Monitoring Parameter for Environmental Change

Ants have numerous advantages over vertebrates and other arthropods in studies of landscape disturbance and species diversity (Graham et al., 2004); and these make them suitable for biodiversity and environmental monitoring studies. Ants are eusocial organisms, characterized by cooperative brood care, overlapping generations of workers within the colony, and a highly developed caste system (Wilson, 1971, cited in Agosti et al., 2000), which contribute towards the ants' numerical and biomass dominance, high diversity and their presence in almost every habitat throughout the world (Alonso and Agosti, 2000). Moreover, ants as indicators of ecological niches, especially soil systems, have other advantages, such as a fairly good existent taxonomic knowledge for ease of identification, their relative ease of collection, stationary nesting habits that allow them to be resample overtime, and their relative sensitivity to environmental changes (Alonso and Agosti, 2000; Andersen et al., 2002). Ants are an ideal indicator group for inclusion in such a program. Many ant species have narrow tolerance and thus respond quickly to environmental changes. Ants' small size and reliance on relatively high temperatures make them especially sensitive to climate and microclimate changes. In addition, some ant colonies are long lived and have permanent nests that can be marked and revisited. Long-lived species can be monitored for the health of a colony as the surrounding environment changes. In contrast, short-lived ant species may show high turnover and immediate responses to a stressor. Ant assemblages allow a monitoring program that is sensitive to change on a number of temporal scales (Kaspari and Major, 2000). Thus overall, as well as broadly common species, most habitats are likely to have specialized species which occur in sufficient numbers of species and abundance as to serve as suitable terrestrial indicator species of habitat quality and changes. In Thailand, Phoonjumpa (2002) reported the ants as indicator in each plant community at Khao Yai National Park. Senthong (2003) studied the relationship between ant distribution and air quality variation in urban communities of Bangkok that ants could be preliminary used to monitor air quality in urban area. Thienthaworn (2004) reported that *Monomorium floricola*, *Paratrechina longicornis*, and *Plagiolepis* sp.3 of AMK seemed to show the preliminary potential to be air pollution bioindicators at the area surrounding Ratchaburi Power Plant, Ratchaburi province.

2.4 Influence of the Physical Factors on the Ant Diversity

Several physical and biological factors could affect species richness and abundance of ant communities inhibiting particular environments (Ríos-Casanova, Valiente-Banuet, and Rico-Gray, 2006). Because ants are small size that make they heat up and dry out more quickly, physical factor, such as temperature, solar radiation, and water, could play an important role in determining ant diversity (Bestelmeyer, 1997). Ants, as ectotherms, are constrained to forage when they are warm enough, but not too warm. This results in which most ants forage at temperatures greater than 10°C and cease foraging much above 40°C, with an average peak foraging temperature of 30°C (Hölldobler and Wilson, 1990). These environmental conditions can limit the distribution and abundance of ants. In Bala

Forest at Hala-Bala Wildlife Sanctuary, Narathiwat province, Noon-anant (2003) found that the temperature was positively correlated with number of species of *Pheidologeton*, but negatively correlated with number of species of *Meranoplus*, *Tetramorium*, *Amblyopone*, *Mystrium*, and *Platythyrea*. Humidity was positively correlated with number of species of *Cerapachys*, *Monomorium*, and *Solenopsis*, but negatively correlated with number of species of *Acanthomyrmex*, *Cataulacus*, and *Crematogaster*. Seasonal change influenced the number of species in genus *Aenictus*, *Pheidole*, and *Pyramica*, significantly difference between the wet and dry seasons.

Vegetation structures also affected the incidence of direct solar radiation, soil temperature, and water evaporation. Sites with complex vegetation structures provide better conditions for ant activity than sites with simple structures (Retana and Cerdá, 2000).

