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THE DESCRIPTION OF ECONOMICALLY IMPORTANT MACROALGA AT INTERTIDAL COASTAL AREA IN MANOKWARI, WEST PAPUA

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Abstract

Macroalga, known as seaweed, is a biological resource that has important roles in biological, ecological, and economical aspects as well as in protecting marine biodiversity. This study aimed to describe species of algae (inventory and identification) and community assemblage of macroalgae species surrounding Manokwari coastal area. Collecting data was done during east season period (from June 2011 to September 2011) from two different main coastal areas, mainland and outland coastal area. Twenty eight macroalga species were identified and consisted taxonomically of three divisions, three classes, eleven orders, sixteen families, and nineteen genus. Three divisions of macroalga species were green alga (*Chlorophyta*), red alga (*Rhodophyta*), and brown alga (*Phaeophyta*), which each division comprised with 14 species, 8 species, and 6 species respectively. The total of average density of macroalga species significantly differed between mainland and outland coastal area, which the density and relative density of macroalga species were generally higher in outland coastal areas than mainland coastal areas. The diversity, evenness, and dominance index in Manokwari coastal area showed no significantly difference value among all stations.

Keywords : description, macroalga species, community assemblage, Manokwari, coastal area.

INTRODUCTION

Macroalga, known as seaweed, is a biological resource that potentially can be developed (e.g culture), and distributes widely in (all islands of) Indonesia particularly in either intertidal zone or coral islands. Macroalga has important roles in biological, ecological, and economical aspect as well as in protecting marine biodiversity. Macroalga has a higher of species biodiversity in the tropical area especially in the eastern area of Indonesia. It is, however, sensitive to environmental change (ecological pressure) that can influence its existence. Therefore envirnmental conditions, namely substrat, water movement, temperature, salinity, tide, light, pH, nutrient,

and water quality, have to be kept well so they can not degrade (decrease of quality) and finally have impact to destruction or even extinction of macroalga species (Atmadja *et al,* 1996).

Manokwari, an eastern part of Indonesia, is located on headbird of New Guinea and geographically on 132°35'Latitude – 134°45'Latitude and 0°15'Longitude – 3°25'Longitude. The sea floor topography on research area surrounding mainland is slope whereas in outland is slope as well as steep. The research area consists also of three types of ecosystems, mangrove, seagrass,and coral, which significantly support the growth and development of algae (Manokwari in number, 2011). The abundance and diversity of algae in this coastal area are very high, however, studies or even scientific information about algae is still rare. Therefore, it needs scientific study in order to describe species of algae (inventory and identification) and community assemblage of algae surrounding coastal area in Manokwari.

MATERIAL AND METHOD

I collected data for four months from June 2011 to September 2011 during east season period. Observation was conducted on two different main coastal areas, mainland coast and outland coast. Mainland coast areas consist of three chosen stations, namely Arfai beach (Station 1), Rendani beach (Station 2), and Pasir Putih beach (Station 3), whereas outland coast areas comprise two chosen stations, coastal area of Mansinam Island (Station 4) and coastal area of Lemon Island (Station 5). Map processing used *software ArcView* 3.3 according to satelite image of Landsat 5 (TM) 2009 as seen in figure 1 below.

