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Article

BIODIVERSITY OF SAGO (*Metroxylon* spp.) AND ITS UNDERSTORY IN MALUKU, Indonesia

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Abstract:

Sago (Metroxylon spp.) is an important crop in Maluku. This study aims to identify the biodiversity of sago palm and understory vegetation around sago clumps in Maluku. The research was carried out in six sago area from September 2015 to October 2016. The Sago Plant identification was carried out through the growth phase of sago, i.e. seedlings, saplings, weaning, trunks, and ripening. Vegetation observation was done in radius 100 m2 surrounding sago clumps. The result shows that Metroxylon rumphii Mart type. (Tuni sago), M. sagus Rottb. (Molat sago) and M. Silvester Mart. (Ihur Sago) dominates sago palms area in Seram and Ambon Islands, Maluku. There are significant morphological differences between the types of sago, especially in stem height, midrib width, leaf midrib colour, number of thorns, and flower stalk length, as well as the difference of carbohydrate content. Understory vegetation of each observation sites diverse consist of 15 families and 20 species. The families that dominate the vegetation under the sago palms are Araceae, Thelypteridaceae, and Athyriaceae. The types of plants from Araceae are taro types and broadleaf, while those from the Thelypteridaceae and Athyriaceae families are types of ferns.

Keywords: Biodiversity, Maluku, Metroxylon spp, Understory

1. Introduction

Sago (*Metroxylon* spp.) is an important socio-economic crop in Southeast Asia [1], where the centres of sago diversity originating from Papua New Guinea and Maluku [2]; [3]; [4]. Sago is known as a plant that can grow and thrive in various ecologies, such as in swamps area [5], acidic peat soils, saline and submerged soils [3]; [6]. This plant resistant to flooding, drought, fire and strong winds due to strong fibrous roots. Stuck in the mud.

Sago is the main source of carbohydrates for the people of Eastern Indonesia, especially in Papua and Maluku. The total area of sago in Indonesia in 2018 reached 311,964 ha, and the largest area of sago is in Papua province (155,943 ha), while the area of sago in Maluku is in third place, which is 36,484 ha. In terms of productivity, sago palms have higher productivity than other carbohydrate-producing crops, such as sweet potato, corn, rice and cassava. However, until now the production is still very low because most of it is still in the form of natural sago forests that have not been properly cultivated, and only plants that are easily accessible are harvested.

Sago palm grows in swampy, alluvial and peaty soils where almost no other major crops can grow without drainage or soil improvement [7]; [8]. Sago palm is one of the most important bioresources for not only sustainable agriculture but also rural development in swampy areas of the tropics. However, Metroxylon palms, even sago palm is recognized as an unexploited or underexploited plant because this species has been harvested from natural forests and/or has been semi-cultivated under very simple maintenance.

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Sago palms grow well in freshwater areas as well as in brackish water areas near the coast. [9] reported that saline water treatment up to EC 6 to 7 mmho/cm did not affect sago palm growth. [10] and Singhal *et al.* (2008) reported that sago palm tolerant to salinity to 10 S/m. However, few studies exist of the mechanism of salt tolerance in sago palm. It is usually very difficult to get uniform plant materials because of low germination percentage of sago palm seeds and large variation in days for germination, sometimes longer than one year needed, which may be main reasons why there is no experimentally further information of ecological and physiological growth response regarding salt tolerance in sago palm.

Since sago palms grow in a wide range of ecosystem, it seems that there are genetic variations of sago palms according to its ecosystems. The difference in an ecosystem will also determine the vegetation diversity understory of the sago stands. This study aims to identify the biodiversity of sago palm and understory vegetation around sago clumps in Maluku.

2. Materials and Methods

This research was conducted in sago area in Maluku. Sago forest in six villages was chosen as research sites representing sago area in Maluku Province, i.e. Rutong and Tawiri villages, Ambon; Tulehu village, Central Maluku Regency; Ariate, Eti, and Waisamu villages, West Seram Regency. Vegetation identification was made at Maluku Assessment Institute for Agricultural Technology (AIAT) Laboratory, and Laboratory of Department of Botany, Center Research of Biology, Indonesian Institute of Science at Cibinong, Bogor. The research was carried out from September 2015 to October 2016.

Plant identification was carried out through the growth phase of sago, i.e. seedlings, saplings, weaning, trunks, and ripening. Vegetation observation was done in radius 100 m2 surrounding sago clumps. Observation data includes the growth phases of sago (type, number, height, and circumference of stems) and understory vegetation (type and numbers of vegetation). Sago clumps growth consist of five phases, namely: a) Stolon phase, which is the smallest sago tiller or called a seedling, b) Sago seedling phase, usually used as sago seedling, c) Weaning phase, starting forming trunks, d) tree phase, and e) ripening phase, where sago trees are ready to be harvested. Observations were carried out both in the dry season and rainy season.

