

SPECIES DIVERSITY OF THE MORACEAE FAMILY AT THE SORAYA RESEARCH STATION IN THE LEUSER ECOSYSTEM AREA, SULTAN DAULAT DISTRICT, SUBULUSSALAM CITY, ACEH PROVINCE

Muslich Hidayat, Rizky Ahadi, Masitah*

Departement of Biology, Faculty of Sciences and Technology, University of Islamic State Ar-Raniry, Banda Aceh, Indonesia

*Email Correspondence: masitahbrberutu98@gmail.com

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ABSTRACT

Biodiversity is defined as the number of species inhabiting a particular area. Forests serve as ecosystems dominated by diverse plant species, primarily trees, which constitute the majority of the vegetation in these landscapes. Trees play a pivotal role in shaping forest communities and function as critical life-support systems. However, frequent environmental challenges and deforestation have resulted in insufficient attention toward research on the Moraceae family. Therefore, this study aims to identify species within the Moraceae family and analyze their diversity in the Soraya Research Station area. This research was conducted in September 2023 at the Soraya Research Station, located within the Leuser Ecosystem Area, Sultan Daulat District, Subulussalam City. The study employed an exploratory method using transect sampling across three main transects, each extending 1 km. Vegetation data were analyzed using the Importance Value Index (IVI) and Shannon-Wiener Diversity Index (H'). The findings revealed the presence of 8 Moraceae species, with a total of 221 individuals belonging to 2 genera. The species with the highest IVI was *Damli* (*Artocarpus* sp), with a value of 83.54, while the species with the lowest IVI was *Damli lebar daun* (*Artocarpus* sp), with a value of 8.87. The diversity index (H') of the Moraceae family at the Soraya Research Station was classified as moderate, with an H' value of 1.575.

Keywords : moraceae; sultan daulat; diversity index (H')

ABSTRAK

Keanekaragaman hayati menjadi jumlah spesies yang hidup di tempat tertentu. Hutan menjadi area yang ditumbuhi oleh berbagai tumbuhan, terutama pohon-pohon yang mendominasi lahan tersebut. Pohon memiliki peran sentral dalam bentuk komunitas hutan dan berperan penting sebagai penopang kehidupan. Dengan adanya permasalahan dan deforestasi lingkungan yang sering terjadi menyebabkan kurang perhatiannya terhadap penelitian tentang Famili Moraceae, maka dalam penelitian ini bertujuan penelitian ini adalah untuk mengidentifikasi spesies dari Famili Moraceae dan untuk menganalisis keanekaragaman Famili Moraceae di Kawasan Stasiun Penelitian Soraya. Penelitian ini dilakukan pada bulan September 2023 di Stasiun Penelitian Soraya Kawasan Ekosistem Leuser, Kecamatan Sultan Daulat, Kota Subulussalam. Metode yang digunakan dalam penelitian ini berupa metode jelajah menggunakan metode transek yang dilakukan pada 3 jalur utama dengan masing-masing jalur dilalui sepanjang 1 km. Data vegetasi dianalisis menggunakan Indeks Nilai Penting (IVI) dan Indeks Keanekaragaman (H'). Hasil penelitian ditemukan sebanyak 8 jenis spesies Moraceae dengan jumlah total 221 dari 2 genus. IVI tertinggi terdapat pada jenis *Damli* (*Artocarpus* sp) dengan nilai IVI 83,54 sedangkan nilai IVI terendah pada jenis *Damli lebar*

daun (Artocarpus sp) dengan nilai IVI 8,87. Indeks keanekaragaman famili Moraceae di Stasiun Penelitian Soraya di kategorikan sedang dengan indeks $H' = 1,575$.

Kata kunci : *Moraceae; Sultan Daulat; Indeks Keanekaragaman (H')*

Introduction

Indonesia is recognized as a mega-biodiverse country, second only to Brazil. Despite accounting for only 1.3% of the world's land area, Indonesia is home to 17% of the world's species (Gunawan, 2019). Among this biodiversity is Moraceae family.