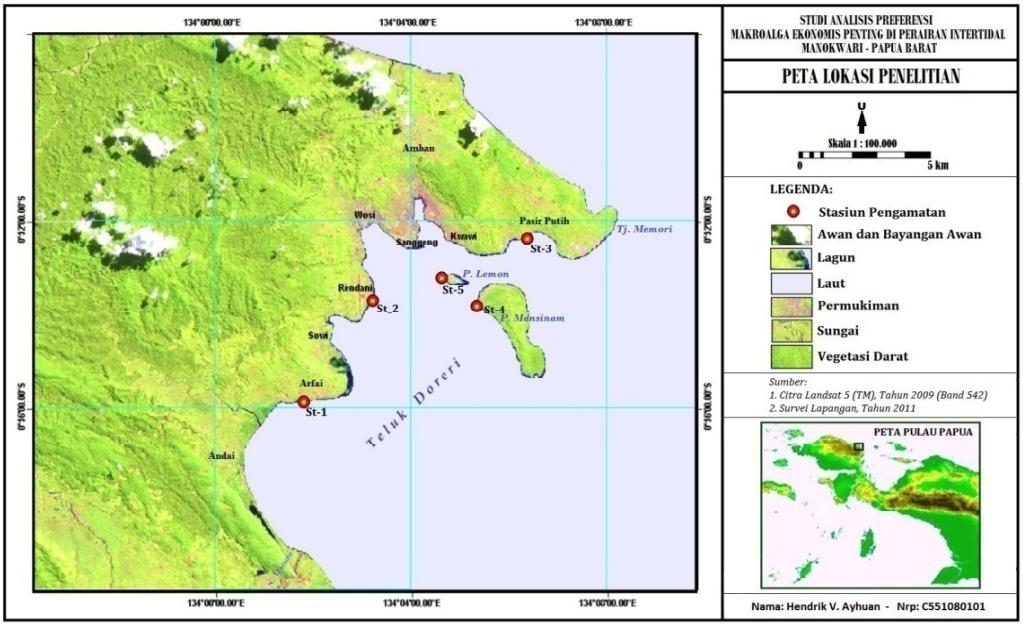

Figure 1. Map of observed areas in Manokwari intertidal coast

Sample collecting used line transect method with quadrate sampling technique (English et al., 1997). Collecting sample was done on five selected stations where three line transects were placed perpendicularly to coast line. The length of a line transect was 50 meters while the distance between line transects was also 50 meters. A-50-meter line transect was placed five quadrates (1 x 1 m^2) where distance between quadrates along line transect was 10 meters. Macroalga on each quadrate was counted into individual number of a species. Collected samples were then identified in laboratory and seperated according to each species. Furthermore, identified sample (or speciment) was categorised into three divisions, Chlorophyta, Rhodophyta, and Phaeophyta. Collected sample was indentified according to Atmadja et al.,(1996); Bold and Wyne (1985); Calumpong and Menez (1997); Chapman and Chapman (1990); Lewmanomont and Ogawa (1995); Silva et al.,(1996); Teo and Wee (1983); Trono, G (1997); William and Hunt (1979).

Data analysis used some formulas as follow:

1. **Density of macroalga** species was counted by formula according to Krebs (1989)

   $$Di = ni/A$$

2. **The relative density of macroalga** or the composition of macroalga species was counted following as (Krebs, 1989):

   $$RDi\ (\%) = ni/N \times 100$$

   where : RDi = the individual number of macroalga species *i* by the total individual of macroalga species
   ni = the individual number of macroalga species *i*
   N = the total individual number of macroalga species

3. **Diversity (H')**

   The diversity of macroalga species was counted by using Shannon index as follow (Ludwig and Reynolds, 1988):

   $$H' = \sum_{i=1}^{s} p_i \ln p_i$$

   where : H' = Shannon diversity index
   p_i = the ratio between the individual number of macroalga species *i* (n_i) and the total individual number of macroalga species
   s = the number of macroalga species *i*

The criteria of assessment species diversity are follow as:

1) If $H' \leq 1$, low diversity, low distribution, low macroalga species, and low community stability
2) If $1 < H' < 3$, moderate diversity, moderate distribution, moderate macroalga species, and moderate community stability
3) If $H' > 3$, high diversity, high distribution, high macroalga species, and high community stability

4. Evenness (E)

Species evenness (E) is the ratio between diversity index and maximum diversity index, as follow Krebs (1989):

$$E = \frac{H'}{H' \max}$$

where :

E = Evenness index (ranging from 0 to 1)
H' = Diversity index
H'_{max} = ln s ($\log_2 s$) = maximum diversity index (s= the number of macroalga species)

Evenness index ranges from 0 to 1. If the index value closes to 0, the evenness is lower. This means that the individual distribution of macroalga species is unequal and the population of macroalga tends also to be dominated by a certain macroalga species. Otherwise, If the index value closes to 1, the individual of macroalga species distributes equally and the population of macroalga species does not tend to be dominated by any particular macroalga species.