2.1. Data Analysis

The identification results are tabulated in a pivot table in Microsoft Excel 2007. Vegetation analysis data includes density, frequency, dominance and important value index (INP) using Microsoft Excel 2007 program.

Density (density = D) is the number of individuals per unit area or per unit volume. The density of the i-th species can be calculated by:

$$D - i = \frac{Number\ of\ individuals\ (i)}{Unit\ area} \quad \text{..... (1)}$$

$$D\ relative\ -i \quad = \quad \frac{D\ each\ species}{D\ total\ species\ per\ unit} \quad \text{..... (2)}$$

The frequency of plant species is the number of plots where a species is found from the number of plots made. Frequency is the intensity of the species found in the observation of the presence of organisms in the community or ecosystem. For a plant community

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analysis, the species frequency (F), the frequency of the i-th species (F-i), and the relative frequency of the i-th species (FR-i) can be calculated using the following formula:

$$F - i = \frac{number\ of\ plots\ occupied\ by\ vegetation}{number\ of\ plots} \quad \text{..... (3)}$$

$$F\ \ relative - i = \frac{Frequency\ of\ vegetation\ \ \ type\ (i)}{Total\ of\ frequency}\ x\ 100\% \text{..... (4)}$$

The Important Value Index (IVI) is an index that describes the important role of vegetation in its ecosystem. The higher the value of each vegetation, the greater of its effect on the ecosystem stability. The index value at the understory level was calculated from the relative density (DR) and relative frequency (FR):

$$IVI = DR + FR \quad \text{..... (5)}$$

3. Results and Discussion

3.1. Distribution and Diversity of Sago Type

The distribution of sago in Maluku spreads throughout coastal areas, rivers and medium lowlands at altitude 700 m above sea level, even though this plant is found at the altitude 1000 m above sea level. However, [12] reported that sago growth might be slower at an altitude higher than 400 m asl. Sago grows well in tropical lowland humid areas. The optimum conditions for growing sago are at a minimum temperature of 26 oC, relative humidity of 90%, and light radiation of 9 MJ/m2 per day [6]. Sago is also found grows in the saline area [13]; however, the salinity not exceed 10 S/m [10]; [11].

Based on the distribution, we choose six sago forest at six villages representing distribution and diversity of sago type in Maluku. There are five types of sago that are found and dominate the sago area on Seram and Ambon islands, namely M. rumphii Mart. (Tuni sago), M. sagus Rottb. (Molat sago), M. Silvester Mart. (Ihur sago), M. longispium Mart. (Makanaru Sago), and M. micracantum Mart (Rattan sago). [14] reported significant morphological differences between the five types of sago, especially in stem height, midrib width, leaf midrib colour, number of thorns, and flower stalk length. The stems of Tuni sago, Molat sago, Ihur sago, Makanaru sago, and Rattan sago are 25 m, 16 m, 20 m, 10 m and 9 m, respectively, while the width of the base of the fronds is 25 m, 20 m, respectively. 19 m, 8 m and 20 m. M. rumphii Mart type. (Tuni sago) has fewer saplings, drooping tips of the leaflets are more regular and rarely grows around the main tree. Ihur sago species have more tillers, grow irregularly, the tips of the leaves are upright, and many tillers grow around the main tree. The appearance of each growth phase of sago for the five types of sago found in Maluku during the dry and rainy seasons (Table 1).

The five types of sago also contain different carbohydrates. [15] reported that the carbohydrate content in Tuni Sago, Molat sago and Sago Ihur were respectively 89.13%, 88.6% and 76.03%, while two others are lower. Therefore, economically, these three types of sago are more widely used and processed by the community [16].

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Table 1 Average of plant height, number of midribs, and stem diameter of sago palm during rainy and dry season in Maluku.

