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Biodiversity, Density, Distribution Patterns and Cell Structure of Algae in Manado Bay

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Abstract

The results of study on the diversity of algae species at five stations in Manado Bay showed that the number of algae reached 4254 individuals per research station. The average density was 284 ind/m². There are 23 species of macroalgae found in Manado Bay, namely Chlorophyta (10 species), Rhodophyta (7 species) and Phaeophyta (6 species). The species are *Padina pavonica*, *P. australis*, *Turbinaria ornate*, *T. decurrens*, *Sargassum polycystum*, *Dictyota dichotoma*, *Gracilaria Salicornia*, *G. edulis*, *Eucheuma denticulatum*, *Amphiroa fragilissima*, *Acetabularia dentata*, *Bornetella oligospora*, *Ulvase*, *C. lactuta*, *U. intestinalis*, *Actinotrichia fragilia* and *Chaetomorpha crassa*.

The diversity of algae species (H') in Manado Bay is 2.41. This indicates that the diversity of algae species in Manado Bay is moderate and the condition of the community is moderate, which is no overall extreme ecological pressure in the waters. Waters condition is stable with an evenness index value (E) of 0.77. No species dominates the waters, although *Acetabularia dentata* has the highest number of individuals reaching 1148 individuals at station 1, but the moderate dominance index with a value of $C = 0.557$ is still in the medium category value range ($C = 0.50- 0.75$). The results of overall dominance index of Manado bay waters are low ($C = 0.270$), which means that no algae species dominate in Manado Bay. The distribution pattern of algae species in Manado Bay is random and clustered. The clumping pattern is one of the algae's strategies to avoid predators, an effort to maintain the existence of their species in nature so that they continue to exist in nature. Water conditions, especially water quality, such as pH, salinity and water temperature are still in the range suitable for algae growth. Algal cell structure is eukaryotic.

Key Words: diversity, algae, density, distribution pattern

INTRODUCTION

The waters of Indonesian archipelago, including the waters of North Sulawesi, is rich of marine biodiversity. Algae is one of the marine biological resources that has a great opportunity to be used in various industries such as food industry, pharmaceuticals, textiles and cosmetics. Algae in the cosmetic industry is used for premature aging or anti-aging (Rasyid, 2004; Oktarina, 2017; Wang et al, 2014). Utilization of algae can be done by providing information about the presence of algae in a waters, especially the characteristics and classification of the algae. Macroalgae are classified into 3 division groups, namely Rhodophyta (red), Phaeophyta (brown) and Chlorophyta (green). Algae are lower plants that do not have vascular and do not have true roots, stems and leaves (Dawes, 1981; Baweja et al 2016;). Macroalgae have eukaryotic cells, in which there are organelles such as, mitochondria, chloroplasts, cell nuclei, ribosomes and others, which can be observed by TEM (Transmission Electron Microscope).

In Batu Putih natural tourist park, Bitung city, there are 7 species and 6 families of red algae found and described, scattered in the Rhodophyta division. Furthermore, in Malalayang waters it has been found 11 species of Rhodophyta, 3 species of Phaeophyta and 12 species of Chlorophyta, with the value of species diversity (H') = 2,682, where the ecological pressure for algae life in the waters is moderate (Kumampung et al., 2009). Moderate ecological stress means that no species dominates in these waters. The presence of algae in this

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waters allows it to be exploited. Sustainable use can lead to a reduction in species or their presence in nature. Over time, the presence of algae species in the waters can decrease or increase in number of species.

There is a macroalgae community in Manado Bay which needs to be utilized as much as possible while maintaining its sustainability in nature. Utilization of algae, of course, requires some information about the existence of these algae, especially the diversity of species so that we clearly know the types of algae that exist and can be further utilized for various purposes in various industries and research. Complete information about this algae in Manado Bay is still lacking. For this reason, research has been carried out in Manado Bay on the biodiversity of algae species, their density and distribution patterns, and their cell structure. The aim is to find out the species of algae which exist in Manado Bay, the density, the distribution patterns, and the cell structure. The information obtained is a data base that can be used for various purposes and for further management of the algae.

METHODS

Algae sampling method using line transects was carried out at 5 station points. Locations/stations were selected randomly, with stratified clusters. The selected location will represent the entire waters of Manado Bay. A transect line was drawn at each station parallel to the coastline 100 meters long out to sea, and 50 x 50 cm² squares were placed randomly along the transect line, at the lowest low tide. All algae in the squares were counted, and one individual for each algae species was taken, put in a plastic bag and brought to the laboratory of Fisheries and Marine Sciences Faculty. Samples were then identified using the algae identification book (Dawes, 1981) and WoRMS (World Register of Marine Species). Measurements of water quality are also carried out at the same time as sampling, including measurements of temperature, pH, salinity and water brightness.

