Exploring the type of ferns (pteridophyta) to realize the Wonorejo Surabaya mangrove forest ecology balance

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Abstract. Mangrove forests are the habitat of various organisms, including Ferns plants. Ferns plants as plant communities in biodiversity have important ecological functions in the mangrove forest ecosystem. The objectives of the study were (1) to know the index of the diversity of Ferns plant species (pteridophyta), (2) to determine the type of Ferns plant found in the mangrove forest of Wonorejo Surabaya, (3) to know the environmental parakeet of mangrove forest of Wonorejo Surabaya as the place of life of Ferns plant (pteridophyta). The research was conducted from March 2018 - June 2018 in Wonorejo mangrove Surabaya. This type of research is descriptive skin to obtain information about the diversity of Ferns plant species in terms of sporangium type, habitat and environmental factors that may affect. Samples were obtained from 5x5m plot of land at 5 research stations. The method used in this study is the method cruse with direct observation and explore each point of the location that can represent the types of ecosystems or vegetation in the area under study. The result shows that the diversity of Ferns plant species in the mangrove forest of Wonorejo Surabaya is said to be low in terms of diversity index because there are only 3 types of Ferns plants that consist of pteridaceae family, with Acrostichum aerum, Acrostichum speciosum and Pytirogramma calomelanos. This is due to environmental factors that are less suitable as a place of life of Ferns plants such as habitat, temperature, humidity, light intensity and wind speed. The benefit of this research is to go to the ecosystem that is suitable with Ferns plant by adding the habitat for Ferns plant to live.

1. Introduction

Indonesia is known as one of the world's mega diversities because it has a lot of flora. The diversity of plants owned by Indonesia ranks the top five in the world, which has more than 38,000 species of plants (55% endemic). Diversity in the types of flora in nature which creates human consciousness to simplify the object of study through classification, identification, and giving the right name for each group of plants by utilizing the characters found in each plant, and classifying into certain groups [1].

Based on the IUCN report, ferns have a 52% risk of extinction and some species are threatened with extinction [2]. Clearance of forest areas can cause ferns to diminish. Some species of ferns will experience extinction if they continue to be left unattended [3].

Research on the composition, diversity and distribution of ferns in mangrove forests has been carried out. Research conducted in the mangrove estuary Peniti the District Segedong Pontianak district is known that this type of fern found a total of 11 types of Acrostichum aureum, Acrostichum speciosum, Asplenium nidus, blechnum indicum, Drymoglossum piloselloides, Elaphoglossum callifolium,
Lygodium flexuosum, Lygodium scandens, Nephrolepis biserrata, Nephrolepis falcata and Stenochlaena palustris [4].

Types of ferns in the Wonorejo mangrove Surabaya have never been documented. Therefore, research on types of ferns (Pteridophyta) in the Wonorejo Surabaya mangrove forest needs to be done.

2. Research methods

2.1. Research design and experiment
Judging from the type of data the research used was qualitative descriptive research. Qualitative research is research that intends to understand the phenomenon of what is experienced by research subjects holistically, and by means of descriptions in the form of words and languages. In a special natural context and by utilizing various scientific methods [5].

This type of qualitative descriptive research used in this research is intended to obtain information about the variety of ferns (Pteridophyta) in the Wonorejo Surabaya mangrove forest [6]. Types of ferns obtained in the field were identified in the Biology Laboratory of the Faculty of Mathematics and Natural Sciences of the University of PGRI Adi Buana Surabaya.

The sampling of ferns was carried out by Cruise Method, namely by direct observation and exploring each location point that could represent ecosystem types or vegetation in the area under study [7]. Sampling was based on 5 research station points representing Wonorejo mangrove vegetation, namely 1. Sonneratia station, 2. Rhizophora, 3. Avicennia, 4. Excoecaria (Manengen), and 5. Bruguiera (Lindur).

2.2. General condition of mangrove Wonorejo
The wonorejo mangrove area is located at 7°18’31” S’s and 112°49’18” E based on Google Earth 2018, covering an area of ± 3-4 Hectares.

![Figure 1. Map of the research location.](image)

2.3. Wonorejo mangrove zone
Wonorejo Surabaya Mangrove has a mangrove zoning pattern from the sea to the outermost pond boundary starting with Avicennia marina, Avicennia alba, Nypha, Rhizophora stylosa, Rhizophora mucronata, Rhizophora apiculata, then Sonneratia alba to the outermost pond boundaries [8].