Sago growth phase	Observation sites, season, type of sago											
	Tulehu		Rutong		Tawiri		Ariate		Eti		Waisamu	
	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry	Rainy	Dry
	Ihur	Ihur	Tuni	Tuni	Tuni	Tuni	Tuni	Tuni	Tuni	Tuni	Ihur	Ihur
1. Seedling												
Number of plants	4.00	4.67	3.67	4.00	3.00	3.00	3.00	3.00	5.67	5.67	4.00	6.00
Plant height (cm)	191.00	191.00	185.00	185.00	192.00	192.00	185.67	185.67	188.33	188.33	190.33	190.,33
Number of midribs	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
2. Tiller												
Number of plants	4.67	6.00	3.67	3.67	3.00	3.67	4.33	4.67	5.00	5.00	6.33	7.00
Plant height (cm)	395.00	395.00	398.67	398.67	398.67	398.67	398.67	398.67	398.67	398.67	398.67	398.67
Number of midribs	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
3. Weaning												
Number of plants	4.33	4.33	2.00	2.00	3.67	3.67	2.33	2.33	2.67	2.67	5.33	5.33
Plant height (cm)	597.33	597.33	597.33	597.33	597.33	597.33	597.33	597.33	597.33	597.33	597.33	597.33
Number of midribs	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
4. Stem												
Number of plants	1.67	1.67	2.33	2.33	1.00	1.00	2.33	2.33	2.33	2.33	2.00	2.00
Stem diameter (cm)	160.67	160.67	156.67	156.67	156.67	156.67	151.33	151.33	145.33	145.33	156.00	156.00
Plant height (cm)	767.00	767.00	786.67	786.67	758.33	758.33	786.67	786.67	786.67	786.67	786.67	786.67
Number of midribs	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
5. Trunk												
Number of plants	1.00	1.00	1.00	1.00	1.33	1.33	1.00	1.00	1.33	1.33	1.33	1.33
Stem diameter (cm)	164.67	164.67	147.67	147.67	163.33	163.33	156.33	156.33	160.67	160.67	154.67	154.67
Plant height (m)	12.33	12.33	11.00	11.00	12.33	12.33	12.67	12.67	11.67	11.67	12.33	12.33
Number of midribs	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00

Source of primary data

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The diversity of sago found at the six research sites are as follows;

- **Sago area at Ariate Village**

  This village is located on Seram island. Three sago clumps which used as observation sites located at coastal area elevated 2 m asl. First sago clumps are located at E: 128° 04.234' and S: 03° 11.475', the second clumps are located at E: 128° 04.233' and S: 03° 11.520', and the third is located at E: 128° 04.238' and S: 03° 11.503' in this site sago forest spread across various ecosystems, namely the coast, river flow, dry land and inundated land. The structure of the sago population is clustered (150 - 200 sago clumps) and spots (5 - 10 sago clumps). The dominant types of sago are *M. rumphii* Mart (Sago Tuni), *M. sagus* Rottb. (Sago Molat), *M. Silvester* Mart. (Sago Ihur), *M. longispium* Mart. (Sago Makanaru), and *M. micracantum* Mart. (Rattan Sago). In some locations, sago grows mixed with other plants such as coconut, langsat, durian, cacao, cloves, and bananas. Local people intensively process sago for consumption as sago starch to be used as papeda and plate sago as a staple food.

- **Sago area at Eti Village**

  Eti village is located on Seram Island, West Seram Regency, Maluku Province. The location of the observation is located at an average height of 2 m above sea level. The observation point of the first sago grove is at E: 128° 12,794 'and S: 03° 05.974', the second sago grove is at E: 128° 12.832 'and S: 03° 05.978', and the third sago grove is at E: 128° 12.861' and S: 03° 06.017'. Sago forest spreads in lowland areas, river flow, dry land and inundated land. The structure of the sago population is clustered (30-50 sago clumps) and spots (5-10 sago clumps). The dominant types of sago are *M. rumphii* Mart, (Tuni sago), *M. Silvester* Mart. (Ihur Sago) and *M. micracantum* Mart (Rotan sago). Apart from the lower vegetation, in the sago area, there are also other types of forest plants such as sugar palm, coconut, langsat, durian, cloves, bananas, and cassava. Local people intensively process sago for consumption as sago starch to be used as papeda and plate sago as a staple food. Sago stems are also used as cattle feed.

- **Sago area at Waisamu Village**

  Waisamu Village is located on Seram Island, Kairatu Barat District, West Seram Regency, Maluku Province. Sago forest spreads in lowland areas, wetlands and inundated lands. The observation sites are located at an average height of 4 m asl. The first sago grove at E: 128° 19,498' and S: 03° 16,949', the second sago grove at E: 128° 19.510' and S: 03° 16.945', and the third sago grove at E: 128° 19.502' and S: 03° 16,957'. The structure of the sago population is clustered (80 - 100 sago clumps) and spots (5 - 10 sago clumps). The dominant types of sago are *M. rumphii* Mart (Tuni sago), *M. sagus* Rottb. (Molat Sago), *M. Silvester* Mart. (Ihur Sago), *M. longispium* Mart. (Makanaru Sago), and *M. micracantum* Mart (Rotan sago). The canopy of sago plants is closed, and the sago area is bordered by paddy fields, which are a source of irrigation water for irrigating rice fields. Lower vegetation and sago groves dominate this area. Local people intensively process sago for consumption in the form of sago starch to be used as papeda and plate sago as a staple food. In addition, there is a factory for processing sago stalks to extract sago starch.

