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Species Diversity and Distribution of Palm Plants in Aketajawe Lolobata National Park, North Maluku, Indonesia

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Abstract—This research aimed to determine the diversity of species and distribution of palm plants. This research is a qualitative description. The data collection technique was carried out by roaming techniques, then counting the number of individuals of each palm plant species at each observation point. The data collection results were then analyzed using species diversity index analysis and dispersal index to determine species distribution. The results showed that the diversity of palm species in Aketajawe Lolobata National Park had a species diversity index value of $H' = 0.98$, so it was categorized as a low species diversity index. In contrast, the distribution of palm plant species has varying values ranging from <0 to >1 , so it can be categorized into random, uniform, and group distributions.

Keywords—Species diversity, distribution, palm trees, Aketajawe Lolobata National Park.

I. INTRODUCTION

The Palm plant was one of the major horticultural crops of the ancient world and served as an essential food source. Its geographic distribution is between latitudes 24° and 34° north latitude, and it is considered a significant center of biodiversity for the palm tree [1]. Indonesia is known as a country that is rich in a diversity of palm plant species, and it is estimated that there are around 576 types of palms belonging to 46 genera that are widespread in the territory of Indonesia, one of which is on Halmahera Island, namely in the Aketajawe Lolobata National Park (TNAL). Palm can grow well on sandy soil types, peat soils, limestone soils, and hilly soils [2].

The Aketajawe Lolobata National Park area, has an area of 167,300 Ha which consists of two blocks, namely: the Aketajawe area block and the Lolobata area block. This area is located in three regions: Central Halmahera Regency, Tidore Islands City, and East Halmahera Regency [3]. The Ecosystem of the Aketajawe Lolobata National Park (TNAL) is a protected area with various habitats and types from the Halmahera group biogeographical unit within a management unit (Ministry of Environment and Forestry, 2004). The protection expected from this area is the conservation of biodiversity, ecosystems, and a series of habitats from the lowlands to the mountains, including various types of palm plants.

Palm plants are an exciting group of plants from species diversity. Palms are generally trees or shrubs, varying in size from 25 cm to 60 m, with varying shapes of leaves, roots, inflorescences, fruits, and seeds [4].

Palm plants are widely used by the people around the Aketajawe Lolobata National Park area to fulfill their needs; for example, coconut, sago, and sugar palm are used as a source of staple food, and some make them as ornamental plants to make money. The people around Aketajawe Lolobata National Park always cut down palm trees for building materials for houses, made into works of art, and for areca climbing contests and others. This condition has an impact on decreasing species diversity and even the distribution of palm plants. This condition has continued until now, so it is feared that it will impact reducing the diversity and distribution of palm plant species in the region. Therefore, this research was conducted to conduct an in-depth study of the diversity and distribution of palm trees in Aketajawe Lolobata National Park.

II. MATERIAL AND METHODS

This research is descriptive by using the nature walk method, which takes place in Aketajawe Lolobata National Park in January-February 2022. In this study, three observation points were determined with a distance of 500m each, and then at each point, four transect lines were made with a length of 500m each transect, then the total number of observations transects is 12. After that, observations were made on the vegetation by recording the types of palm plants and counting the number of individuals of each type. Bioecological factors measured include temperature, soil moisture, light intensity, and soil pH. The results of the observations were then analyzed descriptively and qualitatively.

III. RESULTS

Composition of types of Palm Plants

Based on the research results conducted in Aketajawe Lolobata National Park, nine palm trees were found on four transects. The composition of palm plant species is presented in Table 1 below.

