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Diversity of Chlorophyta on Karapyak Beach, Pangandaran, West Java Province, Indonesia

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ABSTRACT

The purpose of this study is to determine and analyze the level of diversity of Chlorophyta on the intertidal area of Karapyak waters. The study was conducted from January to March 2018 at Karapyak beach, Pangandaran regency. Research parameters analyzed were species density, species frequency, species cover, Importance Value Index, Diversity and Uniformity of macroalgae. The measured environmental parameters are temperature, salinity, DO, pH, nitrate and phosphate. The results showed that there were 6 species macroalgae of the division Chlorophyta found on Karapyak Beach. The macroalgae (H) diversity index value is in the low category based on the index of the Shannon-Wienner. Meanwhile, the uniformity index value (E) is in the high category according to the Evennes index, which means that no species dominates the Karapyak waters.

***Keywords*:** Macroalgae, Chlorophyta, Diversity, Karapyak Beach

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1. INTRODUCTION

Indonesia is a country with the world's second largest biodiversity wealth after Brazil [1]. [2] states that Indonesia's sea level is rich in marine biota and fauna diversity that have ecologically and economically important potential and values. One of the marine flora in Indonesia is macroalgae.

Indonesia has more than 628 types of macro algae from 8,000 types of macroalgae found throughout the world [3]. The Intertidal Region of Karapyak Beach is one of the regions in Indonesia that is the habitat of marriage because Karapyak is a beach with coral substrate. [4] stated that macroalgae is generally found in coral reefs, attached to rocks, coral pieces, shells of mollusks and pieces of wood. [5] states that macroalgae habitats are generally found on the coast of the intertidal and subtidal regions, namely the area between the coastline to the reef slope or commonly called the reef flats [29-35].

Macroalgae abundance on Karapyak Beach is used as a source of livelihood for local people. Some types of Makroalga are used by residents to sell out of town or for personal consumption [1]. Chlorophyta is one of the divisions of macroalgae found in Karapyak Beach. Besides being used as a livelihood, macroalgae from the Chlorophyta division is used as food for the community because of the abundant amount in Karapyak Beach, one of which is the Ulva lactuca species. Meanwhile, in other countries macroalgae from the Chlorophyta division have been shown to have various benefits. [1] states that Ulva is also used as a salad and soup and is widely consumed as food in China, the Philippines, Chile and the West Indies. Meanwhile, in Japan and Korea, other species of the Chlorophyta division are *Codium fragile* used as salads, soups and sweets. *Codium fragile* has a high Fe content. Ulvapertusa macroalgae used for drugs often because has properties as an antibiotic [6], [27], [28]. Besides being consumed by humans, macroalgae is also a food source for other marine biota [7]. Combination is a food source for various herbivorous biota and become a habitat for the biota of vertebrates and invertebrates [8], [24].

Macroalgae from the Chlorophyta division has high economic and ecological potential in Karapyak Beach, but there is no identification of the type of macroalgae from any Chorophyta division that has founded in the intertidal area of Karapyak Beach, making this potential not optimally utilized. So it is necessary to do research on the identification of macroalgae species diversity found in the intertidal area of Karapyak Beach, Pangandaran Regency, West Java, Indonesia.

2. MATERIALS AND METHODS

This research method is a survey method. The sampling method used in the research was purposive sampling. The purposive sampling is a sample determination technique with certain considerations.

2. 1. Time and Place of Research

The research took place at Karapyak Beach, Pangandaran, West Java. The study was conducted from January to May 2018. The area of sampling was carried out along Karapyak Beach at the coordinates 07º41’31.6”S 108º45’11.9”E.

Figure 1. Karapyak Beach, Pangandaran, West Java Province, Indonesia

2. 2. Tools and Materials of Research

The tools used in the study include tools for research, including transects, roll meters, plastic ziplock, scissors, GPS, stationery, paper labels, cameras, DO meters, pH meters, thermometers, sample bottles, slate paper, identification books using the book Marine Biology [9] and the Algaebase.org website. Materials used in the study include Chlorophyta and 600 ml water samples.