- **Sago area at Rutong Village**

  Rutong Village is located on Ambon Island, South Leitimur District, Ambon City, Maluku Province. The three observation points for the sago grove are located at an average height of 2 m above sea level. The first sago grove is located at E: 128° 16.055' and S: 03° 42.327', the second sago grove is at E: 128° 16.077' and S: 03° 42.295', and the third sago grove at E: 128° 16.080' and S: 03° 42.296'. Sago forests spread in lowland and coastal areas, wetlands and inundated lands. The structure of the sago population is clustered (100 - 150 sago clumps) and spots (5 - 10 sago clumps). The dominant types of sago are *M. rumphii* Mart (Tuni sago), *M. sagus* Rottb (Molat sago). and *M. Silvester* Mart. (Ihur Sago). Closed sago canopy, lower vegetation and sago groves dominate this area. Local people intensively process sago for consumption as sago starch to be used as papeda and plate sago as a staple food.

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- **Sago areal at Tawiri Village**

  Tawiri Village is located on Ambon Island, Teluk Dalam District, Ambon City, Maluku Province. The three observation sites are located at 3 m asl. The first sites located at E: 128° 06.331' and S: 03° 41.372', the second sago site at E: 128° 06.321' and S: 03° 41.379', and the third sago grove at E: 128° 06.320' and S: 03° 41.395'. Sago forests spread in lowland areas, river flow, dry land and wetlands. The structure of the sago population is clustered (20 - 40 sago clumps) and spots (5 - 10 sago clumps). The dominant types of sago are *M. rumphii* Mart (Tuni sago), *M. sagus* Rottb. (Molat sago) and *M. Silvester* Mart (Ihur sago). Sago palms grow intercropped with other cash crops such as coconut, langsat, durian, clove, banana, and cassava. Local people intensively processed sago for consumption and being used as papeda and plate sago as a staple food.

- **Sago area at Tulehu Village**

  Tulehu Village is located on Ambon Island, Salahutu District, Central Maluku Regency, Maluku Province. Three sago observation sites are located at 3 m asl. The first observation site located at E: 128° 18.542' and S: 03°35,449', the second sago grove at E: 128° 18.576 'and S: 03° 35.471', and the third sago grove at E: 128° 18.556' and S: 03° 35.440'. Sago forest spreads in lowland areas, and the river flows dry land and wetlands. The structure of the sago population is clustered (80 - 100 sago clumps) and spots (5 - 10 sago clumps). -The dominant types of sago are *M. rumphii* Mart (*Tuni sago*), *M. sagus* Rottb. (Molat sago), *M. Silvester* Mart. (Ihur sago), *M. longispium* Mart. (Makanaru sago), and *M. micracantum* Mart. (Rattan sago) Apart from the lower vegetation, in the sago area, there are also other types of forest plants such as coconut, langsat, mango, clove, durian, cocoa, banana, cassava, beans, and corn. sago for consumption in the form of sago starch to be used as papeda and plate sago as a staple food.

3.2. Understory Vegetation of Sago Palms

The results of vegetation identification under sago stand in the six observation sites are shown in Tables 2, 3, 4, 5, 6 and 7. The number and types of vegetation under the sago stands varied in each site. Table 2 describes the number and types of vegetation understorey of sago palms in Ariate Village, which 21 types of vegetation from 15 families were found. This family of vegetation grows well under shade conditions. Some of the vegetation found is beneficial for humans, but there are also plants that interfere with the growth of sago. Several types of plants, such as *Typhonium flagelliforme* L, *Piper betle* L, and *Cissus sicyoides* L are known as medicinal plants [17]; [18]; [19]. *Pandanus amaryllifolius* Roxb is widely used for cooking spices [20], while *Etlingera coccinea* (Blume) S. Sakai & Nagam is known as a plant that produces essential oils [21]. *Cissus sicyoides* L is a weed that interferes with the growth of sago.

According to the important value index of vegetation, during the dry season, more vegetation plays an important role in maintaining ecosystem stability, such as *Christella parasitica*, Etlingera *coccinea* (Blume) S. Sakai & Nagam, *Typhonium flagelliforme* L, and *Bridelia* sp. Willd. In the rainy season the importance value index changes, where *Typhonium flagelliforme* L and *Bridelia* sp. Will has a higher IVI than *Christella parasitica* and *Etlingera coccinea* (Blume) S. Sakai & Nagam. Other vegetation has lower relative density and IVI values, both in the dry season and the rainy season.

