

## **Diversity of Macroalgae Species on Pramuka Island and Kotok Besar Island, Thousand Island Regency, DKI Jakarta Province**

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### **Abstract**

Indonesia's coastal and marine biodiversity is present in various ecosystems, including coral reefs, mangroves, seagrass beds, estuaries, beaches, open seas, and deep seas. Each ecosystem has unique characteristics and an important role in maintaining ecological balance. Interactions between ecosystems also contribute to the health and sustainability of the coastal environment, as well as providing various benefits to the community, such as protection from coastal abrasion, provision of food resources, and improvement of environmental quality. Therefore, the purpose of this study was to provide an overview of the condition of the aquatic ecosystem on Pramuka Island and Kotok Besar Island. The research method used was a survey method using the quadratic transect method. Analysis of species composition data, Shannon-Wiener diversity, and importance value index. Water quality tests on Pramuka Island and Kotok Besar physical parameters and chemical parameters. Physical parameters are temperature, salinity, brightness, depth, and current speed. Chemical parameters are pH and DO (Dissolved Oxygen). Based on the results of the study, 26 types of macroalgae were found on Pramuka Island, and 19 types of macroalgae on Kotok Besar Island. The macroalgae diversity index values obtained by both are categorized as moderate, with a value of 2.64 on Pramuka Island and a value of 2.26 on Kotok Besar Island. The highest Importance Index value on Pramuka Island is the *Halimeda macroloba* species from the Chlorophyta division and *Hypnea asperi* from the Rhodophyta division. The Importance Index value on Kotok Besar Island is the *Halimeda macroloba* species from the Chlorophyta division and *Sargassum binderi* from the Phaeophyta division.

Keywords: Kotok Besar Island, macroalgae, Pramuka Island.

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### **INTRODUCTION**

The Seribu Islands Marine National Park (TNKpS) is composed of small island ecosystems and shallow sea waters, consisting of an archipelago with 78 small islands, 86 island sandbars, shallow sea expanses, fringing reef-type coral reefs, mangroves, and seagrass. The ecosystems found in TNKpS include mangroves, coral reefs, seagrass, sandbars, and lagoons. TNKpS has very high biodiversity, both from marine plants, coral reefs, and other natural potentials such as types of water birds, ornamental fish, and other marine biota. TNKpS is also a habitat for the protected Hawksbill Turtle (*Eretmochely simbricata*) (Thousand, 2008).

Biodiversity in coastal and marine areas of Indonesia includes various ecosystems, such as coral reefs, mangrove forests, seagrass beds, estuaries, beaches, open seas, and deep seas. This diversity, both in terms of genetics, species, and ecosystems, is a valuable asset that plays an important role in supporting economic development in

Indonesia. Each ecosystem is interconnected and works together through water flow and biota migration. This biodiversity provides various benefits, both directly, such as a source of food, drinks, medicines, cosmetics, and fertilizers, and indirectly, for example as protection from waves, fish spawning grounds, and supporting nutrient cycles (Nengsih, 2020).

Overall, coastal waters are dominated by primary producers such as coral reefs, seagrass beds, and mangrove forests. In addition, coastal ecosystems are also habitats for various types of macroalgae. Macroalgae themselves are benthic organisms that grow in shallow waters and have photosynthetic abilities, thus acting as the main source of primary productivity in the aquatic environment. In addition, macroalgae also function as a food source for various herbivorous organisms, such as gastropods, molluscs, and marine fish, thus having a significant ecological role (Melville & Pulkownik, 2006).

Macroalgae live by attaching to the substrate using holdfasts to prevent currents and tides, various types of substrates that become places for macroalgae to attach such as sand, coral reef fragments, and coral in shallow waters up to a depth of 180 m (Aswandi et al., 2023). Macroalgae are divided into three divisions based on their pigment content, green macroalgae (Chlorophyta), red macroalgae (Rhodophyta), and brown macroalgae (Phaeophyta). The pigments contained in macroalgae are photosynthetic pigments, such as chlorophyll a and chlorophyll b, as well as supporting pigments such as carotenoids and their derivatives (Akmal et al., 2017).