Moraceae family comprises flowering plants consisting of 37 genera (Rofifah and Asmarahman, 2022). Historically, this family originated from humid tropical regions and is now distributed across Central and South America, Thailand, Malaysia, India, and Indonesia (Hasanuddin, 2017). The species of this family are widely utilized by communities for traditional medicine, household tools, construction materials, and even as raw materials for boat and shipbuilding, among other uses.

Tree vegetation serves as a critical indicator within biological communities, offering insights into community stability and structure. Investigating the vegetation of the Moraceae family is essential to understanding its response to environmental conditions, including changes that may lead to species decline or loss. These environmental factors encompass both abiotic and biotic influences (Hidayat et al., 2021).

The forests of Aceh, known as primary forests, are among the key habitats for various flora and fauna. One notable site is the Soraya Research Station, the third research station established in 1994 by the Leuser Management Unit, lies outside the boundaries of the Leuser National Park.

The first research station, Ketambe, was established in the south-eastern region of Aceh, while the Suaq Balimbing Research Station was built in southern Aceh. However, the Suaq Balimbing Research Station is part of the Leuser Ecosystem and is also included in the Gunung Leuser National Park (Leuser Management Unit, 1997). Spanning approximately 6,732 hectares, the Soraya Research Station occupies a former forest concession area previously managed by PT. Hargas Industries Indonesia, now designated as a conservation area. Its lowland tropical forest is characterized by hilly topography, with elevations ranging from 75 to 350 meters above sea level. The region experiences annual rainfall of up to 2,450 mm, average temperatures between 21.6°C and 27.7°C, and relative humidity levels of 94.3% in the morning and 88.8% in the evening. Interviews with the Soraya Research Station management reveal that research on the biodiversity of Moraceae family within the Leuser Ecosystem remains limited. Few scientific publications or articles have been produced on the diversity of Moraceae species in the area, despite the management's assertion that many unidentified species remain. An initial survey conducted in March 2021 identified 5 Moraceae species.

This study aims to identify species within the Moraceae family, analyze the Importance Value Index (IVI), and evaluate the diversity of Moraceae species found at the Soraya Research Station in the Leuser Ecosystem, Sultan Daulat District, Subulussalam City, Aceh.

Methods

Place and Time of Research

This research was conducted at the Soraya Research Station, located in the Sultan Daulat District, Subulussalam City, Aceh Province. The study took place over one week in September 2023.

Tools and Materials

The tools used in this study included a digital camera, GPS (Global Positioning System), lux meter, soil tester, tally sheet, measuring tape, writing instruments, hygrometer, and an identification guidebook. The materials used included Moraceae plant samples and a map of the Soraya Research Station area.

Research Methods

The research utilized an exploratory method across three main transects provided by the station's management. Samples were collected for all species within the Moraceae family. Data collection and observation were conducted directly by examining vegetation along the transects and recording the characteristics of each Moraceae plant encountered.

Data recorded for each Moraceae tree included the number of individual species, diameter at breast height (DBH), tree height, and canopy dimensions. Environmental conditions, such as air temperature, humidity, soil moisture, soil pH, and light intensity, were measured at three locations along each transect, starting at 0 m, 500 m, and 1000 m.

Data collection employed an exploration technique to directly observe Moraceae species at the study site. Photographs were taken of each plant's stem, leaves, and fruit. Physical characteristics of the plants, such as diameter at breast height (DBH), tree height, and canopy dimensions—were measured. Physical parameters, including air temperature, air humidity, soil moisture, soil pH, and light intensity, were also recorded. Additional data, such as location, exploration date, species identification, local names, transect information, and unique morphological characteristics, were documented. Morphological observations were performed by placing plant samples on a flat surface, photographing them, and noting any distinctive features. Other relevant field notes were recorded based on the researchers' observations. Data collection involved direct observation, accompanied by documentation of the species encountered (Welda, 2017).