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Table 2 Type of vegetation, relative density, relative frequency and Important Value Index (IVI) of understory vegetation of sago area in Ariate village, Maluku

Family	Type of vegetation	Dry season			Rainy season		
		Relative density	Relative Frequency	IVI	Relative density	Relative Frequency	IVI
Araceae	*Typhonium flagelli-forme* L.	21.24	8.11	29.35	22.32	6.38	28.71
Araceae	*Colocasia* sp.	10.32	8.11	18.43	10.70	6.38	17.09
Araceae	*Colocasia esculenta* L.	4.72	5.41	10.13	5.50	6.38	11.89
Piperaceae	*Piper betle* L.	5.31	8.11	13.42	5.50	6.38	11.89
Piperaceae	*Piper aduncum* L.	0.88	2.70	3.59	1.53	6.38	7.91
Poaceae	*Cynopoghon dactylon.* Spreng.	4.42	5.41	9.83	4.59	4.26	8.84
Poaceae	*Phyllostachys* sp.	0.29	2.70	3.00	0.61	4.26	4.87
Poaceae	*Axonopus* sp.	0.59	2.70	3.29	0.61	2.13	2.74
Melastomataceae	*Melastoma affine D. Don*	4.42	8.11	12.53	4.59	6.38	10.97
Melastomataceae	*Clidemia hirta* (L.) D. Don	0.29	2.70	3.00	0.31	2.13	2.43
Thelypteridaceae	*Christella parasitica* (L.) Lev	23.89	8.11	32.00	18.96	6.38	25.34
Athyriaceae	*Diplazium dietrichianum* (Luerss.) C. Chr.	10.03	8.11	18.14	10.40	6.38	16.78
Selanigellaceae	***Selanigella plana* (Desv. ex Poir.) Hi-eron.**	3.54	5.41	8.95	3.06	6.38	9.44
Moraceae	*Ficus septica* (Burm.)	2.36	5.41	7.77	2.75	6.38	9.14
Convolvulaceae	*Ipomoea triloba L.*	2.95	5.41	8.36	3.06	4.26	7.31
Marantaceae	*Phrynium* sp. willd	1.18	5.41	6.59	0.92	6.38	7.30
Pandanaceae	*Pandanus amarylli-folius* Roxb.	0.59	2.70	3.29	0.92	4.26	5.17
Vitaceae	*Cissus sicyoides* L.	0.59	2.70	3.29	0.92	4.26	5,17
Marattiaceae	*Marattia sylvatica* (Blume)	2.36	2.70	5.06	2.45	2.13	4.57
Phyllanthaceae	*Bridelia* sp. Willd.	21.24	8.11	29.35	22.32	6.38	28.71
Zingiberaceae	*Etlingera coccinea* (Blume) S. Sakai & Nagam	23.89	8.11	32.00	18.96	6.38	25.34

Source of primary data

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Table 3 Type of vegetation, relative density, relative frequency and Important Value Index (IVI) of understory vegetation of sago area in Eti village, Maluku

Family	Type of vegetation	Dry season			Rainy season		
		Relative density	Relative Frequency	IVI	Relative density	Relative Fre-quency	IVI
Araceae	*Typhonium flagelli-forme* L.	8.07	5.13	13.20	12.30	6.38	18.68
Araceae	*Colocasia* sp.	19.25	7.69	26.95	19.79	6.38	26.17
Araceae	*Colocasia esculenta* L.	7.76	7.69	15.46	6.68	6.38	13.07
Poaceae	*Cynopoghon dactylon.* Spreng.	10.25	7.69	17.94	8.29	6.38	14.67
Poaceae	*Phyllostachys* sp.	0.31	2.56	2.87	0.27	2.13	2.40
Poaceae	*Axonopus* sp.	2.80	7.69	10.49	2.41	6.38	8.79
Thelypteridaceae	*Christella parasitica* (L.) Lev	20.81	7.69	28.50	18.72	6.38	25.10
Athyriaceae	*Diplazium dietrichianum* (Luerss.) C. Chr.	13.35	7.69	21.05	12.57	6.38	18.95
Piperaceae	*Piper aduncum* L.	2.17	5.13	7.30	3.74	6.38	10.13
Convolvulaceae	*Ipomoea triloba L.*	3.42	5.13	8.54	2.67	6.38	9.06
Marantaceae	*Phrynium* sp. willd	0.62	2.56	3.19	0.53	2.13	2.66
Pandanaceae	*Pandanus amarylli-folius* Roxb.	0.93	5.13	6.06	0.80	4.26	5.06
Vitaceae	*Cissus sicyoides* L.	2.48	7.69	10.18	2.14	6.38	8.52
Marattiaceae	*Marattia sylvatica* (Blume)	3.42	7.69	11.11	2.94	6.38	9.32
Melastomataceae	*Clidemia hirta* (L.) D. Don	0.62	2.56	3.19	0.80	4.26	5.06
Asteraceae	*Mikania micrantha* Kunth	1.24	2.56	3.81	1.60	4.26	5.86
Phyllanthaceae	*Bridelia* sp. Willd.	2.17	5.13	7.30	2.14	6.38	8.52
Zingiberaceae	*Etlingera coccinea* (Blume) S. Sakai & Nagam	0.31	2.56	2.87	1.34	4.26	5.59

