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***Research Article***

# Ecology and Phenotic Variation Study of Seagrass in Coastal of Ambon Island

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**ABSTRACT**

The phenetic diversity of seagrass species along the coast of Ambon Island is also still relatively limited; indeed, research into the phenetic diversity of seagrass species along the coast of Ambon Island based on morphometry and meristics has only been carried out at specific locations, such as the coasts of Suli Village, Poka Village and Morela Village. However, there are several locations on Ambon Island that harbour seagrass, such as the coasts of Mamala Village and Rutong Village. The aim of this study was to determine the ecology and phenetic variation of seagrass along the coast of Ambon Island. The samples observed in this study comprised 20 seagrass individuals from each species at every location. Measurements of environmental factors such as temperature, salinity, pH, DO and substrat type were also carried out. Data analysis was conducted to determine several ecological parameters of seagrass vegetation, including species composition, density, and community structure (diversity, evenness, dominance), as well as the phenetic relationships among the seagrasses. The results of the study indicate that the ecology of seagrasses along the coast of Ambon Island comprises two families Hydrocharitaceae family, consisting of three species (*Enhalus acoroides*, *Halophila ovalis* and *Thalassia hemprichii*); and Cymodoceaceae family, consisting of a one species, *Halodule pinifolia*. The phenetic similarity index comprises two main clusters; cluster 1 consist of *Halodule pinifolia* and *Halophila ovalis*, with a similarity index value of 61. Clusters 2 consist of *Enhalus acoroides* and *Thalassia hemprichii*, with a similarity index of 81. It is recommended that further research be carried out in other seagrass areas on Ambon Island in order to obtain more comprehensive data on phenetic diversity.

**Keywords**: ecological study, phenetic variation, seagrass

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## INTRODUCTION

Indonesia is an archipelagic country, most of which is coastal with a coastline of 95,181 km and a sea area of 3.1 million km$^2$ (Goblue, 2011). Indonesia has the potential for biodiversity and coastal natural resources, both renewable and non-renewable resources. This coastal area has three important ecosystems for marine organisms, one of which is the seagrass ecosystem. The seagrass ecosystem plays a major role in the survival of various biota in it as a place to spawn, forage, and habitat for various types of biota (Arkahm dkk. 2018).

One of the coastal areas in Indonesia that has an abundant seagrass ecosystem is Ambon Island. The waters of Ambon Island have two bays, namely the inner Ambon Bay and the outer Ambon Bay. Seagrass grows densely to form fields, so it is known as seagrass beds. Seagrass can grow to form seagrass fields with a density of up to 4,000 plants per m$^2$ and has a fixed biomass of 2 kg/m$^2$ (Tuapattinaya dkk. 2021a).

In Ambon Bay, there are six species seagrass consisting of *Cymodocea rotundata*, *Halodule pinifolia*, *Thalassia hemprichii*, *Halophila ovalis*, *Halophila minor*, and *Enhalus Acoroides* (Irawan and Nganro, 2016). This type of seagrass has quite high ecological and economic value. Ecologically, seagrass together with mangroves and coral reefs are components of coastal water ecosystems. Seagrass communities play a very important role in the biological and physical functions of the environment. Economically, seagrass processing can also produce various goods and services (Oktawati dkk. 2018).

The presence and distribution of seagrass are influenced by environmental factors, particularly substrate conditions and sedimentation. Tuapattinaya et al. (2021b) stated that the presence of seagrass species in the waters of Ambon Island varies across locations. Differences in seagrass occurrence at each site are influenced by differences in substrate type, as the bottom substrate plays a critical role in supporting seagrass growth and development (Hidayat, 2018). Furthermore, Brouns and Heijs (1991) explained that mixed seagrass beds generally consist of at least four out of seven species, including *Cymodocea rotundata*, *Cymodocea serrulata*, *Enhalus acoroides*, *Halodule uninervis*, *Halophila ovalis*, *Syringodium isoetifolium*, and *Thalassia hemprichii*. However, in their community structure, *Enhalus acoroides* and *Thalassia hemprichii* are often dominant and consistently associated. Environmental conditions within seagrass ecosystems also influence the life of aquatic organisms inhabiting these areas