Macroalgae are widespread in almost all shallow waters of Indonesia, especially around coral reefs, such as in Bangka-Belitung, Riau Islands, East Nusa Tenggara, West Nusa Tenggara, Seribu Islands, Sunda Strait, South Coast of Java, Karimun Jawa, Bali, and islands in Sulawesi and Maluku. The distribution of macroalgae can be distinguished based on their depth; in shallow waters, macroalgae from the Chlorophyta division dominate, followed by the Phaeophyta division, while at maximum depth, macroalgae from the Rhodophyta division are more dominant (Odum, 1996). Although macroalgae can be found in the intertidal zone, some types of macroalgae can also live at depths of up to 150 meters (Nontji, 2007).

The abundance of macroalgae in nature is influenced by the condition of the aquatic environment (Hurrey et al., 2013; Han & Liu, 2014). In general, macroalgae grow in intertidal areas that experience higher variations in environmental factors compared to other parts of the marine ecosystem (Satyam & Thiruchitrabalam, 2018). Environmental factors that vary include temperature, brightness, salinity, substrate, dissolved oxygen, depth, and others. Differences in location or characteristics of each location that has a different environment can have an impact on the diversity of macroalgae types in waters. (Cleary et al., 2016).

The results of this study aim to provide an overview of the condition of the aquatic ecosystem in several locations of the Seribu Islands National Park, namely Pramuka Island and Kotok Besar Island and its relationship to the abundance of macroalgae. In addition, it can also be useful as information related to the condition of the coastal aquatic ecosystem on Pramuka Island and Kotok Besar Island by looking at the diversity data contained therein, namely macroalgae.

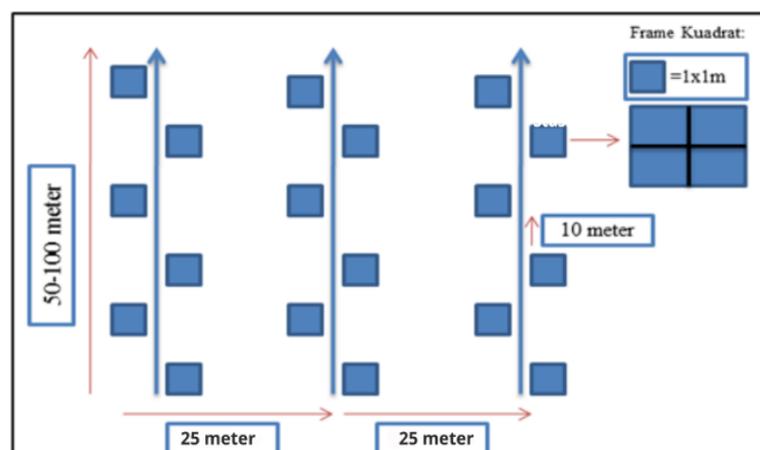
**METHOD**

This research was conducted in January - February 2022. The research was conducted on Pramuka Island and Kotok Besar Island, Seribu Islands Regency, Seribu Islands National Park, DKI Jakarta Province (Figure 1).



**Figure 1. Data Collection Locations on Pramuka Island and Kotok Besar Island**

Data collection was conducted at 4 stations on Kotok Besar Island and 4 stations on Pramuka Island, each with three transects. Data collection was conducted when the beach was receding, and data collection was conducted at a depth of 0-1 m. Stations were determined based on the direction of the wind, namely North, West, East, and South. Data were collected using a quadrat plot placed left and right or zigzag according to the transect line that had been installed. The method used to collect macroalgae data was the quadrat transect method (Figure 2). The installation of the transect began on the coast by drawing a transect line and starting from where the algae were found. The transect line was drawn perpendicular to the coast for 50 m, the transect was made three times with a distance between transects of 25 m, this was done to determine whether there were differences in communities between each transect and to represent the community at each station. The first quadrat plot was placed where the macroalgae began to grow, then the plot was moved 10 meters along the transect line and placed left and right up to 50 meters.



**Figure 2. Research plot transect**

Observations of water conditions and substrates at the research location were carried out by measuring physical and chemical parameters. Physical parameters include temperature, salinity, brightness, depth, and current speed. Chemical parameters are pH and DO (Dissolved Oxygen). Measurements of both parameters were carried out in the field. The methods or equipment used in measuring physical parameters are Temperature with Lutron series T 017219, Salinity with Lutron TF 06213, Brightness with Secci disc, depth with a regular stick, and current speed with floating droudge. In addition, measurements of chemical parameters are pH with Lutron series TP 07 and DO (Dissolved Oxygen) with Lutron Series WAC-2019CP. Measurements of both parameters were carried out directly at the research location. Identification of macroalgae species found using identification books (Atmadja et al., 1996, Handayani et al., 2014). Identification also uses the scientific nomenclature of macroalgae that is currently internationally applicable. Data analysis includes species composition, Shannon-Wiener diversity index, and Important Index Value.

