

Diversity and population structure of Dipterocarpaceae species in Weh Island Nature Tourism Park, Indonesia

RIDHA UL FAHMI¹, SAIDA RASNOVI^{1*}, ESSY HARNELLY¹

¹Biology Department, Faculty of Mathematics and Natural science, Universitas Syiah Kuala, Building B FMIPA, Jl. Syech Abdurrauf No. 3 Kopelma Darussalam 23111, Banda Aceh

Abstract. The Dipterocarpaceae family is one of the identified plant groups with high conservation value that exist in Weh Island Nature Tourism Park. However, the data availability on the species diversity and population structure of Dipterocarpaceae in Weh island in particular and Aceh in general is still very limited. Thus, it is necessary to conduct studies on species diversity and population structure of Dipterocarpaceae from Weh Island. This study aims to obtain data on species abundance and diversity, species composition of each stratum, population structure, and stand structure of Dipterocarpaceae in Weh Island Nature Tourism Park. This research utilized transect method with randomly selected plots according to topographic conditions. We found two Dipterocarpaceae species: *Shorea sumatrana* (Slooten) Desch and *Dipterocarpus hasseltii* Blume. *Shorea sumatrana* (Slooten) Desch has the greatest abundance of all types and strata. The diversity of Dipterocarpaceae species in Weh Island Nature Tourism Park is categorized as low because the diversity index value is in the range of $H' < 1$. This means that the presence of seedling and sapling strata from each species has a major effect on the survival of the Dipterocarpaceae family in the future. The stand structure of the Dipterocarpaceae family in normal conditions is indicated by an inverted “J” shaped diagram.

Keywords: Dipterocarpaceae, Diversity, Population Structure

INTRODUCTION

Dipterocarpaceae is family with the large number of species reaching 512 species and belonging to 16 genera. Dipterocarpaceae in Indonesia reaches 62% (238 species) from Malesian region, this shows that Indonesia is a suitable place for the growth of Dipterocarpaceae [1,2]. As many 53.78 % (128 species) from that were endemic in Indonesia, mainly found in Kalimantan and Sumatra island. Most of the Indonesian Dipterocarpaceae species were classified by IUCN as critical category, 37 of which are from the *Shorea* genus. Meanwhile, four species of Dipterocarpaceae were included in the IUCN vulnerable category, that is *Cotylelobium lanceolatum* Craib, *Dipterocarpus retusus* Blume, *Hopea pachycarpa* (Heim) Sym., and *Shorea uliginosa* Foxm [2].

Factors such as slow growth, as well as simultaneous fertilization events make Dipterocarpaceae vulnerable to the impact of uncontrolled logging activities. Some species of the Dipterocarpaceae family form a forest community [3], making them particularly vulnerable to uncontrolled exploitation. Wood from the family Dipterocarpaceae is widely traded because of its high economic value and strong and durable wood properties, so it is widely used for building materials. If this activity is carried out continuously, over time will experience a drastic reduction in the population of Dipterocarpaceae and to recover it will take a very long time.

Sumatra is a large island with a prominent distribution of the Dipterocarpaceae group, both in terms of population and number of species. In fact, most of the remaining primary forest in Sumatra, the vegetation is still dominated by the Dipterocarpaceae, so it is often referred to as Dipterocarp forest. Most of the Dipterocarpaceae are in Sumatra, as many as 111 species (31.9%) [4].

*Corresponding Author:
saida_rasnovi@unsyiah.ac.id

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METHODOLOGY

The method used in data collection is the transect with plot method. The length of the transect used in this study was 300 meters. Along the transect, five sample plots were placed regularly with a distance of 50 meters between the plots. Each transect is placed at 10 observation points (stations) which are randomly selected according to topographical conditions, so that the total number is 50 plots (Figure 5). Sampling in each plot will include the strata of seedlings, saplings, poles and trees. Each plot is divided into 4 sub-plot sections, seedling (2 x 2 m), sapling (5 x 5 m), pole (10 x 10 m), and trees (20 x 20 m) [5].

Diversity of Dipterocarpaceae

The data collected were the number of species and the abundance of each Dipterocarpaceae species found in each plot. We also collected herbarium specimens from each plot for species identification purposes.

Stand structure

We measured Diameter at Breast Height (DBH) of all Dipterocarpaceae species for strata poles and trees. Measurements were taken to determine the diameter class of each species so that it can be calculated for the basal area (BA) of the recorded Dipterocarpaceae species.

