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Inventory and Description of Macroalgae In Rambut Island Kepulauan Seribu DKI Jakarta

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Abstrak

Macroalgae is a marine biological resource that has the potential to be developed because macroalgae have an important role both in terms of ecology and economy. But anthropogenic pressures such as domestic waste, solid waste disposal, urban community activities, urban planning development activities, and community activities in the waters tend to affect macroalgae growth and diversity which even cause damage to the extinction of macroalgae species. This research needs to be done as the limited information about macroalgae on Rambut Island. The purpose of this study was to determine the composition, and diversity by inventorying and describing the types of macroalgae and to analyze the state of the macroalgae community structure in the Rambut Island waters. Data and information on types and descriptions of macroalgae morphology can be used as a basis for managing and enriching macroalgae biodiversity, especially on Rambut Island, Kepulauan Seribu. The methodology is the quadratic transect method. The results obtained 28 species belonging to 3 divisions, namely 18 species of *Chlorophyta*, 5 species of *Phaeophyta*, and 5 species of *Rhodophyta*. The diversity index of macroalgae is moderate (1.73) and there are no dominant species. The quality of the waters in Rambut Island supports the growth of macroalgae. The macroalgae community structure in Rambut Island is still in a stable condition.

***Keywords**: Description, Diversity, Community, Macroalgae, Rambut Island*

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INTRODUCTION

Macroalgae is a biological resource that has the potential to be developed and disseminated in the intertidal coastal areas of Indonesia. Coastal areas or coastal zones are areas prone to change due to human activities and natural factors. Human activities such as agriculture, urbanization, tourism, industrial and domestic waste disposal, offshore oil spills, and aquaculture development have led to an increase in nutrient loads to shallow shores impacting the toeutrophication of seawater in the coastal marine ecological environment. On the other hand, nutrient enrichment is needed to increase macroalgae biomass, especially in some dominant species, but has a major effect on the survival of other macroalgae, resulting in the gradual loss of species because they cannot adapt to the environment (Damar, 2003; Mc Clanahan *et al*., 2007; Zhao *et al*., 2016; Rositasari *et al*., 2017).

Macroalgae have an essential role in terms of an ecological and economic point of view. The ecologicals' benefit of macroalgae are providing habitat for several types of marine biota such as

crustaceans, mollusks, echinoderms, fish, and the small algae. While the economic value of macroalgae can be used as food, industrial raw materials, and materials for laboratories such as wet preservation materials, media materials for the proliferation of bacteria and fungi to produce antibiotics, and there are also types of macroalgae used as medicines (Marianingsih *et al*., 2013). Macroalgae are highly susceptible to the unstable environmental conditions or natural factors such as wind, waves, currents, and seasons which can trigger changes in macroalgae habitat (Saleh & Hairati, 2013). Anthropogenic pressures such as urban community activities, urban planning development activities, and community activities in the waters tend to affect the growth and development of macroalgae diversity. This condition is worrying because of a prominent role as a food, energy, medicines and cosmetics sources in the future, as well as acting as the lungs of the world and maintaining environmental stability (Prasetyaningsih & Raharjo, 2016). Environmental factors; such as substrate, water movement, temperature, salinity, tides, light, pH, nutrients, and water quality should be maintained to prevent macroalgae's degradation, detract the quality that will cause damage and even the extinction (Langoy *et a*l., 2011; Litaay, 2014).

Rambut Island is the only small island in the Kepulauan Seribu, DKI Jakarta Province area of 90 ha consisting of 45 ha of land and 45 ha of the sea. Rambut Island in located in front of Jakarta Bay which is vulnerable to anthropogenic activities because the 13 major rivers, such as the Ciliwung and Citarum carry waste from the mainland. The high burden of waste will affect the waters and ecosystem condition, for example, the macroalgae ecosystem. In addition, highly human activity level on inhabited islands, especially marine tourism activities, can disrupt ecosystems and habitats on Rambut Island (Rustam, 2020). It needs to handle macroalgaes' diversity, assess the extinction and develop the existing macroalgae resources potential. As a result, research in inventory, identification macroalgae types, and analyze the state of the macroalgae community structure is crusial in the Rambut Island waters. The aim was to determine the macroalgae type and to describe the macroalgae of Rambut Island. The results of this study can provide scientific data information to the local government of Kepulauan Seribu, DKI Jakarta Province for development, utilization, and sustainable management of macroalgae resources.

