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Research Article

TREE SPECIES DIVERSITY IN PHRA THAT SI MUEANG PONG AREA, CHIANG MAI PROVINCE, THAILAND

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ARTICLE HIGLIGHTS

- Rich tree diversity found in Phra That Si Mueang Pong area.
- Endangered species identified, promoting conservation efforts.
- Unique plant distribution influenced by land use and water proximity.
- Potential for ecotourism and environmental education in the region.
- Study provides foundational data for future ecological research.

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ABSTRACT

This research conducted a survey of tree species in ten subplots along the pathway leading to Phra That Si Mueang Pong, identifying a total of thirty species representing twenty families, twenty-eight genera. Dominant species included *Lagerstroemia duperreana* var. *duperreana*, *Shorea siamensis, Pterocarpus macrocarpus, Tectona grandis,* and *Vitex canescens*. Families with the highest species number were Fabaceae, Lamiaceae, Combretaceae, and Malvaceae. The study revealed the presence of both common and rare plant species in the area, with differences in species distribution between plots 1-5 and 6-10. Plots 1-5, near the Mae Tha Chang River, exhibited a higher number of species. The dominant species, based on the importance value index (IVI), were *P. macrocarpus, L. duperreana, T. grandis, S. siamensis*, and *Millettia brandisiana*, respectively. Two species, Burma Padauk (*P. macrocarpus*) and Teak (*Tectona grandis*), were classified as endangered in the areas. Soil analyses indicated slightly acidic pH and relatively low water content, with significant differences between plots 1-5 and 6-10. The study suggested the potential for ecotourism and environmental learning centers in the Chiang Mai Province cultural tourism destination, emphasizing the rich biodiversity and ecological value of the mixed deciduous and dry dipterocarp forest ecosystems.

Keywords: diversity index, dry dipterocarp forest, importance value index, mixed deciduous forest

INTRODUCTION

Exploration of biological diversity and utilization of plant resources in Thailand has been an ongoing effort, encompassing both areas of base surveys and specific group-focused investigations (Sudchaleaw *et al.* 2023; Boonma *et al.* 2023; Panyadee *et al.* 2023; Ragsasilp *et al.* 2022; Pansumrit *et al.* 2022; Sutjaritjai *et al.* 2022; Saensouk *et al.* 2021). This research unveiled that biological diversity of plant species, varying across different regions, consistently generates new knowledge and insights. While studies on plant diversity in ecotourism areas in Thailand have provided limited information, most research has focused on national parks, such as Doi Inthanon National Park, Phu Kradueng National Park, Khao Yai National Park, and Kaeng Krachan National Park.

Chiang Mai Province, located in the northern region of Thailand, has a tropical monsoon climate. The average temperature ranges from 22.3 °C to 34.4 °C, with annual rainfall of 972.1 mm (Northern Meteorological Center 2020). With its mountainous terrain, there are many cultural tourist attractions situated on various mountains outside the boundaries of national parks. With a well-preserved environmental system, these factors make it feasible to promote sustainable ecotourism destinations in the future, facilitating easier access for visitors.

Phra That Si Mueang Pong, also known as the White Pagoda, stands as a prominent cultural and ecological tourist destination within the province of Chiang Mai. It is situated on the summit within the Aranyawat Temple in Hang Dong District, Chiang Mai, Thailand.

There are two routes to reach Phra That Si Mueang Pong, i.e., one involves climbing the stairs, while the other allows for driving up the road. The ascent via the staircase serves as an ecotourism route, winding through mixed deciduous forest and dry dipterocarp forest. During the climb to Phra That Si Mueang Pong, both sides of the staircase are influenced by significant factors contributing to plant diversity. One side is situated near the Mae Tha Chang River, while the other side borders an agricultural area, resulting in distinct variations in plant diversity.

Therefore, this study investigated the diversity of tree species along the ascent to Phra That Si Mueang Pong in the ecotourism area, encompassing detailed analyses of biodiversity index and importance value index. The findings from this study were expected to benefit the local community, tourists, as well as educational institutions in the vicinity to utilize the area for studying ecotourism, focusing on the diversity of tree species. Additionally, this research provided foundational information for future studies in various research areas.

MATERIALS AND METHODS

Study Area

The study area was located surrounding Phra That Si Mueang Pong in Hang Dong District, Chiang Mai, Thailand. The geographical features comprised a mountainous terrain consisting of deciduous forest and dry dipterocarp forest, with elevations ranging from 350 to 450 meters above sea level (masl).