Table 1. Composition of palm species in Aketajawe Lolobata National Park

No	Families	Clan	Types	Number of Individuals
1	Areaceae	Pinanga	<i>Pinanga Kuhlii</i>	69
2	Areaceae	Oncosperma	<i>Oncosperma tigillarum</i>	145
3	Areaceae	Livistona	<i>Levistonina rotundifolia</i>	381
4	Areaceae	Caryota	<i>Caryota mitis</i>	56
5	Areaceae	Licuala	<i>Licuala spinosa</i>	192
6	Areaceae	Pinanga	<i>Pinanga caesia</i>	25
7	Areaceae	Arenga	<i>Arenga microcarpa</i>	27
8	Areaceae	Pigafetta	<i>Pigaffeta filaris</i>	17
9	Areaceae	Arenga	<i>Arenga pinnata</i>	25
Total				937

(Source: Research Results, 2022)

Based on table 1 above shows that of the nine palm plant species, there are 9 Areaceae families with a total number of individuals of 937, then the number of individuals is then analyzed on the species diversity index.

Species Diversity

Based on the data in table 1, an analysis of the species diversity index was carried out, presented in table 2 below.

Table 2. Results of Species Diversity Index Value Analysis

No	Species Name	H'	Ha
1	<i>Pinanga kuhlii</i>	0,06	0,24
2	<i>Oncosperma tigillarum</i>	0,12	
3	<i>Levistonina rotundifolia</i>	0,31	
4	<i>Caryota mitis</i> Lour.	0,05	
5	<i>Licuala spinosa</i>	0,16	
6	<i>Pinanga caesia</i>	0,02	
7	<i>Arenga microcarpa</i>	0,02	
8	<i>Pigaffeta filaris</i>	0,01	
9	<i>Arenga pinnata</i>	0,02	
Total		0,98	

(Source: Research Results, 2022)

Based on table 2 above, the analysis results of the diversity of palm species in Aketajawe Lolobata National Park have a species diversity index value of $H' = 0.98$, so it is categorized as a low species diversity index.

From the results of this analysis, it can be assumed that this low species diversity can occur due to the many activities of the surrounding community who cut down and utilize these palm plants of various types for their daily needs as well as for the needs of celebrating religious holidays and the need for areca climbing competitions. This condition can result in a reduction in the number of individuals of each type of palm plant at the study site.

Species diversity tends to increase or decrease according to the area size. Diversity tends to decrease in stressed biotic communities because it is influenced by anthropogenic factors which always utilize the various species needed. However, it can also be reduced by competition in senior communities and environmental stability. Plant diversity shows variations in an area's shape, body structure, color, number, and other characteristics. Living natural resources are part of the living environment chain, which enables this environment to revive the surrounding people from generation to generation [5].

Distribution of Palm Plant Types

Distribution of palm plant species in Aketajawe Lolobata National Park, presented in table 3 below.

3. Results of the analysis of the distribution of Palm species

No	Species Name	Area					Distribution Pattern
		Iδ 1	Distribution Pattern	Iδ 2	Distribution Pattern	Iδ 3	
1	<i>Pinanga kuhlii</i>	1,319	Uniform	3,588	Group	8,516	Group
2	<i>Oncosperma tigillarum</i>	0,038	Random	0,011	Random	0,255	Random
3	<i>Levistonina rotundifolia</i>	0,367	Random	1,646	Uniform	6,408	Group
4	<i>Caryota mitis Lour.</i>	3,867	Group	1,968	Uniform	0,012	Random
5	<i>Licuala spinosa</i>	0,359	Random	4,000	Group	0,109	Random
6	<i>Pinanga caesia</i>	2,622	Random	0,205	Random	2,950	Group
7	<i>Arenga microcarpa</i>	0,198	Random	4,552	Group	4,916	Group
8	<i>Pigaffeta filaris</i>	0,004	Random	0,000	Random	0,000	Random
9	<i>Arenga pinnata</i>	0,198	Random	2,556	Group	2,283	Group
Total		12,08		22,01		36,49	

(Source: Research Results, 2022)

Based on the results of the research presented in table 3 above show that the distribution of palm plant species in Aketajawe Lolobata National Park has varying values ranging from $<0 > 1$, so it can be categorized into three distribution models, namely random, uniform distribution and in groups (clumped).

