CHAPTER 1

Introduction

1.1 Historical Background

Arabica coffee (*Coffea arabica* L.) is the main cash crop for the hill tribes in the mountainous region in northern Thailand after it was promoted by the government approximately 30 years ago (Riwthong *et al*., 2015). However, a major pest problem has been caused in some regions by the coffee berry borer (CBB, *Hypothenemus hampei*). Although the origin of CBB is not known, it is now found in all coffee producing areas worldwide, including Thailand (Jaramillo *et al*., 2011; Vega *et al*., 2009). Females of CBB bore galleries into the coffee berries to lay eggs, after which the larvae feed on and destroy the coffee beans (Schmutterer, 1990). Borer infestation reduces the quality of the coffee crops. Although insecticides have been widely used to control this pest, it is not always effective because the CBB spends most of its life inside the coffee fruit. In addition, CBB has developed a resistance to insecticides (Gonthier *et al*., 2013). Therefore, in recent years, the Thai government and institutions have recommended growers to apply female attractant traps using ethanol and methanol, the entomopathogenic fungus *Beauveria bassiana*, as well as cultural control. Moreover, in other coffee growing countries, the parasitic wasp *Cephalonomia stephanoderis* and predators such as birds, thrips and ants have been used for the biological control of CBB (Vega *et al*., 2009). In South American countries such as Mexico and Colombia, there are several reports on the effects of ants on the CBB. For example, *Pheidole synanthropica* was confirmed to carry the CBB to their nests, and *Azteca instabilis* that have a symbiotic relationship with scale insects on coffee trees expels the CBB (Jiménez-Soto *et al*., 2013). Besides these two ant species, the usefulness for the CBB control is expected for the following species; *Brachymyrmex* sp., *Camponotus* sp.,

Crematogaster sp., *Dorymyrmex* spp., *Gnamptogenys sulcate*, *Pseudomyrmex* sp., *Solenopsis* spp. and *Tetramorium* sp. (Jiménez-Soto *et al*., 2013; Philpott and Armbrecht, 2006).

In Thailand, too, it is possible that some ant species play an important role for controlling the CBB, however, no studies of ant effects on the CBB have been carried out to date. Furthermore, the ant fauna in coffee plantations in Thailand has been rarely studied so far. Research of ant effects on the CBB is indispensable for the establishment of integrated management of the CBB in Thailand. As a first step for evaluating ant effects on the CBB, we investigated the ant species diversity in coffee plantations in northern Thailand. Then, the ant behavior toward adult CBB was observed in order to know the potential of ants as biological control of the CBB.

1.2 Objectives

The objectives of this study are:

1. To identify ant species found in coffee plantations in northern Thailand
2. To identify the dominant ant species in coffee plantations in northern Thailand
3. To investigate the effect of the dominant ant species on coffee berry bore

1.3 Literature Review

1.3.1 Coffee in Thailand

East and Southeast Asia has seen a steady increase of coffee consumption in recent years (Ngaochay *et al.*, 2015). In Thailand, the consumption of coffee bean reached 72,000t (ton) per year, or 1.07kg per capita. Furthermore, coffee-drinking culture has been penetrated Thailand. Thailand is also a coffee producer with an annual production of 29,640t per year (International Coffee Organization, 2016). There are two main kinds of coffee cultivated. In the south, 17,028t per 30,084ha of robusta coffee (*Coffea canephora* Pierre ex. A. Froehner) are produced, while in the north 8,876t per 9,844ha of arabica coffee (*Coffea arabica* L.) are produced annually (Office of Agricultural Economics, 2016). Arabica coffee was introduced as cash crop alternative opium poppy by the Thai / UN Crop Replacement and Community Development Project from 1972 – 1979 (Angkasith, 2001). It is produced at altitudes of more than 800m above sea level making the mountainous Northern Thailand most suitable for the cultivation of arabica coffee. It has become an important agriculture product in the local communities. The arabica coffee is the main cash crop for the hill tribe in the mountainous region in Northern Thailand at present from approximately 30 years ago, when the government promoted to product the arabica coffee to them (Riwthong *et al*., 2015). For example, Akha, a northern Hill-tribe, produce arabica coffee as their brand “Akha Ama coffee” and arabica coffee has become indispensable to their lives (Thiemboonkit, 2013).