2.5 Effect of Land Use Changes on Ant Diversity

Anthropogenic disturbance affect the composition of ants through mechanisms, including alterations in shade, vegetation structure, and plant species richness (Hoffman, Griffiths, and Andersen, 2000). Ant genera have been assigned to functional groups that are thought to respond predictably to disturbances and environmental variation, such as changes in habitat structure, associated with disturbance (Andersen, 1990). The major reason for the decline in biodiversity around the world is loss of native habitat, principally as a result of agricultural activities (Major, Delabie, and McKenzie, 1997). In general, it has been showed that agricultural practices, such as heavy grazing, irrigation, drainage, fertilization, mowing, conventional tillage, ploughing, and reseeding, reduce ant biodiversity and/or biomass, and colony densities (Perfecto and Snelling, 1995). Perfecto and Snelling (1995) showed that the ant ground community was likely to suffer more reductions in diversity than those of the arboreal strata in coffee bushes as technological intensification increase in coffee plantations. Along a gradient of increasing grazing intensity in the semi-arid Chaco region in Argentina, overall ant species richness changed little across sites, but favored opportunists and hot climate specialists (over cryptic and specialized predators) at highly disturbed areas (Bestelmeyer and Wiens, 1996).

2.6 Methods to Estimate Ant Diversity

Ants, in general, are very easy to sample. Baiting techniques, pitfall traps, aspirators, litter sifting, Berlese-Tullgren or Winkler funnels for litter or soil core samples, and hand collections with forceps or nets are among the most common methods to sample ground foraging ants. All these methods are easy to use, cheap, and not incredibly time consuming (Hölldobler and Wilson, 1990). A comparison of the litter and soil ant fauna have showed that a combination of pitfalls, litter sifting, baiting, and hand sorting increase the efficiency of species captures in comparison to any single method by itself (Majer and Delabie, 1994). The combination of methods will ensure the complete a representation of the ant fauna as can be expected. The success of any sampling protocol used alongside each method, as well as a careful interpretation of the data that accounts for the limitation of the methodology (Bestelmeyer et al., 2000). In fact, numerous studies have pointed out the need to use more than one method in quantifying ant diversity (Olson, 1991; Bestelmeyer et al., 2000; Hashimoto, Yamane, and Mohamed, 2001).

2.7 Ant Diversity in the Natural and Other Habitats in Thong Pha Phum district

Thong Pha Phum district, in the Kanchanaburi province, western Thailand, is located at the junction of three ecoregions: the Tenasserim-South Thailand semi-evergreen rain forest, the Kayah-Karen montane rain forest, and the Chao Phraya lowland moist deciduous forest (Beamish, 2007). Therefore, with such a relatively high diversity of habitats and organisms including flora, then likewise the biodiversity of ants including habitat-specific or specialist species, is expected to be high. Consistent with this notion, Bourmas (2005) reported that 202 ant species belonging to 56 genera in nine subfamilies, were found from four forest types: namely a dry evergreen, lower mixed deciduous, dry upper mixed deciduous, and disturbed mixed deciduous forests, in the Golden Jubilee forest reserve in Thailand. Besides, the forest reserve and national park, Thong Pha Phum district also has several other land use types which include the commercial plantings of teak, *Tectona grandis* (Lamiales: Verbeniceae), and rubber, *Hevea brasiliensis* Mull. Arg. (Malpighiales: Euphorbiaceae) trees, and also agricultural areas, such as the cultivation of fruit orchards, including rice and field crops that require an extensive use of pesticides to control pests and weeds. Sematong, Zapuang, and Kitana (2008) reported that 84% of farmers in Thong Pha Phum used pesticides in their agricultural activities during 2006-2007. The most commonly used herbicides were glyphosate and paraquatdichloride; and the most commonly used insecticides were methomyl, chlorpyrifos, and parathion methyl.

However, there is currently no information about the diversity of ants in these habitats which have been modified from the natural forest, yet such changes in the land-use patterns have resulted in areas that significantly differ in vegetative cover, management and some environmental factors and so would be expected to have changed the ant species composition and abundances.