5. Dominance index

The species dominance index of macroalga is calculating according to Simpson dominance index (Krebs, 1989):

$$C = \sum_{i=1}^{s} \left(\frac{n_i}{N} \right)^2 = \sum_{i=1}^{s} (P_i)^2$$

where:

C = Simpson dominance index
n_i = the individual number of macroalga species i
N = the total individual number of macroalga species

Simpson dominance index value ranges from 0 to 1, such the criteria of index follows as:

$C = \sim 0$, no one macroalga species dominates others in the community or the community exists in a stable condition and this usually is followed by a higher evenness value

C = ~ 1, a certain macroalga species dominates others in the community or the community exists in an unstable condition and this usually is followed by a lower evenness value.

RESULT AND DISCUSSION

Description of macroalga spesies composition

Twenty eight species of macroalga were found on two different coastal areas, mainland (three selected stations) and outland (two selected stations), during research period. All species of macroalga were consisted taxonomically of three divisions, three classes, eleven orders, sixteen families, and nineteen genus. Three divisions of macroalga were green alga (*Chlorophyta*), red alga (*Rhodophyta*), and brown alga (*Phaeophyta*), which each division comprised with 14 species, 8 species, and 6 species respectively.

The result showed that the number of macroalga species in both coastal areas appeared significantly difference especially in either green alga or brown alga. Both coastal areas, however, consisted of a relatively similar number of red alga. For instance, the number of macroalga species on both green and brown alga in Pasir Putih were 7 and 2 species respectively in comparing to Mansinam island comprised with 11 and 4 species respectively. On the contrary, both Pasir Putih and Mansinam island resembled 6 species of red macroalga. The number of macroalga species based on division in five selected stations can be seen in figure below.

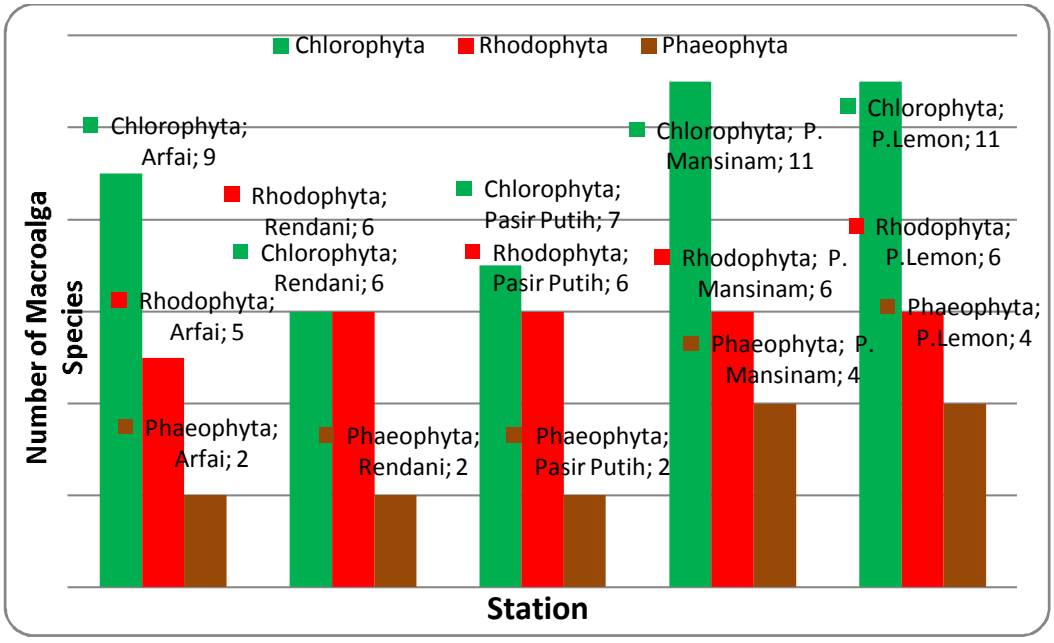

Figure 2 The histogram of the number of macroalga species based on division in five selected stations

The number of macroalga species in Arfai (station 1) based on three divisions, green alga, red alga, and brown alga, consisted of 9, 5, and 2 species respectively. It can be specifically seen on Table 1 below.