## RESULT

### Water Conditions on Pramuka Island and Kotok Besar Island

Based on the results of the water quality research that we obtained from chemical parameters and physical parameters including PH, salinity, temperature, current speed, brightness, depth, substrate, pH, and dissolved oxygen. The temperature values obtained on Pramuka Island and Kotok Besar Island are 27.5 - 31 ° C. Salinity on Pramuka Island is 31.5‰, while on Kotok Island the salinity value is high, namely 26‰. The current speed on Pramuka Island and Kotok Besar Island ranges from 0.10 - 0.19 m / s. The brightness obtained at all stations is 100%, this is because the conditions at each station are still in the intertidal zone which has a depth of 0.33 - 0.58 m. The type of substrate obtained on Pramuka Island is predominantly sand and dead coal, while the substrate on Kotok Besar Island has a diverse substrate consisting of sand, dead coral, rocks, and muddy sand. The pH value on Pramuka Island and Kotok Besar Island is 8. Dissolved oxygen on Pramuka Island is 4-6mg.L-1, while in Puu Kotok Besar it is 6.7 - 8.4mg.L-1 (Table 1).

**Table 1. Environmental conditions of the waters on Pramuka Island and Kotok Besar Island**

	Pramuka Island	Big Kotok Island
<b>Physics Parameters</b>		
Temperature (°C)	27.5	31
Salinity (‰)	31.5	26
Brightness (%)	100	100
Current Velocity (m/s)	0.19	0.10
Depth (m)	0.33	0.58
Substrate	Sand, DC	Sand, DC, Muddy sand, rocks
<b>Chemical Parameters</b>		
pH	8	8
DO (mg.L-1)	5	7.3

**Macroalgae Composition on Pramuka Island and Kotok Besar Island**

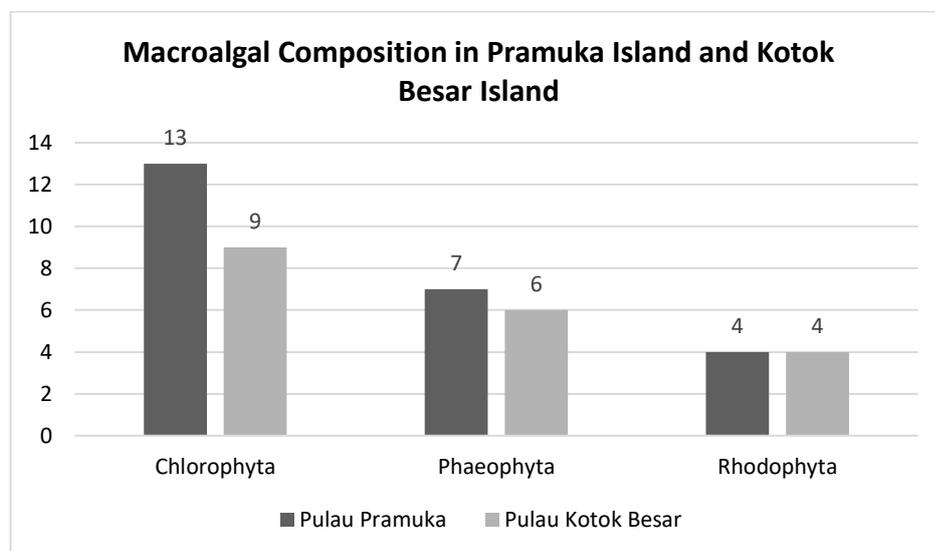
Based on the results of the identification that has been carried out, it was found that there were 28 types of macroalgae on Pramuka Island and Kotok Besar Island consisting of 3 macroalgae divisions, namely Chlorophyta (green algae), Phaeophyta (brown algae), and Rhodophyta (red algae) (Table 2).

