Macroalgae Abundance And Cover As Ecological Indicators Of Coral Reef Management In The Waters Of Katapang Village, West Seram Regency, Maluku Province

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Abstract.
Macroalgae are the main competitors for coral reefs in fighting for aquatic ecological space in coral reef ecosystems. The purpose of this research; Knowing the condition of the aquatic environment, the abundance and cover of macroalgae, and the potential of macroalgae for indicators of coral reef management in the coastal waters of Katapang Village. Data on the physical condition of the waters were measured in situ while macroalgae data for each research station were obtained using the LIT (Line Intercept Transect Method). Macroalgae taxa were identified using an identification guide book from FAO (1998). The distribution of each type of macroalgae was mapped spatially based on the distribution conditions of the macroalgae at each study station. The results showed that the condition of the waters of the coral reef ecosystem in Katapang Village was supportive for the growth of macroalgae. The macroalgae found came from 3 orders, 4 families, 5 genera and 8 species. The results also indicate that the abundance and cover of macroalgae determines the shift in dominance in reef ecosystems so that these two factors can be used as indicators of coral reef management.

Keywords: *Macroalgae, abundance, ecological indicators and coral reefs.*

I. INTRODUCTION

Macroalgae are organisms that are often found in almost all of Indonesia's coasts, especially on coasts that have flat coral reefs. Indonesia has no less than 628 types of macroalgae out of 8000 types of macroalgae found worldwide (Luning, 1990). Macroalgae generally live on the seabed and the substrate is sand, rubble, dead coral, and hard objects submerged on the seabed. In coral reef ecosystems, macroalgae occupy a position as primary producers that support the life of other organisms at a higher tropic level in the waters. The benefits of macroalgae as germplasm of food ingredients producing phycocolloids (alginate, agar and carrageenan) (Holdt & Kraan, 2011), medicinal ingredients (Murata & Nakazoe, 2001; Deville et al., 2004; Holdt & Kraan, 2011), and cosmetic ingredients (Holdt & Kraan, 2011). The ecological benefits of macroalgae include: primary producers (Bruno et al., 2005; Tait & Sciel, 2010), food sources for other marine biota (Filbee-Dexter & Scheibling, 2014; shelters (Amsler et al., 2015; Okuda, 2008), a nurturing habitat (Chaves et al., 2013; Giakuomi et al., 2012; Filbee-Dexter & Scheibling, 2014), and as a carbon sink (Phang et al., 2008; Chung et al., 2011).Macroalgae are an important component of the coral reef ecosystem, potentially becoming the main competitor of coral reefs. Macroalgae become the main competitor in degrading coral reefs when the abundance of macroalgae dominates the coral reef ecosystem.

Coral reefs are an identical ecosystem in tropical waters whose main constituents are calcareous animals, especially types of rock coral and calcareous algae. In coral reef ecosystems there are benthic algae which are one of the keys to the coral reef community which provide vital ecological functions such as stabilization of coral reef structures, storage and recycling of nutrients, and primary productivity (Dubinsky and Stambler, 2011).Algae are known to compete with corals for space or light and the interaction between the two is often interpreted as superiority of algae due to the abundance of nutrient availability (McCook and Diaz-Pulido, 2001). The growth of algae or algae is very fast, so it can be used as an indicator in early studies to find out the processes that affect coral reef populations and communities (Hay, 1997 in Gede, 2011). Macroalgae predators are herbivorous fish. Macroalgae competition with coral biota is carried out in obtaining nutrients in the same growing space. Habitat complexity affects the abundance and diversity of the main types of macroalgae substrate, namely sand, coral rubble, dead coral and coral reef.The coastal waters of Katapang Village, West Seram Regency, Maluku Province, is one of the villages that has a reef ecosystem associated with macroalgae. Over the past three decades, there have been several shifts in coral reef communities from being dominated by corals to corals dominated by algae, which is called a phase shift. The shift in the dominance of coral reefs to the dominance of macroalgae is a very important study for the future management of coral reefs. This study aims to determine the physical condition of the waters, the abundance and cover of macroalgae in coral reef ecosystems, and to study the abundance and cover of macroalgae as an ecological indicator of coral reef management in the waters of Katapang Village.