Table 1 The Classification of Macroalga in Arfai

No	Division	Class	Order	Family	Genus	Species
1	Chlorophyta	Chlorophyceae	Bryopsidales	Caulerpaceae	*Caulerpa*	*Caulerpa racemosa* Var occidentalis (J.Agardh) Boergensen, 1898
2	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda borneensis* (W.R.Taylor), 1950
3	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda cylindraceae* Decaisne, 1842
4	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda cunneata* Hering, 1846
5	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda opuntia* (Linnaeus) Lamouroux,1758
6	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda macroloba* Decaisne, 1841
7	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda macrophysa* Askenasy, 1888
8	Chlorophyta	Chlorophyceae	Ulvales	Ulvaceae	*Ulva*	*Ulva reticulata* Forsskal, 1775
9	Chlorophyta	Chlorophyceae	Cladophorales	Valoniaceae	*Valonia*	*Valonia ventricosa* J. Agardh 1823
10	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Actinotrichia*	*Actinotrichia fragilis* (Forsskal) Boergesen, 1775
11	Rhodophyta	Rhodophyceae	Crytonemiales	Corallinaceae	*Amphiroa*	*Amphiroa fragilissima* (Linnaeus) Lamouroux, 1877
12	Rhodophyta	Rhodophyceae	Crytonemiales	Corallinaceae	*Amphiroa*	*Amphiroa* sp, 1786
13	Rhodophyta	Rhodophyceae	Ceramiales	Ceramiceae	*Acanthophora*	*Acanthophora spicifera* (Vahl.) Boergesen, 1802
14	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Galaxaura*	*Galaxaura subfruticulosa* Chou, 1983
15	Phaeophyta	Phaeophyceae	Dictyotales	Dictyotaceae	*Dictyota*	*Dictyota bartayresiana* Lamouroux, 1809
16	Phaeophyta	Phaeophyceae	Dictyotales	Dictyotaceae	*Padina*	*Padina minor* Yamada, 1925

Source : Primary data, 2011.

The number of macroalga species in Rendani (station 2) based on three divisions, green alga, red alga, and brown alga, comprised with 6, 6, and 2 species respectively. It can be specifically seen on Table 2 below.

Table 2 The Classification of Macroalga in Rendani

No	Division	Class	Order	Family	Genus	Species
1	Chlorophyta	Chlorophyceae	Bryopsidales	Udoteaceae	*Avrainvilea*	*Avrainvilea erecta* (Barkley) A. Geppy. 1842
2	Chlrorophyta	Chlorophyceae	Bryopsidales	Codiaceae	*Codium*	*Codium edule* P.C. Silva, 1952
3	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda borneensis* (W.R.Taylor), 1950
4	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda macroloba* Decaisne, 1841
5	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda macrophysa* Askenasy, 1888
6	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda opuntia* (Linnaeus) Lamouroux,1758
7	Rhodophyta	Rhodophyceae	Ceramiales	Ceramiceae	*Acanthophora*	*Acanthophora spicifera* (Vahl.) Boergesen, 1802
8	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Actinotrichia*	*Actinotrichia fragilis* (Forsskal) Boergesen, 1775
9	Rhodophyta	Rhodophyceae	Crytonemiales	Corallinaceae	*Amphiroa*	*Amphiroa fragilissima* (Linnaeus) Lamouroux, 1877
10	Rhodophyta	Rhodophyceae	Crytonemiales	Corallinaceae	*Amphiroa*	*Amphiroa* sp, 1786
11	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Galaxaura*	*Galaxaura rugosa* (Solander) Lamouroux, 1816
12	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Galaxaura*	*Galaxaura subfruticulosa* Chou, 1983
13	Phaeophyta	Phaeophyceae	Dictyotales	Dictyotaceae	*Padina*	*Padina minor* Yamada, 1925
14	Phaeophyta	Phaeophyceae	Fucales	Sargassaceae	*Sargassum*	*Sargassum polycystum* C.A Agardh, 1824

Source : Primary data, 2011

The number of macroalga species in Pasir Putih (station 3) based on three divisions, green alga, red alga, and brown alga, comprised with 7, 6, and 2 species respectively. It can be specifically seen on Table 3 below.