The distribution of plants, generally, can be described in three patterns, namely: first, random distribution, where the condition of the individual at a point does not affect the probability of having members of the same population at adjacent points; second, clustered distribution, where the existence of an individual at a point allows the existence of the same individual at another nearby point; and thirdly distribution evenly, where the existence of an individual at a point reduces the probability of the existence of the same individual at a point around it. Population distribution plays an essential role in the geographical distribution of plants, animals, or humans to an area they have never occupied before.

Distribution in a population is the movement of individuals into or out of a previously inhabited population. Individuals carrying out distribution can be in the form of larvae, spores, seeds from plants and animals, and humans. Population distribution can be caused by the urge to find food, avoid predators, climatic influences from water or wind, mating behavior, and other physical factors. Population distribution can affect existing biodiversity [6]

IV. DISCUSSION

Composition of types of Palm Plants

The composition of palm plants is the constituent of a stand which includes the number of family types or the number of individuals of a plant species. The palm plants found were nine species consisting of the Arecaceae Family, Pinanga Clan, Oncosperma, Livistona, Caryota, Licuala, Arenga, and Pigafetta, which are found in Aketajawe Lolobata National Park with a total number of individuals of 937. This shows that the number of individuals of each type has a different adaptation. They depended on the physical condition of the environment. [2] generally, the more extreme the environmental conditions, whether due to climate, soil, or altitude, the less the diversity of the vegetation species composition, and one or two species will become more dominant.

According to Suin (2002), in a community, it can be seen that there are differences in the types of constituents vertically, such as differences in life forms and their levels. Organisms whose density is rare can be used as an indicator of the state of the environment in a research location because it can provide an overview of the physical condition of a habitat.

Odum (1993) explains that most natural communities contain a few species with a more prominent (dominant) number of individuals, and conversely, many species are represented by a few individuals. With a small number, the mastery over the plant environment is more significant, so the pattern of species concentration -dominant species will be spread evenly because fewer types allow the number of individuals to grow and develop properly.

The Species Diversity

Based on the analysis of the diversity index value of palm plant species, found as many as nine species, the total diversity index results are $H' = 0.98$. It is included in the low category. [8] explains that in communities or ecosystems with low diversity and productivity, there are heavy ecological pressures, resulting in unstable ecosystems. In contrast, in communities and ecosystems with moderate diversity, the diversity index of undergrowth, seedlings, saplings, poles, and trees and vegetation types with sufficient productivity, the community and ecosystem conditions are balanced with moderate ecological pressure.

Arbi (2012) states that the high or low value of the diversity index can be influenced by various factors, including the number of species found and some species found in more significant numbers than other types, as well as disturbances from nature and humans.

McNaughton and Wolf (1998) state that extreme pressure and various disturbances result in low diversity of an ecosystem. The low diversity in monsoon forests and savanna makes the area vulnerable to disturbances from nature, animals, and humans, one of which is invasive foreign plants. [9] Hypothesized a negative relationship between diversity and the ease with which a community can be invaded. That is, a community with many species will be more resistant to invasion by foreign plants, while a community with fewer species will be more susceptible.

Species diversity tends to be low in physically controlled ecosystems and high in biologically regulated ecosystems [7]. A forest that is disturbed by both nature and humans will affect the value of its species diversity between the growth phases of the trees and

the availability of individuals. Conditions like this prove that the area around Aketajawe Lolobata National Park is experiencing disturbances due to community activities that always cut down and utilize palm trees. This will reduce species richness in the area.

The low diversity of palm species in Aketajawe Lolobata National Park indicates that efforts are needed to increase species diversity, both adding new species and increasing the number of individuals and their distribution evenly. The impact of reduced species diversity and the number of individual trees can cause the balance of the ecosystem to decrease and disrupt its stability of the ecosystem.