2. 3. Research Parameters

Species Density Value

The number of species is done by looking at the number of colonies for each species in the observation plot [10]. The density of each species at each station is calculated using the following formula:

$$Ki = ni/A$$

Information:

Ki = i-Species density (m^2)
Ni = Total of i-species in transects
A = Total area of sampling (1 m^2)

Relative density value

Relative density, is the ratio between the number of individual species and the total number of individuals of all types [10]. Relative density of marriage is calculated by the formula:

$$KR = ni/(\sum n) \times 100\%$$

Information:

KR = Relative density (%)
Ni = Total species
Σn = Total of all species

Species Frequency Value

Frequency of type (F), which is the probability of a species being found in the observed sample points. The frequency of seaweed types is calculated by the formula [10].

$$Fi = Pi/(\sum Pi)$$

Information:
Fi = Frequency of i-species
Pi = Number of sample plots where i-species is found
∑P = The total sample plot observed

Relative Frequency Value

Relative Frequency (FR), which is the ratio between the i-type frequency (Fi) and the number of frequencies for all types. Relative frequency of seaweed is calculated by formula [10]:

$$R = Fi/(\sum F) \times 100\%$$

Information:

FR = Frequency Relative
Fi = Frequency of species
ΣF = Total of frequencies for all species

Species Coverage

Species coverage is the area that covered by species -I. Coverage of macroalgae species can be calculated using a formula [10].

$$P = ai/A$$

Information:

P = Area covered
ai = Total area of i-cover
A = Total sampling area

Relative Coverage

Relative Coverage is a comparison between the individual coverage of all the species with the total coverage of all species. The relative cover of the type of macroalgae can be calculated by the formula [10].

$$PR = Ci/(\sum Ci) \times 100\%$$

Information:

PR = relative species coverage
Ci = i-Species coverage area
∑Ci = Total coverage area for all species

Diversity Index

Generally, community diversity is measured using a distribution pattern of several measures of abundance among species [4]. Diversity index according to Shannon-Weaner [11], is formulated as follows:

$$H' = -\sum ni/N \log 2 \{ni/N\}$$

Information:

H' = Shannon-Weaner diversity index (bits / ind)
Pi = the proportion of species 1 in the total sample
Ni = total individuals of each species
N = total individuals from all species
With the following range:
H' < 2.0: Low diversity
2.0 < H' < 3.0: Medium diversity
H' > 3.0: High diversity

Uniformity Index

Community balance can be known by using a uniformity index, which is a measure of the similarity in the number of individuals between species in a community. The more similar the number of individuals between species (more evenly spread) the greater the degree of balance. Uniformity index formula (e) [12]:

$$E = H' / \ln S$$

Information:

E: Evenness Uniformity Index
H': Diversity index
S: total species
With the following range:
E < 0.4: Low population uniformity
0.4 < E < 0.6: Medium population uniformity
E > 0.6: High population uniformity

Important Value Index

The important value index is the total value of relative density, relative frequency and relative cover. This important value provides an illustration of the influence or role of a plant species in a community [13].

$$INP = RD + RF + RC$$

Information:

INP: important value index
RD: Relative Density
RF: Relative Frequency
RC: Relative Coverage

Criteria:

INP 201% - 300% = Height
INP 101% - 200% = Medium
INP 0% - 100% = Low

3. DIVERSITY OF CHLOROPHYTA ON KARAPYAK BEACH

3. 1. Water Quality Parameters

Temperature of Karapyak Beach

Based on the measurement results, the temperature of Karapyak Beach ranges from 24-30 ºC. The highest water temperature at Karapyak Beach reaches 30 ºC in transect 3 area at station II. The temperature range is within the limits of Chlorophyta growth tolerance.

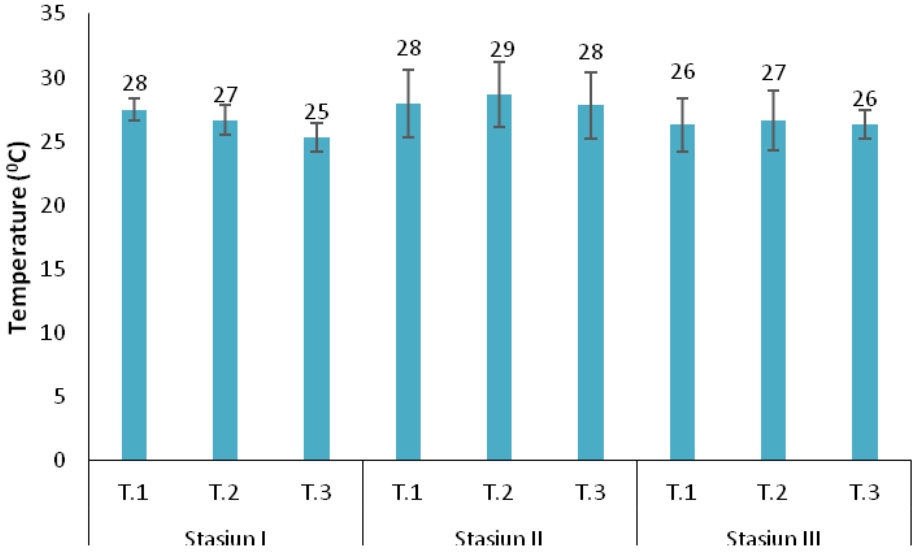

Figure 2. Temperature of Karapyak Beach

The normal temperature range for macroalgae life is between 25–35 ºC [14]. Each data collection station location has a range of different water temperatures (Fig. 2). The waters in station II have a high temperature range compared to the other two stations in all transect replications, this is because the data collection time at station II ranged between 09.00 WIB or 14.30 WIB which is the tidal time of the coast. Water temperatures at station I and station III tend to be lower due to data collection time in the morning at station I and evening at station III.