Table 3 The Classification of Macroalga in Pasir Putih

No	Division	Class	Order	Family	Genus	Species
1	Chlorophyta	Chlorophyceae	Cladophorales	Cladophoraceae	*Chaetomorpha*	*Chaetomorpha crassa* (Ag.) Kuetzing, 1895
2	Chlrorophyta	Chlorophyceae	Bryopsidales	Codiaceae	*Codium*	*Codium edule* P.C. Silva, 1952
3	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda borneensis* (W.R.Taylor), 1950
4	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda laccunalis* Taylor, 1959
5	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda macrophysa* Askenasy, 1888
6	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda opuntia* (Linnaeus) Lamouroux,1758
7	Chlorophyta	Chlorophyceae	Ulvales	Ulvaceae	*Ulva*	*Ulva reticulata* Forsskal, 1775
8	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Actinotrichia*	*Actinotrichia fragilis* (Forsskal) Boergesen, 1775
9	Rhodophyta	Rhodophyceae	Crytonemiales	Corallinaceae	*Amphiroa*	*Amphiroa fragilissima* (Linnaeus) Lamouroux, 1877
10	Rhodophyta	Rhodophyceae	Crytonemiales	Corallinaceae	*Amphiroa*	*Amphiroa* sp, 1786
11	Rhodophyta	Rhodophyceae	Gigartinales	Solieriaceae	*Eucheuma*	*Eucheuma denticulatum* (Burman) Collins dan Harvey, *1917*
12	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Galaxaura*	*Galaxaura subfruticulosa* Chou, 1983
13	Rhodophyta	Rhodophyceae	Gigartinales	Gracilariaceae	*Gracilaria*	*Gracilaria coronopifolia* J. Agardh, 1852
14	Phaeophyta	Phaeophyceae	Dictyotales	Dictyotaceae	*Padina*	*Padina minor* Yamada, 1925
15	Phaeophyta	Phaeophyceae	Fucales	Sargassaceae	*Sargassum*	*Sargassum polycystum* C.A Agardh, 1824

Source : Primary data, 2011

The number of macroalga species in Mansinam island (station 4) based on three divisions, green alga, red alga, and brown alga, comprised with 11, 6, and 4 species respectively. It can be specifically seen on Table 4 below.

Table 4 The Classification of Macroalga in Mansinam Island

No	Divisi	Kelas	Ordo	Famili	Genus	Spesies
1	Chlorophyta	Chlorophyceae	Bryopsidales	Udoteaceae	*Avrainvilea*	*Avrainvilea erecta* (Barkley) A. Geppy,1842
2	Chlorophyta	Chlorophyceae	Dasycladales	Dasycladaceae	*Bornetella*	*Bornetella nitida* Munier-Chalmas, 1887
3	Chlorophyta	Chlorophyceae	Bryopsidales	Caulerpaceae	*Caulerpa*	*Caulerpa racemosa* Var occidentalis (J.Agardh) Boergensen, 1898
4	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda borneensis* (W.R.Taylor), 1950
5	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda cunneata* Hering, 1846
6	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda cylindraceae* Decaisne, 1842
7	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda macroloba* Decaisne, 1841
8	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda macrophysa* Askenasy, 1888
9	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda opuntia* (Linnaeus) Lamouroux,1758
10	Chlorophyta	Chlorophyceae	Ulvales	Ulvaceae	*Ulva*	*Ulva reticulata* Forsskal, 1775
11	Chlorophyta	Chlorophyceae	Cladophorales	Valoniaceae	*Valonia*	*Valonia ventricosa* J. Agardh 1823
12	Rhodophyta	Rhodophyceae	Ceramiales	Ceramiceae	*Acanthophora*	*Acanthophora spicifera* (Vahl.) Boergesen, 1802
13	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Actinotrichia*	*Actinotrichia fragilis* (Forsskal) Boergesen, 1775
14	Rhodophyta	Rhodophyceae	Crytonemiales	Corallinaceae	*Amphiroa*	*Amphiroa fragilissima* (Linnaeus) Lamouroux, 1877
15	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Galaxaura*	*Galaxaura rugosa* (Solander) Lamouroux, 1816
16	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Galaxaura*	*Galaxaura subfruticulosa* Chou, 1983
17	Rhodophyta	Rhodophyceae	Gigartinales	Gracilariaceae	*Gracilaria*	*Gracilaria coronopifolia* J. Agardh, 1852
18	Phaeophyta	Phaeophyceae	Dictyotales	Dictyotaceae	*Dictyota*	*Dictyota bartayresiana* Lamouroux, 1809
19	Phaeophyta	Phaeophyceae	Dictyotales	Dictyotaceae	*Hydroclathrus*	*Hydroclathrus clatratus* (C.Agardh) Howe, 1813
20	Phaeophyta	Phaeophyceae	Dictyotales	Dictyotaceae	*Padina*	*Padina australis* Hauck, 1887
21	Phaeophyta	Phaeophyceae	Fucales	Fucaceae	*Turbinaria*	*Turbinaria ornata* (Turner) J. Agardh, 1848