METHOD

This research was conducted on Rambut Island, Kepulauan Seribu, DKI Jakarta (Figure 1). The research took place in February 2021.

Figure 1. Research Location

Data collection was carried out at low tide using the quadratic transect method by drawing a perpendicular line to the shore, then placing a plot measuring 1m x 1m with a distance of 10 meters for each plot and 20 meters on each transect (Figure 2). All types of macroalgae found in the plots were counted individually, several subplots, type of substrate, and recorded macroalgae morphological characteristics to facilitate the identification process. Macroalgae specimens found at the research station were taken if they could not be identified. Identification is done using identification according to Taylor, 1961; Atmadja et al., 1996; Trono, 1997; Critchley & Ohno, 1998; Trono, 1999; Liao *et a*l., 2013; Handayani *et al*., 2014). Macroalgae found in plots that have not been identified are then photographed. Furthermore, the specimen was preserved and put into a plastic bag containing 70% alcohol and labeled using newtop paper for further identification in the laboratory.

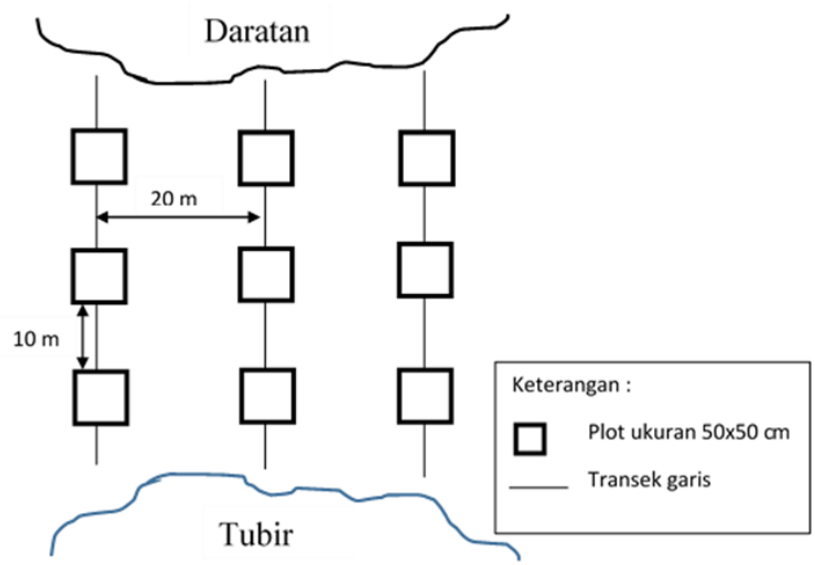


Figure 2. Plot Laying Design

Data Analysis

To see the composition of macroalgae species in the research location, macroalgae identification was carried out, macroalgae species diversity using the Shanon-Wiener diversity index (Brower and Zar, 1997). Dominance is expressed in the Simpson index. Coverage is calculated by comparing the area covered by a species with the total area covered by all species (Hadi & Ayu, 2020)

RESULT

A. Composition of macroalgae

The results of the identification of macroalgae in Rambut Island were recorded in 3 divisions, namely *Chlorophyta*, *Phaeophyta*, and *Rhodophyta* with 28 types of macroalgae. The composition of macroalgae species on Rambut Island is shown in Table 1.

