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Inventory of Non-Timber Species in Ayer Hitam Utara Forest Reserve, Johor

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Abstract: Ayer Hitam Utara Forest Reserve (AHUFR) is one of the permanent reserved forests (PRFs) in Johor, which is consisted of lowland and peat swamp ecosystems. In AHUFR, there has been little progress in the study of non-timber species. Non-timber forest products (NTFPs) are forest products other than timber that are obtained from both plants and animals and are vital to all species, including people. Among the objectives of this research project were the creation of a checklist of non-timber species in the AHUFR, the identification of non-timber species in the forest reserve, and the measurement of the diversity of non-timber species in the forest reserve. Survey was conducted in 10m × 5m quadrats, in which three quadrats were established in two different ecosystems, namely site A (lowland forest) and site B (peat swamp). The preliminary study documented 92 individuals from 19 families and 33 species of non-timber plants. Melastomataceae was the most dominant family, whilst *Clidemia hirta* (L.) D.Don was the most dominant species. Based on the Shannon-Wiener and Margalef indices, lowland forest indicated higher diversity of non-timber species compared to peat swamp forest.

Keywords: Herbs, diversity, lowland forest, *Nepenthes*, peat swamp forest, shrubs

1. Introduction

Peat swamp forests make up almost 75% of Malaysia's total wetlands. There is an estimated 1.54 million hectares left, with 80% in East Malaysia (Sarawak 73%, Sabah 8%), and 20% in Peninsular Malaysia [1]. Impoverished countries benefit from a diverse range of forest resources and services, including agricultural land, timber, agroforestry, non-timber forest products, and ecosystem services [2]. Non-timber forest products (NTFPs) are forest-harvested wild plant and animal products such as wild fruits, vegetables, nuts, edible roots, honey, palm leaves, medicinal plants, poisons, and bushmeat [3]. In this study, the non-timber forest products included are only-plants. People use NTFPs in their households and trade them locally or regionally for money or in exchange for other goods [4]. Thus, recognizing the existence of NTFPs is crucial in evaluating the significance of these species to the well-being of a country and particularly, the ecosystems. However, management of these NTFPs lacks the attention they deserve. -The awareness of the value and potential of these resources is extremely low, and the lack of accessible information on these NTFPs

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demands for more research to be conducted on unknown or undiscovered areas [5]. Ayer Hitam Utara Forest Reserve (AHUFR) was selected as the study site because it is one of the few remaining undisturbed peat swamp forests in Johor while there is rapid conversion of the peat swamp forests in other areas of Johor. Besides peat swamp forests, AHUFR also house the lowland forests, hence, allowing for a useful comparison of the species diversity and species richness between the different forest types within AHUFR. The natural forest in AHUFR is vital for biodiversity conservation [6] as there are species, especially the non-timber species, that exhibit great importance for the ecosystem and potentially have high value economically. This study will fill the knowledge gap regarding the species diversity and species richness of non-timber species in AHUFR. The data collected will be used as the primary database on non-timber species in AHUFR and thus, will be useful in conducting conservation management specifically on this type of ecosystem. This study will contribute to Malaysia's overall conservation of plant diversity and is in line with the efforts of the Convention of Biological Diversity (CBD) where it stated the objective to 'develop mechanisms for valuing non-timber forest resources and the environmental services provided by forests and other ecosystems to incorporate them into national accounting systems and forest management practices [5]. The primary objective of this study was to conduct a field survey on non-timber species at AHUFR besides identifying and measuring the diversity of non-timber species in AHUFR. Next objective was to create a checklist of the non-timber species that are available in AHUFR for future reference. The sampling was conducted for four days. This study involves data field collection using quadrat sampling which consists of two patches of ecosystem labelled as site A (lowland forest) and site B (peat swamp forest) with three plot sizes of 10m × 5m that were placed at each site.

