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# Analysis of Relations Organic Carbon in Sediment with Growth Rate of Seagrass *Enhalus acoroides* and *Thalassia hemprichii*

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## Abstract

This study aims to determine and analyze the relationship of organic carbon in sediments with the growth rate of seagrass *Enhalus acoroides* and *Thalassia hemprichii*. This research was conducted on Langkai Island, Makassar City, with three points, namely near the coast, in the middle and near the coral reefs. The research phase began with marking the seagrass *E. acoroides* and *T. hemprichii* in the field, then measuring the growth rate of the seagrass, followed by a sieving process to determine the texture of the sediment, and burning to determine the organic carbon content of the sediment. The results showed that differences in sediment organic carbon showed a weak correaltion and insignificant. The differences in the growth rates of seagrass *E. acoroides* and *T. hemprichii* based on point were not significant. The relationship between organic carbon and sediment texture has a weak correlation and insignificant. Similarly, the effect of organic carbon on the growth rate of seagrass *E. acoroides* and *T. hemprichii* also showed a weak correlation and insignificant.

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Organic carbon;
Growth rate;
Sediment;
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## Introduction

The waters of the Spermonde Islands are an area that has very complex marine biological resources, one of which is a very extensive and diverse seagrass ecosystem (Jompa et al., 2005). Seagrass is a plant that is adapted to living submerged in shallow seas. Seagrass has rhizome roots (rhizomes) that grip the seabed and substrate, so it can help protect beaches from waves and waves. Apart from that, seagrass is a sediment catcher and nutrient recycler that is needed by various marine organisms (Nontji, 2002; Bortone, 2000 ;Rosalina et al., 2018). Previous research explains that there is a lot of organic carbon in seagrass beds, so that seagrass plants can make the soil or sediment rich in organic carbon (Hertyastuti et al., 2020; Budiarto et al., 2021)

The availability of organic carbon in waters is considered important because it can be used to mitigate climate change. Coastal ecosystems have a very important ecological role in absorbing CO2 gas. Seagrass beds in Indonesia have an area of around 150,693.16 hectares which are capable of absorbing 992.67 kilo tons of carbon or the equivalent of 3.64 mega tons of CO2 (Wahyudi et al., 2018).

Seagrass ecosystems have many important roles, such as primary producers of marine biota; as a residence (habitat) for aquatic organisms; Seagrass roots function as sediment traps and inhibit erosion, and can stabilize the waterbed. Dense seagrass leaves can also slow down water movements caused by currents and waves, so that the surrounding waters become calm (Costanza et al., 1997; Hitalessy, 2015; Muzani et al., 2020).

The organic carbon content in sediment is used by plants for photosynthesis as food. Whether or not there is a lot of organic carbon can influence the progress of the food chain and the growth process. Apart from that, there has been no research regarding sediment organic carbon content in relation to seagrass growth in Sulawesi waters. Based on this, this research needs to be carried out. The aim of this research is to determine and analyze the relationship between sedimentary organic carbon and the growth rate of seagrass *Enhalus acoroides* and *Thalassia hemprichii* in the near coast, middle and near coral reefs on Langkai Island, Makassar City.

## Materials and Methods

### Sample collection

This research was carried out on Langkai Island, Barrang Caddi Village, Kec. Sangkarrang Islands, Makassar City. This research includes several research stages, namely: Preparation, Observation, station determination, secondary data collection, data and sample collection, sample analysis and data analysis. Sample analysis was carried out at the Physical Oceanography and Coastal Geomorphology Laboratory, Department of Marine Science, Faculty of Marine and Fisheries Sciences, Hasanuddin University, Makassar.