Data Collection

Plant diversity data were collected from 2019 to 2020 within a permanent sample plot measuring 200 x 200 m^2. The quadrat method, specifically employing 10 x 10 m^2 subplots, was utilized for the systematic sampling of plant species. Along the ascent to Phra That Si Mueang Pong, a total of ten subplots were established, with five plots positioned on the side adjacent to the agricultural area, while the remaining five plots were situated on the side bordering the Mae Tha Chang River (Fig. 1).

In each subplot, the circumference of tree trunks with a diameter greater than or equal to 15 cm was measured at a height of 1.30 m. Subsequently, the measured trees were tagged with number tapes, which also included information on the species, such as local name, common name, scientific name, and family of the perennial tree. Data on tree species were gathered through consultation with experts and relevant literature (Chayamarit & Chamchumroon 2016). Additionally, the status of trees was assessed based on the IUCN red list of threatened species (IUCN 2024).

Physical and chemical parameters of the soil were analyzed, including soil pH content and water content. Soil pH was determined using the Soil-H_2O system (FAO 2021), while soil water content was calculated as a percentage based on oven-dried soil weight according to FAO (2023) as follows:

$$W\% = \frac{M_{cms} - M_{cds}}{M_{cds} - M_c} \text{ X } 100$$

where:

W = soil water content expressed in units of percentage (%)
M_{cms} = mass of container and moist soil (g)
M_{cds} = mass of container and moist soil (g)
M_c = mass of container (g)

Data Analysis

Data obtained from the field survey were analyzed to determine the Importance Value Index (IVI). This calculation involved assessing the Relative Density (RD), Relative Frequency (RF), and Relative Dominance (RDo), following the methodology outlined by Ismail *et al.* (2017). In addition, species diversity index (H') and evenness value (E) of tree species were determined and calculated following the Shannon's Diversity Index (Odum 2004).

The baseline statistics used were the mean±standard deviation. One-way analysis of variance (ANOVA) was performed using the Statistical Package for the Social Sciences (SPSS) software program. To further analyze the results, Duncan's new multiple tests was performed at a significant level of 5%.

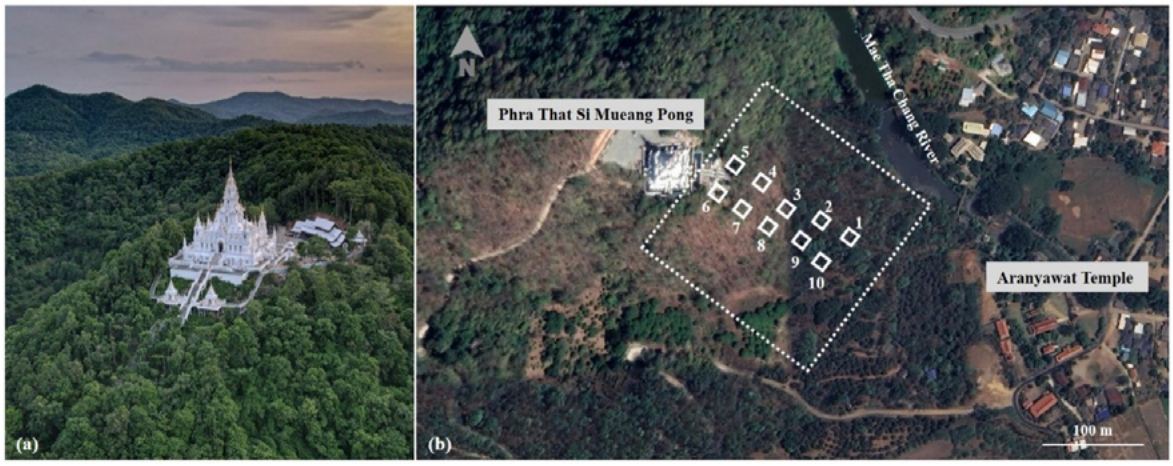

Figure 1 Aerial photograph of Phra That Si Mueang Pong (a) and the map illustrates sample plots measuring 200 x 200 m^2 and the 10 subplots with dimensions of 10 x 10 m^2 located at Phra That Si Mueang Pong in Hang Dong District, Chiang Mai, Thailand (b)

RESULTS AND DISCUSSION

In the survey of tree species across all 10 subplots, a total of 157 trees were identified, representing 20 families, 28 genera and 30 species (Table 1). The dominant species with their relative abundance percentages were *Lagerstroemia duperreana* var. *duperreana* (10.2%), *Shorea siamensis* (9.6%), *Pterocarpus macrocarpus* (8.3%), *Tectona grandis* (7.0%) and *Vitex canescens* (6.4%), respectively (Table 1). Families with the highest number of species encountered were Fabaceae (6 species), Lamiaceae (3 species), Combretaceae (3 species), Malvaceae (2 species), respectively.