2.4. Measurement of mangrove environment parameters
Measurement of environmental conditions parameters of the mangrove ecosystem includes data collection such as temperature data, light intensity, wind speed and humidity. Measurement of temperature and humidity and wind speed are used in the form of a thermometer and digital hygrometer.
Measurement of light intensity is used by lux meter. Measurement of mangrove environmental parameters was carried out at all stations in the mangrove research location.

2.5. Sampling
Sampling was based on 5 research station points representing Wonorejo mangrove vegetation, namely 1. Sonneratia station, 2. Rhizophora, 3. Avicennia, 4. Excoecaria (Manengen) and 5. Bruguiera (Lindur).

The sampling technique of ferns was carried out by using an observation plot of size (10m × 10m) as many as 5 plots. Observations were made on all types of ferns in the observation plot [3].

Search is carried out on each cruise line starting from the edge of the highway and then entering the forest by tracing and splitting the forest. The distance of each cruise line is determined based on the condition of the vegetation in the forest and the limit of view of the extent to which plants can be observed. Each type of ferns found photographed is then taken and given a hanging etiquette that contains information about the location, date of exploration, type of ferns, name of area, habitat where it grows, and other characteristics encountered for further identification [7].

![Figure 2. Research station.](image)

Information:

- Station 1: a mangrove area dominated by Sonneratia species.
- Station 2: mangrove area dominated by Rhizophora.
- Station 3: a mangrove area dominated by Avicennia.
- Station 4: a mangrove area dominated by Excoecaria (Manengen).
- Station 5: a mangrove area dominated by Bruguiera (Lindur) species.

2.6. Plant identification
Identification is done by looking at the morphological characters of ferns which include the roots, stems, leaves and spores. If spores are not found in a type of fern, then identification is only carried out on the vegetative morphological character. Identification of ferns using the reference book Flora [9] and the book Biology and Evolution of Ferns and Lycophytes [10].

2.7. Making identification keys
The key to determination is made by arranging the characteristics of plants into every word consisting of two lines of guides containing characteristics that are opposite to each other. Each word is given a guide number marked with letters [11].
2.8. Data analysis

2.8.1. Diversity index. Diversity is determined using the Diversity index (Diversity) Shannon-Wiener [12]:

\[
H' = - \sum (pi \cdot \ln pi)
\]

Explanation:

- The value of \( H' > 3 \) indicates that species diversity in a place is high abundance.
- A value of \( 1 \leq H \leq 3 \) indicates that species diversity in one place is moderate.
- \( H' < 1 \) value indicates that species diversity in one place is little or low.

3. Result

The results of observations carried out in the mangrove Wonorejo Surabaya, found 3 types of ferns from the Pteridaceae family. The types of ferns can be seen in table 1.

| Class            | Familia               | Spesies                        | Regional Name        |
|------------------|-----------------------|--------------------------------|----------------------|
| Polypodiopsida   | Pteridaceae           | Acrostichum aureum Linn.       | Paku laut            |
|                  |                       | Acrostichum speciosum Linn.    | Paku laut            |
| Polypodiopsida   | Pteridaceae           | Pityrogramma calomelanos L     | Paku perak           |

3.1. Diversity of ferns

Ferns found in the Wonorejo mangrove forest have different amounts at each research station based on mangrove vegetation. The number of individual ferns can be seen in table 2.

| Station | Mangrove Zone      | A. a | A. s | P. c | Total |
|---------|--------------------|------|------|------|-------|
| 1       | Sonneratia         | 25   | 8    | 1    | 34    |
| 2       | Rhizophora         | 4    | 9    | -    | 13    |
| 3       | Avicennia          | 9    | 27   | -    | 36    |
| 4       | Excoecaria (Manengen) | 11 | 21   | -    | 32    |
| 5       | Bruguiera (Lindur). | 4    | 3    | -    | 7     |

Explanation:

A.a = Acrostichum aureum
A. s = Acrostichum speciosum
P. c = Pityrogramma calomelano

|     | \( \Sigma \) | \( \Pi (n/N) \) | \( \ln \Pi \) | \( \Pi.(\ln \Pi) \) |
|-----|-------------|-----------------|---------------|-------------------|
| Acrostichum aureum Linn. | 53 | 0,43 | -0,84 | -0,361 |
| Acrostichum speciosum Linn. | 68 | 0,56 | -0,58 | -0,324 |
| Pityrogramma calomelanos | 1   | 0,008 | -4,8 | -0,0384 |
| Total | 121        |                 |       | -0,7234 |
\[ H' = - \sum (p_i \ln p_i) \]
\[ = - (-0.7234) \]
\[ = 0.7234 \]
Species diversity index = 0.7234

Figure 3. Morphological observations of ferns (a) *Acrostichum aureum*, (b)*Acrostichum speciosum*, (c) *Pityrogramma calomelanos*.