1.3.2 Coffee pests

There are many coffee pests and they create a high risk for coffee productions, such as the coffee berry borer *Hypothenemus hampei* Ferrari; green scale *Coccus viridis* Green; white stem borer *Xylotrechus quadripes* Chevrolat, red branch borer *Zeuzera coffeae* Nietner, coffee leaf miner *Leucoptera coffella* Guérin-Méneville, and the coffee rust fungus *Hemileia vastatrix* Berk & Broom (Waller *et al*., 2007; Vandermeer *et al*., 2010). In Northern Thailand, the coffee berry borer and the green scale are found in shaded coffee plantations and the white stem borer and the red branch borer are found in un-shaded coffee plantations in particular (Buranapanichpan and Chanbang, 2014; Suttiprapan and Chanbang, 2014; Thayaping and Suttiprapan, 2015). Scale insect prefers to attack green wood and leaves and they cause sooty mould. Sooty mould has grown on the honeydew excreted by the large colonies of scales, and this causes a reduction in the photosynthesis in the leaves and has harmful effect on growth (Waller *et al*., 2007). The white stem borer is a major pest of arabica coffee in some Asian countries. The larvae of the white stem borer enter the heartwood and tunnel in all directions. Then, the affected trees appears yellow and wilted. (Venkatesha and Dinesh, 2012). The adults of the red branch borer attack shoots and young stems and kill or render them to breakage. (Waller *et al*., 2007).

1.3.3 Coffee berry borer

The coffee berry borer (CBB; figure 1.1), *Hypothenemus hampei* Ferrari (Coleoptera: Scolytidae), is one of the most economically damaging pests of commercial coffee in all producer countries of the world (Jaramillo *et al*., 2011; Jiménez-Soto *et al*., 2013; Le Pelley, 1968; Trible and Carroll, 2014; Vega *et al*., 2009). This pest is not known of the place of origin, originally prevalent in Central Africa, it is now found in the world of coffee producing areas, including Thailand (Jaramillo *et al*., 2011; Vega *et al*., 2009).

Classification and characteristics of coffee berry borer (*H. hampei*)

Phylum Arthropoda
Class Insecta
Order Coleoptera
Family Scolytidae
Genus *Hypothenemus*
Species *Hypothenemus hampei*

The female of the coffee berry borer are approximately 1.4 – 2.0 mm in length. They can live up to 282 days with an average life span of 156 days (Le Pelly, 1968). It bores into the coffee berries to lay eggs, averaging 30 to 70 eggs per bean. When the eggs hatch, the larvae eat and destroy the coffee beans (Schmutterer, 1990). Their life cycle is just 25 to 35 days in good environmental conditions, and they can produce seven generations per year (Le Pelly, 1968). Borer infestation reduces the quality of the coffee crops. The main control method for CBB is the use of pesticides. However, the pesticides are not always effective against the CBB, because the CBB spends most of its life inside coffee berries. Furthermore, the CBB has developed resistance to insecticides (Gonthier *et al.*, 2013).