Table 1. Types of Macroalgae Found on Rambut Island

Rambut Island	
Division	**Type**
Chlorophyta	*Caulerpa sertularoides*
	Caulerpa serrulata
	Caulerpa racemosa
	Boergesenia forbesii
	Caulerpa racemosa var. uvifera
	Halimeda renschii
	Halimeda macroloba
	Rhipidosiphon javensis
	Halimeda opuntia
	Caulerpa peltata
	Caulerpa lentilifera
	Caulerpa cupressoides
	Halimeda lacunalis
	Caulerpa taxifolia
	Caulerpa racemosa var. Occidentalis
	Chaetomorpha crassa
	Enrteromorpha intestinalis
	Phyllodictyon pulcherrimum
Phaeophyta	*Padina tetrastomatica*
	Dictyota bartayresiana

	Padina australis
	Sargassum cinerium
Rhodophyta	*Lobophora variegata*
	Amphiroa fragilissima
	Halymenia durvillei
	Gracilaria salicornoia
	Acanthopora specifera
	Gracilaria coronopifolia

B. Diversity Index

Based on the analysis of the diversity index (H`) of the macroalgae describes that the value of species diversity at station I is 1.097, station II is 2.076, station III is 1.532, and Station IV is 2.219 (Figure 3).

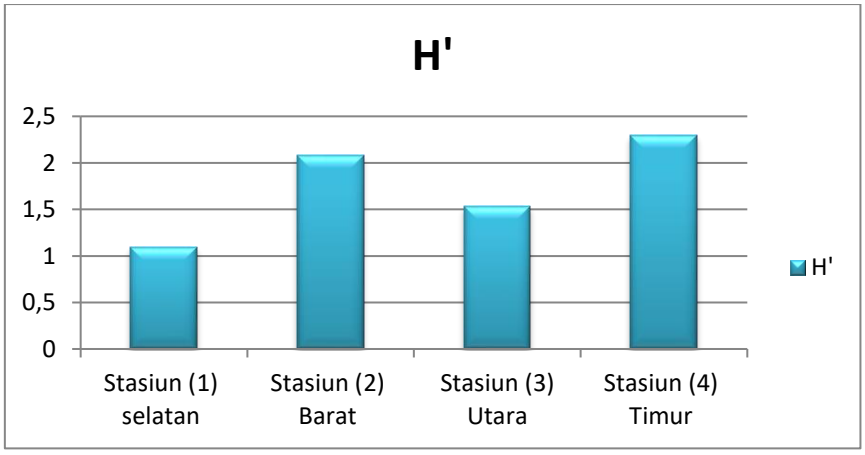


Figure 3. Value of Diversity at each Reseach Station

C. Macroalgae Cover

The results of observations at four research stations, obtained the average percentage of macroalgae cover in the waters of Pulau Rambut at Station (1) at 26%, Station (2) at 36%, Station (3) at 37%, and Station (4) 44% (Fig. 4). The average macroalgae cover in Rambut Island with a range of 26% - 44% classified as moderate.

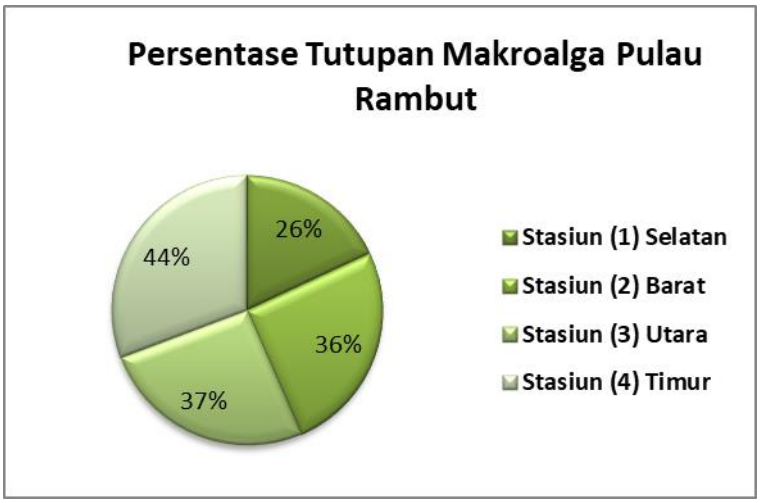


Figure 4. Macroalgae Cover in Rambut Island

D. Chemical Physics Parameter

The values of the Physico-chemical parameters of the waters of Rambut Island is shown in Table 2.
Table 2. Average Physical and Chemical Parameters of Rambut Island Waters.