Salinity of Karapyak Beach

The results of measuring the salinity level of Karapyak Beach showed that the waters had salinity ranging from 23-32 ‰. The highest salinity levels are in the transect 3 region at station II, proportional to the temperature in the region (Fig. 3)

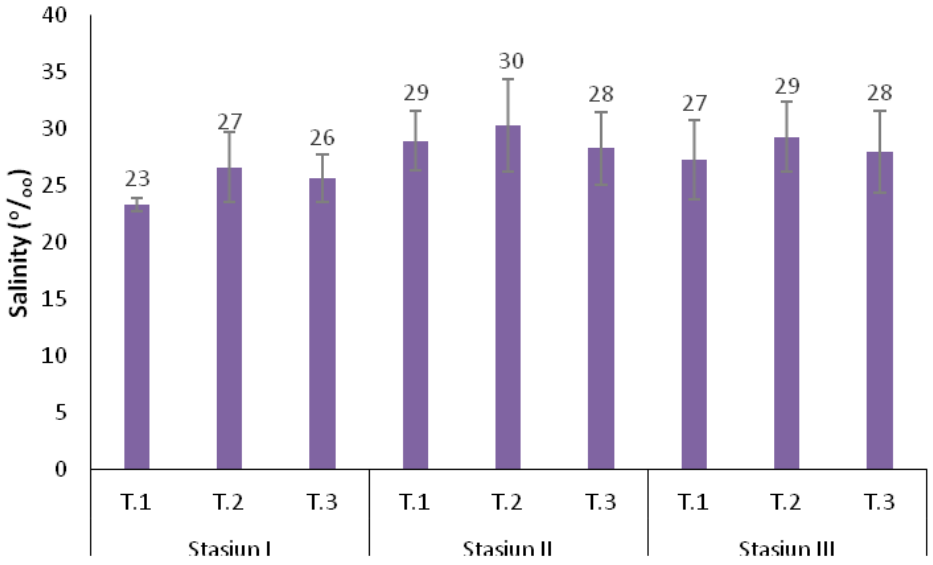

Figure 3. Salinity of Karapyak Beach

Salinity levels in Karapyak Beach of 23-32 ‰ can still be tolerated by Chlorophyta. The macroalgae in the sea generally lives in salinity between 30-32 ‰ [12], but most macroalgae species live in a greater range of salinity. Salinity that is too high or too low will cause interference with macroalgae physiological processes. The station II is a station that has the highest salinity compared to other stations, because at station II the temperature of the area is also high which affects the evaporation process of sea water so that it increases the salt concentration in these waters. The sea surface salinity is very closely related to the process of evaporation of sea water so that the salt will settle or be concentrated [14].

DO of Kapyak Beach

Based on the results of measurements of DO concentration in Karapyak Beach, the results of DO waters were obtained from 5.2 to 9.4 mg / l. The maximum value of DO Karapyak Beach is high for sea water with a temperature in the range of 24-30 ºC, but it is still within the

tolerance range of Chlorophyta growth. According to the Decree of the State Minister of Environment No. 51 of 2004 stated that DO concentrations for marine biota are above 5 mg / l. Odum (1971) states that oxygen levels in sea water will increase with lower temperatures and decrease in salinity. In the surface layer, oxygen levels will be higher, due to the diffusion process of water with free air and the presence of photosynthesis.