In addition, variations in environmental conditions can lead to phenotypic differences within the same seagrass species growing in different locations. These characteristics are inherited and result in phenetic variation, often indicated by high heterozygosity within species (Pharmawati et al. 2015). Along with population growth and increasing human activities in the coastal areas of Ambon Island such as settlement development, fishing, aquaculture, and marine transportation there is increasing ecological pressure on seagrass ecosystems. Moreover, the lack of up-to-date information on species composition, density, and community structure of seagrass vegetation in relation to habitat characteristics provides a strong basis for conducting this research.

Information regarding the phenetic diversity of seagrass species in the coastal of Ambon Island is still limited. Previous studies on phenetic diversity based on morphometric and meristic characteristics have only been conducted in certain locations, such as Suli Village, Poka Village, and Morela Village. Meanwhile, many other areas with seagrass beds, such as Mamala and Rutong, have not been studied. This limitation of data can become a constraint in the management and conservation of seagrass resources. Therefore, this study is important to provide comprehensive information on seagrass ecology and phenetic variation. Furthermore, basic data on morphometric and meristic characteristics can serve as a foundation for accurate identification of seagrass species in the waters of Ambon Island.

## METHODS

This type of research is descriptive to study the ecology and phenetic variation of seagrass found in the coastal of Ambon Island.The location of this research is based on the results of researcher observations in the coastal of Ambon Island. The presence of the largest number of seagrass species was found in the coastal of Poka Village, Mamala and Rutong. So researchers are interested in testing the ecology of seagrass vegetation which includes the composition of species, density and community structure. his research was conducted in September–October 2024. Seagrass samples were then taken for morphometric analysis, in which a total of 9 morphometric characters were measured, at the Basic Biology Laboratory of the Biology Education Study Program, Pattimura University, Ambon. The sample in this study was 20 seagrass individuals of each type found in each location of Poka Village, Mamala and Rutong selected using purposive sampling. Measurement of environmental factors such as temperature, salinity, pH, DO and substrat type were carried out. Data analysis was carried out to determine several ecological parameters of seagrass vegetation, including: species composition, density, and community structure (diversity, uniformity, dominance) and phenetic relationships of seagrass in the waters of Ambon Island.

## RESULTS AND DISCUSSION

### Results

### Environment parameters

Measurement of environmental parameters in the coastals of Ambon Island can be seen in Table 1 below.

**Table 1.** Environmental parameters in coastals of Ambon Island

| Location | Temperature ($^{0}$C) | Salinity (ppm) | DO (mg/L) | pH | Substrat type |
|---|---|---|---|---|---|
| Poka | 35.4 | 13 | 70.2 | 7.9 | Sandy and muddy |
| Rutong | 33.9 | 33 | 64.5 | 7.7 | Sandy and muddy |
| Mamala | 34.0 | 24 | 60.4 | 7.2 | Sandy |

The results of environmental parameter measurements in the coastal of Ambon Island show temperatures ranging between 33.9 – 34.0 $^{o}$C, salinity 13 – 33 ppm, and DO 60.4 – 70.2 mg/L with mud and sandy substrates.

**Ecological study of seagrass species in coastals of Ambon Island**

The presence of seagrass species found in the coastals of Ambon Island varies in each research location. This can be seen in Table 2.

**Table 2.** Composition of seagrass species in coastals of Ambon Island

| Nu | Species | Research Location | | |
|---|---|---|---|---|
| | | Poka | Rutong | Mamala |
| 1. | *Enhalus acoroides* | √ | √ | - |
| 2. | *Thalassia hemprichii* | √ | √ | √ |
| 3. | *Halophila ovalis* | - | √ | √ |
| 4. | *Halodus pinifolia* | - | √ | √ |
| | Amount | 2 | 4 | 3 |

The results of observations of the presence of seagrass species in coastal of of Ambon Island show four species of seagrass. The four species of seagrass consist of two families, namely *Hydrocharitaceae*, which three species (*Enhalus acoroides*, *Halophila ovalis*, and *Thalassia hemprichii*). While the *Cymodoceaceae* family is *Halodule pinifolia*. All species found on the coastal of Poka and Mamala are generally in Rutong. The number of *Thalassia hemprichii* species found is relatively high compared to other species. This phenomenon indicates a change in the composition of species which is thought to be due to changes in the physical environment of the waters.

