CHAPTER III

MATERIALS AND METHODS

Sample collection

1. Samples of the aculeates were collected from several areas in the north of Thailand. There were Chiang Mai, Chiang Rai, Kamphaeng Phet, Lampang, Lamphun, Mae Hong Son, Nakhon Sawan, Nan, Phayao, Phetchabun, Phichit, Phitsanulok, Phrae, Sukhothai, Tak and Uttaradit (Figure 2). Those areas included botanic gardens and parks, and different types of forests i.e. evergreen forest and deciduous forest between January 2006 and June 2007.

2. The method of systematic random sampling was used for sample collections (Krebs, 1999). The techniques for efficiently collecting flying and non-flying Aculeata were different. Flying species were collected by insect sweeping nets. Other apterous species were most frequently collected by hands, forceps and/or grates.

3. All specimens were preserved in 95% ethyl alcohol. Details of the samples (e.g. the localities, habitats and microhabitats) were recorded. The position and altitude of all insect samples were determined by means of a Global Positioning System (GPS) receiver (Garmin).

Sample classification

1. The insect samples of each species were divided into 2 groups. The first group was preserved as dried specimens and was used for further identification (Elzinga, 2000) and the second group was preserved at the Department of Biology, Naresuan University, Phitsanulok, Thailand.

2. The specimens were identified using taxonomic literatures and references following Schwarz (1939), Vecht (1966), Hirashima (1969), Mitchell (1980), Archer (1989), Sakagami, Inoue and Salmah (1990), Yamane (1990), Brothers and Finnamore (1993), Finnamore and Michener (1993), Goulet and Huber (1993), Bolton (1997), Shattuck (1999), Yamane, Ikudome and Terayama (1999), Carpenter and Garcete-Barrett (2002), Carpenter and Nguyen (2003), Gupta and Jonathan (2003), Michener

and Boongird (2004), Tüzün (2004), Nguyen et al. (2006), Oldroyd and Wongsiri (2006) and Michener (2007).

3. Specimens were confirmed by experienced taxonomists from the Natural History Museum (National Science Museum, Thailand), the Center of Excellence: Bee biology, biodiversity of insects and mites (Chulalongkorn University, Thailand), Department of Biology (Chiang Mai University, Thailand), Insect Museum (Kasetsart University, Kamphaeng Saen Campus, Thailand) and Institute of Zoology (Bulgarian Academy of Sciences, Bulgaria).

4. The dichotomous keys of families, subfamilies, genera and species were constructed for identification of all the collected insects in infraorder Aculeata in the studied areas, according to Goulet and Huber (1993).

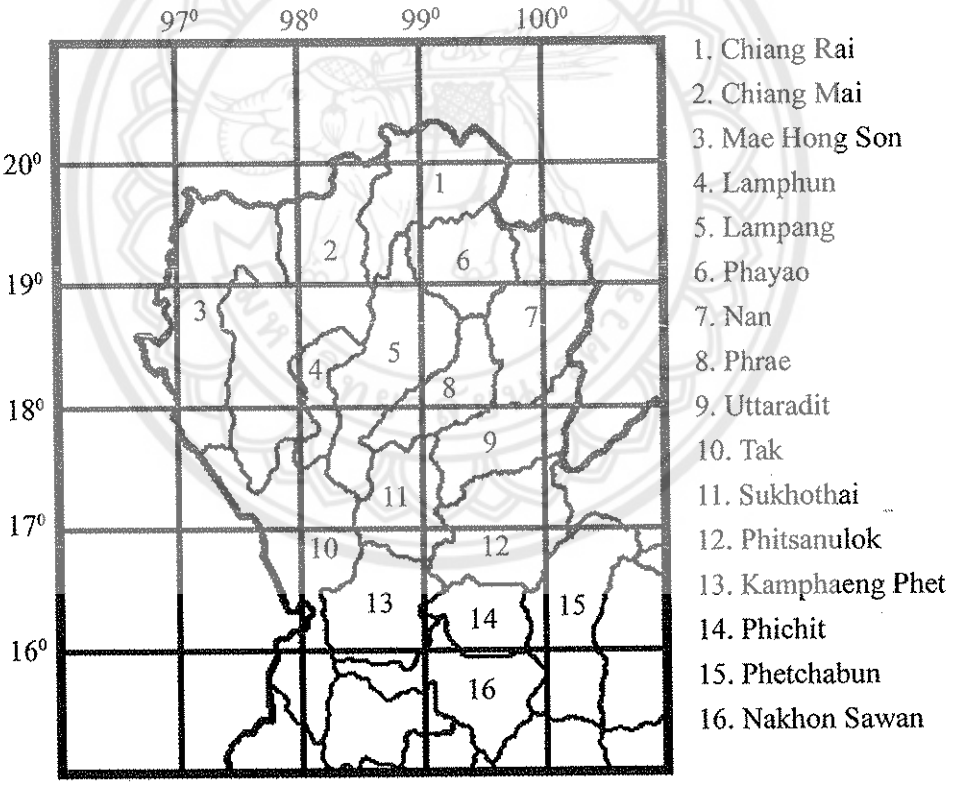

Figure 2 Provinces surveyed for the presence of aculeate bees.

Data analyses

The list of aculeate bee species was presented in each habitat which was done for species composition and species structure indices. The results were used to indicate the aculeate bee species structure in each type of habitat i.e. deciduous dipterocarp forest, evergreen forest and cultivated area.

Similarity index

The values, ranging from 0-1 scale of Sorensen coefficient; S_s (Krebs, 1999), were used to match species in 2 community areas, using the following equation:

$$S_s = \frac{2a}{2a+b+c}$$

where: S_s = Sorensen's similarity coefficient

a = number of species in sample A and sample B

b = number of species in sample B but not in sample A

c = number of species in sample A but not in sample B

Species diversity index

The species diversity of the aculeate bees living in each type of habitat was estimated using the Shannon-Wiener function; H' and Pielou's index of equitability; J' (Krebs, 1999). The J' values of this measure (0-1) were used to determine that the species diversity is more or less diverse than others, using the following equation:

$$H' = -\sum_{i=1}^{s}(p_i)(\log p_i)$$

To standardize this measure, calculate evenness from equation:

$$J' = \frac{H'}{\log N}$$

where: H' = species diversity of Shannon-Wiener index

J' = evenness measure of the Shannon-Wiener index

log = $\log_{10}$

N = number of species

p_i = proportion of the total sample belonging to i^{th} species

S = number of species

Dominant species index

The measurement of dominant species in each habitat was calculated using Simpson's index; C (Krebs, 1999). The value ranges from 0-1 and was used to determine the dominant species in each area. The calculation was done following equation:

$$C = \sum p_i^2$$

where: C = dominant species of Simpson's index

p_i = proportion of the total sample belonging to i^{th} species