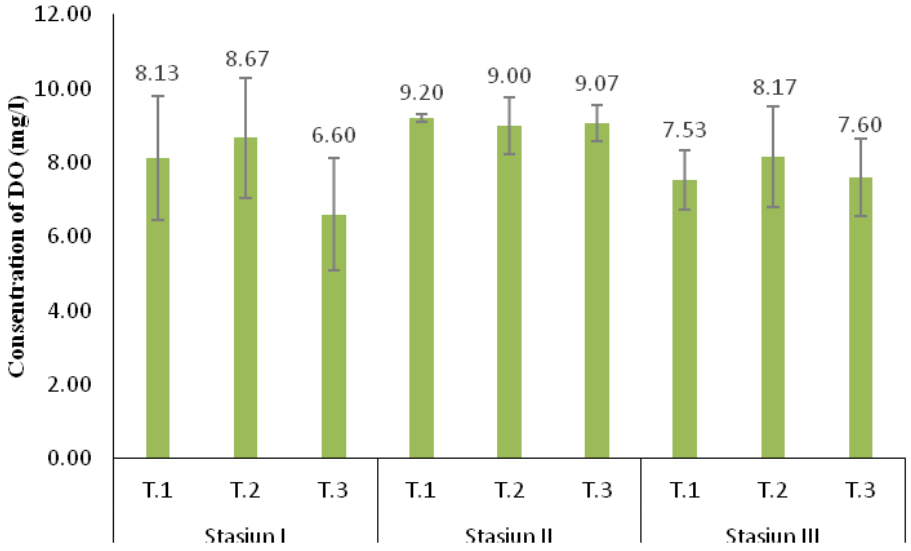

Figure 4. DO of Karapyak Beach

The intertidal zone has a high nutrient wealth and is very rich in oxygen. Stirring that often occurs causing the interaction between the atmosphere and the waters is very high so that the diffusion of gas from the surface of water is also high [5].

pH of Karapyak Beach

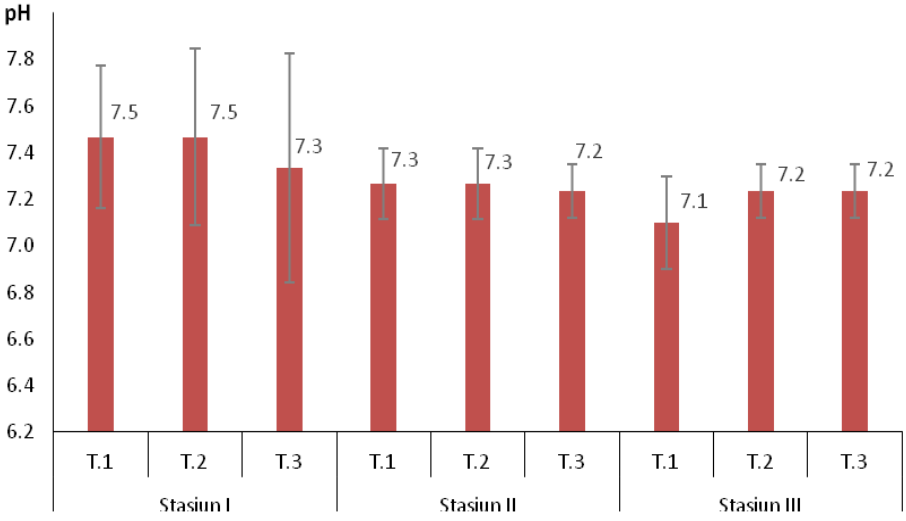

Figure 5. pH of Karpayak Beach

Based on the measurement of pH, the pH of the waters ranged from 6.9 to 7.9. The highest pH value is at station I whereas, the lowest pH value is at station III (Fig. 5), but the pH value is still within the tolerance limit for Chlorophyta growth. A good pH value for the growth of green algae ranged from 6 to 9 [15]. The effect on organisms is very large and important, a pH range of less than 6.5 will suppress the growth rate and pH level 9 is the optimal range in an waters.

Nitrat and Phosphate of Karapyak Beach

The test results of nitrate and phosphate levels on the coast showed that the nitrate levels of the waters ranged between 0.52 - 1.75 mg / l. The nitrate content is still relatively high from the quality standard. Normal nitrate levels in marine waters generally range from 0.001 to 0.007 mg /l [14]. The nitrate content of Karapyak Beach can still be tolerated by macroalgae, The nitrate content which describes the good water conditions for macroalgae growth is 0.09 to 3.5 mg /l [12].