Comparing the findings of this study with those of previous research, the identified plants were commonly encountered in mixed deciduous forests and dry dipterocarp forests in Thailand (Chernkhunthod & Hioki 2020; Rundel *et al.* 2017). Additionally, some plant species considered rare were identified in the area, such as *Sindora siamensis, Vitex pinnata, Terminalia corticosa, Sterculia villosa, Grewia eriocarpa, Irvingia malayana, Stereospermum neuranthum, Schleichera oleosa, Croton persimilis, Aegle marmelos, Protium serratum, Antidesma ghaesembilla, Morinda coreia* and *Canango brandisiana*. These were plant species with fewer than five individuals found within the entire study site.

In the comparison of plant species between plots 1-5 and 6-10, it was found that there were a total of 18 species identified in both areas. Among the tree species found exclusively in plots 6-10, there were 4 species, namely *Sindora siamensis, Irvingia malayana, Holarrhena pubescens*, and *Canango brandisiana*. On the other hand, a total of 8 tree species were found exclusively in plots 1-5, including *Stereospermum neuranthum, Schleichera oleosa, Vitex pinnata, Sterculia villosa, Croton persimilis, Aegle marmelos, Protium serratum*, and *Antidesma ghaesembilla*. From these results, it was evident that the presence of these plants was influenced by land use in the area. Plots 1-5, situated on the side bordering the Mae Tha Chang River, exhibited a higher number of species and less disturbed environment compared to the other side adjacent to agricultural land. However, when comparing the Shannon's diversity index and evenness values of plots 1-5 with those of plots 6-10, no statistically significant differences were found ($P < 0.05$) (Fig. 2).

Table 1 List of tree species recorded in Phra That Si Mueang Pong area and their biological index

Taxonomic categories	Common name	Local name	Biological index				
			Number	RD	RF	RDo	IVI
Family Fabaceae							
Dalbergia cultrata Graham ex Benth [NT]	Burma Blackwood	กระพี้เขาควาย	5	3.18	3.30	0.93	7.41
Millettia brandisiana Kurz.	-	กระพี้จั่น	9	5.73	6.59	5.87	18.20
Pterocarpus macrocarpus Kurz.[EN]	Burma Padauk	ประดู่ป่า	13	8.28	7.69	17.43	33.40
Albizia odoratissima (L.f.) Benth. [LC]	Black Siris	กางขี้มอด	6	3.82	2.20	4.86	10.88
Xylia xylocarpa (Roxb.) W. Theob. var. *kerrii* (Craib & Hutch.) I.C. Nielsen [LC]	Ironwood	แดง	6	3.82	4.40	2.02	10.24
Sindora siamensis Teijsm. ex Miq. var. *siamensis* [LC]	-	มะค่าแต้	1	0.64	1.10	0.35	2.08
Family Lamiaceae							
Vitex pinnata L. [LC]	Malayan Teak	ตีนนก	2	1.27	1.10	0.68	3.05
Vitex canescens Kurz. [LC]	Chaste tree	ผ่าเสี้ยน	10	6.37	7.69	3.84	17.90
Tectona grandis L. f. [EN]	Teak	สัก	11	7.01	6.59	10.11	23.71
Family Combretaceae							
Anogeissus acuminata (Roxb. ex DC.) Guill. & Perr.	-	ตะเคียนหนู	7	4.46	3.30	2.85	10.61
Terminalia corticosa Pierre ex Laness	-	ตะแบกเลือด	3	1.91	3.30	2.96	8.17
Terminalia alata B. Heyne ex Roth	-	รกฟ้า	7	4.46	5.49	5.87	15.82
Family Malvaceae							
Sterculia villosa Roxb. [LC]	-	ปอตุ๊บหูช้าง	1	0.64	1.10	0.56	2.29
Hibiscus macrophyllus Roxb. ex Hornem [LC]	Largeleaf Rosemallow	ปอหู	6	3.82	4.40	2.38	10.59
Family Tiliaceae							
Grewia eriocarpa Juss. [LC]	-	ปอแก่นเทา	3	1.91	3.30	3.08	8.29
Family Irvingiaceae							
Irvingia malayana Oliv. ex A. W. Benn. [LC]	Wild Almond	กะบก	1	0.64	1.10	1.49	3.22
Family Bignoniaceae							
Stereospermum neuranthum Kurz.	-	แคทราย	1	0.64	1.10	0.24	1.97
Family Bombacaceae							
Bombax anceps Pierre	-	จิ้วป่า	5	3.18	3.30	2.17	8.65
Family Sapindaceae							
Schleichera oleosa (Lour.) Merr . [LC]	Ceylon Oak	ตะคร้อ	2	1.27	2.20	0.27	3.74
Family Lythraceae							
Lagerstroemia duperreana Pierre ex Gagnep.	Crepe Myrtle	ตะแบกเปลือกบาง	16	10.19	6.59	10.16	26.95
Family Euphorbiaceae							
Croton persimilis Mull. Arg.	-	เปล้าใหญ่	1	0.64	1.10	0.15	1.89
Family Burseraceae							
Canarium subulatum Guillaumin [LC]	-	มะกอกเกลื้อน	5	3.18	5.49	3.99	12.67
Family Rutaceae							
Aegle marmelos (L.) Correa ex Roxb. [NT]	Bael	มะตูม	1	0.64	1.10	0.67	2.40
Family Burseraceae							
Protium serratum (Wall. ex Colebr.) Engl.	-	มะแฟน	2	1.27	2.20	0.87	4.34
Family Phyllanthaceae							
Antidesma ghaesembilla Gaertn.	Black currant tree	เม่าไข่ปลา	1	0.64	1.10	0.60	2.34
Family Apocynaceae							
Holarrhena pubescens Wall. ex G.Don	-	โมกใหญ่	5	3.18	2.20	0.84	6.22