Data Analysis

1. Density

Formula used for species density is as follows :

$$\text{Species Density} = \frac{\text{individual number of species}}{\text{The area of sampling site (m}^2\text{)}}$$

$$\text{Relative density} = \frac{\text{individual number of species}}{\text{The total individual number of species}} \times 100$$

2. Distribution Pattern

The pattern of algal distribution was determined by using the ratio of diversity to the average value of Ludwig and Reynolds (1988):

$$M = \frac{F}{X} ; S = \frac{\sum (x/m)}{n-1} ; ID = \frac{S^2}{m}$$

3. Species diversity

The formula used is the Shannon-Weiner Diversity Index (Krebs, 1989).

$$S$$

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$$H' = \sum_{i=1} (n_i/N, \ln n_i/N)$$

Where: H' = Index of species diversity

S = Number of species

n_i = Number of individuals per species

N = Number of individuals of all species

4. Analysis of cell structure using TEM (Transmission Electron Microscope)

RESULTS AND DISCUSSION

1. Species of algae and their density

There were 23 species of algae found in Manado bay waters, namely Rhodophyta (red algae), Phaeophyta (brown algae) and Chlorophyta (green algae). All species can be seen in the Table 1. The species of algae are distributed over five stations, namely Tateli waters (15 species), Tongkaina (16 species) Molas waters (17 species), Wenang waters (7 species), and Malalayang waters (16 species). Some of the same species were found at different locations. The highest number of 1809 individuals and a density of 121 ind/kuadrat was at station I, and the lowest number of 178 individuals and a density of 12 ind/m² was at station 5 in Wenang waters. Overall, the waters of Manado Bay had the highest number of *Acetabularia dentata* (1148 individuals) and species density is 15.31 ind/m², found at station 1 in Tateli waters (1007 individuals), then *Hydropuntia edulis* (671 individuals), species density 8,95/ind/m² and the highest number found at station 4 in Molas waters (410 individuals).

Table 1. Classification of the types of algae research results

.No.	DIVISIO	KELAS	ORDO	FAMILI	GENUS	SPESIES	1	2	3	4	5
1	Phaeophyta	Phaeophyceae	Dictyotales	Dytotiaceae	Padina	<i>Padina pavonica</i> (Linnaeus) Thivy, 1960	+	+	+	+	-
2	Phaeophyta	Phaeophyceae	Dictyotales	Dytotiaceae	Padina	<i>Padina minor</i> <i>Yamada</i>	+	+	+	+	-
3	Phaeophyta	Phaeophyceae	Dictyotales	Dytotiaceae	Padina	<i>Dictyota dichotoma</i> (Hudson) J.V.Lamouroux, 1809	-	-	-	+	-
4	Phaeophyta	Phaeophyceae	Fucales	Sargassaceae	Turbinaria	<i>Turbinaria ornate</i> (Turner) J.Agardh, 1848	-	-	+	+	-
5	Phaeophyta	Phaeophyceae	Fucales	Sargassaceae	Turbinaria	<i>Turbinaria decurrens</i> (Turner) J.Agardh, 1848	+	-	+	-	-
6	Phaeophyta	Phaeophyceae	Fucales	Sargassaceae	Sargassum	<i>Sargassum polycystum</i> C. Agardh, 1824	-	+	-	+	-
7	Rhodophyta	Florideophyceae	Gracilariales	Gracilariaceae		<i>Gracilaria salicornia</i> (C.Agardh) Dawson 1954	+	+	+	+	+
8	Rhodophyta	Florideophyceae	Gracilariales	Gracilariaceae	Hydropuntia	<i>Hydropuntia edulis</i> (S.G.Gmelin) Gurgel & Fredericq, 2004	+	+	+	+	+
9	Rhodophyta	Florideophyceae	Girgatinales	Solieriaceae	Eucheuma	<i>Eucheuma denticulatum</i> (N.L.Burman) Collins & Hervey, 1917	+	+	+	+	-
10	Rhodophyta	Florideophyceae	Corallinales	Corallinaceae	Amphiroa	<i>Amphiroa fragilissima</i>	+	+	+	+	-