Distribution of Palm Plant Types

Based on table 3, data on the distribution of palm trees in Aketajawe Lolobata National Park shows that the values vary from <0 to >1 , which means that the distribution of palm species consists of uniform and clumped random distributions. [10] Explained that there are three types of distribution patterns, namely: (1) random, this pattern reflects habitat homogeneity and non-selective behavior patterns, and (2) clumped, this pattern reflects heterogeneous habitats., reproductive models, group behavior, etc., (3) uniform, reflecting negative interactions between individuals such as competition for space and nutrients or light.

Random distribution occurs because there is no strong attraction or repulsion between individuals in a population, and the position of each individual does not depend on other individuals. Random distribution generally occurs in habitats where environmental conditions and available resources are sufficient or consistent. Suppose the factors that affect the presence of a species in a place are relatively small. In that case, this is purely an opportunity and usually results in a random pattern of species distribution [11].

Random distribution occurs when a type is spread arbitrarily (randomly), meaning that each type does not have a specific direction and position relative to other types. Suppose you look at the environment in open areas. In that case, the environmental conditions and resources that exist in nature are available evenly so that no area is formed differently from the others, mainly because it is overgrown by different plant species. Resources that are evenly distributed in open areas make these individuals able to grow and develop in certain positions without having to interact with other individuals of the same type. Dispersal factors by wind and animals can also be one of the factors causing random distribution in plants.

Following the statement of [12], the random distribution pattern is also known as the distribution with unexpected distances. It occurs when members of a species are found in a homogeneous environment. In ecology, random distribution is a characteristic of populations, where individuals of the same kind form a population within an ecosystem. In its distribution, these individuals live separately from one another.

Random distribution generally occurs in habitats where environmental conditions and resources are consistent. If the factors that affect the presence of a species in a place are relatively small, then this is pure chance and usually results in a random distribution of species [13]. At the same time, the clustered distribution is caused by several things, for example, environmental conditions, eating habits, and how to reproduce. Group distribution will make it easier for individuals to relate to each other to share needs such as reproduction and finding food.

Campbell et al. (2004) described that random distribution occurs because there is little or no attraction or repulsion between individuals in a population. With the nature of random distribution, reproductive activity will be low, and the presence of these populations in nature will be weak or less robust.

This type of palm plant dominates places with more humid and shaded environmental conditions and less light intensity, causing it to spread in groups. Living in groups of plants will be able to withstand the effects of wind or inhibit water evaporation rather than living alone. This is under the conditions at the research location; at a certain altitude, there are no trees, so to deal with the effects of wind blowing and water evaporation, the distribution of palm plants in this area tends to be in groups. [12] explains that group distribution in a population is a typical distribution in nature for plants and animals.

The uniform distribution indicates that the environmental conditions in Aketajawe Lolobata National Park are the same, both for growing space, nutrient availability, and sunlight. Pemberton and Frey (1984) stated that uniform distribution could also be caused by antagonistic interactions between individuals, such as competition for food availability and growing space.

Uniform distribution with individuals more or less equidistant from one another is rare, and a uniform distribution is rare in natural populations. Approaching this situation when there is thinning due to competition between individuals, which is relatively tight, but generally in a managed ecosystem, and here the plants are deliberately arranged like that so that the distance is the same to produce optimal products. If individuals are spread over relatively equal distances, it can occur when environmental conditions are reasonably uniform throughout the area and there is intense competition between individuals within the population. Strong competition between individuals in the population will encourage the division of space equally, giving an example that forest is dense, and the tall trees have an almost uniform distribution. The dominant trees in the forest are spaced regularly because of intense competition for light and nutrients [7] in [14].

V. CONCLUSION

Based on the results of the research and discussion, it can be concluded that:

1. Diversity of palm plant species in Aketajawe Lolobata National Park. It has a species diversity index value of $H' = 0.98$, so it is categorized as a low species diversity index.
2. The distribution of palm plant species in Aketajawe Lolobata National Park has values ranging from <0 to >1 , so they can be categorized into random, uniform, and group distributions (clumped).

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