**Table 2. Macroalgae species found on Pramuka Island and Kotok Besar Island**

<b>Division</b>	<b>Class</b>	<b>Ethnic group</b>	<b>Type</b>
Chlorophyta	Chlorophyceae	Halimedaceae	<i>Halimeda macroloba</i> <i>Decainsne</i>
		Halimedaceae	<i>Halimeda laccunalis</i> <i>WRTaylor</i>
		Halimedaceae	<i>Halimeda oppuntia</i> (Linnaeus)
		Halimedaceae	<i>Halimeda macrophyta</i> <i>Askenasy</i>
Chlorophyta	Chlorophyceae	Caulerpanceae	<i>Caulerpa lentillifera</i> J. Agardh
		Caulerpanceae	<i>Caulerpa taxifolia</i> (M. Vahl) C. Agardh
		Caulerpanceae	<i>Caulerpa sertularoides</i> (SGGmelin) M. Howe
		Caulerpanceae	<i>Caulerpa racemosa</i> (Forsskal). Agardh
		Caulerpanceae	<i>Caulerpa serrulata</i> (Forsskal) J. Agardh
Chlorophyta	Chlorophyceae	Dasycladaceae	<i>Neomeris annulata</i> Dickie
	Chlorophyceae	Ulvaceae	<i>Enteromorpha intestinalis</i> (Linneus) Nees
Chlorophyta	Ulvophyceae	Cladophoraceae	<i>Chaetomorpha crassa</i> (C. Agardh) Kutzling
			<i>Cladophora glomerata</i> (Linnaeus) Kutzling
Phaeophyta	Phaeophyceae	Dictyotaceae	<i>Padina tetrasomastica</i> Hauck
		Dictyotaceae	<i>Hauck's australis padina</i>
		Dictyotaceae	<i>Dictyota bartayresiana</i> JV Lamouroux
Phaeophyta	Phaeophyceae	Sargassaceae	<i>Sargassum binderi</i> Sonder ex J. Agardh
		Sargassaceae	<i>Cystoceria</i> sp C. Agardh.
		Sargassaceae	<i>Tubinaria ornata</i> (Turner) J. Agardh
		Sargassaceae	<i>Turbinaria conoides</i> (J. Agardh) Kutzling
Rhodophyta	Rhodopyceae	Hypneaceae	<i>Hypnea aspergius</i> Kutzling.
Rhodophyta	Rhodopyceae	Corallinaceae	<i>Corallina</i> sp Linnaeus
		Corallinaceae	<i>Amphiroa fragillissima</i> (Linnaeus) JVLimouroux.
Rhodophyta	Rhodopyceae	Soliericeae	<i>Eucheuma spinosum</i> J. Agardh

Rhodophyta	Rhodopyceae	Rhodomelaceae	<i>Acanthophora muscoides</i> (Linnaeus) Bory
		Rhodomelaceae	<i>Acanthophora spicifera</i> (M. Vahl) Borgesen
		Rhodomelaceae	<i>Laurencia nidifica</i> J. Agardh
Rhodophyta	Rhodopyceae	family Gracilaria	<i>Gracilaria salicornia</i> (C. Agardh) Dawson

On Pramuka Island, the types of macroalgae found came from 13 types of Chlorophyta division, 7 types of Phaeophyta, and 4 types of Rhodophyta. On Kotok Besar Island, the types of macroalgae found came from 9 types of Chlorophyta division, 6 types of Phaeophyta, and 4 types of Rhodophyta (Figure 3).



**Figure 3. Macroalgae Composition on Pramuka Island and Kotok Besar Island**

#### **Macroalgae Diversity Index of Pramuka Island and Kotok Besar Island**

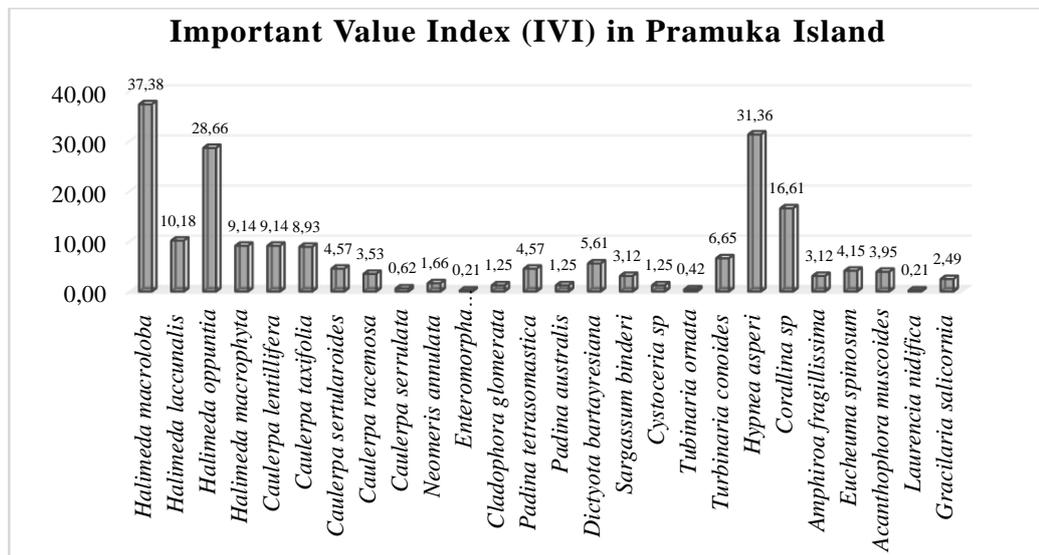
Based on the results of the identification that has been carried out, it was found that there were 26 types of macroalgae on Pramuka Island and 19 types of macroalgae on Kotok Besar Island consisting of the Chlorophyta, Phaeophyta, and Rhodophyta Divisions. The results of the Diversity Index Value analysis obtained on Pramuka Island were categorized as moderate with a value of 2.64 and on Kotok Besar Island were categorized as moderate with a value of 2.26. (Table 3).