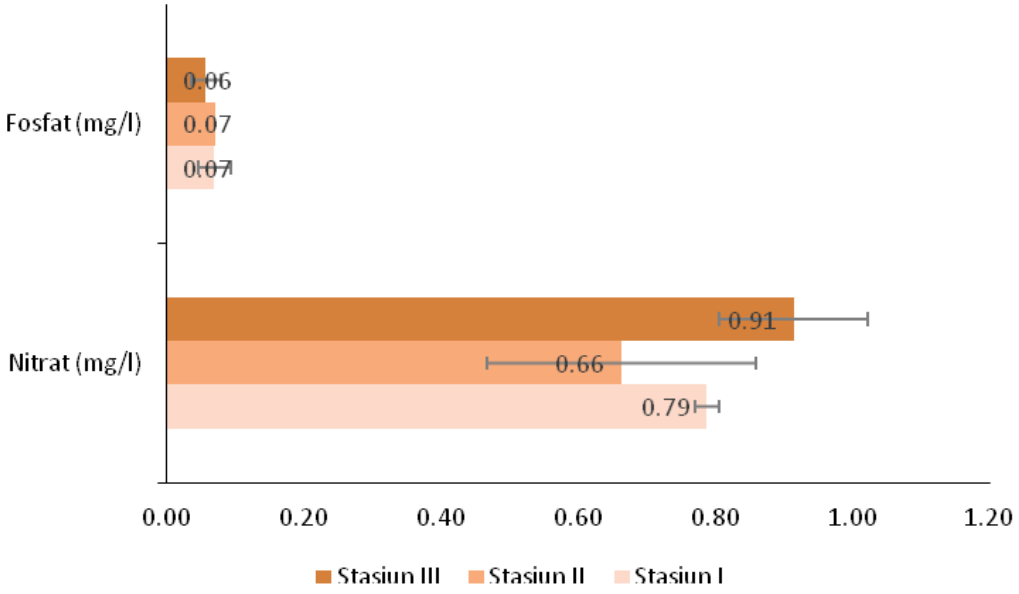

Figure 6. Nitrat and Phosphate Karapyak Beach

Phosphate levels in waters ranged from 0.015 to 0.085 mg / l. This level is considered high for the life of marine biota, the standard quality of phosphate concentration that is feasible for the life of marine biota in the Minister of Environment Decree (2004) is 0.015 mg / l. However, these levels can still be tolerated by macroalgae growth, [15] states that the need for phosphate for algal growth will be lower if nitrogen is in the form of ammonium salts and if nitrogen is in the form of nitrates the required phosphate concentration is higher. The phosphate concentration needed for algae growth ranges from 0.018-0.090 mg / l and the highest limit is 8.90-17.8 mg / l (P-PO4) if nitrogen is in the form of nitrate.

3. 2. Composition of Chlorophyta Species

Based on the results of the research on the three stations on Karapyak Beach, there were 6 macroalgae species from the Chlorophyta division including species of *Borgenesia forbesii*, *Caulerpa racermosa*, *Chaetemorpha crassa*, *Cladopora catenata*, *Ulva fleuxosa*, and *Ulva lactuca*.

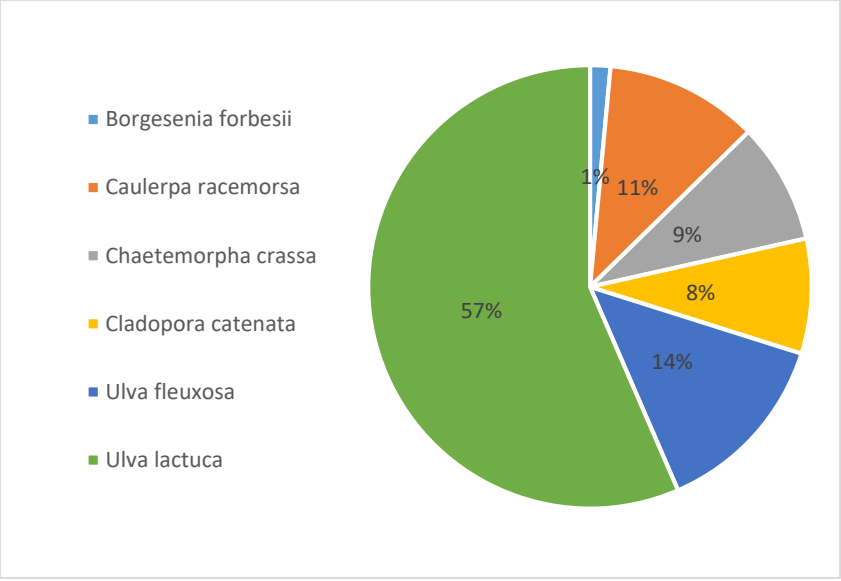

Figure 7. Composition of Chlorophyta Species

The macroalgae composition diagram from the Chlorophyta division shows that *Ulva lactuca* species dominates macrolaga composition with a percentage value of 57% from other species, namely *Borgenesia forbesii* at 1%, *Caulerpa racemorsa* at 13%, *Chaetemorpha crassa* at 9%, *Cladophora catenata* at 8%, and *Ulva fleuxosa* is 14% (Fig. 7). The genus Ulva is the highest genus of its presentation because Ulva has the potential for rapid growth and good development with distribution everywhere, the genus Ulva can also live in various habitats and environments. Although the main Ulva species live in the sea but can grow well in freshwater habitats [16]

