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Diversity of fern plants (Pteridophyta) in the oil palm plantation area of Gontara Village, Central Sulawesi

Rinaldy Kristokam Ranuntu, Astija * and Musdalifah Nurdin

Biology Education Study Program, Faculty of Teacher Training and Education, Tadulako University, Jl. Soekarno Hatta Km. 9 Tel. (0451) 422611 - 422355 FAX: (0451) 422844 Palu, Central Sulawesi, Indonesia.

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Abstract

Ferns are a kind of plant that exhibits a high degree of adaptability and may be cultivated with relative ease in the Gontara Village Region, located in Central Sulawesi, Indonesia. The decline in the variety of this particular plant species can be attributed to the extensive conversion of land for oil palm plantations. So far, no empirical investigations or datasets have been conducted or published that provide insights on the extent of fern species diversity subsequent to the conversion of the region into an oil palm plantation. Hence, the present study was undertaken with the objective of ascertaining the various classifications of ferns and assessing the extent of fern variety. The present study employs the route approach in conjunction with a purposive sampling strategy. The present study was done in the oil palm plantation region of Gontara Village, Mori Atas District, Central Sulawesi. A total of 21 fern species were identified, belonging to 5 distinct classes, 5 orders, and 9 families. The Shannon-Wiener Diversity Index yields a value of 2.82, indicating the extent of diversity.

Keywords: Fern; Diversity; Oil palm plantation; Pteridophyta; Central Sulawesi

1. Introduction

Indonesia is internationally recognized as a prominent mega-biodiversity nation due to its remarkable abundance and variety of biological species. Indonesia is widely recognized as the second-largest hub of biodiversity globally, behind Brazil [1]–[4]. According to a studies that the tropical forest settings in Indonesia exhibit a much higher level of biodiversity compared to temperate temperature forests, with an estimated 300-fold difference [5], [6]. In order to ensure the correct functioning and sustainability of forests as natural resources, it is imperative to effectively manage and utilize them while also maintaining their sustainability [7], [8]. One approach to doing this is through preserving and promoting species variety within forests.

North Morowali Regency, located in the province of Central Sulawesi, is considered to be one of the administrative divisions within the broader region of Central Sulawesi. In terms of its geographical location, the North Morowali Regency can be found in a latitude ranging from 1° 31' to 3° 04' South, and a longitude ranging from 121° 02' to 123° 01' East [9]. Gontara Village, situated within the Mori Atas District of North Morowali Regency, is characterized by a significant transformation of its forested regions into expansive oil palm plantations.

According to several studies that oil palm farms have been identified as a favorable environment for the proliferation of diverse plant species [10], [11]. Oil palm farms include a somewhat intricate environment, hence accommodating many plant species, including herbs and shrubs. Ferns are a prevalent kind of bush plants found in oil palm farms [12]–[16]. Ferns typically exhibit a preference for environments with high moisture levels, since regions characterized by

* Corresponding author: Astija

humidity tend to possess soil that is rich in humus and fertile [17], [18]. According to several studies that ferns are classified as cormus plants, which implies that they possess discernible structures for roots, stems, and leaves [19], [20].

The findings from surveys conducted in the oil palm plantation region of Gontara Village revealed the presence of twelve distinct species of ferns that thrive in various habitats, including terrestrial environments such as weathered wood and decomposed fruit bunches, as well as epiphytic growth on stems. Ferns are commonly seen as undesirable vegetation or plants that disrupt oil palm fields due to their propensity to serve as habitats for pests, such as rats, who consume the oil palm fruit [21]. Consequently, the oil palm cultivators residing in Gontara Village regularly engage in the practice of clearing the vicinity surrounding the oil palm plantation. In contrast, the ferns have a significant part in the process of humus production, as well as in safeguarding against soil erosion and preserving soil moisture [22], [23]. Furthermore, it is noteworthy that ferns possess considerable economic significance as they are much sought after as aesthetic flora and may also serve as components in culinary preparations [24], [25].

The region has undergone a transition from a tropical forest ecosystem to an oil palm plantation, which has led to a shift in the attitudes of people towards fern plants, namely into prioritizing oil palm plants. This change in perception is expected to have implications for the amount of species variety of ferns in the area. Consequently, it is imperative to do thorough study, particularly pertaining to the biodiversity of ferns and the extant species inside Gontara Village, which is encompassed by the oil palm plantation region.

2. Material and methods

The study was undertaken inside the oil palm plantation region of Gontara Village, located in the Mori Atas District, throughout the period of February to June 2023. The selection of the research site was conducted by taking into account the soil characteristics observed in the oil palm farms. Station 1 is situated across an expanse devoid of obstructions, Station 2 is located within a hydrological basin, and Station 3 is positioned within a residential locality.

