

Native Bee Pollinators and Pollen Sources of Apidae (Hymenoptera) in Four Forest Types of Lower Northern Thailand

(Pendebunga Lebah Asli dan Sumber Debunga Apidae (Hymenoptera)
dalam Empat Jenis Hutan di Hilir Utara Thailand)

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ABSTRACT

Bee species diversity and pollen sources of Apidae (Hymenoptera) in Thung Salaeng Luang National Park, lower northern Thailand, were studied from 2011 to 2012. The forest types encountered were deciduous dipterocarp, deciduous with bamboo, seasonal evergreen and dipterocarp - pine forests. Sweep nets and honey bait traps were used to collect bee samples. The beta diversity of native bees was high with 22 recorded insect species from 12 genera and pollen grains collected by native bees were 62 plant species from 28 families. The plant family Fabaceae (Leguminosae) contained the greatest number of species (9 species). The main pollen source of native bees was Hopea odorata Roxb. (Dipterocarpaceae) which was collected by 19 bee species. The result from biodiversity indices i.e. species diversity (H'), species evenness (J'), similarity habitat (S) and species richness (D) indicated that this area has relatively high species diversity. In addition, the dwarf honey bees, Apis florea Fabricius, 1787, are the main pollinator at the study site with the highest number of pollinated plant species (46 species). Thus, this bee could be used as a biological indicator for future studies.

Keywords: Biodiversity; native bees; seasonal forests; Thailand; vegetation

ABSTRAK

Kepelbagaian spesies lebah dan sumber debunga Apidae (Hymenoptera) di Taman Negara Thung Salaeng Luang, hilir Utara Thailand telah dikaji dari 2011 hingga 2012. Jenis-jenis hutan yang dikenal pasti adalah meluruh dipterokarpa, meluruh dengan buluh, malar hijau bermusim dan dipterokarpa - hutan pain. Jaring sapu dan perangkap umpan madu telah digunakan untuk mengumpul sampel lebah. Kepelbagaian beta lebah asli adalah tinggi dengan 22 spesies serangga yang direkodkan daripada 12 genus dan debunga yang dikumpul oleh lebah asli terdiri daripada 62 spesies tumbuhan daripada 28 keluarga. Keluarga pokok Fabaceae (Leguminosae) mengandungi jumlah spesies paling banyak (9 spesies). Punca utama debunga lebah asli adalah Hopea odorata Roxb. (Dipterocarpaceae) telah dikumpul melalui 19 spesies lebah. Hasil daripada indeks kepelbagaian biologi seperti spesies kepelbagaian (H'), spesies sama (J'), persamaan habitat (S) dan kekayaan spesies (D) menunjukkan bahawa kawasan ini mempunyai kepelbagaian spesies yang agak tinggi. Di samping itu, lebah madu kerdil, Apis florea Fabricius, 1787, adalah pendebunga utama di tapak kajian dengan jumlah spesies tumbuhan yang didebungakan (46 spesies). Oleh itu, lebah ini boleh digunakan sebagai penunjuk biologi untuk kajian pada masa hadapan.

Kata kunci: Hutan bermusim; kepelbagaian biologi; lebah asli; Thailand; tumbuh-tumbuhan

INTRODUCTION

Habitat destruction is 4 of the main threats to biodiversity (Ney-Nifle & Mangel 2000). In Thailand, during the severe degradation of forests over the past 5 decades, most of the forest area has been experienced for timber exploitation, agricultural purposes and urbanization. Thus, many protected areas have been designated in order to protect Thailand's biodiversity since 1962. The national parks in lower northern Thailand are mountainous and covered with many different types of forests e.g. deciduous forest (DF), deciduous dipterocarp forest (DDF), seasonal evergreen forest (SEF), evergreen forest (EF), dipterocarp - pine forest (DPF) and mixed evergreen-deciduous forest (MEDF) (Maxwell 2004). The DF, DDF, SEF and DPF are the main vegetation ecosystems found in this area. Thung Salaeng