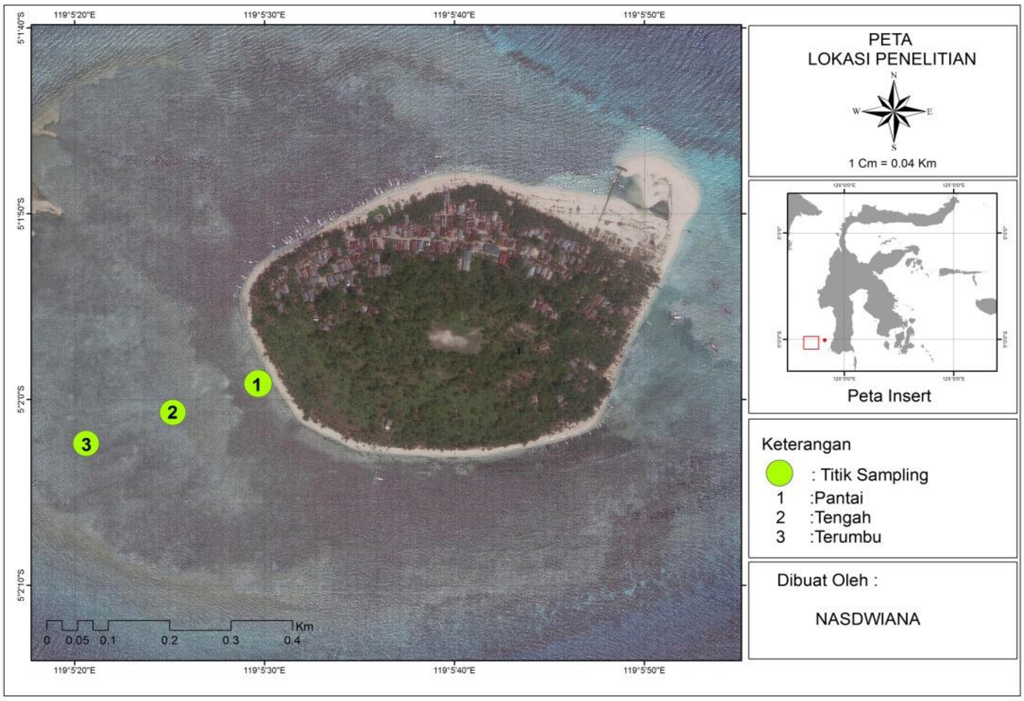


**Figure 1. Study Location**

### Determination of sampling points

The sampling location is along the reef shelf which still grows seagrass *Enhalus acoroides* and *Thalassia hemprichii* from the specified island. The three sampling points to be determined are on a line perpendicular to the coast. Once determined, the sampling points were divided into areas near the coast labeled beach, the middle part labeled middle and those near the coral reef labeled reef. Then the coordinates of each sampling point were recorded using GPS.

### Measuring the growth rate of seagrass leaves (Leaf Growth)

Seagrass leaf growth rate was measured using the leaf marking method (Short & Duarte, 2001 in Steven, 2013). 5-10 stands were selected in the sampling point area and marked with cable ties. The leaves from the selected stand are then arranged in sequence with the oldest leaves on the outermost part. At a distance of ± 3-4 cm from the tip of the outermost leaf (the oldest leaf), a triangular hole is made in the leaf so that all the leaves in the stand have needle marks.