Table 2. Average Physical and Chemical Parameters of Rambut Island Waters

Parameter	Unit	Rambut Island
Temperature	ºC	29
Current speed	m/s	0,84
Depth and Brightness	m	2,87
pH	-	8
Salinity	PSU	33
Substrate :		
Texture :		
a. Sand	%	97,34
b. Dust	%	0,53
c. Clay	%	2,13
d. Total N	%	0,05
e. Total P	%	0,01

E. Description of Macroalgae

A. Chlorophyta

Caulerpa peltata

The thallus has a large (5cm) stolon with relatively large roots that are pointed like spikes. Ramuli arise in branched stolons and have spheres with flat, button-like ends, green in color. Habitat on sandy substrate.

Caulerpa racemosa var occidentalis

Thallus grows horizontally with stolons. The blade is erect, round to form slightly flattened balls, and the number of ramuli is 8-16, with a diameter of 2.92 mm. The distance between the branches is 5 mm. It is yellowish dark green that grows in sandy substrate habitat rather infrequently.

Caulerpa taxifolia

Thallus has stolons, upright thallus resembling feathers therefore this alga is referred to as Caulerpa bulu (feather Caulerpa).

Caulerpa cupressoides

Thallus has stolons with long rhizoids, forming branching ramuli with elongated flattened ramuli and serrated edges. The ends of the stalk are yellow or brown.

Caulerpa lentiifera

Thallus with round branches like grapes propagates. Branches are tightly closed, the shape of the blade is round, and the number of ramuli is 17-31, with a diameter of 1.26 mm dark green color, yellowish holdfast. Its habitat is on sandy substrates.

Caulerpa sertularoides

Thallus completed stolons propagate with roots anchored to the substrate. The ramuli appear on stolons between roots, pinnately arranged tightly and thinly with light green-dark green color reaching 2 cm in length.

Caulerpa serrulata

Thallus has stolons which erect, sometimes falling with green color, height between 5-8 cm. The part near the base of the cylindrical, flattening upwards, often becoming twisted or spiral-like, with jagged or wavy edges.

Halimeda macroloba

The thallus is lush with a calcareous-stiff blade. The holdfast resembles elongated tubers. This species has a green color and changes to yellowish green color in dry conditions that prefer sandy substrate habitat.

Halimeda lacunalis

The thallus is arranged in segments, green color, and thin carbonate content. Dichotomous branches sometimes grow four new segments in one main branch. The basal segment is relatively small, subcuneate, or obovate.

Halimeda opuntia

The thallus is dense, erect, and overlapping, with trichotomous branches. The adhesive is a filament, and the blade is calcareous, stiff with green color. Its habitat is in sandy areas.

Halimeda renschii

The thallus is composed of spherical, flattened, or oval segments. The main branch of the dichotomous or trichotomous. Growing upright thali in a clump 8 cm high.

Borgesenia forbesii

The thallus is like a balloon, cylindrical, transparent thin-walled, filled with fluid inside, and looks shiny. It has a light green color, holdfast rhizoid. Its habitat is on rock substrates.

Thallus cylindrical hollow like a flat pipe; grows from the thallus at the base with branching at the roots. The upper branches bulge, turning in the middle, forming ribbon-shaped in the lower; attached to the substrate with a small disc-shaped adhesive device. It has a bright green to yellowish green color.

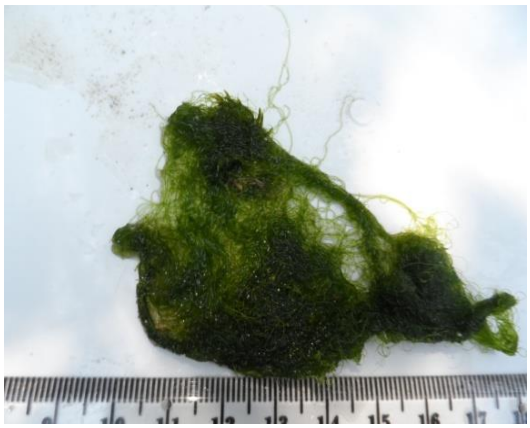
Enteromorpha intestinalis

The thallus forms a pedestal or underpinning 20 cm wide and 3.5 cm thick, closely branched, with entangled filaments, usually covered with small hairs at the edges.

