Research article

Diversity of Insect Pollinators at a Conservation Forest in Chaiyaphum Province, Northeastern Thailand

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Abstract The purpose of the study was to examine the diversity and abundance of insect pollinators. Data on insect pollinators was collected from the Plant Genetic Conservation area, Chulabhorn Dam, Chaiyaphom Province using observation techniques. The data was collected during the dry season (March 2018) and wet season (September 2018). In total, 41 species from 4 orders and 34 families were found, of which 30 species were from the order Lepidoptera, followed by Hymenoptera, Diptera, and Coleoptera with 10, 8, and 3 species respectively. The Shannon index of diversity (H) was compared to a variety of insect pollinators. The diversity index showed that the species diversity of insect pollinators in the study area was low (H' = 1.13) while the evenness index showed high dominant species (J' = 0.30). Order Hymenoptera was the most common pollinator among the species found in this study (with 35.01% frequency compared to all obtained insect specimens).

Keywords diversity, pollinators, plant genetic conservation area, Chulabhorn Dam

INTRODUCTION

Pollination is one of the important services for increasing crop productivity, environmental conservation, and ecosystem balance (Ranjitha et al., 2019). Insect pollinators are needed because certain plants are not able to carry out self-pollination (Krishnan et al., 2020). Insects that play a role in pollination are mostly from the order Hymenoptera (bees and wasps), Coleoptera (beetles), Lepidoptera (butterflies and moths), and Diptera (flies) (Soh and Ngiam, 2013). They help to pollinate both wild and flowering plants and humans, their role is to increase agricultural production and preserve plants in nature (Widhiono et al., 2016). Deforestation and conversion from forests to other land uses, such as agricultural plantations, recreation parks, or urban areas, have a great impact on insect pollinator diversity.

Chulabhorn Dam is in Khon San District, Chaiyaphum Province, Thailand. The conservation forests at Chulabhorn Dam (approximately 130 hectares) have become a protected area under the Plant Genetic Conservation Project under the Royal Intuitive of Her Royal Highness Princess Maha Chakri Sirindhorn since 2007 (Chaianunporn and Chaianunporn, 2019). There are diverse types of natural habitats, such as dry evergreen forests and mixed deciduous forests. The mixed deciduous forest is located within 27°45’ to 27°52’ N latitude and 85°16’ to 85°45’ E longitude. The elevation range is 789 masl to 791 masl. The mixed forest is dominated by *Fagus spp*. (Fagaceae), *Dipterocarpus obtusifolius* (Dipterocarpaceae) and *Pinus kesiya* (Pinaceae). The forest is a natural ecosystem that attracts numerous insects for nesting, resting, hunting available foods, or biological activities. Insects are important keys to the success of the ecosystem. Forests generally have a wealth of flora and fauna, which are a lot more diverse compared to plantations. Therefore, each type of habitat produces a richness and diversity of insect pollinator species that differ from that of nearby habitats (Koneri et al., 2021). Converting natural landscapes to agricultural land and human activities affects insect pollinators. Studies of insect diversity and abundance of insect pollinators in this location are still unknown.

OBJECTIVE

This study aimed to investigate the diversity and abundance of insect pollinators in the conservation forest of Chulabhorn Dam.

METHODOLOGY

The study was carried out in the forest of Chulabhorn Dam under the Plant Genetic Conservation Project, which is located in Khon San District, Chaiyaphum Province, in northeastern Thailand. Within the forest area, there are diverse types of natural habitats, such as dry evergreen forests and mixed deciduous forests. Insect specimens were collected around line transect surveys (Fig.1) including Zone A and Zone B. The forest in Zone A is a forest edge in which the forest edges have been disturbed by humans and invasive plant species. The forest in Zone B is a mixed deciduous forest. Sampling methods in this study were based on direct observation in all transects. We conducted these transect surveys between 10:00 and 16:00. Each transect was visited in the dry season (March) and the wet season (September). All the collected specimens were preserved in 70% ethyl alcohol in the multipurpose containers and were brought back to the laboratory for pinning and identification. Identification of insects in terms of order, family, genus, and species was based on the keys by Triplehorn and Johnson (2005). Additionally, detailed identification was based on comparisons with specimens in the Insect Museum in the Entomological Section, Faculty of Agriculture, Khon Kaen University, and several taxonomic references. The percentage of insect samples was then calculated.