The methodology employed in this research is the utilization of the transect approach, which is strategically positioned at three pre-established observation sites. Each transect in the study has an area of 50 m × 40 m, and inside each transect, the plots are methodically organized in a zigzag pattern. The size of each plot is 10 m x 10 m. The selection of the sample station was conducted in a deliberate manner, taking into account the abundance of ferns present at the observation site.

The identification of samples acquired through the utilization of a fern identification study is being conducted [26]–[30]. The calculation of the diversity index for ferns is based on the species diversity index formula developed by Shannon-Wiener, as described in the study conducted [31], that is:

$$H' = - \sum P_i \ln P_i; \text{ where } P_i = n_i/N$$

Information:

H' = Diversity Index

n_i = Number of individuals of each species

N = Total number of individuals

3. Results

The physical-chemical characteristics of the environment were assessed using measurements, which encompassed variables such as temperature, soil pH, humidity, and light intensity. The physical-chemical conditions were assessed and the corresponding findings are presented in Table 1.

According to the data shown in Table 1, the mean temperature attains a value of 29 °C, the humidity level is recorded at 62%, the pH level is measured to be 6.83, and the light intensity is quantified as 118.8 cd.

Table 1 Physical-Chemical Conditions of the Gontara Village

No	Parameter	Physical-Chemical Conditions			Mean
		Station 1	Station 2	Station 3	
1.	Air temperature (°C)	30 °C	30 °C	28 °C	29 °C
2.	Humidity (%)	60 %	62 %	64 %	62 %
3.	Soil pH	6.8	6.9	6.8	6.83
4.	Light intensity (Cd)	111.5 cd	93.1 cd	151.8 cd	118.8 cd

The findings pertaining to the identification of the ferns yielded a total of 21 distinct species, encompassing 8 terrestrial ferns and 13 epiphytic ferns. The ferns encountered encompass a total of five classes, five orders, and nine families. The information is shown in Table 2.

Table 2 Species of Ferns in the Oil Palm Plantation Area of Gontara Village

No	Class	Order	Family	Species	Habitat
1	Pteridopsida	Polypodiales	Pteridaceae	<i>Pteris cretica</i>	Terrestrial
		Polypopiales	Dryopteridaceae	<i>Dryopteris carthusiana</i>	Epiphytes
		Polypodiales	Polypodiaceae	<i>Drynaria quercifolia</i>	Epiphytes
		Polypodiales	Polypodiaceae	<i>Phymatosorus scolopendria</i>	Terrestrial
2	Polypodiopsida	Polypodiales	Polypodiaceae	<i>Pyrrosia piloselloides</i>	Epiphytes
		Polypodiales	Polypodiaceae	<i>Stenochlaena palustris</i>	Epiphytes
		Polypodiales	Polypodiaceae	<i>Drynaria sparsisora</i>	Epiphytes
		Polypodiales	Pteridaceae	<i>Vittaria elongata</i>	Epiphytes
		Polypodiales	Pteridaceae	<i>Adiantum petiolantum</i>	Terrestrial
		Polypodiales	Dryopteridaceae	<i>Nephrolepis biserrata</i>	Terrestrial
		Polypodiales	Dryopteridaceae	<i>Nephrolepis</i> sp	Epiphytes
		Polypodiales	Aspleniaceae	<i>Asplenium seratum</i>	Epiphytes
		Polypodiales	Davalliaceae	<i>Davallia solida</i>	Epiphytes
		Polypodiales	Davalliaceae	<i>Davallia canariensis</i>	Epiphytes
		Polypodiales	Davalliaceae	<i>Davallia denticulata</i>	Epiphytes
		Polypodiales	Davalliaceae	<i>Davallia trichomanoides</i>	Epiphytes
		Schizaeales	Lygodiaceae	<i>Lygodium microphyllum</i>	Terrestrial
		Schizaeales	Lygodiaceae	<i>Lygodium palmatum</i>	Terrestrial
3	Gleicheniopsida	Gleicheniales	Gleicheniaceae	<i>Dicranopteris linearis</i>	Terrestrial
4	Lycopodiosida	Lycopodiales	Lycopodiaceae	<i>Lycopodiella cernua</i>	Terrestrial
5	Psilotopsida	Ophioglossales	Ophioglossaceae	<i>Ophioglossum pendulum</i>	Epiphytes

The diversity species ferns is further examined, as depicted comprehensively in Table 3.