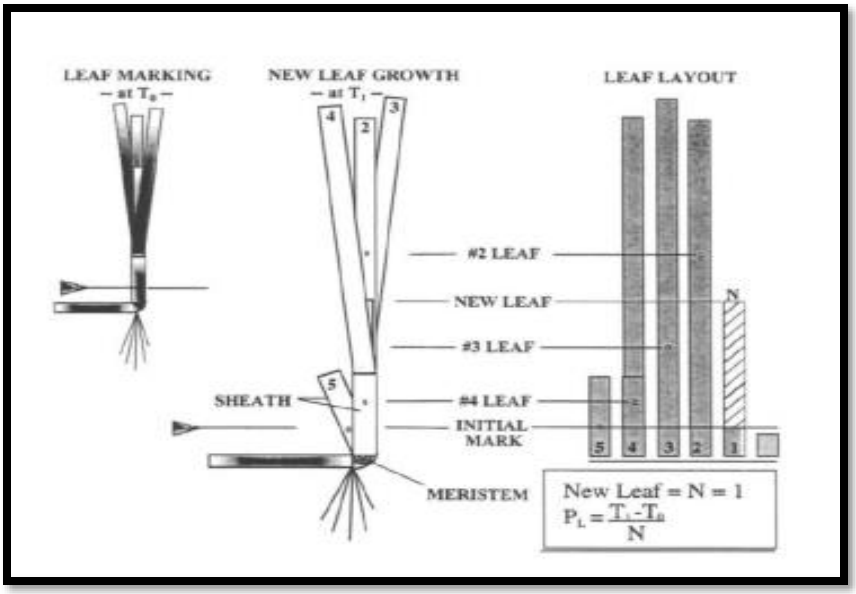


**Figure 2. Seagrass marking method (Short & Duarte, 2001)**

The hole in the outermost seagrass leaf becomes the standard hole (L0) in calculating the growth of the second, third, fourth leaves, etc. because the outermost leaves have the lowest value. After 14 days for *Thalassia hemprichii* and 23 days for *Enhalus acoroides* all leaves in the marked stand were cut using scissors at the base of the leaf. Growth measurements were carried out using a scale ruler (in mm) by comparing the distance between the holes that make up the base of the triangle on the old leaf (L0) with the same holes on the second, third, etc. leaves (Lt). This measurement is carried out for each leaf in a marked stand.

Seagrass growth rate is obtained by dividing the results of measuring the growth of seagrass leaves by the number of days since the seagrass leaves were marked (Short & Duarte, 2001). The growth rate of seagrass leaves is calculated using a formula.

$$P = \frac{\mathrm{Lt} - \mathrm{Lo}}{\Delta \mathrm{t}} \times 100$$

Information :
P = Leaf length growth rate (mm)
Lt = Leaf length after time t (mm)
Lo = Leaf length at initial measurement (mm)
Δt = Measurement time interval

**Sediment sampling**

Sediment sampling was carried out using a core tool from a pipe, on each island there are three points, namely beach, middle and reef. Next, the sediment was taken in the seagrass sample marking area, using a 40 cm core, the top 5 cm of the sample was taken, then closed the end of the core to block air and then pulled it upwards (Yudha et al., 2020). This is done with three repetitions at each point. Next, the sediment is put into a sample bag that has been labeled and stored in a coolbox to avoid contamination (Sridamayani & Lane, 2022). The same procedure is carried out for the other sample points.

**Sediment sieving**

Before the sieving process is carried out, the sample is first cleaned and separated from the rhizome roots and seagrass leaves as well as from the remains of animal shells, then put in an oven at a low temperature until dry, then weighed 100 grams as the initial weight, then put into the sieve net that has been prepared. arranged sequentially with sizes 2 mm, 1 mm, 0.5 mm, 0.25 mm, 0.125 mm, 0.063 mm and < 0.063 mm for sifting. After being sifted, the sediment samples were separated based on the size of the sieve net, then weighed and analyzed using the Excel Gradistat application, after which they were classified into the Wenworth scale (Hutabarat & Evans, 1984). This procedure is carried out for each observation.

**Analysis of sediment organic carbon content**

Analysis of organic matter content was carried out using the Loss On Ignition (LOI) method (ASTM, 2000). The LOI method aims to determine the total organic matter (organic carbon) content in the sediment so that the depositional environment and sedimentary processes are known based on the organic carbon content. The analysis process is carried out every 5 cm of the core sediment layer at a certain depth. sediment samples that have been dried in an oven at a low temperature, then each sample is weighed at 5 grams, then stored in a labeled cup, the ashing process uses a furnace at a temperature of 650°C for 3 ½ hours. After that, cool it to room temperature and then weigh it again.

The analysis stage for total organic matter content was carried out using the ashing method which refers to the LOI method according to the provisions of Allen et al. (1974) in Sahertian & Wakanao (2017) with the following equation:

$$\mathrm{LOI} = \frac{\mathrm{Wo} - \mathrm{Wt}}{\mathrm{Wo}} \times 100\ \%$$

Dimana : LOI = *loss on ignition* (%)
Wo = first weight (gram)
Wt = last weight (gram)

Based on the guidebook for measuring peat soil carbon stocks (Agus et al., 2011), the organic carbon content is assumed to be 1/1,724 of the total organic matter content of the soil.

### Data analysis

The data was processed using Excel to see the seagrass growth rate and % organic carbon. Meanwhile, for statistical analysis, SPSS 25 was used, to determine differences in seagrass growth rate, texture and sediment organic carbon at each point using One-Way Anova analysis. To determine the relationship between organic carbon in sediment and seagrass growth rate, a correlation test was carried out.

## Results and Discussion

### Sediment Organic Carbon

The results of measuring organic matter content using the LOI method on each island show that the highest percentage is in the coastal area, namely 0.517%, and the lowest point is at the midpoint, namely 0.368%. The results of statistical analysis showed that the differences in sediment texture at each point showed a weak relationship ($r=0.155$), and were not significantly different ($p>0.05$).