Moraceae species identified at the Soraya Research Station were analyzed qualitatively and quantitatively. The calculations were performed using the following formulas:

Importance Value Index (IVI)

The Importance Value Index (IVI) is a quantitative parameter used to assess the dominance level of plant species within a community (Indriyanto, 2006). The IVI is calculated as:

$$\text{IVI} = \text{Relative Density} + \text{Relative Frequency} + \text{Relative Dominance}$$

- a. Density represents the number of individuals of a species encountered within all plots. It is calculated as:

$$\text{Density (K)} = \frac{\text{Number of individuals of a species}}{\text{Area of the observation plot}} \times 100\%$$

$$\text{Relative Density (KR)} = \frac{\text{Density of a species}}{\text{Total density of all species}} \times 100\%$$

- b. Frequency refers to the number of plots in which a species appears. It is calculated as:

$$\text{Frequency (F)} = \frac{\text{Number of plots occupied by a species}}{\text{Total number of observation plots}} \times 100\%$$

$$\text{Relative Frequency (FR)} = \frac{\text{Frequency of a species}}{\text{Total frequency of all species}} \times 100\%$$

- c. Dominance refers to the basal area or canopy coverage of each species within the plots. It is calculated as:

$$\text{Dominance (D)} = \frac{\text{Total basal area}}{\text{Observation are}} \times 100\%$$

$$\text{Relative Dominance (DR)} = \frac{\text{Dominance of a species}}{\text{Total dominance of all species}} \times 100\%$$

Species Diversity

To evaluate vegetation species diversity, which also indicates the stability of vegetation, the diversity index can be calculated as follows:

Shannon-Wiener Diversity Index:

$$H' = -\sum(Pi \cdot \ln Pi)$$

Explanation:

H' = Shannon-Wiener Diversity Index

Pi = Proportion of individuals of species i

$\ln Pi$ = Total number of individuals

Based on the Shannon-Wiener formula (Mangguran, 1998), the diversity levels are classified as follows:

Low: $H' < 1$

Moderate: H' is between 1 and 3

High: $H' > 3$

Results and Discussion

Species of Moraceae Family in the Soraya Research Station

The research conducted across three main transects at the Soraya Research Station, part of the Leuser Ecosystem, identified 8 species of the Moraceae family, totalling 221 individuals from 2 genera: *Artocarpus* and *Ficus*. The list of identified species is detailed in Table 1.

Table 1 Species of Moraceae Family in the Soraya Research Station, Leuser Ecosystem

No	Local Name	Scientific Name	Genus	Station			Total
				1	2	3	
1	Damli	<i>Artocarpus elongatus</i>	<i>Artocarpus</i>	53	51	11	115
2	Damli lebar daun	<i>Artocarpus</i> sp	<i>Artocarpus</i>	0	1	0	1
3	Cempedak air	<i>Artocarpus dadah</i>	<i>Artocarpus</i>	46	18	1	65
4	Cempedak rawan	<i>Artocarpus rigidus</i>	<i>Artocarpus</i>	5	10	3	18
5	Rambong tampuk	<i>Ficus</i> sp	<i>Ficus</i>	1	0	1	2
6	Rambong kuda	<i>Ficus pedunculosa</i>	<i>Ficus</i>	1	0	1	2
7	Rambong konyel	<i>Ficus variegata</i>	<i>Ficus</i>	0	0	1	1
8	Terap	<i>Artocarpus elasticus</i>	<i>Artocarpus</i>	6	8	3	17
Total				112	88	21	221

The data reveals that across the three main transects at the Soraya Research Station, a total of eight Moraceae species were recorded, with 221 individuals representing two genera. Transect 1 exhibited the highest number of 112 individuals, while Transect 3 had the lowest with 21 individuals. Among the dominant species, *Damli* (*Artocarpus elongatus*) predominated in most transects at the station.

While this dominance was evident, it also led to reduced diversity of other species. Hidayat et al. (2021) reported similar findings in which the dominance of *Dracontomelon* sp. and *Ficus elastica* in the Buluputi Forest suppressed the presence of other tree species, thereby lowering biodiversity levels. Dominant species significantly influence biodiversity levels by occupying a substantial ecological niche. The Moraceae family plays a critical role in soil and water conservation due to its water retention capabilities, stabilizing the surrounding hydrological system. Furthermore, *Ficus* species are pivotal to forest ecosystems (Nur' Aini et al., 2013).