2. Materials and Methods

2.1 Study Area

The study on the peat swamp ecosystem, which includes recording and documenting the non-timber species and measuring the diversity of non-timber species, were carried out in (AHUFR) (Latitude: 2.0355 Longitude: 102.8005) in Muar district in the state of Johor. Covering 3795.84 hectares, AHUFR is gazette as a permanent forest reserve and is currently Johor's largest and last remaining peat swamp forest. On July 30, 2008, Johor State EXCO meeting agreed for AHUFR to be developed as Peat Swamp State Park under Section 10(1) State Forestry Enactment 1985 [7].

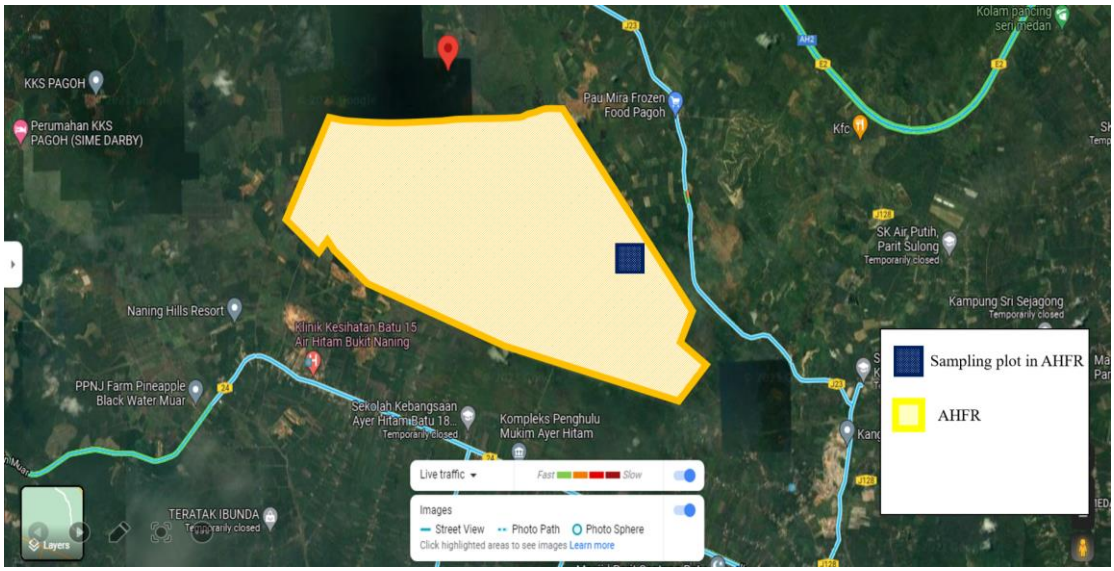

Fig. 1 - Map showing the location of Ayer Hitam Utara Forest Reserve on Google Map

2.2 Data Collection

For this study, quadrat sampling was conducted, as it is the most suitable inventory method and the easiest to apply. Plots measuring 10 m × 5 m were mapped and placed in both sites A and B. Site A was referred to as the lowland forest of AHUFR, while site B was the peat swamp forest of AHUFR. Both sites were divided into three plots, resulting in a total of six plots for the entire project. Three samples of leaves were collected and recorded for each non-timber species present on the site for identification reasons. Following that, the samples will be kept as herbarium specimens for future reference.

2.3 Data Analysis

In this study, the diversity of the non-timber species was measured using the Shannon-Wiener index and the Margalef index. The Shannon-Wiener Index (1) assumes that individuals are randomly selected from a large independent population and that all species are represented [8]. The formula for determining the value of the index is as follows:

$$H' = \sum_{i=1}^{s} pi \, Ln \, pi \qquad (1)$$

The Margalef index (2) of diversity was applied to study the species richness of the area. Margalef index adjusts for the sample size impacts by dividing the number of species in a sample into the natural log of the number of organisms sampled [5].

$$D_{mg} = \frac{S-1}{Ln(n)} \qquad (2)$$

3. Results and Discussion

3.1 Geographic Range of the Quadrats

In this study, two sampling sites were established with three plots for each site in two different ecosystems, lowland forest and peat swamp forest, with an elevation of around 40 m above sea level. Site A is a lowland forest type of ecosystem. The area was dense with different types of species. Numerous non-timber species were spotted in each quadrat within site A compared to site B, which is the peat swamp ecosystem. There were numerous bushes and saplings in the plots, as well as a few perennial trees scattered around the area of the plots. There were also fewer forest floor plants in the lowland ecosystem, owing to the presence of many taller trees in the area, which prevented sunlight from reaching the forest floor plants.