Taxonomic categories	Common name	Local name	Biological index				
			Number	RD	RF	RDo	IVI
Family Meliaceae							
Chukrasia tabularis A.Juss.	Chittagong Wood	ยมหิน	7	4.46	3.30	3.26	11.02
Family Rubiaceae							
Morinda coreia Ham.	Indian Mulberry	ยอป่า	4	2.55	3.30	1.71	7.55
Family Dipterocarpaceae							
Shorea siamensis Miq.	Dark Red Meranti	รัง	15	9.55	3.30	9.59	22.44
Family Annonaceae							
Cananga brandisiana (Pierre) I. M. Turner	-	สะแกแสง	1	0.64	1.10	0.22	1.96

Notes: EN = Endangered; NT = Near Threatened; LC =Least Concern (IUCN 2024); RD = Relative Density; RF = Relative Frequency; RDo = Relative Dominance; IVI = Importance Value Index.

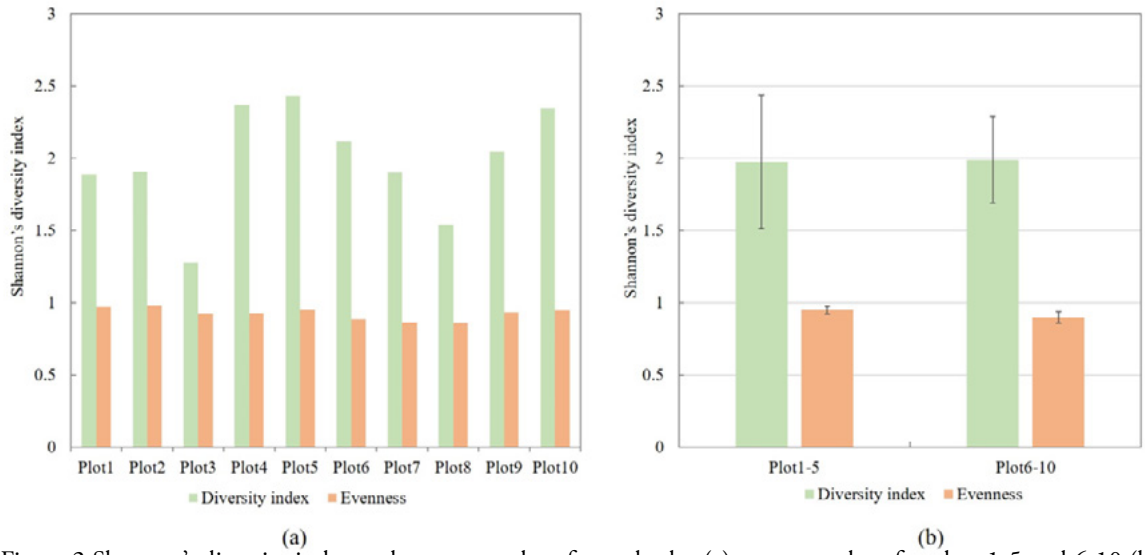

Figure 2 Shannon's diversity index and evenness values for each plot (a); average values for plots 1-5 and 6-10 (b)