Source of primary data

The relative density of each type of vegetation is related to the morphological characteristics of the vegetation, such as plant height, sunlight requirements and their habitat. Large trees vegetation is generally lower in density than shrub vegetation. This situation is in accordance with the findings of [22], where the small vegetation that makes up the ecosystem tends to be denser than the large trees.

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Table 4 Type of vegetation, relative density, relative frequency and Important Value Index (IVI) of understory vegetation of sago area in Waesamu village, Maluku

Family	Type of vegetation	Dry season			Rainy season		
		Relative density	Relative Frequency	IVI	Relative density	Relative Frequency	IVI
Araceae	*Typhonium flagelli-forme* L.	13.06	7.69	20.75	11.60	6.12	17.73
Araceae	*Colocasia* sp.	19.78	7.69	27.47	17.75	6.12	23.87
Araceae	*Colocasia esculenta* L.	13.43	7.69	21.13	12.97	6.12	19.09
Piperaceae	*Piper betle* L.	1.87	5.13	6.99	1.71	4.08	5.79
Piperaceae	*Piper aduncum* L.	3.36	5.13	8.49	4.44	6.12	10.56
Melastomataceae	*Melastoma affine D. Don*	0.75	5.13	5.87	1.71	6.12	7.83
Melastomataceae	*Clidemia hirta* (L.) D. Don	0.75	5.13	5.87	0.68	4.08	4.76
Thelypteridaceae	*Christella parasitica* (L.) Lev	14.18	7.69	21.87	13.65	6.12	19.77
Athyriaceae	*Diplazium dietrichianum* (Luerss.) C. Chr.	14.18	7.69	21.87	14.68	6.12	20.80
Selanigellaceae	*Selanigella plana* (Desv. ex Poir.) Hieron.	1.87	5.13	6.99	2.39	6.12	8.51
Convolvulaceae	*Ipomoea triloba L.*	5.22	7.69	12.92	4.78	6.12	10.90
Pandanaceae	*Pandanus amarylli-folius* Roxb.	1.49	5.13	6.62	1.71	6.12	7.83
Vitaceae	*Cissus sicyoides* L.	0.75	5.13	5.87	1.02	6.12	7.15
Marattiaceae	*Marattia sylvatica* (Blume)	3.73	5.13	8.86	3.75	6.12	9.88
Poaceae	*Axonopus* sp.	3.36	7.69	11.05	3.07	6.12	9.19
Asteraceae	*Mikania micrantha* Kunth	2.24	5.13	7.37	2.39	4.08	6.47

Source of primary data

Tables 3, 4, 5, 6 and 7 describe the diversity of understory vegetation and around sago clumps in the villages of Eti, Waesamu, Tulehu, Rutong and Tawiri, respectively, where the number of families and species are 15 families and 20 species; 14 families and 20 types of vegetation; 13 families and 15 types of vegetation; 14 families and 14 types of vegetation, and 15 families and 17 types of vegetation. The high number of vegetation families and species indicates that the ecosystem is still natural. [22] reported that natural ecosystems tend to have a high number of vegetation types, on the other hand, damaged ecosystems experience a decrease in the number of vegetation types

Understory vegetation of sago palms dominated by three vegetation families, namely Araceae, Thelypteridaceae, and Athyriaceae. Types of plants included in the Araceae family taro and broadleaf plants, while Thelypteridaceae and Athyriaceae are ferns. The understory vegetation plays an important role in forest conservation and nutrient availability and is also an important component in forest aesthetics [23]. The vegetation structure includes 1) vertical vegetation structure, classifies the layers of vegetation largely according to the different heights to which their plants grow, i.e. tree layers, poles, weaning, seedlings, and herbs that makeup vegetation, 2) horizontal distribution which describes spreading of each vegetation, and 3) the abundance of each species in a community [24]. It seems that the observation site has different type and structure of vegetation.