Population structure

Data on the population structure of the Dipterocarpaceae species was conducted by recording the number of individuals of each species found based on the following strata: seedling (height of less than 1.5 m), sapling (height more than 1.5 m, and has a diameter of less than 10 cm.), poles (height measuring more than 1.5 m, and has a diameter ranging from 10 to/less than 20 cm), and trees (height measuring more than 1.5 m, and having a diameter of 20 cm). The population structure of the Dipterocarpaceae family is used to predict future populations of Dipterocarpaceae [6].

Data analysis

Importance Value Index (IVI)

Species data from the Dipterocarpaceae family were then analyzed by calculating the Importance Value Index (IVI). Importance value index calculation for seedling and sapling strata is based on the cumulative values of relative density and relative frequency. Pole and trees strata Importance Value Index calculations are based on the cumulative values of relative density, relative frequency, and relative dominance. The relative value of these three parameters can be calculated [7]:

Importance Value Index (IVI) = Relative Density + Relative Frequency + Relative Dominance

Categorization of Importance Value Index (IVI) [8]:

- IVI > 42.66, categorized as high,
- IVI 21.96 - 42.66, categorized as medium,
- IVI < 21.96, categorized as low.

Species Diversity index (H')

To determine species diversity, it is analyzed using the Shannon-Wiener formula:

$$H' = - \sum p_i \ln p_i \quad \{p_i = (n_i/N)\}$$

H' = species diversity index

Pi = proportion of the number of individuals n_i to the number of individuals all species

The criteria for the diversity index (H') [9]:

- H' > 3, indicates that species diversity on a transect is high
- 1 < H' ≤ 3, indicates that species diversity on a transect is medium
- H' < 1, indicates that the diversity of species on a transect is low

RESULTS AND DISCUSSION

Diversity of Dipterocarpaceae in Weh Island Nature Tourism Park

There are two Dipterocarpaceae species found in Weh Island Nature Tourism Park: *Shorea sumatrana* (Slooten) Desch and *Dipterocarpaceae hasseltii* Blume. *S. Sumatrana* has a regional name namely "kedawang" which is distributed in Sumatra [10]. Same with *D. hasseltii*, this species is distributed in Sumatra, has a regional name "keruing".

Shorea sumatrana (Slooten) Desch

Morphological characteristics are trees of medium to large size, reaching 50-70 meters in height, with buttresses and high branches (Figure 1). Medium header, meeting, semicircular, green from below. Cylindrical, twisted, non-grooved rod, straight, hollow, thin buttresses. Branches are few, not dangling, and slender. Scaly skin surface, thin irregular peeling, yellowish brown color. Petiole 1-1.6 cm in size, short hair, sparse or thick, gray brown color. Leaves ovate, elliptical, oval or lanceolate with a size of 9-18 cm x 2.5-8 cm, like paper, long tapered leaf tips, rounded base of leaves, symmetrical.

Dipterocarpus hasseltii Blume

Morphological characteristics are trees reaching upright, straight, cylindrical stems, large buttresses, whitish-gray or pinkish brown trunk surfaces, thin peeling stems and lenticels, resinous stems, dark brown resin after exposure



Figure 1. *Shorea sumatrana* (Slooten) Desch. (a) leaves, (b) tree trunk

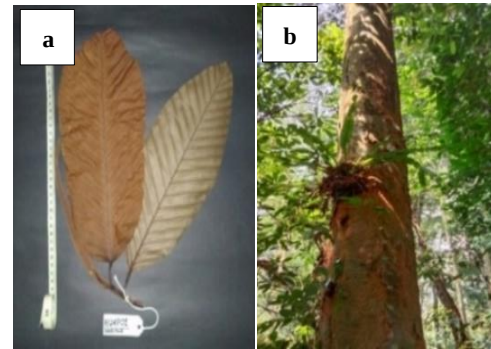


Figure 2. *Dipterocarpus hasseltii* Blume. (a) leaves, (b) tree trunk

to air. Shady header umbrella or shaped, symmetrical or slightly symmetrical (Figure 2). The surface of the stem is cylindrical, sometimes flattened at the end, former curved leaves of the twig, thin hairy twig tips, old, hairless twigs, elongated lanceolate leaves, measuring 5-12 x 1-1.5 cm, dry brown leaves which will loose generally curl, leaf buds lanceolate shape, 2 x 0.5 cm. Single leaf with alternating positions, measuring 9-16 cm x 5-10 cm, wavy leaf edges.