Phyllodictyon pulcherrimum

The thallus is an erect, monosiphonous, calcareous fan-like shape and forms dichotomous branches. Habitat in the sand with cracked coral.

Rhipidosiphon javensis



Cylindrical thallus resembles hair and forms clumps like tangled threads, green color.

Chaetomorpha crassa

B. *Phaeophyta*

The thallus is multi-layered, ear-fungus shaped, with a cartilaginous texture, and its habitat is on dead coral.

Lobophora variegata

The fan-like thallus forms thin sheet segments divided into several small lobes, regular and vivid concentric lines covered with yellowish brown color.

Padina tetrastomatica

Padina australis

The fan-like thallus forms thin sheet segments (lobes) with vivid concentric lines and commingling on the leaf surface. The color is yellowish brown or sometimes white because there is calcification.

Sargassum cinerium

A stem (caloid) is a cylindrical, smooth, disc-shaped holdfast. Branches alternate irregularly at long intervals. The leaves are oval, and the edges are tortuous or serrated and small.

Dictyota bartayresiana

Flat thallus has a length of up to 5 cm and a width of 2-3 mm with flat edges, dichotomous branches, and tapered ends forming dense clumps forming a cluster. It has a yellowish brown color and habitat on the fraction coral substrate.

C. Rhodophyta

Gracillaria coronopifolia

The thallus is cylindrical, smooth, brown-green, or yellow-brown color (blonde), attached to the substrate by small discs. It has dichotomous branching, repetitive, and dense at the top portion of the clumps

Gracillaria salicornia

The thallus is cylindrical, smooth, ribbed, or segmented. There is a bulge on the thallus like a bubble. It forms a dense clump (radial) dispersed up to 25 cm. Thallus size is about 1 - 1.5 mm and 15 cm in height.

Acantophora specifera

The thallus is cylindrical, 11 cm high, and dense with a calcareous blade. It has dichotomous branches with brownish green color. The stem is 1.5 mm long and the branches-distance is 2.29 mm. The size of the cell cross-sectional area is 41.59 mm consisting of 1-2 cortex on a surface with a diameter of 2.72 mm, and an elongated-shape. Cortical cells on the surface are elongated with a diameter of 2.57 mm. Its

The thallus is cylindrical and high calcareous, branching dichotomous, with a stem length of 1-2 mm. The distance between branches is 3-5 mm. It has a light brown color in sandy areas

Amphiroa fragillaria

The thallus is flat, smooth, soft flexible (gelatinous), and dark red or pink color. Branches alternate irregularly on both sides of the thallus. The bottom of the thallus usually widens and tapers to the top. The edges of the thallus are indented

Halymenia durvillei

DISCUSSION

The identification of macroalgae on Rambut Island found 28 types included 18 *Chlorophyceae* species, 5 *Phaeophyceae* species, and 5 *Rhodophyceae* species. The highest composition of macroalgae in Rambut Island is *Chlorophyceae* because of the substrate difference. The results of the texture substrate analysis on Pulau Rambut were 94.34% sand, 0.53 dust, and 2.13 clay. Sand substrate is suitable for macroalgae growth from *Chlorophyceae* because these types thrive well (Johan et al., 2015; Arami et al., 2018).

The diversity index on Rambut Island shows a moderate value as the stable environmental conditions and the number of species found. This finding is in line with the statement of Odum (1996); the value of 1<H'<3, means that species diversity is moderate and the environmental carrying capacity of the community is quite good. The high and low diversity of species in water is strongly influenced by the number of species itself, the higher the number of species, the higher the diversity. According to MaggSeuran (2014), species diversity is related to species richness and distribution within a

community. The low diversity value illustrates the small number of macroalgae present in these waters and indicates the presence of dominant species. This is under the statement (Farito et al., 2018), the difference of macroalgae diversity index value is influenced by the number of each type and the total number of all macroalgae types, the fewer species number and the individuals number each type of organism, the smaller the value of the diversity index.