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						(Linnaeus) Lamoroux					
11	Rhodophyta	Florideophyceae	Corallinales	Corallinaceae	Acanthopora	<i>Acanthopora spicifera</i> (Vahl) Bergesen	+	+	+	+	+
12	Rhodophyta	Florideophyceae	Bonnemaisoniales	Galaxauraceae	Galaxaura	<i>Galaxaura filamentosa</i> (Ellise & Solander) Lmoroux	-	+	+	-	-
13	Rhodophyta	Florideophyceae	Bonnemaisoniales	Galaxauraceae	Actinotrichia	<i>Actinotrichia fragilis</i> (Forsskal)Borgesen	-	+		-	+
14	Chloropyta	Chlorophyceae	Bryopsidales	Halimedaceae	Halimeda	<i>Halimeda opuntia</i> (Linnaeus) Lamoroux	+	+	+	+	
15	Chloropyta	Chlorophyceae	Bryopsidales	Halimedaceae	Halimeda	<i>Halimeda macroloba</i> Decaisne, 1841	+	+	-	+	-
16	Chloropyta	Chlorophyceae	Dasycladales	Polphysaceae	Acetabularia	<i>Acetabularia dentata</i> Solms-Laubach, 1895	+	+	+	+	-
	Chloropyta	Chlorophyceae	Dasycladales	Dasycladaceae	Bornetella	<i>Bornetella oligospora</i> Solms-Laubach, 1892	+	+	-	-	+
17	Chloropyta	Chlorophyceae	Siphonocladales	Valoniaceae	Valonia	<i>Valonia ventricosa</i> J.Agardh, 1887	+	+	-	+	+
19	Chloropyta	Chlorophyceae	Caulerpales	Caulerpaceae	Caulerpa	<i>Caulerpa racemosa</i> (Forsskal) J.Agardh, 1873	-	-	-	+	-
20	Chloropyta	Chlorophyceae	Caulerpales	Caulerpaceae	Caulerpa	<i>Caulerpa serrulate</i> (Forsskal) J.Agardh, 1837	-	+	-	-	-
21	Chloropyta	Chlorophyceae	Ulvaes	Ulvaceae	Ulva	<i>Ulva lactuca</i> Linnaeus 1753	+	-	+	+	+
22	Chloropyta	Chlorophyceae	Ulvaes	Ulvaceae	Ulva	<i>Ulva intestinalis</i> Linnaeus 1753	-	+	-	-	-
23	Chloropyta	Chlorophyceae	Cladophorales	Cladophoraceae	chaetomorpha	<i>Chaetomorpha crassa</i> (C.Agardh) Kützing, 1845	+	-	+	+	+

Description: + There

- There is not any

The lowest number of individuals was *Ulva intestinalis* and *Turbinaria decurens* each species density 0.01 ind/m and 0,05 ind/m² (see Table 2). When compared to the condition of algae in the waters of Malalayang and Kalasey in the past 15 years, the number of algae species has now experienced a shift in the number of species starting to decline. Previously there were 19 species of macroalgae in Malalayang waters (Kumampung, et al, 2009) and in Kalasey waters 28 species of macroalgae (Eman, 2005), yet several species of algae were no longer found at the time of the study. This is probably due to the seasonal nature of the algae at the time of the research. No other species of algae were found, such as *Liagora sp*, *Halimena durvillaei*. However, there are also several species of algae found in the waters of Manado Bay but not covered in the research squares, such as *Codium sp*, *Neomerius annulate*, *Bornetella sphaerica*, and *Portieria homemanni*.

Table 2. Density of species algae and Density Relative

STATION							Density of Species (ind/m ²)	Density Relative (%)
SPECIES	I	II	III	IV	V	Σ		
<i>Padina pavonica</i>	20	1	2	24	0	47	0.63	1.10
<i>Padina australis</i>	230	51	33	74	0	388	0.17	9.12
<i>Turbinaria ornata</i>	0	0	1	15	0	16	0.21	0.37
<i>Turbinaria decurrens</i>	3	0	1	0	0	4	0.05	0.09
<i>Sargassum polycystum</i>	0	13	0	56	0	69	0.92	1.62

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<i>Dictyota dichotoma</i>	0	0	0	22	0	22	0.29	0.52
<i>Gracilaria salicornia</i>	187	6	36	81	45	355	4.73	8.35
<i>Hydropuntia edulis</i>	21	193	37	410	10	671	8.95	15.77
<i>Euclima sp</i>	29	60	4	138		231	3.08	5.43
<i>Amphiroa fragilissima</i>	19	12	125	124	0	280	3.73	6.58
<i>Acanthopora spicifera</i>	18	40	20	12	0	90	1.2	2.12
<i>Galaxaura filamentosa</i>	0	12	5	0	0	17	0.23	0.40
<i>Halimeda opuntia</i>	15	74	42	178	0	309	4.12	7.26
<i>Halimeda macroloba</i>	2	4	0	80	0	86	1.15	2.02
<i>Acetabularia dentata</i>	1007	28	30	83	0	1148	15.31	26.99
<i>Valonia ventricosa</i>	107	16	0	38	1	162	2.16	3.81
<i>Bornetella oligospora</i>	149	10	0	0	18	177	2.36	4.16
<i>Caulerpa racemosa</i>	0	0	0	42	0	42	0.56	0.99
<i>Caulerpa serrulata</i>	0	6	3	0	0	9	0.12	0.21
<i>Ulva lactuca</i>	1	0	1	1	50	53	0.71	1.25
<i>Ulva intestinalis</i>	0	1	0	0	0	1	0.01	0.02
<i>Actinotrichia fragilis</i>	0	0	18	0	1	19	0.25	0.45
<i>Chaetomorpha crassa</i>	1	0	2	2	53	58	0.77	1.36
Jumlah Individu	1809	527	360	1380	178	4254		
X	121	35	24	92	12	284		