At site B, a few species of non-timber were spotted. Due to its peat swamp ecosystem, most non-timber species were adapted differently than in lowland forests. This area had a lower tree density than the previous site, and there were fewer shrubs, herbaceous perennial trees, and forest floor species than there were at site A. Because most of the trees were several stories high, the sunlight appeared to be unable to reach most of the area, even though it was not a particularly open environment. As well as fallen trees and branches, the area had a lot of mud and swampy areas, making it difficult to maneuver.

3.2 Non-Timber Plant Species in AHUFR

Overall, 19 families and 33 species of non-timber plant species were identified in AHUFR. Four families were identified up to genus level, and 27 families were identified up to species level. The total number of non-timber plant species families recorded at AHUFR was 19, with 15 families discovered in the lowland ecosystem and 8 families found in the peat swamp ecosystem. Sites A and B together had a total of 92 individuals that were counted as part of the study. The family Melastomataceae had the maximum number of individuals (15), and they were found in all the plots at site A. The second highest number of individuals came from the family Piperaceae (10) and was followed by the families Cycadaceae and Arecaceae, which each had six individuals. However, there were two families of non-timber species that were documented in both sites A and B, namely the Moraceae and the Piperaceae, which were present in both lowland and peat swamp ecosystems. The lowest number of individuals discovered belonged to the families Vitaceae (1), Malpighiaceae (1), Rubiaceae (1), Orchidaceae (1), Bombacaceae (1), and Connaraceae (1), with one individual from each of the other families. Because of a scarcity of information about the plants, most of the plant species were only identified up to family taxon level. As a result of the fact that most of the flowering non-timber plants were not in bloom at the time and that many of them were saplings, this occurred. Figure 1 illustrates the overall number of identified families and the number of individuals in both study sites.

A total of 24 non-timber plant species were recorded for the lowland ecosystem's site A, with five species identified to the family level (Vitaceae, Piperaceae, Polypodiaceae, Araceae, and Moraceae) and 19 species identified to the species level. The total number of individuals of non-timber plant species found in the lowland ecosystem was 78 individuals. The least number of non-timber plant species identified were from the Malvaceae (Pachira aquatica), Arecaceae (Dypsis linearis), Malpighiaceae (Hiptage benghalensis), Cycadaceae (Cycas edentata), Polypodiaceae (Pyrrosia aff. lingua), Asparagaceae (Dracaena cantleyi), Rubiaceae (*Lasianthus attenuates*), Asparagaceae (*Dracaena angustifolia*), Piperaceae (*Piper caninum*), and Polypodiaceae (*Microgramma* aff. *Percussa*, Polypodiaceae sp.,), Araceae sp., Moraceae sp., and Vitaceae sp. with one individual each. Table 1 summarizes the documented non-timber plant species compiled for site A.

Table 1 - Documented non-timber plant species in site A (Lowland ecosystem) in order of highest to lowest number of individuals

Families	Species	Number of individuals
Melastomataceae	*Clidemia hirta* (L.) D.Don	19
Piperaceae	*Peperomia pellucida* (L.) Kunth	9
Melastomataceae	*Oxyspora curtisii* King	9
Arecaceae	*Licuala spinosa* Wurmb	5
Cycadaceae	*Cycas pectinata* Buch.-Ham.	5
Aristolochiaceae	*Thottea grandiflora* Rottb.	4
Piperaceae	Piperaceae sp.	3
Cyclanthaceae	*Asplundia insignis* (Duchass. ex Griseb.) Harling	3
Melastomataceae	*Sonerila obliqua* Korth.	2
Arecaceae	*Chamaedorea angustisecta* Burret	2
Marantaceae	*Maranta arundinacea* L.	2
Moraceace	Moraceae sp.	2
Vitaceae	Vitaceae sp.	1
Malvaceae	*Pachira aquatica* Aubl.	1
Arecaceae	*Dypsis linearis* Jum.	1
Malpighiaceae	*Hiptage benghalensis* (L.) Kurz	1
Polypodiaceae	Polypodiaceae sp.	1
Cycadaceae	*Cycas edentata* de Laub.	1
Polypodiaceae	*Pyrrosia* aff. *lingua* (Thunb.) Farw.	1
Asparagaceae	*Dracaena cantleyi* Baker	1
Rubiaceae	*Lasianthus attenuatus* Jack	1
Asparagaceae	*Dracaena angustifolia* (Medik.) Roxb.	1
Araceae	Araceae sp.	1
Piperaceae	*Piper lanatum* Roxb.	1
Polypodiaceae	*Microgramma* aff. *percussa* (Cav.) de la Sota	1
	Total	78