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The analysis of the vegetation index value obtained is important quantitative information about the structure and composition of a plant community. Quantitative estimation of vegetation communities consists of 1) estimating the composition of species vegetation in an area compared to other areas, or the same area with different observation times, 2) estimating the diversity of species within an area and 3) correlating vegetation diversity with certain environmental factors [25]; [26].

Quantitative parameters in plant community analysis include density, frequency, and dominance. The various types of plants that are dominant in the community can be identified by measuring dominance. Dominance measures can be expressed by several parameters, including biomass, crown cover, basal area, and important value index (IVI) [27]; [28]; [29]. The fern species *Christella parasitica* (L.) Lev had a relative density of 26.80 and IVI of 34.69, which the highest compared to other vegetation types both in the rainy and dry seasons. *Etlingera coccinea* (Blume) S. Sakai & Nagam, Bridelia sp. Willd, *Typhonium flagelliforme* L., *Colocasia* sp., *Diplazium dietrichianum* (Luerss.) C. Chr., and *Colocasia esculenta* L., are also common vegetation types found in the sago area. *Cissus sicyoides* L., is known as medicinal herbal, however because of its growth character, this plant interferes sago growth.

Table 5 Type of vegetation, relative density, relative frequency and Important Value Index (IVI) of understory vegetation of sago area in Tulehu village, Maluku

Family	Type of vegetation	Dry season			Rainy season		
		Relative density	Relative Frequency	IVI	Relative density	Relative Frequency	IVI
Araceae	*Typhonium flagelliforme* L.	7.73	7.89	15.63	8.45	7.32	15.77
Araceae	*Colocasia* sp.	16.02	7.89	23.92	16.33	7.32	23.64
Araceae	*Colocasia esculenta* L.	5.80	7.89	13.70	5.54	7.32	12.86
Poaceae	*Cynopoghon dactylon.* Spreng.	10.50	7.89	18.39	10.20	7.32	17.52
Poaceae	*Axonopus* sp.	1.93	5.26	7.20	2.04	4.88	6.92
Thelypteridaceae	*Christella parasitica* (L.) Lev	26.80	7.89	34.69	22.74	7.32	30.06
Athyriaceae	*Diplazium dietrichianum* (Luerss.) C. Chr.	18.23	7.89	26.13	18.95	7.32	26.27
Moraceae	*Ficus septica* (Burm.)	2.49	7.89	10.38	2.33	7.32	9.65
Convolvulaceae	*Ipomoea triloba L.*	2.76	7.89	10.66	3.21	7.32	10.52
Marantaceae	*Phrynium* sp. willd	1.10	5.26	6.37	2.04	7.32	9.36
Vitaceae	*Cissus sicyoides* L.	1.38	7.89	9.28	1.75	7.32	9.07
Marattiaceae	*Marattia sylvatica* (Blume)	3.31	7.89	11.21	3.50	7.32	10.82
Melastomataceae	*Clidemia hirta* (L.) D. Don	0.55	2.63	3.18	0.87	4.88	5.75
Phyllanthaceae	*Bridelia* sp. Willd.	0.83	2.63	3.46	1.17	4.88	6.04
Zingiberaceae	*Etlingera coccinea* (Blume) S. Sakai & Nagam	0.55	5.26	5.82	0.87	4.88	5.75

Source of primary data

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Table 6 Type of vegetation, relative density, relative frequency and Important Value Index (IVI) of understory vegetation of sago area in Rutong village, Maluku

Family	Type of vegetation	Dry season			Rainy season		
		Relative density	Relative Frequency	IVI	Relative density	Relative Frequency	IVI
Araceae	*Typhonium flagelli-forme* L.	13.94	8.82	22.77	14.22	7.50	21.72
Araceae	*Colocasia* sp.	16.35	8.82	25.17	15.60	7.50	23.10
Araceae	*Colocasia esculenta* L.	10.10	5.88	15.98	7.34	5.00	12.34
Thelypteridaceae	*Christella parasitica* (L.) Lev	13.46	8.82	22.29	13.76	7.50	21.26
Athyriaceae	*Diplazium dietrichianum* (Luerss.) C. Chr.	12.50	8.82	21.32	12.84	7.50	20.34
Piperaceae	*Piper betle* L.	7.69	8.82	16.52	7.34	7.50	14.84
Melastomataceae	*Melastoma affine D. Don*	1.44	2.94	4.38	1.38	5.00	6.38
Selanigellaceae	***Selanigella plana* (Desv. ex Poir.) Hieron.**	1.92	2.94	4.86	2.75	5.00	7.75
Moraceae	*Ficus septica* (Burm.)	2.88	2.94	5.83	3.21	5.00	8.21
Convolvulaceae	*Ipomoea triloba L.*	0.96	2.94	3.90	1.38	5.00	6.38
Marantaceae	*Phrynium* sp. willd	3.37	5.88	9.25	4.59	7.50	12.09
Vitaceae	*Cissus sicyoides* L.	2.40	5.88	8.29	2.29	5.00	7.29
Poaceae	*Phyllostachys* sp.	0.96	5.88	6.84	0.92	5.00	5.92
Marattiaceae	*Marattia sylvatica* (Blume)	5.77	5.88	11.65	5,50	5.00	10.50
Asteraceae	*Mikania micrantha* Kunth	5.29	8.82	14.11	5,05	7.50	12.55
Zingiberaceae	*Etlingera coccinea* (Blume) S. Sakai & Nagam	0.96	5.88	6.84	1.83	7.50	9.33