2. Algae Distribution Pattern

Algae distribution patterns in a population can occur in three main patterns, namely uniform, random and clustered. The distribution pattern of algae in this study occurred in 2 patterns, namely random and clustered. According to Kramadibrata (1975) in Kumampung et al. (1993), random distribution occurs when environmental conditions are uniform and there is no tendency for individuals to aggregate. The pattern of clustered distribution is relatively common in nature, this is due to:

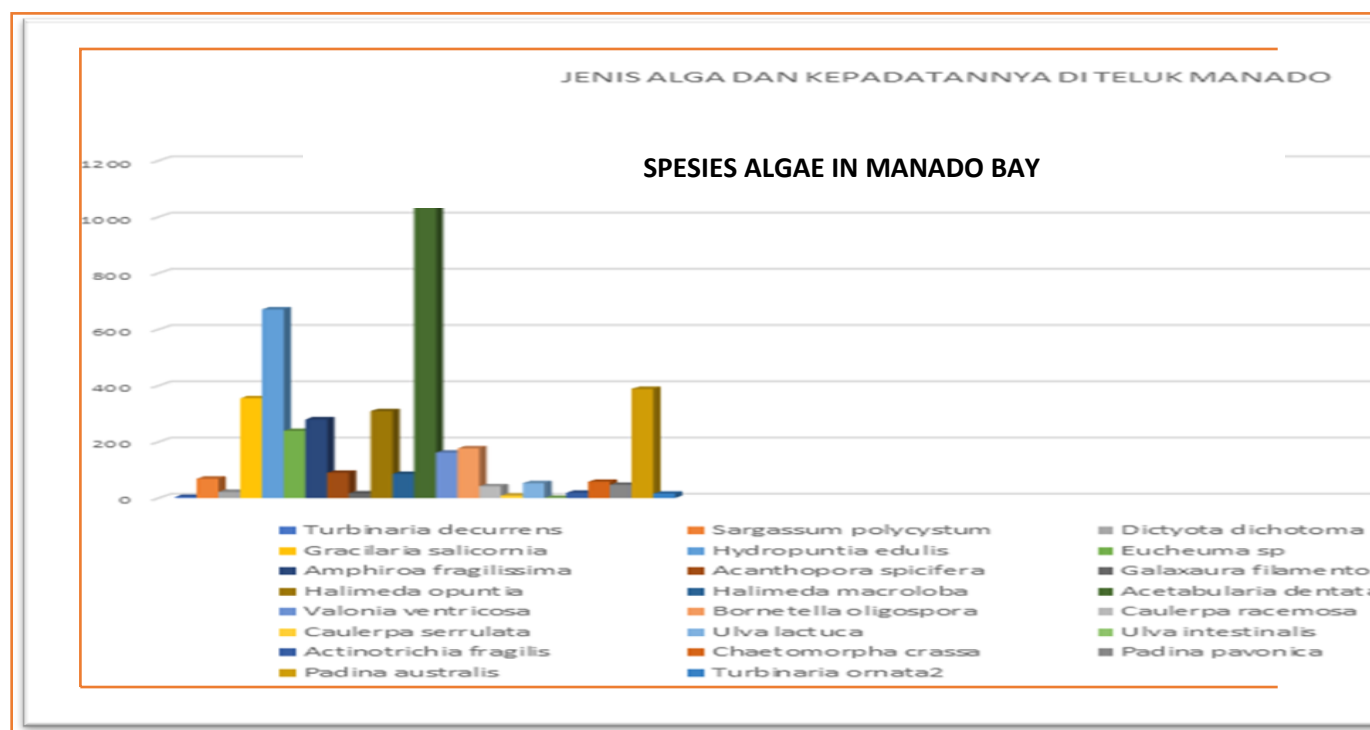


Figure 01. Biodiversity of algae in Manado Bay

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- a. Individual response to local conditions, daily or seasonal weather changes.
- b. Reproductive processes such as sexual attraction to help form mating partners or parent-child groups.
- c. Social attraction which is an active aggregation of individuals to form a particular organization or colony.

In this study, the clustered distribution pattern was most often found in the algal population where the ID value was >1 (see table 3). This occurs as one of the algae's strategic efforts to avoid predation or attack by other organisms so as to reduce mortality. For example, the algae *Acetabularia dentata*, *Padina australis*, *Gracilaria Salicornia*, *Amphiroa fragilissima*, *Hydropuntia edulis*, *Bornetella oligospora*, and *Halimeda opuntia*. So that these algae are most commonly found in several research stations. The results of the study by the brown algae *Sargassum polycystum* and *Turbinaria ornate* that the previous author had conducted in 1998 found a random scattering pattern on the Manado coast. While the results of this study, the distribution pattern of the two algae species is clustered, this is probably due to the larger number of algae samples and research stations so that the results obtained are more than previous studies which only looked at the diversity and distribution pattern of brown algae and alginate content only.