3. 3. Chlorophyta Species Density

The density of an organism is determined by the ability to adjust to the environment in which the organism lives, and the dominance of one type of species shifts the other type [17]. Based on the results of the study, obtained the results of the amount of macroalgae density for three times sampling in the intertidal region of Karapyak Beach at each station as shown in Fig. 7. The highest density of Chlorophyta species in all observation stations was *Ulva lactuca* species, which were 141 - 168 individuals / m^2. This means that *Ulva lactuca* can grow well in all stations on Karapyak Beach. Meanwhile, the value of species density up to more than 50 individuals / m^2 states that the species has a good density on the entire surface of Karapyak Beach. Simatupang (2015) states that the categorized macroalgae density conditions in unfavorable density is less than 50 colonies / m^2.

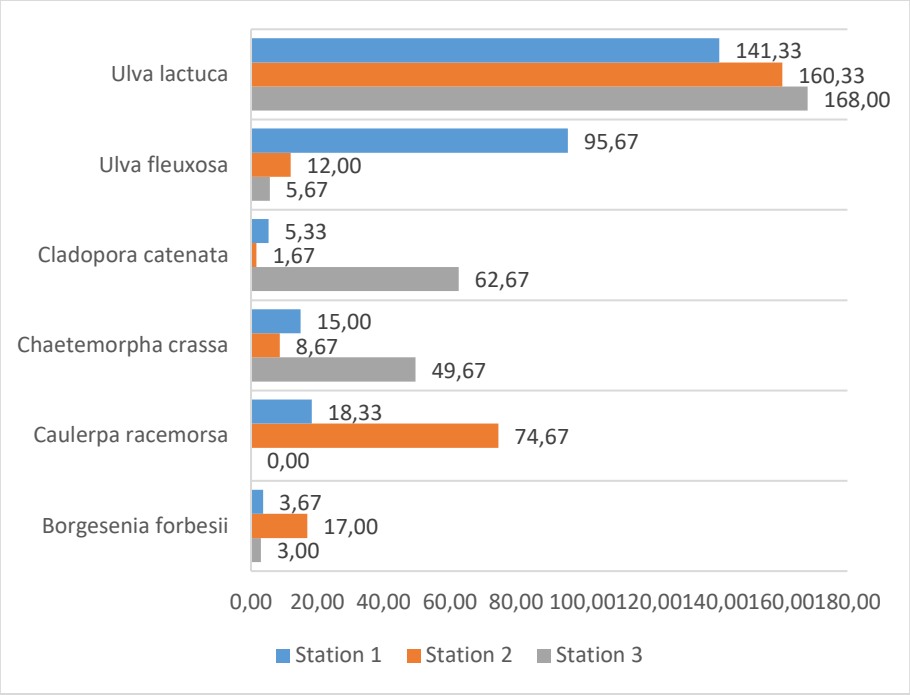

Figure 8. Chlorophyta Species Density

3. 4. Frequency of Chlorophyta Species

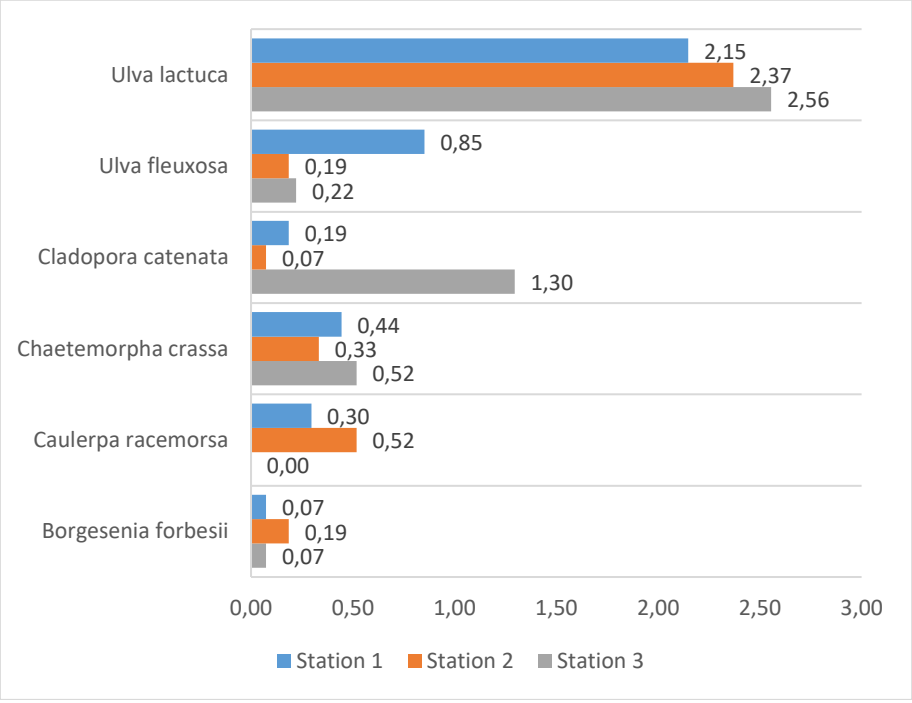

Figure 9. Frequency of Chlorophyta Species

Frequency is an ecological approach that is used to see opportunities for the presence of macroalgae [18]. The results of the Chlorophyta frequency for three sampling times in the intertidal region of Karapyak Beach (Fig. 9) showed that the highest macroalgae frequency was in macroalgae species *Ulva lactuca* of 2.15 - 2.56. It can be interpreted that *U lactuca* has the highest chance of occurrence at all stations in Karapyak Beach. Hatta (2002) states that U. lactuca grows in various habitats, on rocks, especially in dead coral fragments. The *Ulva sp.