CHAPTER I

INTRODUCTION

Among the several groups of the eusocial hymenoptera which large populous colonies have highly developed. Ants are ubiquitous and dominant feature of the terrestrial landscape, playing key roles in symbiotic interactions, soil aeration and nutrient cycling (Moreau *et al.*, 2006). Among the ants, predatory species of the neotropical genus *Eciton*, the African genus *Anomma* and several Asian *Ponerine* species consist of up to several million workers, which hunt in large "armies" and subdue all kinds of arthropods, small reptiles and small mammals in the litter and on the ground. In the canopy of the African and Asian forest the dominant predatory ants are species of the genus *Oecophyllla* (Hölldobler and Wilson, 1978, 1990). Comparable to army ants they have developed a very efficient social hunting and foraging behavior to gain the necessary food for their large colonies.

Figure 1.1 Weaver ant workers carring the honey bee worker, *A. florea*. Photo by O. Duangphakdee.

On the other side large colonies of social Apoidea with up to several thousands of worker bees, numerous larvae and a considerable storage of honey (Michener, 1974; Seeley, 1985; Oldroyd and Wongsiri, 2006) present very rewarding prey and several species of *Apis* and *Meliponini* share the arborous habitat of *Oecophylla* (fig. 1.1). This brings up the question of co-existence of predator and prey.

The stability inherent by the predator on prey is one of the most impressive interactions. Predator phenotypes with the ability to consume the larger and more preys are favored by natural selection. Prey species, however, require mechanisms at all levels which provide an increasing possibility to defend and thus increase their fitness. Both mechanisms operated during million years of encounters and shaped an escalation in traits of attacks and defense as a result of an arms race between predator and prey (Dawkins and Krebs, 1979).

In many habitats, social insects present a significant portion of animal biomass much larger than all mammal species together (Wilson, 1971, 2006). Within the social insects, ants are by far the dominant taxonomic group and mainly predatory ants pose a great challenge to most other arthropods. Thus, the question of how to defend against ants seems to be crucial for many insect species. Social bees are generally not in positions to successfully face larger predatory ants in a face to face combat. Their defense is mainly based on social behavior. Further, biological active substances play a significant role in colony defense (Seeley, 1983, 1985; Burdock, 1998; Roubik, 2006). Several social bee species collect the resinous material from plants to form the propolis and use to protect against the enemies. Since long time it is known that different compounds from honey, propolis and other products of honeybees possess some activity against virus, fungi and bacteria (Burdock, 1998; Kosalec *et al.*, 2003; Sawaya *et al.*, 2004). The question of ant repellent effects from propolis, however, had not been researched yet up to now. Therefore, this investigation was focused on the repellent activity of material from a bee's nest on predatory ants. The development of a sound and reliable bioassay was a key factor for this research project. By means of this bioassay a quantitative determination and comparison of various materials of different bee nests were carried out.

Two predatory ant species, the tropical weaver ant, *Oecophylla smaragdina*, and the European wood ant, *Formica polyctena*, served as test animals in the bioassay. Both species presented the dominant predatory ant species: *F. polyctena* in the temperate European forest and *O. smaragdina* in South-East Asian forest. First the question whether or not the bee material showed a repellent effect against the native predatory ant was tested and then the bioassay was performed with the allopatric ant species. In other words, the response of weaver ants, *O. smaragdina*, and red wood ants, *Formica polyctena* toward European bee material, propolis from *Apis mellifera* and the Asian bee material, sticky band from *Apis florea*, *Apis andreformis*, and nest entrances of *Trigona* spp. was tested.

The experiments were conducted on two main geographical regions, tropical region (Thailand and Malaysia) and temperate region (Germany). We started with the experiments of the specificity of *A. florea* defense against weaver ants (Chapter III). In later scenario (Chapter IV), the experiments were performed to answer three main questions;

1. The intensive interactions (predator-prey relationship) between *O. smaragdina* and several social bees have resulted in several different ways of colony defense. Do all tested bee species apply repellent material for colony protection? Further, are the applied materials similar among the bee species or are there significant differences?

2. In the European forest the interaction of *F. polyctena* versus *A. mellifera* is less specific. In consequence, does propolis of *A. mellifera* have a lower repellent activity?

3. The question of whether natural compounds, collected by bees, possess a general biological activity to repel ants whether each bee species has developed a specific and singular way to repel the predatory ant was examined.

As the bees collected the resinous material from plants, we should find that the bees use both common and specific substances to repel ant enemies. This thesis therefore used interdisciplinary approaches by the chemical isolation and identification techniques were applied. A concise introduction to the "chemical identification" was presented with the intention that this thesis can gain some general idea about the active repellent compounds from resinous material in bee nests.