Uniform distribution patterns of algae were not found because uniform distribution patterns rarely occur in natural populations.

Table 03. Analysis results of the distribution pattern of algal species in the waters of the bay of Manado

STATION	ALGAE	Σ	VARIATY	MEAN	ID	χ^2	D	P
1.Tateli	<i>Padina pavonica</i>	20	1.18	0.33	3.53	208	9.579	Group
	<i>Padina australis</i>	230	24.34	3.83	6.35	374.70	16.558	Group
	<i>Turbinaria decurrens</i>	3	0.15	0.05	3	177	7.998	Group
	<i>Gracilaria salicornia</i>	187	69.70	3.12	22.36	1319.42	40.553	Group
	<i>Hydropuntia edulis</i>	21	2.13	0.35	6.085	359	15.98	Group
	<i>Eucheuma sp</i>	29	3.17	0.48	6.56	386.86	16.99	Group
	<i>Amphiroa fragilissima</i>	19	1.034	0.317	3.26	192.58	8.81	Group
	<i>Acanthopora spicifera</i>	18	1.57	0.3	5.23	308.67	14.03	Group
	<i>Halimeda opuntia</i>	15	0.90	0.25	3.61	213	9.82	Group
	<i>Halimeda macroloba</i>	2	0.07	0.033	2	118	4.55	Group
	<i>Acetabularia dentata</i>	1007	1992.88	16.78	118.74	7005.77	107.55	Group
	<i>Valonia ventricosa</i>	107	23.16	1.78	12.98	766.08	28.33	Group
	<i>Bornetella oligospora</i>	149	120.12	2.48	48.37	2853.82	64.73	Group
	<i>Ulva lactuca</i>	1	0.017	0.017	1	59	0.046	Random
2.Tongkaina	<i>Padina pavonica</i>	1	0.017	0.016	1	59	0.046	Random
	<i>Padina australis</i>	51	5.045	0.85	5.94	350.18	15.65	Group
	<i>Sargassum polycystum</i>	13	0.78	0.22	3.61	213.15	9.83	Group

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	<i>Gracilaria salicornia</i>	6	0.1254	0.1	1.254	74	1.349	Random
	<i>Hydropuntia edulis</i>	193	12.105	3.2167	3.763	222.026	10.256	Group
	<i>Eucheuma sp</i>	60	2.5084	1	2.509	148	6.388	Group
	<i>Amphiroa fragilissima</i>	12	0.5695	0.2	2.847	168	7.514	Group
	<i>Acanthopora spicifera</i>	40	2.8701	0.6667	4.3051	254	11.722	Group
	<i>Galaxaura filamentosa</i>	12	2.0271	0.2	10.136	598	23.77	Group
	<i>Halimeda opuntia</i>	74	9.8768	1.2333	8.0082	472.49	19.924	Group
	<i>Halimeda macroloba</i>	4	0.1311	0.0667	1.9661	116	4.4148	Group
	<i>Acetabularia dentata</i>	28	3.0328	0.4667	6.4988	383.43	16.876	Group
	<i>Valonia ventricosa</i>	16	1.7242	0.2667	6.4661	381.5	16.80	Group
	<i>Bornetella oligospora</i>	10	0.4463	0.1667	2.678	158	6.960	Group
3.Malalayang	<i>Padina pavonica</i>	2	0.0667	0.0333	2	118	4.5456	Group
	<i>Padina australis</i>	33	5.099	0.55	9.271	547	22.259	Group
	<i>Turbinaria ornata</i>	1	0.017	0.017	1	59	0.046	Random
	<i>Turbinaria decurrens</i>	1	0.017	0.017	1	59	0.046	Random
	<i>Gracilaria salicornia</i>	36	3.125	0.6	5.209	307.333	13.976	Group
	<i>Hydropuntia edulis</i>	37	2.749	0.617	4.458	263	12.118	Group
	<i>Eucheuma sp</i>	4	0.267	0.067	4	236	10.909	Group
	<i>Amphiroa fragilissima</i>	125	34.857	2.083	16.732	987.16	33.617	Group
	<i>Acanthopora spicifera</i>	20	6.667	0.333	20	1180	37.763	Group
	<i>Galaxaura filamentosa</i>	5	0.145	0.083	1.746	103	3.536	Group
	<i>Halimeda opuntia</i>	42	8.044	0.7	11.492	678	26.007	Group
	<i>Acetabularia dentata</i>	30	7.814	0.5	15.627	922	32.125	Group
	<i>Caulerpa serrulata</i>	3	0.082	0.05	1.644	97	3.112	Group
	<i>Ulva lactuca</i>	1	0.017	0.017	1	59	0.046	Random
	<i>Actinotrichia fragilis</i>	18	1.129	0.3	3.763	222	10.255	Group
	<i>Chaetomorpha crassa</i>	2	0.067	0.033	2	118	4.546	Group
4.Molas	<i>Padina pavonica</i>	24	1.634	0.4	4.085	241	11.138	Group
	<i>Padina australis</i>	74	8.284	1.233	6.716	396.270	17.335	Group
	<i>Turbinaria ornata</i>	17	0.952	0.283	3.361	198.294	9.098	Group