Source : Primary data, 2011

The number of macroalga species in Lemon island (station 5) based on three divisions, green alga, red alga, and brown alga, comprised with 11, 6, and 4 species respectively. It can be specifically seen on Table 5 below.

Table 5. The Classification of Macroalga in Lemon Island

No	Division	Class	Order	Family	Genus	Species
1	Chlorophyta	Chlorophyceae	Dasycladales	Dasycladaceae	Bornetella	*Bornetella nitida* Munier-Chalmas, 1887
2	Chlorophyta	Chlorophyceae	Bryopsidales	Caulerpaceae	*Caulerpa*	*Caulerpa racemosa* Var occidentalis (J.Agardh) Boergensen, 1898
3	Chlrorophyta	Chlorophyceae	Bryopsidales	Codiaceae	Codium	*Codium edule* P.C. Silva, 1952
4	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda borneensis* (W.R.Taylor), 1950
5	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda cunneata* Hering, 1846
6	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda cylindraceae* Decaisne, 1842
7	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda macroloba* Decaisne, 1841
8	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda macrophysa* Askenasy, 1888
9	Chlorophyta	Chlorophyceae	Bryopsidales	Halimedaceae	*Halimeda*	*Halimeda opuntia* (Linnaeus) Lamouroux,1758
10	Chlorophyta	Chlorophyceae	Cladophorales	Valoniaceae	*Valonia*	*Valonia ventricosa* J. Agardh 1823
11	Chlorophyta	Chlorophyceae	Ulvales	Ulvaceae	*Ulva*	*Ulva reticulata* Forsskal, 1775
12	Rhodophyta	Rhodophyceae	Ceramiales	Ceramiceae	*Acanthophora*	*Acanthophora spicifera* (Vahl.) Boergesen, 1802
13	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Actinotrichia*	*Actinotrichia fragilis* (Forsskal) Boergesen, 1775
14	Rhodophyta	Rhodophyceae	Crytonemiales	Corallinaceae	*Amphiroa*	*Amphiroa fragilissima* (Linnaeus) Lamouroux, 1877
15	Rhodophyta	Rhodophyceae	Crytonemiales	Corallinaceae	*Amphiroa*	*Amphiroa* sp, 1786
16	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Galaxaura*	*Galaxaura rugosa* (Solander) Lamouroux, 1816
17	Rhodophyta	Rhodophyceae	Bonnemaisonales	Chaetangiaceae	*Galaxaura*	*Galaxaura subfruticulosa* Chou, 1983
18	Phaeophyta	Phaeophyceae	Dictyotales	Dictyotaceae	*Dictyota*	*Dictyota bartayresiana* Lamouroux, 1809
19	Phaeophyta	Phaeophyceae	Dictyotales	Dictyotaceae	*Hydroclathrus*	*Hydroclathrus clatratus* (C.Agardh) Howe,1813
20	Phaeophyta	Phaeophyceae	Dictyotales	Dictyotaceae	*Padina*	*Padina australis* Hauck, 1887
21	Phaeophyta	Phaeophyceae	Fucales	Fucaceae	*Turbinaria*	*Turbinaria ornata* (Turner) J. Agardh, 1848