**Table 3. Macroalgae Diversity Index Values of Kotok Besar Island and Pramuka Island**

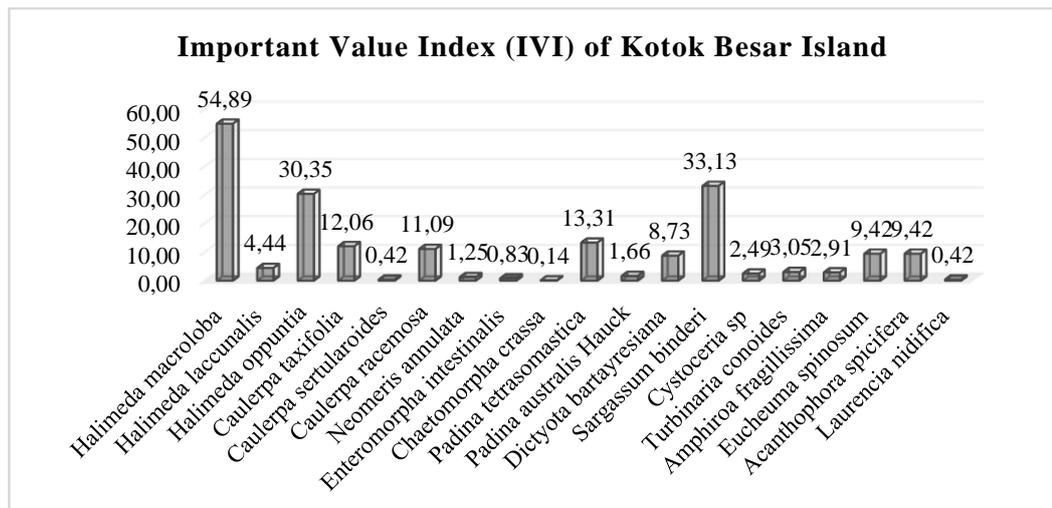
Location	Number of species	Number of Divisions	H'
Pramuka Island	26	3	2.64
Big Kotok Island	19	3	2.26

**Macroalgae Importance Value Index on Pramuka Island and Kotok Besar Island**

The highest Importance Index value on Pramuka Island is *Halimeda macroloba* from the Chlorophyta division and *Hypnea asperi* from the Rhodophyta division (Figure 4). The Importance Index value on Kotok Besar Island is *Halimeda macroloba* from the Chlorophyta division and *Sargassum binderi* from the Phaeophyta division. (Figure 5).



**Figure 4. Importance Value Index of Pramuka Island**



**Figure 5. Importance Value Index of Kotok Besar Island**

## DISCUSSION

Based on the research results, the growth and reproduction of marine biota are influenced by several factors, including physical and chemical factors that can affect the condition of coralfish. Several physical and chemical parameters that play an important role in influencing the condition of coralfish include temperature, pH, salinity, current speed, brightness, and dissolved oxygen (DO). Environmental conditions in the waters of Pramuka Island and Kotok Besar Island show that physical and chemical parameters, such as temperature, salinity, brightness, current speed, depth, DO, and pH, are still in good condition for the growth and reproduction of macroalgae, macrobenthos, and fish. These optimal conditions are very important to support the sustainability of the marine ecosystem because these parameters contribute to the health and productivity of marine biota. By maintaining good environmental quality, it is hoped that it can increase the diversity and abundance of marine biota on the two islands.