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	<i>Sargassum polycystum</i>	56	8.199	0.933	8.785	518.286	21.379	Group
	<i>Dictyota dichotoma</i>	22	3.965	0.367	10.814	638	24.904	Group
	<i>Gracilaria salicornia</i>	81	18.875	1.35	13.982	824.926	29.802	Group
	<i>Hydropuntia edulis</i>	410	90.175	6.833	13.1964	778.585	28.644	Group
	<i>Euclima sp</i>	138	32.214	2.3	14.006	826.348	29.837	Group
	<i>Amphiroa fragilissima</i>	124	40.131	2.067	19.418	1145.677	37.051	Group
	<i>Acanthopora spicifera</i>	12	1.180	0.2	5.898	348	15.565	Group
	<i>Halimeda opuntia</i>	178	26.846	2.967	9.049	533.910	21.861	Group
	<i>Halimeda maculosa</i>	80	12.294	1.333	9.220	544	22.168	Group
	<i>Acetabularia dentata</i>	83	22.817	1.383	16.494	973.145	33.300	Group
	<i>Valonia ventricosa</i>	38	5.863	0.633	9.258	546.211	22.235	Group
	<i>Caulerpa racemosa</i>	42	5.298	0.7	7.569	446.571	19.09	Group
	<i>Chaetomorpha crassa</i>	2	0.067	0.033	2	118	4.546	Group
	<i>Ulva lactuca</i>	1	0.0167	0.017	1	59	0.046	Acak
5.Wenang	<i>Gracilaria salicornia</i>	45	2.461	0.75	3.282	193.667	8.864	Group
	<i>Hydropuntia edulis</i>	10	0.412	0.167	2.475	146	6.271	Group
	<i>Valonia ventricosa</i>	1	0.017	0.017	1	59	0.046	Random
	<i>Bornetella oligospora</i>	18	1.129	0.3	3.763	222	10.255	Group
	<i>Ulva lactuca</i>	50	3.701	0.833	4.441	262	12.074	Group
	<i>Actinotrichia fragilis</i>	1	0.017	0.017	1	59	0.046	Random
	<i>Chaetomorpha crassa</i>	53	5.970	0.883	6.758	398.698	17.422	group

2. Diversity of algae species

The results of the analysis of the species diversity index (H') for each research station are 1,523 (Kalasey), 2,076 (Tongkeina), 2,075 (Malalayang), 2,306 (Molas) and 1,516 (Wenang). All values of the species diversity index (H') are in the range of 1-3. This value indicates that the diversity is moderate and the condition of the algal community is also moderate. The overall, the value of the Species Diversity Index (H') in Manado Bay is 2,407. The results indicate that the research criteria for the condition of species diversity and the condition of moderate algae communities also means that in Manado Bay there is no extreme environmental pressure that can affect the presence of algae. Although in some waters coastal reclamation has been carried out, the overall condition of the waters in Manado Bay is still good. This can also be seen from the analysis of the evenness index of 2,633 species, stable environmental conditions and no species dominating the waters because the results of the analysis of the dominance index were 0.270, meaning $C < 0.50$ low dominance. The results of the analysis of species diversity, dominance and evenness can be seen in Figure 9.

The diversity of algae species in the bay of Manado has important economic value that has not been utilized by people surrounding for vegetables, fresh vegetables, etc. Red algae *Gracilaria salicornia* is widely found in Manado Bay. It can be used as an antiviral HSV-2 related to breathing (Zandy et al., 2007) and a possible

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opportunity to be developed in the pharmaceutical, to overcome the current pandemic problem, in an effort to break the virus chain of Covid-19. Algae *Gracilaria salicornia* can be cultured in vitro (Kumampung, et al 2015) or in nature. Likewise, other species of algae can be used as raw materials in various industries, for pharmaceuticals and nutrition