Abundance of Dipterocarpaceae species in Weh Island Nature Tourism Park based on growth strata

Shorea sumatrana (Slooten) Desch has the highest abundance of 39 individuals (Table 1). The type of *Shorea sumatrana* (Slooten) Desch in the seedling phase is thought to have genetic traits that require low light intensity for early growth. Light intensity and air temperature have a significant and negative (inverse) correlation to the growth of *Shorea sumatrana* (Slooten) Desch, meaning that the lower the light intensity and air temperature, the more abundance there is, and vice versa. Whereas other species require high light intensity but are shaded by a broad canopy cover from other species in tree strata, so they cannot develop properly. Second, several types of Dipterocarpaceae in the seedling strata can survive conditions of high light intensity condition but cannot survive if it lasts for a long time. These seedlings may survive in high light intensity situation, but if this happens for a long time it will cause wilting, drought and death to the seedlings [11].

The high abundance of *S. Sumatrana* in all growth strata (seedling, sapling, pole, and tree) proves the ability of this species to survive under existing environmental conditions. Based on this finding, the ability of *S. Sumatrana* to adapt to its environment is relatively better than other Dipterocarpaceae species along its life-

stages (from seedling to adult tree) and may also more competitive in taking nutrients [12].

Importance Value Index (IVI) of Dipterocarpaceae Family in Weh Island Nature Tourism Park

Shorea sumatrana had the highest IVI at 166.46 in the pole strata, while *D. hasseltii* had the highest IVI at the tree strata, which was 142.85 (Table 2). The difference in the value number for each stratum is caused by the frequency of presence of each species on the plot. This condition also describes the condition of the species in the future where the seedling strata will replace the saplings, poles, and trees in the future to maintain their existence in Weh Island Nature Tourism Park. This value indicates the dominant position of a species over other species in a community. The existence of dominance between species in each stratum, and in each species will compete with each other to defend themselves to keep growing and developing [13].

Diversity Index (H') of Dipterocarpaceae in Weh Island Nature Tourism Park

The diversity index (H') of the species found in Weh Island Nature Tourism is in the low category for all growth strata (Table 3). Diversity index of Dipterocarpaceae species based on growth strata are 0.667, 0.692, 0.673, and 0.683 for seedling, sapling, pole, and tree respectively. The diversity of Dipterocarpaceae species in Weh Island Nature Tourism Park is category as low because the diversity index value is in the range of $H' < 1$.

The small number of Dipterocarpaceae species found in Weh Island Nature Tourism Park affects the diversity index. A community is said to have high species diversity if the community is composed of many species (species) with the same or almost the same species abundance. On the other hand, if the community is composed of a few species and if only a few species are

dominant, then the species diversity is low. The value of the species diversity index (H') is related to species richness at a particular location, but this is also influenced by the

distribution of species abundance. The higher the H index value obtained, the higher the diversity of species that exist [14].

Table 1. Abundance of Dipterocarpaceae species based on growth strata

No	Scientific Name	Growth Strata			
		Seedling	Sapling	Pole	Trees
1	<i>Shorea sumatrana</i> (Slooten) Desch	19	10	6	4
2	<i>Dipterocarpus hasseltii</i> Blume	12	9	4	3
Sum		31	19	10	7

Table 2. Importance Value Index (IVI) species based on growth strata

No	Scientific Name	Importance Value Index (IVI)			
		Seedling	Sapling	Pole	Trees
1	<i>Shorea sumatrana</i> (Slooten) Desch	94.62	94.30	166.46	157.15
2	<i>Dipterocarpus hasseltii</i> Blume	105.38	105.70	133.54	142.85

Table 3. Species diversity index (H') based on growth strata

Diversity Index (H')			
Seedling	Sapling	Pole	Trees
0.667	0.692	0.673	0.683

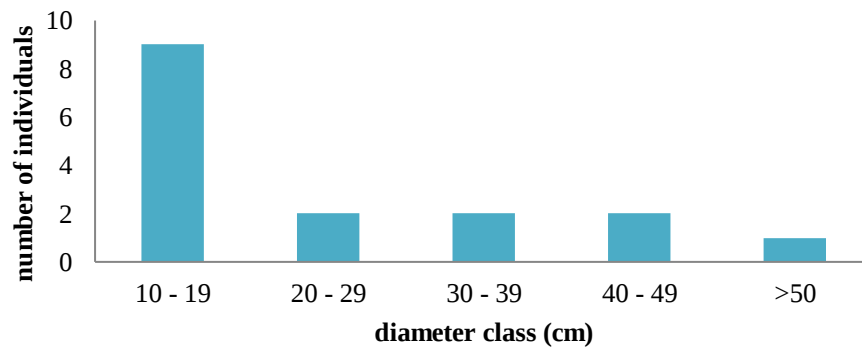


Figure 4. Stand structure of the Dipterocarpaceae family in Weh Island Nature Tourism Park