**Species density and structure species of seagrass**

Based on Table 3, the highest density of species is *Thalassia hemprichii* 1.0 ind/m$^2$ with a relative density of 47.7 % and the lowest *Halophila ovalis* 0.3 ind/m$^2$ with a relative density of 15 %. It can be seen that the community structure of seagrass species in coastal of of Ambon Island is quite varied, where the highest dominance value was found in the *Thalassia hemprichii* species with a value of 0.46 with a relative dominance of 45.7 %, while the lowest dominance was found in *Halophila ovalis* dominance value of 0.15 with relative dominance of 15 %. The highest important value index (INP) is in the *Thalassia hemprichii* species with a value of 137.0 while the lowest is in *Halophila ovalis* of 45.1. The total important value index of seagrass species in coastals of Ambon Island is 300.

**Table 3.** Density and community structure of seagrass species in coastals of Ambon Island

| Nu | Species | Amount (ind) | Density (ind/m$^2$) | Relative density (%) | Composition (%) | Relative composition (%) | Domination | Relative Dominance (%) | INP |
|---|---|---|---|---|---|---|---|---|---|
| 1 | *Enhalus acoroid* | 3634 | 0.4 | 16.4 | 0.16 | 16.4 | 0.16 | 16.4 | 49.3 |
| 2 | *Thalassia hemprichii* | 10095 | 1.0 | 45.7 | 0.46 | 45.7 | 0.46 | 45.7 | 137.0 |
| 3 | *Halophila oval* | 3322 | 0.3 | 15.0 | 0.15 | 15.0 | 0.15 | 15.0 | 45.1 |
| 4 | *Halodule pine* | 5056 | 0.5 | 22.9 | 0.23 | 22.9 | 0.23 | 22.9 | 68.6 |
| | Total | 22107 | 2.2 | 100 | 1 | 100 | 1 | 100 | 300 |

**Diversity of seagrass species in coastals of Ambon Island**

The diversity of species calculated using the Sharon & Winner formula obtained a diversity index (H) greater than 1 and less than 3. Based on the criteria set, the level of diversity of vegetation species in these plants is moderate. Can be seen in Table 4.

**Table 4.** Diversity of seagrass species in coastals of Ambon Island

| Nu | Species | Amount (ind) | Pi (ni/N) | ln Pi | Pi x ln Pi | Criteria |
|---|---|---|---|---|---|---|
| 1 | *Enhalus acoroides* | 3634 | 0.16 | -1.81 | -0.30 | |
| 2 | *Thalassia hemprichii* | 10095 | 0.46 | -0.78 | -0.36 | 1<H<3 |
| 3 | *Halophila ovalis* | 3322 | 0.15 | -1.90 | -0.29 | |
| 4 | *Halodus pinifolia* | 5056 | 0.23 | -1.48 | -0.34 | H = Medium |
| | Total | 22107 | 1 | -5.96 | 1.28 | |

Based on the research results, the diversity of seagrass species was found with a value of 1.28. Referring to the criteria set by Sharon & Winner, the diversity of seagrass species coastals of Ambon Island is classified as moderate.

**Phenetics study based on seagrass morphometrics in coastals of Ambon Island**

Seagrass morphometrics is a description of the research station that can show the condition of seagrass and its surrounding environment. Morphometric research data can be seen in Table 5.