Luang National Park, established in 1963 as Thailand's 3rd national park and the 3rd largest of them, is also 1 of the most abundant forests (DNP 2010). This national park was chosen as study areas to represent 4 dominant forest types (DF, DDF, SEF and DPF) from the lower northern Thailand. The national park is situated between latitudes $16^{\circ} 25' - 16^{\circ} 57' N$ and longitudes $100^{\circ} 37' - 101^{\circ} 00' E$. The park has an area of 1262.55 sq km and an elevation of approximately 700-860 m above sea level, covering Phitsanulok and Phetchabun provinces in lower northern Thailand (DNP 2010; Nakwa et al. 2008). The previous studies of biodiversity have reported that many species of plants and mushrooms have been recorded and still found in the park (Kaewkrom et al. 2007; Mytnik-Ejsmont & Baranow 2010; Prajaksod et al. 2012). Furthermore,

many new species of insects have also been found in this national park (Hippa 2011; Pauly 2012; Tian et al. 2012). The national park has several different kinds of forest types which can support more species of bees than single facies (Holzschuh et al. 2007; Hoover & Parker 1991).

Bees are the major insect pollinators in Thailand's forests (Jongitvimol & Wattanachaiyingcharoen 2006; Warrit 2007) and economic crops in Thailand (Boonithee et al. 1991). Native bee pollinators consist of honey bees, stingless bees and bumble bees (Michener 2007). Several studies have reported that the pollen grains were collected by several bees in Thailand (Boongird & Michener 2010; Burgett et al. 2005; Tangmitcharoen et al. 2006). However, there is a lack of information on bee pollinators and pollen sources in the forest of lower northern Thailand. In this study, Thung Salaeng Luang National Park was chosen as the study area for investigating pollen sources of the native bee pollinators (Hymenoptera: Apidae) and the important to their species diversity.

The results can furnish beneficial knowledge on species assemblage of native hymenopterans as pollinators and their food plants in 4 different dominant forest types from the lower northern Thailand. This knowledge will be useful for further biological studies such as systematic studies and sustainable conservation of native bee pollinators in Thailand and other parts of this region.

MATERIALS AND METHODS

RESEARCH SITE

This research was done in Thung Salaeng Luang National Park, Phitsanulok and Phetchabun provinces from January 2011 to December 2012. A study trail in each forest type, made by experienced park staffs, was used for surveys and sample collection. The detailed descriptions of 4 trails are given below: The DF site is located at Kaeng Sopha Waterfall (elevation 400 m, 16° 53' 16" N and 100° 49' 44" E). The DDF site is located at Nong Mae Na (elevation 700 m, 16° 36' 24" N and 100° 53' 39" E). The SEF site is located at the national park office, Huai Hia (elevation 700 m, 16° 51' 4" N and 100° 52' 45" E). The DPF site is located at Yang Thon (elevation 900 m, 16° 47' 25" N and 100° 59' 4" E). The sampling areas in each forest type were 500 m long and 2 m wide on either side of the trail (2000 sq m).

SAMPLE COLLECTION

Native bee pollinators and pollen samples were collected from each forest type between 09.00 am and 04.00 pm at least once a month, depending on flowering phenology during 2011 to 2012. The sampling areas in each forest type were studied by random sampling and line transects (Krebs 1999). The sampling techniques were sweep net sampling for bees and hand collection for pollens and flowering plants. The honey bait traps were also used to support the purpose for documenting bee species. Plastic Petri dishes (8.5 cm diameter) containing 20 mL of 50% (v/v) honey

solution was used to attract bees. The baits were placed for 30 min on the ground of every 20 m along the trail to attract bees. Pollen and bee samples were preserved in 70% (v/v) ethanol. Tree and plant specimens were collected for identification. Field notes included location, habitat and other details were recorded.

SAMPLE IDENTIFICATION

The insect samples of each species were divided into 2 groups. The first group was preserved as dried specimens and used for further identification (Hatch 1926). The second group was kept in 70% ethanol solution at Pibulsongkram Rajabhat University (PSRU), Phitsanulok. The specimens were identified using keys from Michener (2007), Michener and Boongird (2004), Sakagami et al. (1990), Schwarz (1939) and Yamane et al. (1999). Most specimens were confirmed by comparing with the insects deposited in the Naresuan University (NU) museum, Phitsanulok. All voucher specimens of insects were collected and deposited in the Entomology Laboratory, PSRU.