The seven plant species with the highest Importance Value Index (IVI) were *Pterocarpus macrocarpus, Lagerstroemia duperreana, Tectona grandis, Shorea siamensis, Millettia brandisiana, Vitex canescens*, and *Terminalia alata*, respectively (Table 1). These species are prominent and commonly found in mixed deciduous forests and dry dipterocarp forests. The results highlighted that the studied area maintained a rich and diverse ecological system. Furthermore, in the comparison of plant species with the red list of threatened species, it was observed that *Pterocarpus macrocarpus* and *Tectona grandis* were classified as endangered. *Dalbergia cultrate* and *Aegle marmelos* fell under the near threatened status. Those categorized as least concern tree species included *Albizia odoratissima, Xylia xylocarpa, Sindora siamensis, Vitex pinnata, Vitex canescens, Sterculia villosa, Hibiscus macrophyllus, Grewia eriocarpa, Irvingia malayana, Schleichera oleosa*, and *Canarium subulatum*.

Analyses of soil physical and chemical properties in the studied area revealed that the soil water content was relatively low, ranging between 5.19% and 7.96%, which was considered normal for soil sampling during the dry season (Hanpattanakit & Chidthaisong 2012). However, upon comparing the water content between plots 1-5 and 6-10, it was evident that plots 1-5 had higher moisture levels than plots 6-10, and this difference was statistically significant ($P < 0.05$). The higher water content in plots 1-5 was likely influenced by their proximity to the river. The soil pH was slightly acidic, ranging between 5.09 and 6.53. This mild acidity was attributed to the presence of organic matter from decomposed branches and leaves in the forest. The decomposition process contributed organic compounds, such as humic acid and fulvic acid, resulting in a slightly acidic soil condition (Makan 2022) (Fig. 3).

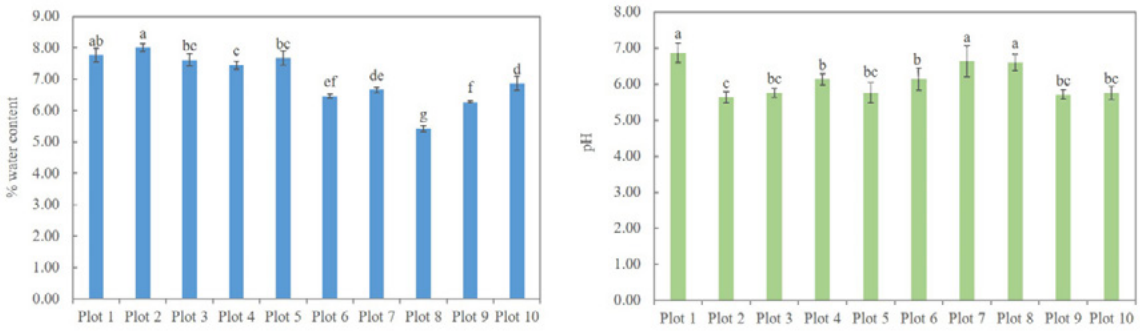

Figure 3 Water content and pH of the studied ten subplots

CONCLUSION

This study revealed that all identified plant species belong to the ecosystems of mixed deciduous forest and dry dipterocarp forest. There was no evidence of invasive species encroaching from other ecosystems. Soil water and pH levels were within the normal range for the mixed deciduous and dry dipterocarp forest ecosystems during the dry season. The dominant tree species, based on the importance value index (IVI), were *Pterocarpus macrocarpus, Lagerstroemia duperreana, Tectona grandis, Shorea siamensis*, and *Millettia brandisiana*, respectively. On both sides of the staircase leading to Phra That Si Mueang Pong, a diverse biodiversity of plant species was discovered, exhibiting distinct variations. The study also identified fifteen species listed in the Red List of Threatened Species (IUCN), with two species classified as Endangered. The Phra That Si Mueang Pong area holds potential for promoting ecotourism, including the establishment of an environmental learning center focusing on the mixed deciduous and dry dipterocarp forest ecosystems within the cultural tourism destination in Chiang Mai Province. Data gathered from this study can serve as a foundation for future research endeavors, particularly in exploring ethnobotany.

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