II. METHODS

This research was conducted in coral reef ecosystems in the waters of Katapang Village, Huamual District, West Seram Regency, Maluku Province. The tools and materials used in this research were motor boats, basic diving equipment, GPS, plastic bags, stationery, roll meters, thermometers, refractometers, underwater cameras, coral identification books, 1x1 meter quadrants, tweezers, and a scale pole made of from the paralon pipe.The initial survey was conducted at the research location to determine the distribution of macroalgae and the environmental conditions of the local waters. The research stations were determined as many as 3 (three) stations, namely station 1 is in front of the mangrove and sea grass ecosystem, station 2 is in the harbor area and station 3 is in front of the residents' housing. The study area is limited to a depth of ≤ 3 meters.

The sampling technique used is by following a 50 meter line transect. At every 10 meter distance a measurement is taken by placing a quadrant transect following a 2 x 50 meter transect line. Each station has 2 observation points. The observation points start from the horizontal reef crest with the shoreline. The data obtained were analyzed descriptively.Measurement of the condition of water parameters was also carried out at the same time as sampling. The water parameters measured were temperature, salinity and depth. The macroalgae samples that had been taken were identified based on their morphology at the MSP Laboratory, Faculty of Fisheries and Marine Sciences, Pattimura University, Ambon. Observations on macroalgae species were carried out by observing the shape of the thallus branching, holdfast, and thallus color.

III. RESULTS AND DISCUSSION

Physical Conditions of the Waters.

The results showed that in the coral reef ecosystem of Katapang Village, macroalgae communities were found spread across three observation stations. The distribution of this macroalgae is influenced by the quality of aquatic environmental conditions in coral reef ecosystems (Table 1). The abundance of macroalgae in nature is influenced by environmental conditions in the waters (Hurrey et al. 2013; Han & Liu 2014). The results of measurements of water surface temperature at all observation stations ranged between 27-30°C, where the temperature is quite optimal for macroalgae growth. The temperature obtained from the sun's heat is useful for macroalgae respiration and breaking down nutrients obtained from seawater (A. Kadi, 2017). The higher the temperature will cause the solubility of oxygen in water to decrease and difficulty in respiration occurs (Jes'us, 2011). Optimal temperatures for algae plants range from 0-10°C for algae in warm climates and 15-30°C for algae that live in tropical regions (Luning, 1990).These waters have basic substrate types of sandy waters, rocky sand, sandy coral fractures, dead coral fractures and coral reef exposure. Such aquatic substrate conditions are very supportive for the growth and development of macroalgae. Macroalgae are included in a group of benthic organisms that require a substrate as a place to attach.

Macroalgae substrates can vary from soft to hard substrates, including: mud, sand, crushed coral, igneous rock, dead coral, soft coral, other marine flora (seagrass and other algae) and mollusk shells (Quartino et al., 2001).Salinity values at all observation stations were in the range of 29-33‰, this salinity value was very suitable for the growth of benthic algae which liked the range of 13-37‰ water salinity. The water brightness in all observation stations at a depth of 1-3 meters is at 100%. The higher the level of brightness, the lower the level of turbidity in the waters. Turbidity in certain types of macroalgae affects growth rates due to insufficient supply of sunlight for photosynthesis. The brightness value of these waters greatly determines the distribution of macroalgae in each water depth because it is related to the penetration of sunlight. According to Luning (1990), macroalgae are commonly found at depths of ≤ 3 meters, and the presence of a type of macroalgae at a certain depth is affected by the penetration of sunlight.

Macroalgae Abundance and Cover.

From the research results, it was obtained that there were 8 species of macroalgae in the coral reef ecosystem, originating from 3 orders, 4 families and 6 genera (Table 1). There were only two macroalgae classes (Phaeophyceae and Rhodophyceae) out of three macroalgae classes (Chlorophyceae, Phaeophyceae and Rhodophyceae) which were found to be spread across all observation stations. Phaeophyceae class macroalgae had the highest abundance at all observation stations (Table 2). Overall the highest abundance of macroalgae was found at station 2 with an abundance of 251 individuals and the lowest abundance of macroalgae was found at station 5 of 94 individuals.