Pollen was taken from pollen baskets of forager bees and flower buds. All samples were prepared by the standard acetolysis method (Erdtman 1960). A pollen key for the local flowering plants was constructed by using pollen grains collected from flower bud and a photograph from a scanning electron microscope (SEM, Leo 1455VP) at NU. Pollen preparation for SEM, acetolysed pollen grains in 70% ethanol solution were mounted on aluminum stubs with double-sided cellophane tape, then air-dried at room temperature. All specimens were coated with gold before SEM study. Having developed the pollen key of this national park, we identified the species of pollen carried by returning forager bees. This pollen was mounted in glycerin jelly for light microscopic (LM) observation. Pollen measurements and morphological observations were analyzed by an Olympus BX-41 microscope at PSRU. Flower visited by native bee pollinators and other plant species were identified at Kasetsart University (KU), Kam Phaeng Saen Campus (KPS), Nakhon Pathom. Finally, the specimen identification was confirmed by comparing them with specimens in Bangkok Herbarium (BK), Forest Herbarium (BKF) and Chulalongkorn University Herbarium (BCU). All voucher herbarium specimens and pollens were deposited in the Botany Laboratory at KU (KPS).

DATA ANALYSES

A list of bee and vascular plant species was made for each forest type. Species composition and species structure indices are calculated to indicate the bee species structure in each forest type. Shannon-Wiener index, H' indicates the bee diversity living in the forest which based on the number of bee species within a site and the relative abundance of each bee species (Magurran 1988). Pielou's index, J' or the species evenness was used for determining the relative abundance or individual distribution among the different communities (Ludwig & Reynolds 1988). Simpson's

Pollen Sources of Stingless Bees (Hymenoptera: Meliponinae) in Nam Nao National Park, Thailand

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ABSTRACT

Stingless bees (Hymenoptera: Meliponinae) play an important ecological role as insect pollinators of many flowering plants in subtropical and tropical regions. This research aimed to investigate the species diversity and pollen sources of stingless bees in Nam Nao National Park, which covers the border between lower northern and upper northeastern Thailand, during January 2013 – June 2014. The sample collections of insects and plants were collected along 2 existing forest trails: bamboo-deciduous forest and deciduous dipterocarp-oak forest. Ten stingless bee species including *Homotrigona fimbriata* (Smith, 1857), *Lepidotrigona nitidiventris* (Smith, 1857), *L. terminata* (Smith, 1878), *L. ventralis* (Smith, 1857), *Lisotrigona cacciae* (Nurse, 1907), *Tetragonilla collina* (Smith, 1857), *Tetragonula laeviceps* (Smith, 1857), *Te. minor* (Sakagami, 1978), *Tetrigona apicalis* (Smith, 1857), and *Tet. melanoleuca* (Cockerell, 1929) were found from this study. All value indices, the species diversity index (H'), the species evenness index (J') and species richness index (D') showed that bamboo-deciduous forest have higher species diversity than the deciduous dipterocarp-oak forest. The similarity coefficient (S_s) showed similar community structure of stingless bees in both types of forest. Moreover, their pollen grains were identified in 70 plant species from 31 families. The family Asteraceae (Compositae) was the most diverse (12 species). The main pollen source of stingless bees found in both types of vegetation was *Synotis cappa* (Buch.-Ham. ex D.Don) C.Jeffrey & Y.L.Chen. The highest number of bee flora was found from pollen loads of *T. collina* (44 species), while *Te. laeviceps* ranked second (44 species), and *L. terminata* ranked third (38 species). These results suggest that the studied areas can provide food sources for stingless bees where is important for maintaining populations of them.