Table 3 A number and category of Ferns Species in the Oil Palm Plantation Area of Gontara Village

No	Species	Number	Pi (ni/N)	Ln (Pi)	Pi. Ln. Pi
1	<i>Pteris certica</i> L.	56	0.08	2.526	0.202
2	<i>Lycopodiella cernua</i> (L.) Pic. Serm.	30	0.043	3.150	0.135
3	<i>Drynaria quercifolia</i>	18	0.026	3.661	0.094
4	<i>Phymatosorus scolopendria</i>	36	0.051	2.968	0.153
5	<i>Dryopteris carthusiana</i> (Vill.) H.P. Fuchs	5	0.007	4.942	0.035
6	<i>Davallia solida</i>	23	0.033	3.416	0.112
7	<i>Davallia canariensis</i>	18	0.026	3.661	0.094
8	<i>Pyrrosia piloselloides</i>	27	0.039	3.255	0.126
9	<i>Davallia denticulata</i>	36	0.051	2.968	0.153
10	<i>Nephrolepis biserrata</i>	15	0.021	3.843	0.082
11	<i>Stenochlaena palustris</i>	17	0.024	3.718	0.090
12	<i>Lygodium microphyllum</i>	55	0.079	2.544	0.200
13	<i>Drynaria sparsisora</i> Moore	48	0.069	2.680	0.184
14	<i>Vittaria elongata</i>	5	0.007	4.942	0.035
15	<i>Nephrolepis sp.</i>	14	0.020	3.912	0.078
16	<i>Davallia trichomanoides</i> Blume	58	0.083	2.491	0.206
17	<i>Dicranopteris linearis</i>	73	0.104	2.261	0.236
18	<i>Lygodium palmatum</i>	58	0.083	2.491	0.206
19	<i>Ophioglossum pendulum</i> L.	6	0.009	4.759	0.041
20	<i>Asplenium serratum</i> L.	77	0.110	2.207	0.243
21	<i>Adiantum petiolantum</i> Desv.	25	0.036	3.332	0.119
	Total	700			2.82

The diversity index yielded a value of 2.82. According to the above criteria, a numerical value falling within the range of $1 < H' \leq 3$ signifies the classification of species diversity as moderate.

4. Discussion

The findings of the study done inside the oil palm plantation vicinity of Gontara Village revealed the presence of 21 distinct fern species, which can be classified into 5 classes, 5 orders, and 9 families. The fern species identified in this study were categorized into two groups based on their respective habitats: terrestrial ferns, including a total of eight species, and epiphyte ferns, encompassing a total of thirteen species. In contrast to the study undertaken that identified a total of 16 fern species, comprising 11 terrestrial fern species and 5 epiphytic fern species [32]. According to the findings of this investigation, the Polypodiaceae family had the highest frequency of occurrence, encompassing a total of six distinct species. In contrast to the study undertaken that examined a total of three species belonging to the Polypodiaceae family [33]. The findings presented in this study demonstrate the capacity of the Polypodiaceae family to exhibit adaptation to various environmental conditions, particularly abiotic factors such as temperature, humidity, and soil pH. The prevalence of species belonging to the Polypodiaceae family is strongly correlated with the existence of physical and chemical environmental elements within the given region. Based on the perspective presented a study, it is suggested that the ideal temperature range for the proliferation of ferns falls between 20.5 and 33 degrees Celsius, accompanied by a humidity level of 60 to 80 percent [30]. Based on the findings obtained from the environmental assessment conducted in the oil palm plantation area situated in Gontara Village, the mean temperature was recorded at 29 °C, while the relative humidity was 62%. Additionally, the soil pH level was determined to be 6.83, and the light intensity was quantified at 118.8 cd.

The physical and chemical characteristics of the environment seem to affect the level of diversity of fern species in the oil palm plantation area of Gontara Village. From the 3 observation stations, overall the species diversity index is in the medium category with $H' = 2.82$ using the Shannon-Wiener calculation. From Table 3, it can be seen that *Dryopteris carthusiana* (Vill.) H.P. Fuchs and *Vittaria elongata* are the least common fern species and the lowest diversity. One of the supporting factors affecting the reduction in fern species found is temperature.

Dryopteris carthusiana (Vill.) H.P. Fuchs and *Vittaria elongata* are grouped into ferns which have small leaves and the leaves are located in a straight line (linear) so that they require low temperatures, namely between 13 °C – 18 °C [34]. The situation is different from the temperature in the oil palm plantation area of Gontara Village, which reaches 29 °C. *Asplenium serratum* L is the most common type of fern found. This is because the Aspleniaceae family is a type of fern that can live in open areas such as oil palm plantations. This is in accordance with the opinion put forward a study that reported that the wide distribution in the Aspleniaceae family was inseparable from its diverse life forms [35]. This family has terrestrial, epiphytic and epiphytic life forms, but in the oil palm plantation area of Gontara Village, they live as an epiphyte.

5. Conclusion

The oil palm plantation region in Gontara Village, Mori District, encompasses a total of 21 distinct species of ferns. The ferns under consideration encompass a total of eight distinct terrestrial species and thirteen distinct epiphytic species. These ferns together fall into five distinct classes, five distinct orders, and nine distinct families. The fern diversity index within the oil palm plantation region of Gontara Village, Mori District is classified as medium, with a value of $H' = 2.82$. Despite the ongoing conversion of forests into oil palm plantations, there is evidence to suggest that the variety of fern species has been able to persist. This practice holds significant use in the preservation of the environment.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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