Table 4. Location of ferns found in the Wonorejo mangrove.

| Stasiun | Location | Species | Habitat       |
|---------|----------|---------|---------------|
| 1       | Sonneratia | A. a    | Open area     |
|         |          | A. s    | shady area    |
|         |          | P. c    | shady area    |
| 2       | Rhizophora | A. a    | Open area     |
|         |          | A. s    | shady area    |
| 3       | Avicennia  | A. a    | Open area     |
|         |          | A. s    | shady area    |
| 4       | *Excoecaria* (Manengen) | A. a    | Open area     |
|         |          | A. s    | shady area    |
| 5       | *Bruguiera* (Lindur). | A. a    | Open area     |

Explanation:
\[ A. a = Acrostichum aureum \]
\[ A. s = Acrostichum speciosum \]
\[ P. c = Pityrogramma calomelanos \]

Table 5. Environmental parameters of research stations 1 to 5.

| Stasiun | Mangrove Zone | Temperature | Humidity | Light intensity | Wind velocity |
|---------|---------------|-------------|----------|-----------------|--------------|
| 1       | Sonneratia    | 33.0°C      | 61%      | 3080 lux        | 2            |
| 2       | Rhizophora    | 31.9°C      | 71%      | 2340 lux        | 3            |
| 3       | Avicennia     | 33.7°C      | 67%      | 7700 lux        | 2            |
| 4       | Excoecaria    | 34.8°C      | 64%      | 2400 lux        | 2            |
| 5       | Bruguiera     | 32.3°C      | 70%      | 6900 lux        | 2            |

4. Discussion
The index of species diversity of ferns in the Wonorejo Surabaya mangrove forest was 0.7234 according to the Shanon – Wiener if \( H' < 1 \) showed that species diversity in one place was small or low.
Diversity is low due to environmental factors and lack of growth media for ferns. Wonorejo mangroves are only available in two habitats, namely open terrestrial and protected terrestrial, while fern habitat is terrestrial surface, rocks, swamp areas, river banks, aquatic, and attached to trees / epiphytes [13].

Based on table 1 found 3 types of ferns from the Pteridaceae family in the mangrove Wonorejo Surabaya. Ferns plants were found in three types, namely Acrostichum aureum, Acrostichum speciosum and Pytirogramma calomelanos.

Wonorejo mangrove is only found in 3 types of ferns because of the environmental conditions that are not suitable for its growth. According to Ngadiani Ferns plants are usually found under the close of a tight tree canopy. The optimal temperature for ferns growth is 21 ° C -27 ° C, while the temperature in the mangrove forest is Wonorejo Surabaya 31 °C-34 °C. This temperature difference causes a lack of varieties of ferns in mangrove forests because most of the ferns live in the wet tropics [14].

Optimal humidity for ferns growth is in the range of 60-80% [14]. Humidity in the Wonorejo Surabaya mangrove forest is only around 60-70%, this is what causes only 3 species of ferns found in the mangrove.

Ferns plants generally live in places that have sufficient light intensity in shaded places and are not exposed to excessive sunlight. Good light intensity for ferns growth ranges from 200-600 f.c (foot-candles) [15]. Based on the observations, the light intensity in the Wonorejo mangrove forest has too high value compared to the place of life of the ferns which should be 2200-7700 lux.

Sea spikes can grow in mangroves because these plants cannot withstand flooding of sea water for a long time. In some places, ferns can also grow around rivers with low salinity [16].

5. Conclusion and suggestion

5.1. Conclusion
The diversity of species of ferns in the Wonorejo mangrove forest is said to be low. There are only 3 types, namely Acrostichum aureum, Acrostichum speciosum, and Pytirogramma calomelanos.

Diversity is low due to environmental factors and lack of growth media for ferns. Environmental parameters that are enforced include: temperature, humidity, light intensity, wind speed, and soil texture. The environmental factors of mangrove forest are not in accordance with the needs of ferns because they tend to be higher. The habitat of ferns in the Wonorejo mangrove is only 2 habitats of ferns, which are open terrestrial and protected terrestrial, while there are 6 ferns habitats which are terrestrial, rocky, swampy, riverine, aquatic, and attached to the tree (epiphytes).

5.2. Suggestion
- The ecological balance of the Wonorejo mangrove forest is relatively low, the mangroves should bring other types by providing habitat such as wood pieces.
- Further research is needed on the ecological balance of the Wonorejo mangrove forest in particular.

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