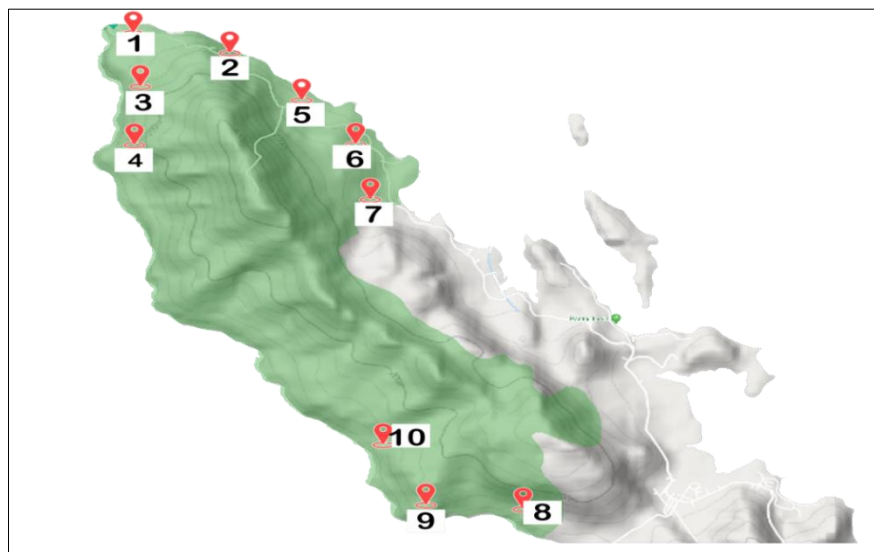


Figure 5. Ten research transect points in Weh Island Nature Tourism Park

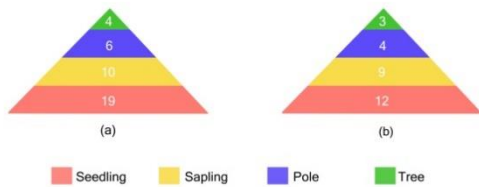


Figure 3. Population Structure. (a) *Shorea sumatrana* (Slooten) Desch, (b) *Dipterocarpus hasseltii* Blume

Population Structure of Dipterocarpaceae Species in Weh Island Nature Tourism Park

The two species of Dipterocarpaceae had more seedling strata than the other growth strata (Figure 3). The results showed that the two species of Dipterocarpaceae were in accordance with the existing age pyramid, which was in the form of a polygon indicating the population structure was in good condition (normal). The shape of the age pyramid consists of a pyramid with a wide base, a clapper-shaped polygon, and an urn or jug shape (formula structure population).

This means that the presence of seedling and sapling strata from Each species has a major effect on the survival of the Dipterocarpaceae family in the future. It needs special support from the government and understanding from the community to maintain its sustainability so that the Dipterocarpaceae species will continue to survive in Weh Island Nature Tourism Park. The community needs to maintain its sustainability by not illegally cutting down Dipterocarpaceae species. The local government needs to create a special area for planting new seeds of Dipterocarpaceae species for the sustainability of these species and provide penalties for those who violate.

Stand Structure of Dipterocarpaceae Species in Weh Island Nature Tourism Park

The stand structure of the Dipterocarpaceae family in Weh Island Nature Tourism Park shows that the number of individuals of the Dipterocarpaceae family species decreases from small diameter class to large diameter class, so that the shape of the curve is generally characterized by the number of distributions resembling an inverted "J" letter (Figure 4).

In general, the stand structure of the Dipterocarpaceae family in the area shows that the forest is still in relatively normal condition. The amount of vegetation in natural forest is inversely proportional to its diameter, that is, the larger the tree diameter, the less the number [15]

CONCLUSION

There were two Dipterocarpaceae species found in Weh Island Nature Tourism Park. These species are *Shorea sumatrana* (Slooten) Desch and *Dipterocarpus hasseltii* Blume. *Shorea sumatrana* (Slooten) Desch and *Dipterocarpus hasseltii* Blume were in accordance with the existing age pyramid, which was in the form of a polygon indicating the population structure was in good condition (normal). Stand structure of the Dipterocarpaceae family in Weh Island Nature Tourism Park shows normal characteristics, the diagram is in the form of an inverted "J" letter.

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