* has wide acclimatization and can grow well at various temperatures and salinity, but morphological characteristics change easily as a response to the environment [19].

3. 5. Coverage of Chlorophyta Species

Species cover is the area covered by certain species [10]. The following is the result of the amount of Chlorophyta cover for three times sampling Do Karapyak Beach seen in Figure. 10. The highest cover value of Chlorophyta species in Karapyak Beach is in macroalgae species Ulva lactuca, which ranges from 6.2-7.3. This indicates that the spread of U.lactuca species covered most of the intertidal areas of Karapyak Beach. The high percentage of U. lactuca can also be caused by the wide leaf type from U. lactuca which covers almost half of the macroalgae cover percentage in Karapyak Beach. The U. lactuca has a green sheetlike talus resembling a braid and grows to form thick colonies and is related to a solid substrate that grows abundantly in the upper tidal zone (supratidal). U. lactuca forms a thick colony so the beach looks green.

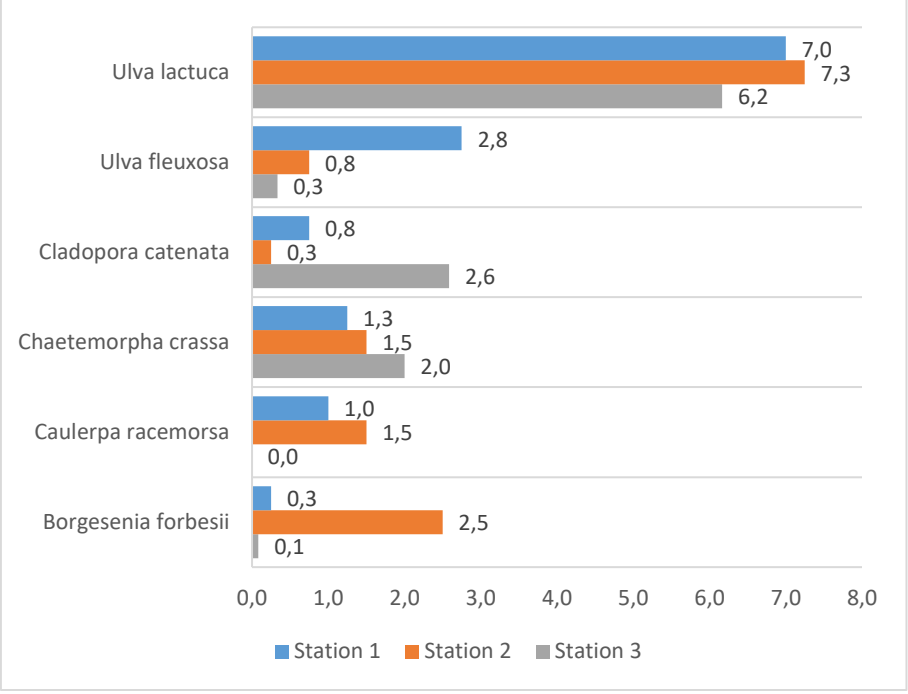

Figure 10. Coverage of Chlorophyta Species

According to [20], that the difference in the form of holdfast occurs due to the process of adaptation to the state of the substrate and environmental influences such as strong waves and currents that can pull the holdfast so that it affects the presence of macroalgae.