Moraceae species found in the Soraya Research Station are as follows:

1. Damli (*Artocarpus elongatus*)

A tree reaching up to 25 meters in height with a cylindrical trunk. Its rough, brown bark is marked by green lichens and irregular cracks. This species thrives in lowland tropical forests.



(a) Leaves



(b) Trunk

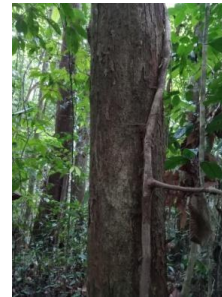
Figure 1. Damli (*Artocarpus elongatus*)

2. Damli lebar daun (*Artocarpus* sp)

This species grows 8–25 meters tall with a straight stem, dense canopy, and grayish-brown, rough bark. Its thick inner bark produces white latex, and the tree has a deep taproot system.



(a) Leaves



(b) Trunk

Figure 2. Damli lebar daun (*Artocarpus* sp)

3. Cempedak air (*Artocarpus dadah*)

This species can reach a height of 36 meters with a trunk diameter of up to 80 cm. This plant is known as cempedak air and is quite rare. Its habitat is often found at the boundary between primary and secondary forests, along riverbanks, and in moist areas. The fruit of cempedak air is a favorite food for various primate species, such as Sumatran orangutan and other monkey species.



(a) Leaves



(b) Trunk

Figure 3. Cempedak air (*Artocarpus dadah*)

4. Cempedak rawan (*Artocarpus rigidus*)

This species grows 45 metres, cylindrical bole up to 90cm in diameter, with buttresses up to 300 cm high. Commonly harvested as the source of keledang timber materials and occasionally cultivated for its edible fruit.



(a) Leaves



(b) Trunk

Figure 4. Cempedak rawan (*Artocarpus Rigidus*)

5. Rambong tampuk (*Ficus sp*)

A tree reaching 15 meters in height and 50 cm in trunk diameter. It produces small to medium-sized fruits that hang down, making them attractive to birds and small mammals.



(a) Leaves



(b) Trunk

Figure 5. Rambong tampuk (*Ficus sp*)

6. Rambong kuda (*Ficus pedunculosa*)

Growing up to 20 meters in height and 50 cm in trunk diameter, this species features grayish-brown rough bark, pinnate leaves with smooth edges, and fruits growing at leaf tips.



(a) Leaves



(b) Trunk

Figure 6. Rambong kuda (*Ficus Pedunculosa*)

7. Rambong konyel (*Ficus variegata*)

Similar to *Ficus pedunculosa*, this species reaches 20 meters in height and 50 cm in trunk diameter. Its fruits also grow at the tips of its smooth, non-serrated leaves.



(a) Leaves



(b) Trunk

Figure 7. Rambong Konyel (*Ficus Variegata*)

8. Terap (*Artocarpus elasticus*)

Reaching up to 40 meters in height with a trunk diameter of 80 cm, this species inhabits both primary and secondary forests. Its fruits are favored by primates. The tree features buttress roots reaching 3 meters high, with ovate leaves covered in reddish-brown hairs.



Figure 8. Terap (*Artocarpus Elasticus*)

Importance Value Index (IVI) of Moraceae Vegetation in the Soraya Research Station

The Importance Value Index (IVI) for Moraceae species at the Soraya Research Station is presented in Table 2.