The average macroalgae cover in Rambut Island ranges from 26% - 44% categorized as moderate. The cover differences at each research station possibly caused by different current speeds as it will affect the spread of spores from macroalgae and the process of attachment of macroalgae to the substrate. The average current velocity in Rambut Island ranges from 0.11 – 0.6 m/s while the depth ranges from 1.8-4.1 m. This is in accordance with the opinion of Farito et al., (2018) that the difference in the number of macroalgae is caused by the depth and brightness at each depth. In addition, current is an essential factor in accelerating the rate of macroalgae attachment where a strong current will accelerate the process of macroalgae attachment to the substrate.

Macroalgae growth is highly influenced by water and environmental conditions such as temperature, current, brightness, pH, and salinity. Besides waters condition and their environment, the substrate also has an essential role for macroalgae life in shallow marine waters.

The results of the pH measurement in Rambut Island (8.0), the pH value is within the optimal pH range according to the Minister of Environment Decree No. 51 (2004) 7 - 8.5. The degree of acidity (pH) can affect the composition of the species. The pH value is prominent for water quality parameter to control the reaction rate of some ingredients in water and determine CO2 levels. Macroalgae can thrive at optimal pH because the compounds needed for macroalgaes' photosynthesis are in abundant state (Widianingsih, 1991; Nybakken, 1993). The temperature in the Rambut Island waters ranges from 29-30^{o}C. This temperature is still included in the optimum temperature range for macroalgae life which is 25^{o}C-30^{o}C. This temperature is the optimum temperature for macroalgae to carry out photosynthesis.

The current velocity in Rambut Island is 0.11-0.26 m/s. The optimum current velocity (0.05-1.00m/s) is required to support the growth and distribution of macroalgae. The movement of water will be necessary for the continued growth of macroalgae, including the increase in the rate of nitrate uptake and the transport of carbon and nutrients from the water column to the thallus surface. If the current velocity is too weak, it can cause an accumulation of organic matter, causing one type of macroalgae to become dominant over other less adaptable species. On the other hand, if the current

velocity is too strong, it will result in excessive and unevenly distributed sediment transport, which can lead to low macroalgae cover levels.

The depth measurements recorded on Rambut Island are 1.2-3.4 m. Depth affects macroalgae diversity; shallower waters effects to higher sunlight exposure and increase macroalgae stress, especially on thin thallus type. The brightness in Rambut Island is still included in the optimum according to the Minister of Environment Decree No. 51 (2004) that the standard for brightness is more than 3 m. Depth and brightness are important factors to the intake of sunlight which is a major component in the ongoing process of photosynthesis (Berwick, 1983).

The salinity at the Pulau Rambut Research Station was relatively the same (33 PSU). The salinity number is included in the optimal salinity range (±35 PSU) which can affect the rate of photosynthesis and macroalgae growth. The results of the substrate particle-size analysis showed that Rambut Island and was followed by dust and clay fractions. This may be one of the reasons for the greater number of species on Rambut Island where most of the species found prefer sandy substrates. This can be seen at Stations 3 and 4, where the substrate consists mostly of sand fraction, the type of macroalgae found is a type of macroalgae that likes sand substrate. Such as *Caulerpa racemosa, Caulerpa cupresoides, Caulerpa crassa, Halimeda macroloba, Halimeda opuntia, Halimeda peltata, Halimeda renchii, Enrteromorpha intestinalis, Padina australis.*

CONCLUSION

The results of the identification and description, as well as analysis of the macroalgae community, can be concluded as follows:

1. On Rambut Island found 28 species of macroalgae consisting of 18 species of *Chlorophyta*, 5 species of *Phaeophyta*, and 5 species of *Rhodophyta*;
2. The diversity of macroalgae species (H`) in Rambut Island include in the moderate category, value of no species dominates.
3. The condition of the waters of Rambut Island is still quite good for the growth and development of macroalgae.

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