**Table 5.** Morphometrics of seagrass in coastals of Ambon Island

| Nu | Species | JDT (blade) | JDU | JUD | LD (cm) | PD (cm) | JR (cm) | PA (mm) | DR (mm) | DA (mm) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | *Enhalus acoroides* | 6 | 1 | 1 | 1.4 | 32 | 1.5 | 12.9 | 10.9 | 3.4 |
| 2 | *Thalassia hemprichii* | 7 | 2 | 1 | 0.6 | 8.1 | 4.1 | 7.9 | 2.9 | 1.1 |
| 3 | *Halophila oval* | 6 | 4 | 1 | 0.7 | 1.2 | 1.7 | 3.3 | 0.6 | 0.3 |
| 4 | *Halodule pine* | 10 | 8 | 1 | 0.2 | 5.5 | 2.1 | 5.2 | 0.9 | 0.4 |

Note: JDT (total number of leaves), JDU (number of whole leaves), JUD (number of leaf veins), PD (leaf length), LD (leaf width), JR (rhizome distance between stands), PA (root length), DR (rhizome diameter), DA (root diameter).

The results of morphometric measurements on seagrass in three research locations have varying values. The presence of seagrass species in each research location representing coastals of Ambon Island is also different. The length of the leaves and the width of the leaves from the three locations are very different and varied (Figure 1).


**Figure 1.**Types of Seagrass in the Waters of Ambon Island
A. *Enhalus acoroides*, B. *Thalassia hemprichii*, C. *Halophila ovalis*, D. *Halodule pinifolia*

Based on the research results, *Enhalus acoroides* has long leaves, large rhizomes reaching 10 mm and looks yellow.parallel leaf blades, rounded leaf tips, leaf length up to 32 cm and width up to 1.4 cm and grows on muddy substrates.*Thalassia hemprichii* has large rhizome up to 2 mm, leaf length reaches 8.1 cm and width 0.4 - 1.0 cm, leaf blades are ribbon-shaped and grow on muddy substrates. *Halophila ovalis*has round leaf blades, relatively small rhizomes and a length of between 1-4 cm and a width of 0.5 - 2.0 cm. *Halodule pinifolia* has a rhizome with a diameter of 1 mm, 2-3 leaves, 15 cm long and no more than 1 mm wide.

**Phenotypic relationships of seagrass species in coastals of Ambon Island**

The average morphometric results of 200 individuals for each type of seagrass found in the coastals of Ambon Island, the results of which are shown in the following Figure 2.

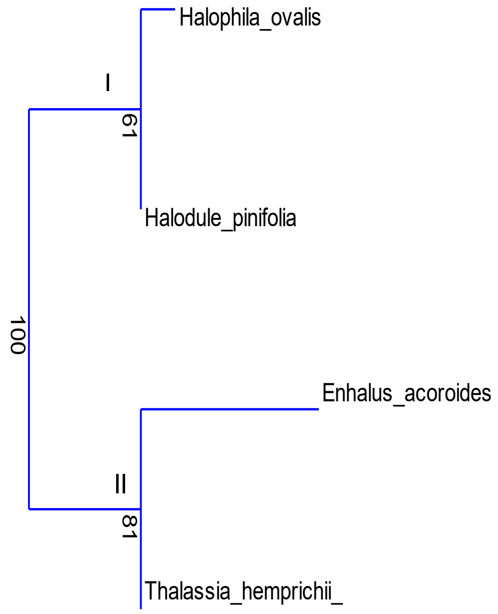


**Figure 2.**The relationship phenotypic of seagrass species in coastals of Ambon Island based on the Neighbor Joining Clustering method (Similarity Index Morista, Boot N=1000)

Based on the results of the analysis of seagrass species kinship data in coastals of Ambon Island, there are two main clusters. Cluster 1 consists of species *Halodus pinifolia* and *Halophila ovalis* with a similarity index of 61. The 2nd cluster consists of *Enhalus acoroides* and *Thalassia hemprichii* with a similarity index of 81.

## Discussion

### Ecological study of seagrass species in coastals Ambon Island

The species of seagrass found in coastals of Ambon Island vary at each research location. The same thing was also stated in the research of Tuapattinaya et al. (2021a) that the presence of seagrass species in coastals of Ambon Island varies. There are differences in the presence of seagrass at each research location due to differences in substrate. This is because the type of basic water substrate is very important for seagrass to grow and develop (Hidayat, 2018).