Source of primary data

Table 7 Type of vegetation, relative density, relative frequency and Important Value Index (IVI) of understory vegetation of sago area in Tawiri village, Maluku

Family	Type of vegetation	Dry season			Rainy season		
		Relative density	Relative Frequency	IVI	Relative density	Relative Frequency	IVI
Araceae	*Typhonium flagelli-forme* L.	16.82	7.69	24.51	17.11	6.38	23.49
Araceae	*Colocasia* sp.	11.82	7.69	19.51	11.40	6.38	17.79
Poaceae	*Phyllostachys* sp.	0.91	5.13	6.04	0.88	4.26	5.13
Poaceae	*Axonopus* sp.	4.55	7.69	12.24	4.39	6.38	10.77
Thelypteridaceae	*Christella parasitica* (L.) Lev	14.09	7.69	21.78	13.60	6.38	19.98
Athyriaceae	*Diplazium dietrichianum* (Luerss.) C. Chr.	19.09	7.69	26.78	16.67	6.38	23.05
Piperaceae	*Piper betle* L.	5.00	7.69	12.69	4.82	6.38	11.21

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Melastomataceae	*Melastoma affine* D. Don	6.36	7.69	14.06	5.26	6.38	11.65
Selanigellaceae	***Selanigella plana* (Desv. ex Poir.) Hieron.**	5.45	7.69	13.15	4.39	6.38	10.77
Moraceae	*Ficus septica* (Burm.)	5.00	5.13	10.13	5.26	4.26	9.52
Convolvulaceae	*Ipomoea triloba L.*	3.18	5.13	8.31	3.95	6.38	10.33
Marantaceae	*Phrynium* sp. willd	0.45	2.56	3.02	1.75	4.26	6.01
Vitaceae	*Cissus sicyoides* L.	1.36	5.13	6.49	1.32	4.26	5.57
Marattiaceae	*Marattia sylvatica* (Blume)	0.91	2.56	3.47	0.88	2.13	3.00
Melastomataceae	*Clidemia hirta* (L.) D. Don	1.36	2.56	3.93	1.75	4.26	6.01
Asteraceae	*Mikania micrantha* Kunth	0.91	2.56	3.47	1.32	4.26	5.57
Phyllanthaceae	*Bridelia* sp. Willd.	1.82	2.56	4.38	2.19	4.26	6.45
Zingiberaceae	*Etlingera coccinea* (Blume) S. Sakai & Nagam	0.91	5.13	6.04	1.75	6.38	8.14

Source of primary data

The results showed that ferns more dominance than other species, which is shown by its density, frequency, and Importance Value Index (IVI). The Important Value Index is an index that describes the importance of the vegetation in its ecosystem. The higher the value of IVI index, the greater the vegetation type affect the stability of the ecosystem. The Importance Value Index (IVI) can be used to determine the dominance of plant species over other plant species [25].

4. CONCLUSION

Metroxylon rumphii Mart type. (Tuni sago), *M.* sagus Rottb. (Molat sago) and *M. Silvester* Mart. (Ihur Sago) dominates sago palms area in Seram and Ambon Islands, Maluku. There are significant morphological differences between the types of sago, especially in stem height, midrib width, leaf midrib colour, number of thorns, and flower stalk length, as well as the difference of carbohydrate content.

Understory vegetation of each observation sites diverse consist of 15 families and 20 species. The families that dominate the understory vegetation of sago palms are Araceae, Thelypteridaceae, and Athyriaceae. The types of plants from Araceae are taro types and broadleaf, while those from the Thelypteridaceae and Athyriaceae families are types of ferns. Several types of plants, are known as medicinal plants, used for cooking spices, and produces essential oils plants.

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