In contrast, nine non-timber plant species were recorded in the peat swamp ecosystem, with three species being identified until family level and six species being identified until species level. When compared to the lowland ecosystem, this site contains a significantly lower number of non-timber plant families. Table 2 listed the identified non-timber species at site B. The families Araceae (*Aglaonema nebulosum*) and *Pandanus* sp. recorded the highest

number of individuals of non-timber plant species documented, with three individuals, followed by the family Piperaceae (*Piper caninum*) which had two individuals. Only one individual of each non-timber plant species from the families Orchidaceae *(Plocoglottis javanica*), Moraceae, Arecaceae (*Cyrtostachys renda*), Bombacaceae, and Connaraceae (*Cnestis palala*) were recorded, making them the families with the fewest number of non-timber plant species. There are, in total, 14 individuals of non-timber plant species documented in the peat swamp ecosystem.

Table 2 - Documented non-timber plant species in site B (Peat swamp ecosystem)

Families	Species	Number of Individuals
Pandanaceae	*Pandanus* sp.	3
Araceae	*Aglaonema nebulosum* N.E.Br.	3
Piperaceae	*Piper caninum* Blume	2
Orchidaceae	*Plocoglottis javanica* Blume	1
Moraceae	Moraceae sp.	1
Malvaceae	Malvaceae sp.	1
Arecaceae	*Cyrtostachys renda* Blume	1
Bombacaceae	Bombacaceae sp.	1
Connaraceae	*Cnestis palala* (Lour.) Merr.	1
Total		14

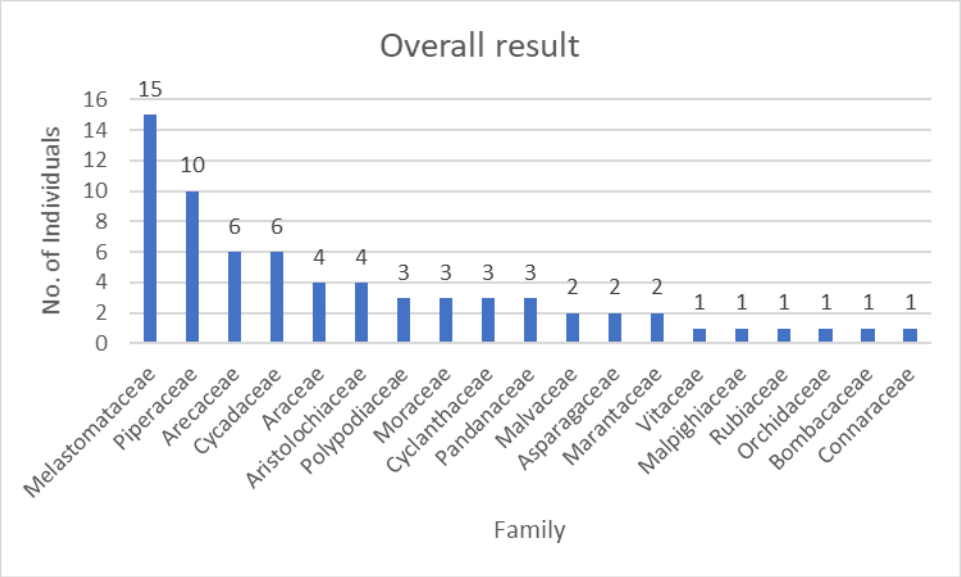

Fig. 1 - Overall identified families and number of individuals in the studied plots of lowland ecosystem and peat swamp ecosystem