Data Analysis

The Shannon-Wiener diversity index (Krebs, 1999) was used to calculate the diversity of insects collected. The formula for Shannon Weiner's diversity index is presented below as Eq. (1):

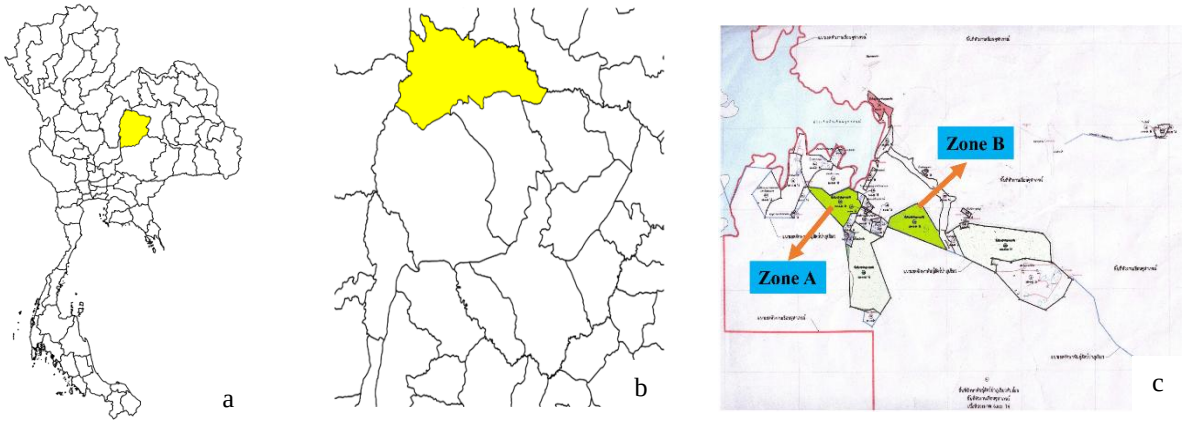
$$H' = -\sum (pi)(\ln pi) \ (i=1) \quad (1)$$

where H' = species diversity index, S = number of species, pi = proportion of the total sample belonging to Ith species.

The evenness index (Krebs,1999) was calculated to determine the equal abundance of insect pollinators in each study site as follows:

$$J' = \frac{H'}{H' max} \quad (2)$$

where H' = observed index of species diversity, $H' max$ = maximum possible index of diversity.



(a) Map of Thailand **(b) Chaiyuphum Province with Khon San District** **(c) Map showing the locations of the study site**

Fig. 1 Study area at the conservation forest at Chulabhorn Dam

RESULT AND DISCUSSION

The survey collected 397 individual specimens of insect pollinators belonging to four orders, 34 families, and 41 species. The four orders of insect pollinators identified were Hymenoptera (family Apidae, Vespidae, Megachillidae, and Hallictidae), Diptera (family Syrphidae, Muscidae, Tachinidae, and Tephritidae), Lepidoptera (Family Paplionidae, Pieridae, Nymphalidae, Lycaenidae, Hesperiidae, Arctiidae, Sesiidae and Zygaenidae) and Coleoptera (family Buprestidae, Chrysomelidae, Coccinellidae, and Scarabaeidae). Order Hymenoptera had the highest abundance (139 individuals, 5 species, and 4 families), followed by order Lepidoptera (114 individuals, 24 species, and 8 families), order Diptera (75 individuals, 8 species, and 4 families). The lowest abundance was for the order Coleoptera (69 individuals, 4 species, and 4 families). The representation of different insect orders among the collected samples was as follows: order Hymenoptera had the highest abundance (35.01%) followed by Lepidoptera (28.72%), Diptera (18.89%), and Coleoptera (17.38%) (Fig. 2 and Table 1).

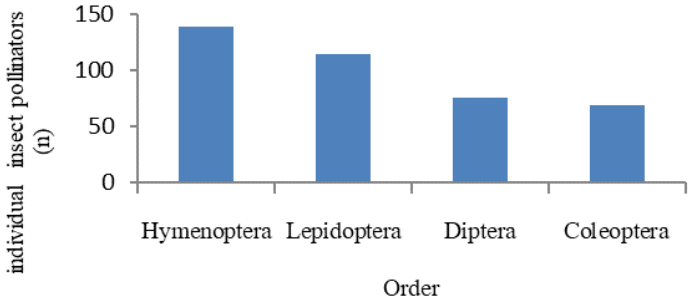


Fig. 2 Comparison between the individual populations of insect pollinators at the study site

Table 1 Taxonomic distribution of insect pollinators at the study site

Order	Taxonomic distribution			Percentage of insect pollinators (%)
	Individual	Family	Species	
Hymenoptera	139	4	5	35.01
Lepidoptera	114	8	24	28.72
Diptera	75	4	8	18.89
Coleoptera	69	4	4	17.38
Total	397	20	41	100.00

The species diversity of insect pollinators in this study. Overall, the results show that the species diversity of insect pollinators in the study area is low (H' = 1.13) while the Evenness index showed high dominant species (J' = 0.30). As shown in Fig. 3. Dipteran (H' = 0.31) and lepidopteran insects (H' = 0.31) were the most diverse than the others in this study, followed by the order Hymenoptera (H' = 0.25) and Coleoptera (H' = 0.22). Furthermore, based on the Pielou evenness index, insect pollinator species were dominant among the areas, because they all had an index less than 0.5 (Koneri et al. 2021).