3. 6. Chlorophyta Important Value Index

Important Value Index (IVI), used to calculate and estimate the overall role of macroalgae species in a community. The higher the INP value of a type relative to other types, the higher the role of the type in the community [10]. Important Value Index (IVI) is also used to determine the dominance of a species against other species [21]. The following are the results of observations on the number of Chorophyta division macroalgae importance indexes for three sampling times which can be seen in Figure 11. Based on the INP criteria, in Figure. 10 showed that Chlorophyta with the highest IVI was *Ulva lactuca* species which was 158% in the satsiun area 1, 168% in the station 2 region, and 176% in the station 3 region.

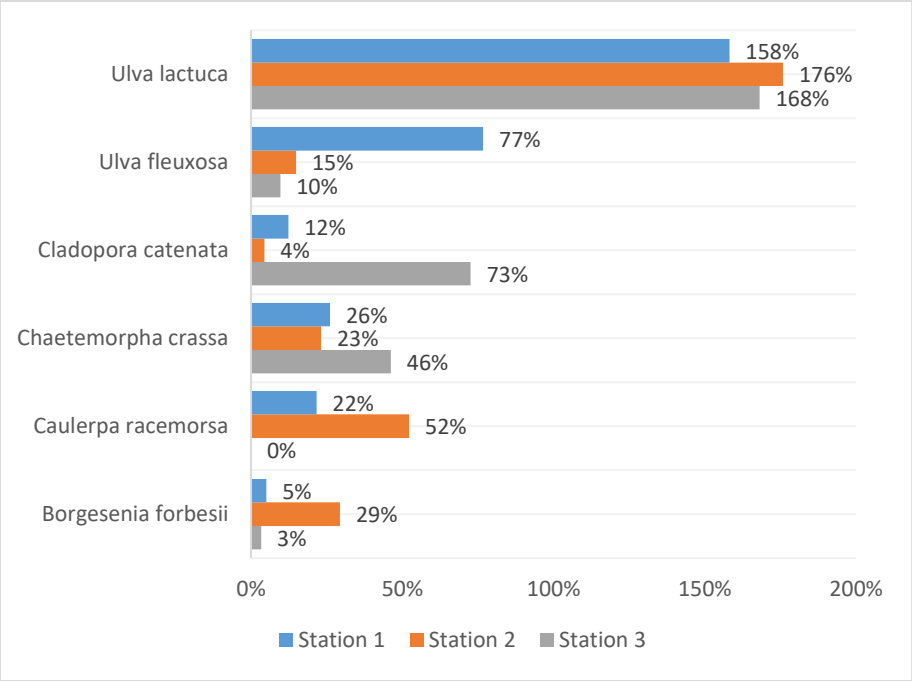

Figure 11. Chalorophyta Important Value Index

The high INP of a species found in an ecosystem shows the importance of the position of plant species in the species in the ecosystem. If in an ecosystem there is a disruption to plants that have the highest IVI, the disturbance will affect other components and the ecosystem concerned. Therefore, *U. lactuca* is a species of Chlorophyta which has a high importance in its ecosystem compared to other Chlorophyta species, it also indicates that the species *U. lactuca* becomes the dominant Chlorphyta in Karapyak Beach.

3. 7. Chlorophyta Diversity and Uniformity

Diversity index (H') is a representation of community structure and can facilitate the process of analyzing information about the types and number of organisms. The more species found, the greater the diversity, although this value depends on the number of individuals of each species [22]. Uniformity index (E) can be said as a balance of individual composition of

each species contained in a community [10], [25]. The diversity index and uniformity of macroalgae in Karapyak Beach can be seen in the Table. 1 below.

Table 1. Chlorphyta Diversity and Uniformity Index

Index	Station			Explanation
	1	2	3	
Diversity	1,70	1,48	1,55	low
Uniformity	0,7	0,6	0,7	high

Based on the results of the study, it was found that the Chlorophyta diversity index value was in the low diversity category at all stations. The value of the diversity index in Karapyak Beach shows that Chlorophyta in these waters is obtained in a small number of species. Meanwhile, the Chlorophyta uniformity index value is in the high uniformity category. This indicates that the Chlotophyta macroalgae species found on Karapyak Beach are relatively equal and there are no species that fall into the dominating species category in Karapyak Beach. one or several species overflow from the other, the uniformity index will be low [23], [26].

4. CONCLUSION

Based on the results of the study can be concluded that the Chlorophyta diversity index value (H') is in the low category of 1.70 at station 1, 1.48 at station 2, and 1.55 at station 3. Then the uniformity index value (E) is in the high category of 0.7 in satsiun 1 and 3, and at 0.6 in station 2. This indicates that the species of macroalgae Chlorophyta in Karapyak Beach is found in small amounts, but in the number of individuals relatively equal so that the dominance level of one species from Chlorphyta in Karapyak Beach is low.

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