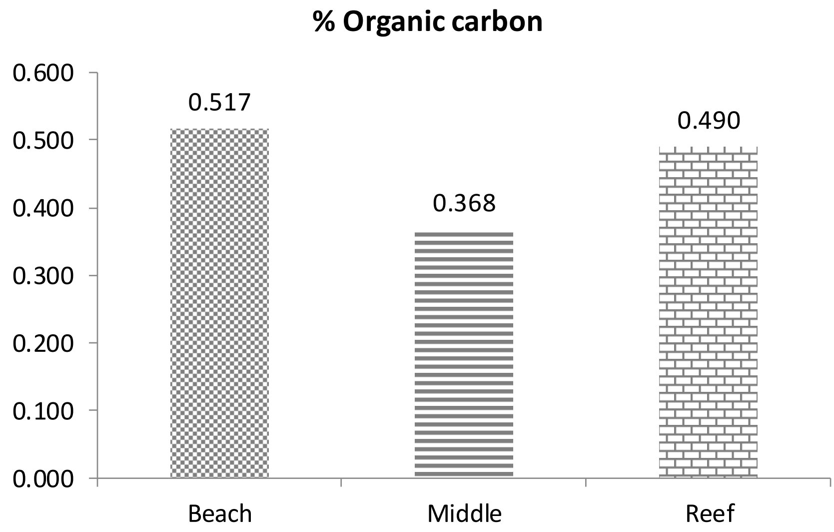


**Figure 3. Sediment organic carbon**

The analysis results show that the coastal area has the highest organic carbon content, this could be because the coastal area is the part closest to the mainland, while the main source of organic material comes from the mainland (Taqwa et al., 2014). This can be influenced by anthropogenic factors such as factory and industrial waste and organic waste (Mushthofa et al., 2014). The results of statistical analysis show that the difference in sediment organic carbon content at each point is not significant ($p>0.05$), and has a weak correlation ($r = 0.327$). This is thought to be caused by the pattern and speed of tidal currents which influence the distribution and texture of sediment. This is in accordance with the statement of Manengkey (2010) and Jalil (2013), that high and low organic material content in sediment is caused by waves which dismantle sediment material carried by currents or tides, if the current is strong then the sediment particles are fine particles will be carried into the deep sea, while coarse particles will settle.

### Sediment Grain Type

The results of measuring the size of sediment grains at each point in the top 5 cm on Langkai Island are presented in Figure 4. Based on statistical analysis, the largest size of sediment grains is found in coastal areas with an average value of 0.684 mm, while the lowest grain size is on the reef with a value average 0.458 mm. The difference in sediment texture at each point shows a significant difference (0.012).

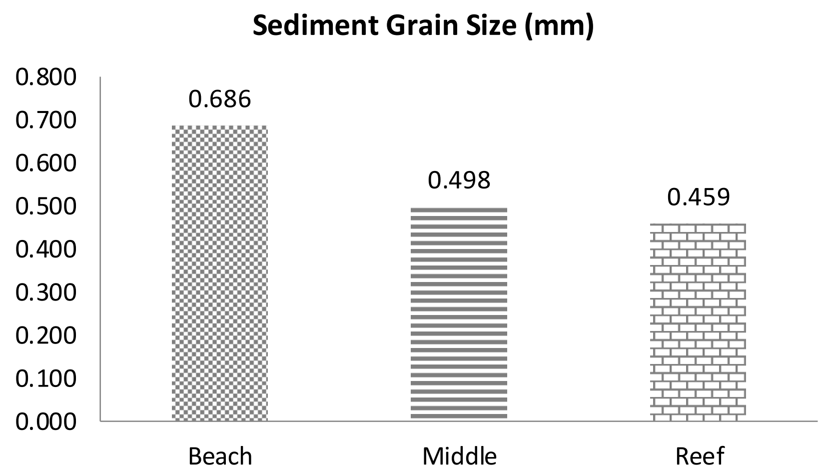


**Figure 4. Sediment grain size**

The sediment size on Langkai Island is dominated by medium – very coarse sand (Figure 4). This result is in line with what was stated by Kusnida et al. (2014) that the sedimentary rocks around the Spermonde islands are in the form of silt sediments from medium to very coarse fractions. Based on different points, the size of sediment grains shows significant differences, this can be caused by several factors, such as the influence of current patterns and speed (Khatib et al., 2013), and the origin of the sediment source (Gemilang et al., 2018). If the current is strong, small particles will be suspended and carried away, while large particles will settle and remain on the coast and in shallow water. This can be proven by research conducted by Jalil (2013) which shows the pattern and speed of currents in the Spermonde Islands at this time. The tide enters Langkai Island at a speed of 0.10 m/sec and bends towards the northeast after passing several other islands. Meanwhile, at low tide, the current originates from the north towards the southwest passing several islands at a speed of 0.01 m/second and the current strengthens when passing Langkai Island, reaching 0.04 m/second.