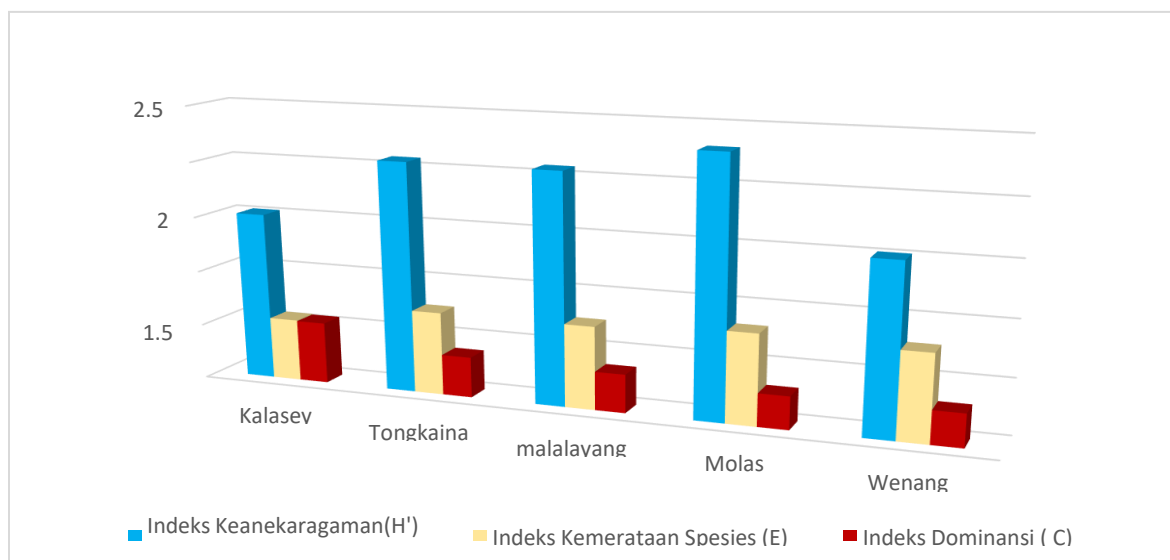


Figure 02. Results of analysis of species diversity (H'), species evenness index (E) and dominance (C) of each research station.

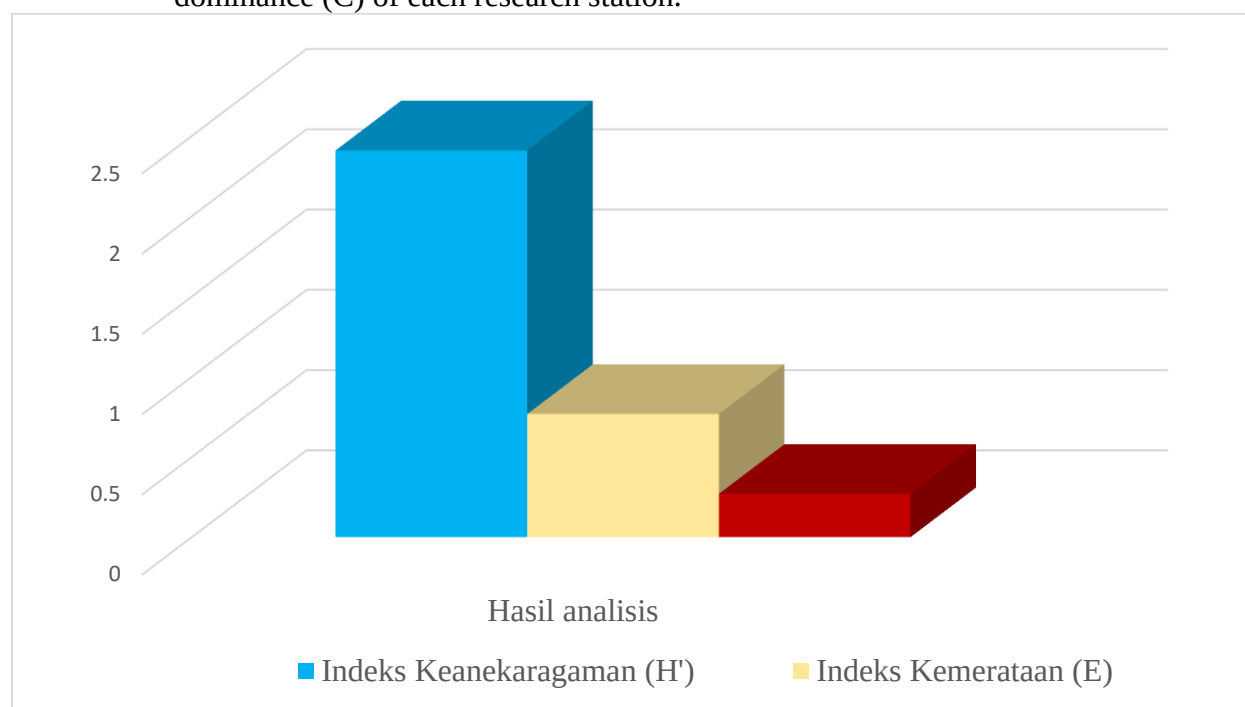


Figure 03. Analysis results of species diversity index (H'), species evenness index (E) and dominance index (D)

3. Water Condition

The condition of the waters in Manado Bay is very good for algae growth. Although in some places coastal reclamation has been carried out, the results of water quality measurements are still in the appropriate range for

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algae growth. The brightness of the water is quite good where sunlight penetrates the bottom of the water in the lowest tidal area, around the Manado Bay at a depth of up to 5 meters at high tide. This indicates that the algal photosynthesis process can take place well with the penetration of sunlight that penetrates to the bottom allowing the excitation of light by chlorophyll to be unobstructed. The range of temperature, pH and salinity of the water is still suitable for the survival of algae (Table 4). The substrate for the algal epiphyte is rock, coral, muddy sand, and dead shells. According to Trono (1997), *Gracilaria edulis* or *Hydropuntia edulis* usually lives on sandy and rocky substrates in intertidal areas. *Hydropuntia edulis* found in the waters of the bay of Manado is also on the same substrate and muddy sand substrate, while *Gracilaria salicornia* found on rocky substrate, *Acetabularia dentata* on slightly dense muddy rock substrate.