In the research of Marni et al. (2020), it was stated that the brightness of the waters is greatly influenced by the sunlight that enters the waters. The higher the intensity of sunlight that enters, the higher the brightness value of the waters. Macroalgae need sunlight to support the photosynthesis process. The measurement results at the research location showed that the brightness reached 100%, where the intensity of sunlight that entered could reach the bottom of the waters. This condition greatly supports the growth of macroalgae, because sunlight plays an important role in the photosynthesis process that occurs in the body of macroalgae.

In addition, through several measurements at several locations at different times, the current speed on Pramuka Island and Kotok Besar Island was recorded as quite high, ranging from 0.1 - 0.2 m/s. This is in line with the statement of Atmadja et al. (1996) which states that good water movement for macroalgae growth is in the range of 0.2-0.5 m/s. Based on the results of research conducted by Irwandi et al. (2017), the diversity of macroalgae species in waters with higher current speeds tends to be more diverse compared to waters with lower current speeds. In addition, the results of observations conducted by Terangi (2009) showed that the tidal conditions in the Seribu Islands can be categorized as single daily. These tidal conditions can also affect the dynamics of aquatic ecosystems, including the growth and distribution of

macroalgae and other marine biota. Thus, physical factors such as brightness and current speed have an important role in supporting the diversity and productivity of marine ecosystems in the region.

The salinity value on Kotok Besar Island is relatively low, ranging between 25-28 ‰. The salinity of open sea water generally ranges between 30-36 ‰ (Brotowidjoyo et al., 1995), and the optimal salinity for macroalgae growth is between 30-32 ‰ (Luning, 1990). The growth of macroalgae species can be disrupted if the salinity in the waters is too low or too high (Choi et al., 2010). The difference in salinity on Kotok Besar Island is likely caused by differences in evaporation and precipitation (Kangkan, 2006). Changes in salinity can affect the quality of aquatic ecosystems, especially in terms of the types and abundance of organisms present (Nontji, 2007). Thus, the low salinity on Kotok Besar Island can contribute to lower macroalgae diversity compared to Pramuka Island, where salinity conditions are more supportive of the growth and diversity of macroalgae species.

On the other hand, Pramuka Island has a higher diversity of macroalgae compared to Kotok Besar Island. The Chlorophyta division was found the most, with 12 species on Pramuka Island and 9 species on Kotok Besar Island. Generally, macroalgae from the Chlorophyta division have the highest abundance compared to other classes. This is due to the wider habitat distribution for macroalgae from the Chlorophyta class so that their occurrence rate is easier to find compared to other classes (Odum, 1993).

The importance index value on Pramuka Island shows that the *Halimeda macroloba* species has the highest value. Meanwhile, on Kotok Besar Island, the importance index value is also dominated by *Halimeda macroloba* from the Chlorophyta division and *Sargassum binderi* from the Phaeophyta division. On both islands, the Chlorophyta division, especially the *H. macroloba* species, is most commonly found. This condition is thought to be caused by the diverse types of substrates, especially on Kotok Besar Island, where one of the stations has sandy mud and sand substrates, which are good places for the macroalgae to grow. The large importance index value of a species indicates that the species has a significant role in the ecosystem. If there is a disturbance in the species with the highest importance index value, this can affect other components and the entire ecosystem concerned (Ulfah et al., 2017).

Research conducted by Ira et al. (2018) supports this statement, that macroalgae from the Chlorophyta division, especially *H. macroloba*, can grow on various types of substrates because they have a high level of adaptation. These macroalgae have holdfasts in the form of collections of fibrous roots that allow them to attach to coarse substrates and sand particles. In addition, according to Kadi and Atmaja (1988), habitats with sand substrates are generally inhabited by macroalgae from the Chlorophyta (green algae) and Phaeophyta (brown algae) divisions, which shows that the type of substrate plays an important role in determining the presence and diversity of macroalgae in an area.

## CONCLUSION

Based on the results of the identification that has been done, it was found that there are 26 types of macroalgae on Pramuka Island originating from 13 types of Chlorophyta divisions, 7 types of Phaeophyta, and 4 types of Rhodophyta. While on Kotok Besar Island consists of 19 types of macroalgae originating from 9 types of Chlorophyta divisions, 6 types of Phaeophyta, and 4 types of Rhodophyta. The

Diversity Index values obtained on Pramuka Island and Kotok Besar Island are in the moderate category with values of 2.64 and 2.26.

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