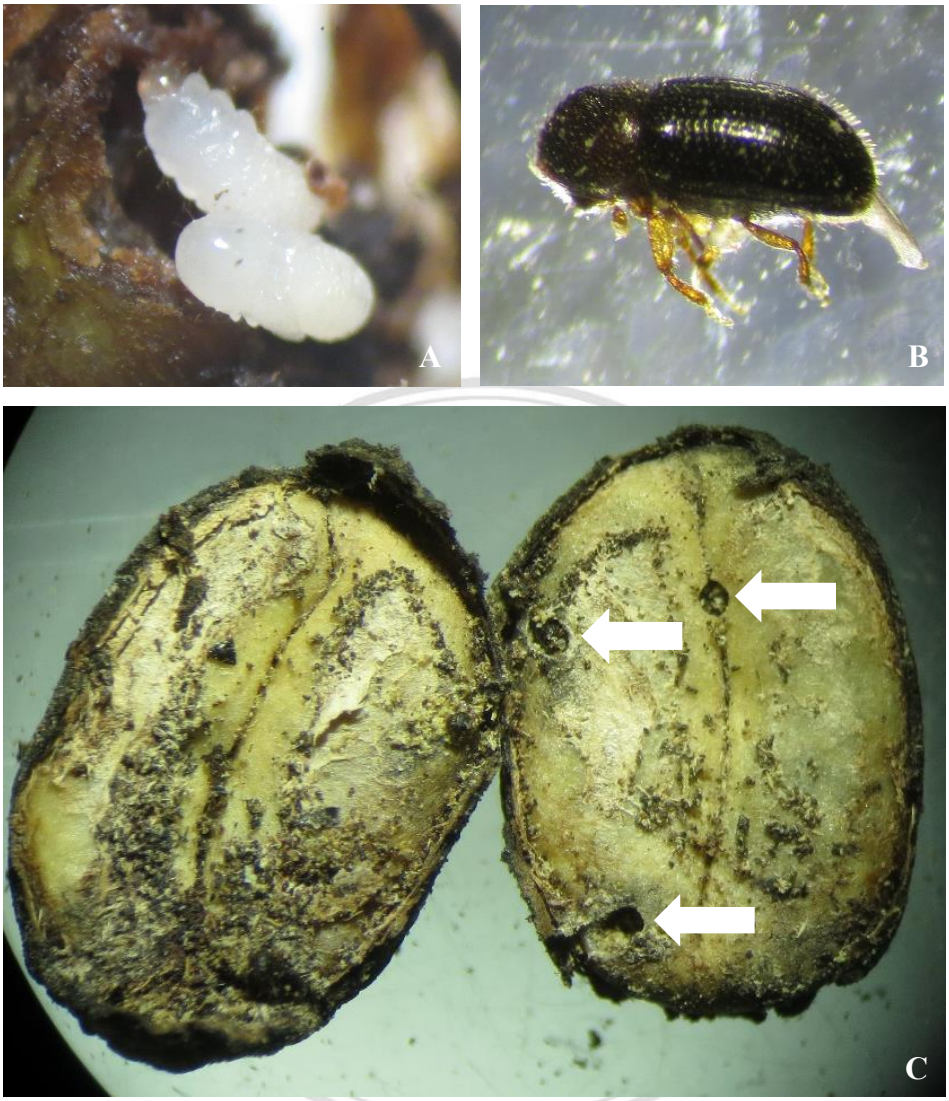

Figure 1.1 Coffee berry borer, *Hypothenemus hampei*

(A) Larvae of CBB
(B) Adult CBB
(C) Holes made by CBBs

1.3.4 Coffee berry borer control

With the advent of the CBB, the control method has been studied in the world of coffee producing countries. For example, in Java, a method using benzene or petroleum was suggested. It was painted on the coffee bushes, then it coated the borer – holes in the berries and killed the CBB (Le Pelly, 1968). In recent years, the Thai government and Department of Agriclture have recommended to growers the CBB control method that does not rely only on pesticides but also applying the female attractant traps using ethanol and methanol, entomopathogenic fungus *Beauveria bassiana*, and cultural control. Moreover, in other coffee growing countries, the parasitic wasp *Cephalonomia stephanoderis* and predators such as birds, thrips and ants are used as the biological control of CBB (Vega *et al*., 2009). In South America such as Mexico and Colombia, there are a lot of research reports about CBB control using ants, for example, *Pheidole synanthropica* was confirmed to carry the CBB to their nests, and *Azteca instabilis* expel the CBB by the symbiotic relationship of the scale insects (Jiménez-Soto *et al*., 2013). Besides these two species, possibility of CBB control are expected in the following species; *Brachymyrmex* sp., *Camponotus* sp., *Crematogaster* sp., *Dorymyrmex* spp., *Gnamptogenys sulcate*, *Pseudomyrmex* sp., *Solenopsis* spp. and *Tetramorium* sp. (Jiménez-Soto *et al*., 2013; Philpott and Armbrecht, 2006).