Table 1. The composition of macroalgae taxa in the waters of Katapang Village

Divisi	Kelas	Ordo	Famili	Genus	Spesies
Phaeophyta	Phaeophyceae	Dictyotales	Dictyotaceae	Padina	*Padina minor*
		Dictyotales	Dictyotaceae	Padina	*Padina australis*
		Fucales	Sargassaceae	Sargassum	*Sargassum crassifolium*
		Fucales	Sargassaceae	Turbinaria	*Turbinaria ornate*
		Fucales	Sargassaceae	Turbinaria	*Turbinaria conoides*
Rhodophyta	Rhodophyceae	Gigartinales	Rhizophyllidaceae	Portieria	*Portieria hornemannii*
		Gigartinales	Rhizophyllidaceae	Gracilaria	*Gracilaria heteroclada*
		Gigartinales	Cystocloniaceae	Hypnea	*Hypnea boergenesi*

Table 2. Abundance of macroalgae species at each observation station

Macroalgae Spesies	Number of Spesies				
	Station 1	Station 2	Station 3	Station 4	Station 5
Phaeophyceae					
Padina minor		121	5	23	
Padina australis	7	55	11	53	9
Sargassum crassifolium	23		55		19
Turbinaria ornate	55	9	92	43	52
Turbinaria conoides	18	11	52		7
Rhodophyceae					
Portieria hornemannii		17	3	12	
Gracilaria heteroclada		13		6	5
Hypnea boergenesi		25		19	2

The results showed that overall the macroalgae species found could be grouped into two main divisions namely brown algae (Phaeophyta) which consisted of five species and red algae (Rhodophyta) which consisted of 3 species. The number of species found shows that the brown algae (Phaeophyta) have a greater number of species than the red algae (Rhodophyta). This is influenced by the substrate and physical conditions of the waters for the growth and development of macroalgae. The combination of substrate and water conditions will also provide a unique characteristic pattern for the macroalgae that grow in it (Duran et al., 2018, Handayani, 2019). These conditions cause macroalgae that grow in the area to have different characteristics from macroalgae that grow in other areas (Handayani, 2019; Macusi & Deepananda, 2013 in Handayani, 2020). Of the 8 types of macroalgae found, only Padina australis and Turbinaria conoides were distributed at all observation stations.The highest abundance distribution of macroalgae was at station 2 followed by stations 3 and 4 while the lowest abundance of individual macroalgae was found at stations 1 and 5. This condition was influenced by the bottom water substrate which was dominated by hard substrates such as coral rubble, dead coral, massive rock, and live coral. suitable for growth characteristics of macroalgae. In addition, the existence of an excess supply of nutrients from community activities and activities around the waters is a major factor that triggers the growth and development of macroalgae.

Macroalgae that have epilytic living properties, namely macroalgae that grow and attach to hard substrates such as massive rocks, coral rubble, dead coral and live coral (Zakaria et all., 2006 in Handayani, 2020; Satheesh & Wesley, 2012).

Macroalgae that can adapt and grow well in rocky substrates include: Sargassum, Turbinaria, Hypnea, Gracilaria, Amphiroa, Chaetomorpha, Ulva, Acanthophora, and Gelidium (Handayani, 2020). This macroalgae genus adapts by having a strong holdfast to attach to hard substrates (Imchen, 2015).It is clear from observations at all research stations that the abundance of macroalgae puts pressure on the growth and development of coral reefs. The high level of abundance of macroalgae will trigger the dominance of macroalgae on coral reefs in controlling the bottom space of the waters. This condition is confirmed by the increasing community activities at each research station such as anthropogenic activities on land, catching herbivore fish, and various community activities at research stations. This has an impact on increasing the abundance of macroalgae itself, which causes macroalgae to become more competitive against coral (Jompa and Mc Cook, 2002). This activity can lead to competition between hard corals and benthic algae which has the potential to affect the benthos structure of coral reefs (Barott et al., 2012). This fact shows that the abundance of macroalgae can be used as an ecological indicator in assessing coral reef ecosystems. The greater the abundance of macroalgae, the smaller the water space for the development of coral reefs.The results showed that the macroalgae cover in the coral reef ecosystem on the coast of Katapang Village ranged from 18.25% - 39.97%, where the highest macroalgae cover was at station 2 (39.97%) and station 3 (27.26%) which were located in front of residential areas, followed by station 4 (23.51%) which is located in Dramaga Harbor, while the lowest macroalgae cover is found at station 1 (18.25%) and station 5 (20.12%) which are located in front of the mangrove community and seagrass %.