The Shannon-Wiener species diversity index (Fig. 4) indicated that the species diversity was more diverse in Zone B (H' = 0.32) than in Zone A (H' = 0.21), There was little difference in the evenness index of insect pollinators between Zone B (J' = 0.20) and Zone A (J' = 0.13) (Fig. 4). The area around the forest Zone A as forest edges have been disturbed by humans and invasive plant species. Species richness, diversity, and evenness were highest in the forest in Zone B because these habitats are natural with little human disturbance.

Hymenoptera is an order of insect pollinators mostly found at the study location and dominant in all habitat types. The dominance of Hymenoptera is due to its ecological function i.e. pollination efficiency, high color recognition capabilities, and an innate color preference. This explains its wide dominance among pollinating flowering plants. Furthermore, several studies have reported that the dominant insect pollinators found were the order Hymenoptera (Soh and Ngiam, 2013; Bashir et al.,

2019). A giant honeybee (*Apis dorsata*) was found in the forest with high abundance in this study. Bee, *A. dorsata*, was reported as a pollinator in the lowland dipterocarp forest at Sarawak (Momose et al., 1998). All the sites investigated have a lower diversity index and lower evenness index. Species richness and abundance of insect pollinators are directly affected by the different environmental conditions, such as diversity and abundance of understory flowers. Flight and foraging of insect pollinators can be affected by some factors, such as food quantity, competition, and climatic conditions (Kajobe and Echazarreta, 2005). The high abundance and species richness of insect pollinators in the morning are related to the availability of nectar and pollen as food sources for insects. The foraging activity of social, solitary bees and hoverflies was higher in the morning and afternoon, whereas that of butterflies was higher in the afternoon. Albrecht et al. (2012) also reported that social bees foraging activity was higher in the afternoon, solitary bees in the morning, and hoverflies in the morning and afternoon. According to the previous research, we gathered those insects in the morning and afternoon, covering the entire period when those pollinators were foraging.

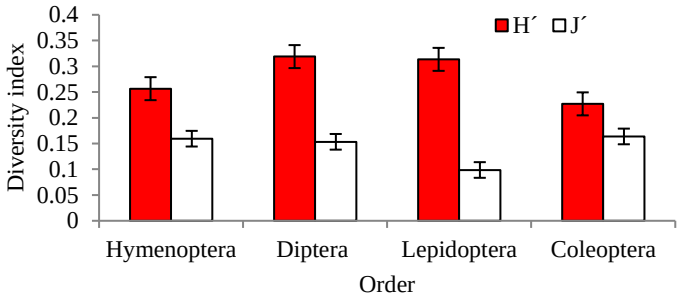


Fig. 3 Species and evenness index of insect pollinators in study sites

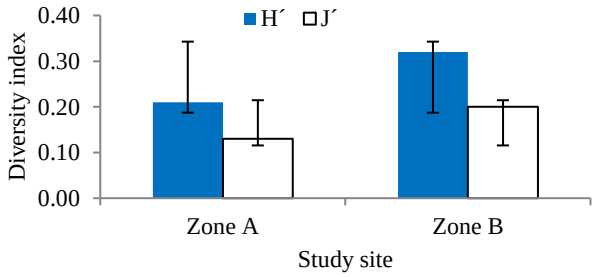


Fig. 4 Species and evenness index of insect pollinators in study sites

CONCLUSION

Based on the results of the study, it was concluded that the forest area of Chulabhorn Dam generally supports the abundance, richness, and diversity of insect pollinators found in the surrounding habitats. This was proven by the presence of insect pollinators from the orders Hymenoptera, Lepidoptera, Coleoptera, and Diptera in intensively managed conservative forests. The information and data on species' richness and diversity will be of assistance to better conserve insect pollinators in natural landscapes. Based on the results of the study, it indicated that there are still some undiscovered species since the sampling technique used was only the Sweep net and observation therefore, an additional technique would increase the species richness. Furthermore, it was necessary to increase the number of sample units or increase the sampling time to obtain better results.

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