Table 2 Importance Value Index of Moraceae Species in the Soraya Research Station

No	Local Name	Scientific Name	KR (%)	KR (%)	DR (%)	IVI (%)
1	Damli	<i>Artocarpus elongatus</i>	52.04	17.95	13.56	83.55
2	Damli lebar daun	<i>Artocarpus</i> sp	0.45	5.98	2.44	8.87
3	Cempedak air	<i>Artocarpus dadah</i>	29.41	17.95	14.83	62.19
4	Cempedak rawan	<i>Artocarpus rigidus</i>	8.14	10.26	14.24	32.65
5	Rambong tampuk	<i>Ficus</i> sp	0.91	11.97	25.97	38.84
6	Rambong kuda	<i>Ficus pedunculosa</i>	0.91	11.97	12.89	25.76
7	Rambong konyel	<i>Ficus variegata</i>	0.45	5.98	3.13	9.57
8	Terap	<i>Artocarpus elasticus</i>	7.69	17.95	12.94	38.58
Total			100	100	100	300

Based on the analysis conducted on the 3 main transects with a total observation area of 60,000 km², 8 Moraceae species were identified: Damli, Damli lebar daun, Cempedak air, Cempedak rawan, Rambong tampuk, Rambong kuda, Rambong konyel, and Terap. Table 2 explains that the analysis results showed that the dominant species, based on IVI, was Damli, with an IVI value of 83.55, while the lowest IVI value was found in Rambong konyel species, with an IVI value of 9.57.

Vegetation analysis indicates that the Damli species (*Artocarpus elongatus*) dominates based on the Important Value Index (IVI), with a value of 83.55. Meanwhile, Damli with broad leaves (*Artocarpus* sp) has the lowest IVI, at 8.85, due to its limited distribution and number along the study trails. Species with high IVI values were able to adapt well to their environment, whereas those with low IVI values less adaptable. The light intensity across the three trails averaged only 0.44-12.00. This aligns with the statement of Daniel et al. (1992), as cited in Karyati et al. (2017), which asserts that light has a significant impact on tree species through variables such as brightness levels, quality, and exposure duration. This view is also supported by Gardner et al. (1991), in Karyati et al. (2017), who emphasized that light plays a key role in plant growth and development. Therefore, light is crucial for plant growth; plants lacking adequate light will experience growth decline and may even die due to an inability to perform photosynthesis.

The Important Value Index (IVI) values generated can indicate the dominance of a species within a habitat. Species with the highest IVI values demonstrate their ability to adapt to the surrounding environment. This is in line with the statement by

Nuraina (2018), which suggests that a high IVI value indicates that the species is better able to adjust to its environment compared to other species. The dominance of a species refers to its significant role in a forest community.

Biodiversity Index of Moraceae Family in the Soraya Research Station

The biodiversity index calculation for Moraceae species at the Soraya Research Station is shown in Table 3.

Table 3 Biodiversity Index of Moraceae Species at the Soraya Research Station

No	Nama Daerah	Species	\sum In	Pi (ni/N)	Ln Pi	Pi Ln Pi	H'
1	Damli	<i>Artocarpus elongatus</i>	115	0.520	-1.306	-0.680	0.680
2	Damli lebar daun	<i>Artocarpus</i> sp	1	0.005	-5.398	-0.024	0.024
3	Cempedak air	<i>Artocarpus dadah</i>	65	0.294	-1.224	-0.360	0.360
4	Cempedak rawan	<i>Artocarpus rigidus</i>	18	0.081	-2.508	-0.204	0.204
5	Rambong tampuk	<i>Ficus</i> sp	2	0.009	-4.705	-0.043	0.043
6	Rambong kuda	<i>Ficus pedunculosa</i>	2	0.009	-4.705	-0.043	0.043
7	Rambong konyel	<i>Ficus variegata</i>	1	0.005	-5.398	-0.024	0.024
8	Terap	<i>Artocarpus elasticus</i>	17	0.077	-2.565	-0.197	0.197
Jumlah			221	1	-27.809	-1.575	1.575

Based on the Shannon-Wiener diversity index, Moraceae family at the Soraya Research Station exhibited a diversity index value of 1.575, which falls under the moderate category.

The highest species-specific diversity index (H') was recorded for *Damli* (*Artocarpus elongatus*) at 0.680, while the lowest value was observed for *Rambong Konyel* (*Ficus variegata*) at 0.024. The overall biodiversity index across all species was 1.575. This indicates that none of the species-specific diversity indices were categorized as high. According to Isnan (2015), a diversity index value below 1 indicates low diversity, values between 1 and 3 represent moderate diversity, and values exceeding 3 reflect high diversity. Consequently, the data suggest that the biodiversity level in this area is moderate. Prabaningrum (2018) notes that higher diversity index values correspond to greater stability within a community. The moderate biodiversity level at the Soraya Research Station suggests limited ecological stability, potentially influenced by its transition from an industrial area to a conservation zone.