This condition indicates that the high level of macroalgae cover at each station is influenced by water conditions and various community activities that suppress the growth of coral reefs and trigger the growth of macroalgae in the waters. Water areas adjacent to harbors and settlements allow for competition between hard corals and macroalgae (Dubinsky and Stambler, 2011). This is due to excessive nutrient input and sedimentation compared to waters that are not affected by anthropogenic activities.

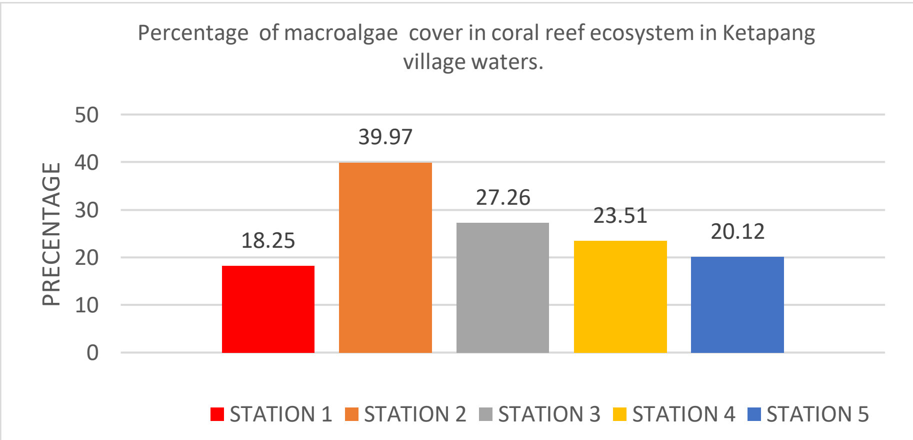

Fig 1. Percentage of macroalgae cover based on observation stations.

The presence of a high percentage of macroalgae cover at the three research stations was influenced by environmental pressure on coral reefs where there was excessive herbivore fishing, marine biota catching activities with the bameti tradition which were not environmentally friendly, garbage disposal, and various other anthropogenic activities that supplied nutrients enter the waters of the coral reef ecosystem, have triggered pressure on the development of coral reefs and encouraged the growth of macroalgae. Macroalgae are superior competitors to corals with a decrease in the abundance of herbivorous fish due to overfishing which makes macroalgae growth difficult to control (Ruttenberg et al., 2011).In addition, a decrease in the level of herbivorous species due to overfishing and an increase in nutrient supply from anthropogenic activities can lead to an increase in the growth of macroalgae presentations which will dominate coral reefs in the waters. This is supported by the statement of Barott et al., (2012) in Ramadhal L, (2018) that the interaction of hard corals with macroalgae in waters that are close to and surrounded by settlements will result in corals experiencing defeat by algae. Various human activities such as overfishing, deforestation, dredging, and excess input of sediment and nutrients can affect the interaction between corals and algae (Hughes, 1994 in Ramadhan L, 2018).The results of this study also indicate that the abundance and presentation of macroalgae cover in the waters of the coral reef ecosystem is the main factor that can accelerate the dominance of aquatic space which was initially dominated by the coral reef community to become the dominant macroalgae community.

IV. CONCLUSION

The physical environmental conditions of the coral reef ecosystem in Katapang Village such as temperature, salinity, water substrate, and turbidity strongly support the growth and development of macroalgae. Macroalgae in the coral reef ecosystem at a depth of 3 meters in Katapang Village come from 3 orders, 4 families, 5 genera and 8 species namely Padina australis, Padina minor, Turbinaria ornata, Turbinaria conoides, Sargassum crassifolium, Gracilaria heteroclada, Portieria hornemannii, and Hypnea boergeseni. The percentage of macroalgae cover in the waters of coral reef ecosystems ranged from 18.25% - 39.97%, where the highest macroalgae cover was at research stations close to residential areas and harbor jetties.Macroalgae abundance and cover are important factors and can be used as ecological indicators in assessing the management of coral reefs in the coastal waters of Katapang Village.

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