Table 4. Water quality

No.	Water parameters	Range
1.	Temperature	30 - 31
2.	pH	7
3.	Salinity	30,5 - 34

5. Algae Cell Structure

The cell structure of macroalgae is eukaryotic. Eukaryotic cells are generally more complex in shape and have more organelles than prokaryotic cells (Anonymous, 2013). The red, green and brown algae found in Manado Bay showed that the cell structure was eukaryotic.

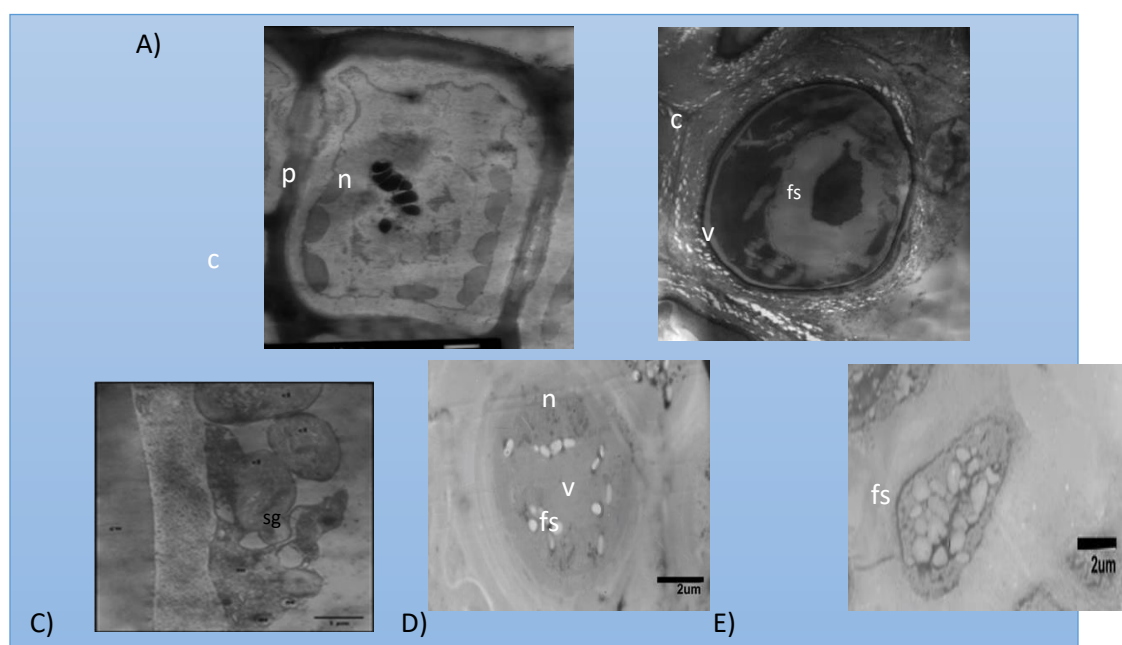


Figure 04. Cell Structure algae as seen with the transmission electron microscope demonstrating the typical cytology brown algae *Padina australis* (A). Green algae *Acetabularia dentata* (C). Red algae *Amphiroa flagillisima*, *Hydropuntia edulis* and *Gracilaria Salicornia* (B, D, and E). Vacuola (v), nucleus (n), Chloroplas (c), Floridean stars (fs), physodes (p), Start grains (sg).

There were organelles in the form of ribosomes, nucleus (n), chloroplasts ©, mitochondria (m) and vacuoles (v) when observed with TEM. The vacuole that looks rather large and wide indicates that the algal cells are old while the smaller ones are in the young cells. Especially for red algae, there are floridean starch grains as food reserves, if in green algae, it is called starch granules, while in brown algae it is known as laminaria.

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This algae is an indicator that there is a process of photosynthesis in algae and growth at the cellular level. This also proves that the condition of Manado Bay is in the range of water quality which is suitable for the growth of algae and other biota. This is reinforced by the results of water quality measurements which are still in the appropriate range for algae growth (see table 4).

CONCLUSIONS

Manado Bay has 23 types of algae, namely Phaeophyta, Rhodophyta and Chlorophyta. Species diversity (H') value is 2,407, which is no extreme ecological pressure. Algae can still live in this waters with sufficient water quality. The evenness index is stable, which are no dominant algae. The distribution pattern of algae is generally clustered. The cell structure shows the presence of complex organelles. These algae can be used for industrial raw materials such as pharmaceuticals and others.

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