3.3 Diversity of Species in Lowland and Peat Swamp Ecosystems

Both lowland and peat swamp ecosystems in AHUFR have a total of 33 non-timber species. It has been discovered that the dominant family was Melastomataceae, with the most dominant species being *Clidemia hirta.* According to [9], the greater the value of H, the greater the diversity of species found within a given population of organisms. Based on Table 3, the lowland ecosystem has a higher H value of 3.003 compared to site B's 2.206. This indicated that the lowland ecosystem had a higher diversity of non-timber communities compared to the peat swamp ecosystem. It is consistent with the number of non-timber families found in the lowland ecosystem, which was 15 families in total. There were fewer diverse non-timber communities recorded in the peat swamp ecosystem, as it has a lower H value. Variations in environmental conditions alter the responses of these facets of species diversity. It is common for a place

lacking in a diverse range of habitats to be devoid of species, yet the few species that can survive in such a location may become overly abundant due to reduced competition for resources [10].

As indicated in Table 3, the values of the Margalef diversity index were 5.396 in the lowland ecosystem and 3.031 in the peat swamp ecosystem. Margalef's index attempts to estimate species richness, but at the same time, it is independent of the sample size, and we can compare the richness of different study sites [11]. The low diversity associated with peat swamp ecosystems, as ascribed by the Margalef index, may be attributed to fewer species and environmental degradation due to anthropogenic pressures, among other biotic factors.

Table 3 - Diversity indices in lowland and peat swamp ecosystems in AHUFR

Site	Shannon-Weiner index (H')	Margalef index (D_{ma})
A (Lowland ecosystem)	3.003	5.396
B (Peat swamp ecosystem)	2.206	3.031

3.4 Other Notable Non-Timber Species Outside the Sampling Plots

Nepenthes species from the Nepenthaceae family are typically found in marginal soils with deficient nutrients, such as low phosphorus, nitrogen, and potassium, as well as acidic environmental conditions. Peat swamps are one of the *Nepenthes* preferred environments. Low-pH peat swamp consisting of constantly flooded ground [13]. In their natural habitat, most Nepenthes are either vines or small shrubs that attach themselves to other plants by means of looped tendrils that sprout from the tips of their leaf blades [12]. Remarkably, at least nine *Nepenthes* taxa were found outside the sampling plots in AHUFR. Four species of *Nepenthes* were recorded, including *N. ampullaria* Jack, *N. gracilis* Korth, *N. mirabilis* (Lour.) Druce, and *N. rafflesiana* Jack. As for nothospecies or natural hybrids, at least five taxa were recorded in AHUFR, including *N.* × *hookeriana* H.Low, *N.* × *trichocarpa* Miq., *N.* × *kuchingensis* Sh.Kurata, *N.* × *sharifah-hapsahii* J.H.Adam & Hafiza and one potentially new nothospecies.

4. Conclusion

This study indicated that lowland forest in AHUFR has better species diversity and species richness compared to the neighbouring peat swamp forest within AHUFR and helps understand the species' ecological significance. Anthropogenic stressors on the habitat include logging, illicit hunting, wood collection (NTFPs), and invasive species entering protected forest regions. The local population's overexploitation of trees has resulted in species extinction and a loss of biodiversity. The paper suggests more broad-based baseline investigations to offer reliable baseline data for the characterization of peat swamp forest ecosystems. To improve the ecosystem stability of these forests, stricter rules and greater monitoring are urgently required. In highly disturbed and human-affected forests, our findings have implications for the successful management and restoration of forest tree species of conservation importance. Besides that, prolonged sampling times and expansion of the study area in AHUFR would be recommended to gather additional information about non-timber species in the area. Besides, it would be beneficial to identify all the gathered specimens further to determine the species of these non-timber species by sending the herbarium to the collection centre to be identified.

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