Keywords: bee flora, native bees, Apidae, Meliponini, vegetation

INTRODUCTION

Stingless bees also known as meliponine bees (Hymenoptera: Apidae: Meliponinae) are abundant in both subtropical and tropical realms. Worldwide stingless bees are classified into over 600 species in 56 genera. A total of 60 species belonging to 14 genera have been reported in Southeast Asia. Currently, 35 species have been recorded in Thailand (Velthuis, 1997; Cortopassi-Laurino *et al.*, 2006; Rasmussen, 2008). They constitute a diverse group, with many species building their nests in living or dead tree trunks. While others build nests above ground (Jongjitvimol and Wattanachaiyingcharoen, 2007). In ecosystems, stingless bees play a major role as pollinators of several flowering plants in tropical forests. They move pollens from 1 plant to another, ensuring seed set and gene flow between plants and plant populations (Venturieri, 2009). In return, the plants provide them with floral resources (pollen and/or nectar) that are vital to their own survival. They are, therefore, important for the balancing and

functioning of food webs of most ecosystems. For stingless bees, pollen is the main source of proteins, free amino acids, lipids, vitamins and minerals. Their adult females feed their larvae with pollen, or a mixture of pollen and nectar (Nicolson, 2011; da Silva *et al.*, 2014).

The lower northern region of Thailand is characterized by a heterogeneous structure, dominated by tropical forests i.e. mixed deciduous and deciduous dipterocarp forests. The species number of pollen feeding insects is directly correlated with the number species of plants (Fontaine *et al.*, 2006; Blüthgen and Klein, 2011). Over the past 5 decades, national parks and wildlife sanctuaries in this area have been deforested. This is one of the most serious threats to biodiversity. Winfree *et al.* (2007) proposed that these bees are sensitive to the change in habitat, thus, deforestation may reduce both populations and species diversity. Although some parts of this region have been deforested and converted for agricultural purposes, it is one of the most biologically diverse areas in Thailand. The Nam Nao National Park encompasses the border between the northern and northeastern parts of Thailand with an average elevation of 800 m. Nam Nao was established as a national park on the 4th May 1972 and was declared the 5th national park of Thailand. Total area of the park is about 966 sq km. The area is mountainous and its forests provide an essential watershed for the surrounding villages and farm lands (DNP, 2010). The aims of this study were to survey pollen sources and to determine species diversity of the stingless bees found in the Nam Nao National Park. The results obtained will provide useful knowledge on species diversity of stingless bees and their food sources. This knowledge, therefore, will be applied for further study in biology and sustainable conservation of those bees in Thailand and elsewhere.

MATERIALS AND METHODS

Study site

Species diversity of stingless bee and the pollen sources were conducted in Nam Nao National Park between January 2013 and June 2014. Two types of forest including bamboo-deciduous forest (BB/DF) and deciduous dipterocarp-oak forest (DOF) were set out to study. The park is conveniently accessible by Asian Highway 16 (AH16) for survey and sample collection. The park was divided into 3 trails in BB/DF and 3 trails in DOF (Figure 1). Each sampling area was 2,000 sq m (500 m long and 2 m wide on either side of the trail).

Sample collection

The stingless bee species and the pollen sources were collected between 08.00 am and 04.00 pm at least once a month, depending on seasonal variations, during January 2013 – June 2014. The nature trails in each forest type were studied by random sampling and line transects (Krebs, 1999). The sampling techniques were sweep net sampling for stingless bees as well as hand collection for pollens and flowering plants. Pollen grains were taken from pollen baskets of forager stingless bees and flower buds. The stingless bee and pollen samples were kept in 70% (v/v) ethanol. Some parts of trees and plant specimens were collected for identification. Basic data obtained through observation were recorded in the form of handwritten field notes i.e. location, habitat and morphological details.

Sample identification

A species list of stingless bee and flowering plant was made for each forest type. Each stingless bee species was divided into 2 groups. The first group was preserved in 70% ethanol solution for identification by using keys from Sakagami *et al.*, (1990) and Rasmussen, (2008). The last group was collected as dried reference specimens (Hatch, 1926). All specimens of stingless bee were confirmed by comparing with the insects deposited in the Naresuan University (NU) museum. The insect specimens were collected and deposited in the Entomology Laboratory, Pibulsongkram Rajabhat University (PSRU).