The composition of the types of seagrass most commonly found in coastals of Ambon Island is *Thalassia hemprichii* because these species live in groups forming large groups.similar research was conducted by Latuconsina and Dawar (2012) on the ecological study of seagrass communities in the waters of Osi Island, Kotania Bay, West Seram Regency, which stated that the species composition showed that *Thalassia hemprichii* was the seagrass vegetation with the highest species composition, while *Halophila ovalis* was found with the lowest species composition. This is supported by the statement of Brouns and Heijs (1991), that seagrass meadows with mixed vegetation generally consist of at least 4 of the 7 species, namely: *Cymodocea rotundata, Cymodocea serrulata, Enhalus acoroides, Halodule uninervis, Halophila ovalis, Syringodium isoetifolium* and *Thalassia hemprichii*, but in its community structure, *Enhalus acoroides* and *Thalassia hemprichii* are always associated, which always dominate. The condition of the waters in the seagrass ecosystem can affect the life of the biota in the waters. Physical and chemical parameters include temperature, salinity, pH, DO, and substrate. Biophysical characteristics (temperature), water chemistry (salinity and turbidity), and the condition of the water's bottom substrate affect the distribution, growth, and development of seagrass species in marine waters (Hidayat, 2018).

The results of temperature measurements at three research stations ranged from 34–36 ºC. This value is higher than the standard quality limit for seagrass growth, namely 28–30 ºC. These conditions are influenced by the hot weather during field measurements because data collection was carried out during the day. Temperature can affect the photosynthesis process. If the temperature is outside the threshold range, the ability of the photosynthesis process can decrease sharply (Poedjirahajoe et al. 2013). On the other hand, seagrass has a high light requirement compared to other angiosperms and lack of light is often the main limiting factor for seagrass growth (Lai et al. 2020). The salinity of the water in coastals of Ambon Island is considered quite good for seagrass growth, which is between 13-33 %. This is in accordance with the salinity quality standards for seagrass waters according to the Decree of the Minister of Environment Nu. 51 of 2004, the range for seagrass growth is around 33-34 %. Most seagrasses have a wide tolerance to salinity, namely 10-40 %. So that the measurement results at each research station show that the salinity value is still within the specified range (Rugebregt, 2015). The acidity level pH obtained at the three research locations was normal with values ranging from 7.0 to 7.9. The acidity level values at the research locations tended to be homogeneous or uniform. This is because the pH of seawater is usually stable and does not show significant changes because there is a carbonate system in seawater (Nybakken, 1992). Based on the quality standard, the pH value at the research location is included in productive waters. Measurement of DO values at the three research locations ranged from 60.4 to 70.2 mg/L. The dissolved oxygen content in waters is related to respiration by seagrass, biota, and use by nitrifying bacteria in the nitrogen cycle process in the seagrass ecosystem (Fahrudin et al. 2017).

The highest density of seagrass species is in the *Thalassia hemprichii* species 1.0 ind/m$^2$ with a relative density of 47.7 % and the lowest *Halophila ovalis* 0.3 ind/m$^2$ with a relative density of 15 %. The same thing was also conveyed by Pratiwy et al. (2020) that the density of the type seagrass*Thalassa hemprichii* almost dominates in every research location. This is because this type of seagrass usually lives in areas with sandy to muddy substrates (Kawaroe et al. 2016). According to Anggraini (2008) this type of seagrass*Thalassia hemprichii* most commonly found in association with other species and grow well up to a depth of 25 m. The density of seagrass species is influenced by the place where the seagrass grows. Several factors that affect the density of seagrass species include depth, brightness, water current and substrate type (Kiswara, 2004; Pratiwy et al. 2020).