Environmental Factors at the Soraya Research Station

Measurements of physical and chemical environmental factors across the observation transects at the Soraya Research Station are summarized in Table 4.

Table 4 Physical and Chemical Environmental Factors at the Soraya Research Station

No	Transect	Location	Physical and Chemical Parameters				
			Temp. (°C)	Soil pH	Soil Moisture (%)	Light Intensity	Air Humidity (%)
1	0	Jalur 1	28.2	5.7	75	18.02	80
2	500		30.1	6	60	18.3	75
3	1000		30.3	5.8	80	0.45	73
Rata-rata			29.5	5.8	71.7	12.3	76.0

1	0		25.6	6	69	10.19	84
2	500	Jalur 2	29.7	6.6	60	0.56	81
3	1000		29.5	6.5	64	0.29	76
		Rata-rata	28.3	6.4	64.3	3.7	80.3
1	0		27.8	6	70	0.33	80
2	500	Jalur 3	29.6	6.2	60	0.8	79
3	1000		30.8	6.1	60	0.18	80
		Rata-rata	29.4	6.1	63.3	0.44	79.7

Environmental factors such as temperature, soil pH, soil moisture, light intensity, and air humidity significantly influenced the vegetation of the Moraceae family in the Soraya Research Station area. The temperature ranged from 25–30°C, soil pH ranged from 5.8–6.6, soil moisture varied from 60–80%, light intensity ranged from 0.18–18.30 Cd, and air humidity fluctuated between 73% and 80%.

The environmental parameters were relatively uniform across transects. The highest temperature (30°C) was observed in Transects 1 and 3, while the lowest (28°C) occurred in Transect 2. Sitanggang (2017) suggests that temperature and altitude influence plant distribution, with variation in temperature at different altitudes affecting the species present. The soil pH values across the transects ranged from 6 to 7, with the highest recorded in Transects 2 and 3 and the lowest in Transect 1.

This neutral pH range aligns with Karamina (2017), who classified soil pH between 6 and 7 as neutral. Soil pH plays a crucial role in determining nutrient availability for plants (Gunawan, 2015). Hardjowigeno (1992) noted that variations in soil acidity or alkalinity result from hydrogen ion (H⁺) concentrations, which significantly affect plant growth. Soil moisture ranged from 60% to 80%, with Transect 1 recording the highest level (70%) and Transects 2 and 3 the lowest (60%). Rahayu (2015) explained that soil moisture tends to be higher in lowland areas than in highland areas, influenced by factors such as rainfall, soil type, and evapotranspiration rates. Karyati (2018) emphasized that soil water availability is critical for plant growth.

Conclusion

1. Moraceae plant species found at the Soraya Research Station, within the Leuser Ecosystem Area, include 8 species: Damli (*Artocarpus elongatus*), Damli lebar daun (*Artocarpus sp*), Cempedak air (*Artocarpus dadah*), Cempedak rawan (*Artocarpus rigidus*), Rambong tampuk (*Ficus sp*), Rambong kuda (*Ficus pedunculosa*), Rambong konyel (*Ficus punctata*), and Terap (*Artocarpus elasticus*), with a total of 221 individuals from 2 identified genera.
2. The overall biodiversity index (H') was found to be 1.575, indicating a moderate level of biodiversity, as the index value falls between 1 and 3.
3. Based on the analysis conducted across three main trails, covering a total observation area of 60,000 km², 8 species of Moraceae were identified: Damli, Damli lebar daun, Cempedak air, Cempedak rawan, Rambong tampuk, Rambong kuda, Rambong konyel, and Terap. The analysis results showed that the dominant or highest species based on the Important Value Index (IVI) was Damli, with an IVI value of 83.55, while the lowest IVI value was found in Rambong konyel, with an IVI of 9.57.

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