The results of the correlation analysis show that the relationship between texture and sediment organic carbon has a weak correlation. The relationship between sediment texture and seagrass growth rate did not have a significant effect (p>0.05). Likewise, the relationship between sediment organic carbon and the growth rate of the seagrass *Enhalus acoroides* and *Thalassia hemprichii* has a weak correlation, and has no significant effect (p>0.05).

### Growth Rate of Seagrass *Enhalus acoroides* and *Thalassia hemprichii*

The results of measuring the growth rate of *Enhalus acoroides* seagrass are shown in table 1. The results of measuring the growth rate of *Enhalus acoroides* seagrass at three points show that the fastest rate is in the coastal area (2.61%/day), then the middle part (2.50%/day), and the lowest reef ( 2.26%/day). Statistical analysis showed that the difference in growth rate of *Enhalus acoroides* based on point was not significant (p=0.262). With low correlation (r=0.360).

For the results of measuring the growth rate of *Thalassia hemprichii*, the highest rate was in the coastal area, namely 3.85%/day. Meanwhile, the lowest growth rate was at Point Reef at 3.37%/day. Statistical analysis showed that differences in *Thalassia hemprichii* growth based on point had a low correlation (r=0.161) and were not significant (p=0.591).

**Table 1. Growth rate of Enhalus acoroides and Thalassia hemprichii**

| | Growth Rate (%/day) | | |
|---|---|---|---|
| | Beach | Middle | Reef |
| *Enhalus acoroides* | 2.610 | 2.499 | 2.262 |
| *Thalassia hemprichii* | 3.851 | 3.614 | 3.367 |

The growth rate of *Enhalus acoroides* was highest on the coast, then in the middle and lowest on the reef. This is thought to be because one of the factors that influence seagrass growth is the availability of nutrients, while the main source of nutrients comes from land, and the part near the coast is the closest point to land. This is reinforced by research conducted by Badria (2007) and Arisa et al. (2014), that *Enhalus acoroides* can grow better in areas near the coast due to the high nutrient content contained in the substrate.

For the growth rate of *Thalassia hemprichii*, the fastest rate is also found in coastal areas, this is because *Thalassia hemprichii* grows better in areas that have rougher substrates. This is in line with the statement by Takaendengan and Azkab (2010) that *Thalassia hemprichii* is a type of plant that thrives on (coarse) sand substrates and dead coral fragments, far from the beach and always flooded with water.

The relationship between texture and organic carbon in sediments has a weak and unidirectional correlation. This can be caused because the organic carbon content is not only influenced by the texture of the sediment or the size of the grains, but also the condition of the aquatic environment, whether it is close to land as the main source of organic material, or can also be influenced by the presence of anthropogenic factors which cause the release of organic waste. or inorganic (Amin, 2012; Siregar et al., 2021). Apart from that, the organic material content in sediment can also be caused by waves dismantling sediment material carried by currents or tides (Manengkey, 2010; Hakim et al., 2016).

The relationship between organic carbon and the growth rate of seagrass *Enhalus acoroides* and *Thalassia hemprichii* did not have a significant effect (p>0.05) and had a weak correlation. This can be caused by the very small contribution of organic carbon content in the sediment in influencing the growth rate of seagrass leaves. According to Mahmudah (2016), the growth rate of seagrass is influenced by internal (physiology, metabolism) and external factors (availability of nutrients, substrate fertility, and environmental parameters).

## Conclusion

The differences in sediment organic carbon were not significant, as were the differences in growth rates of *Enhalus acoroides* and Thalassia hemprichi. For the influence of sediment organic carbon on the growth rate of seagrass *Enhalus acoroides* and *Thalassia hemprichii*. shows a weak and insignificant correlation. The oceanographic conditions of the waters are the main cause of this.

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