The community structure of seagrass species in coastals of Ambon Island is quite varied, where the highest dominance value was found in the *Thalassia hemprichii* species with a value of 0.46 with a relative dominance of 45.7 %, while the lowest dominance was found in *Halophila ovalis* dominance value of 0.15 with relative dominance of 15 %. The highest important value index (INP) is in the *Thalassia hemprichii* species with a value of 137.0 while the lowest is in *Halophila ovalis* of 45.1. The number of species of a community determines the diversity of the community itself (Sutrisna et al. 2018). If a community has many species without any species dominating, the diversity of the species of the community will be high. The high or low value of the diversity of an area determines the level of community stability in the area itself (Wirakusumah 2003; Indriyanto, 2012). Diversity of seagrass species in coastals of Ambon Island with an index value of H = 1.28. Based on the Shannon–Wiener diversity index (H'), the seagrass diversity in the coastal of Ambon Island is classified as moderate, likely due to differences in substrate characteristics, environmental parameters, and human activities, which influence species composition and community structure.

**Phenotypic variation of seagrass species in coastals Ambon Island**

Phenotypic variations of seagrass species in the waters of Ambon Island show that each type of seagrass has a different morphological size. Pratiwy et al. (2020) also stated that the average length of *E. Acoroides* seagrass leaves obtained from measurements at three research locations had varying values. In addition, the presence of seagrass species at each research location representing the coastal waters of Ambon Island also varies. Seagrass morphometrics and meristics are a description of the research station that can indicate the condition of the seagrass and its surrounding environment. The length of seagrass leaves at the three stations varies quite a bit and the variation in leaf length is thought to be due to the condition of the waters that do not get enough sunlight so that the leaf stalks become long to get sunlight in order to carry out the photosynthesis process (Tuapattinaya et al. 2021b). Seagrass has a high light requirement compared to other angiosperms and lack of light is often the main limiting factor for seagrass growth (Lai et al. 2020).

Elongation in seagrass morphology occurs when the water conditions are low in sunlight intensity, when the sunlight intensity is high, it will form a smaller shoot morphology. Research conducted by (Griffiths et al. 2020) found that several physiological factors also play a role in influencing seagrass growth, such as respiration rate, nitrogen, phosphorus, and carbon concentrations. Seagrass has a wide stem diameter indicating that the seagrass has slow growth. This also happens to the rhizome, if it has a wide diameter indicating that its growth is slow. The condition of the substrate that is less fertile due to the presence of nutrients in the low substrate is thought to cause the roots to become longer to get good nutrient intake so that they can balance their root system. However, when the nutrient conditions in the water column are higher than the conditions in the substrate, the seagrass will take nutrients through the leaves (Tuapattinaya et al. 2021b).

When seagrass leaves absorb nutrients maximally, the leaf size and number of seagrass leaf veins have high morphometric and meristic values. The results of small leaf morphometric measurements in seagrass are caused by the influence of seawater salinity which can disrupt the osmotic balance system in seagrass life and have an impact on seagrass physiology (Handayani and Emiyarti, 2016). Morphological variations in each type of seagrass, in addition to being caused by environmental and nutritional parameters, can also be caused by community activities in coastal areas that greatly affect the growth and development of seagrass (Sakey et al. 2015). Local population dynamics and environmental gradients that support sexual reproduction of seagrass in a water area greatly affect the life and presence of seagrass in that area (Arriesgado et al. 2015).

## CONCLUSION

The ecology of seagrass in coastals of Ambon Island with a species composition consisting of two families, namely *Hydrocharitaceae* which includes three species, namely *Enhalus acoroides*, *Halophila ovalis*, and *Thalassia hemprichii* and the *Cymodoceaceae family*, namely *Halodule pinifolia*. The *Thalassia hemprichii* species has the highest species density compared to other seagrass species in the research location. While the species diversity index is classified as moderate.

Seagrass phenetic studies in coastals of Ambon Island which include the total number of leaves, the number of intact leaves, the number of leaf veins, leaf length, leaf width, rhizome distance between stands, root length, rhizome diameter, and root diameter have varying morphological organs. The phenetic relationship of seagrass consists of two main clusters, in cluster 1 consisting of species *Halodus pinifolia* and *Halophila ovalis* with a value of 61. In the 2nd cluster consisting of *Enhalus acoroides* and *Thalassia hemprichii* with a value of 81.

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