Source : Primary data, 2011

Generally, green alga species dominated macroalga community in Manokwari coastal area in terms of the number of species and it then followed by red alga and brown alga respectively. Outland coastal areas, Mansinam island and Lemon island, had a higher number of macroalga species in comparing to mainland coastal areas, Arfai, Rendani, and Pasir Putih. It was assumed that the substrat type in both areas differed signicantly. The substrat in mainland consisted of mixed sand and silt or clay, whereas in outland comprised with mixed sand and coral facture. Moreover, coastal topography and physical and chemical factors in Manokwari coastal area also influenced composition of macroalga species.

Current water, a physical factor, influenced composition of macroalga species. The current water in outland was higher than mainland. If the current water tends to be stronger in a water, macroalga will grow fastly because a lot of nutrient will diffuse into plant cell of macroalga to fasten metabolism and cell growth (Soegiarto et al., 1979).

Density and Relative Density of Macroalga species

The total of average density analysis showed a significant difference of macroalga species density between mainland and outland coastal areas as can be seen in figure 3 below.

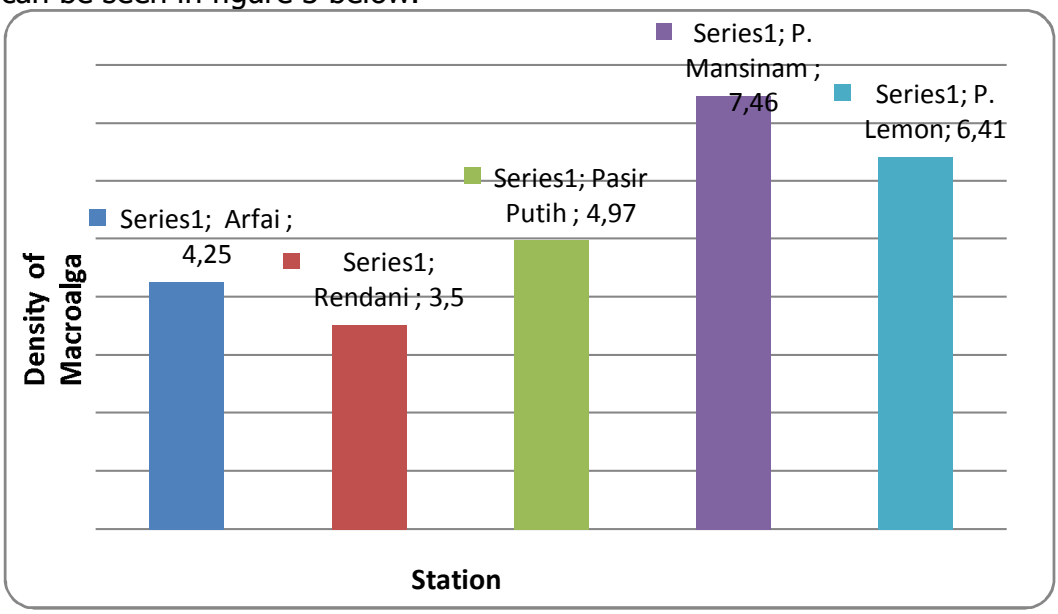

Figure 3. Histogram of the total average density of macroalga in five selected stations.

Density and relative density of macroalga species showed generally that outland coastal area had a higher density and relative density of macroalga species than mainland coastal area had. It was predicted that physical abiotic factors, substrat type, clarity, current speed sirculation, adaptation of macroalga, and antrophogenic waste, also influence existence of macroalga species in Manokwari coastal area.

Table 6 The density and relative density of macroalga in five selected stations

No	Macroalga Species	Station									
		Arfai		Rendani		Pasir Putih		Mansinam		Lemon	
		Di	Rdi	Di	Rdi	Di	Rdi	Di	Rdi	Di	Rdi
1	*Acanthophora spicifera*	3.20	0.05	6.00	0.12	-	-	2.07	0.01	2.00	0.02
2	*Actinotrichia fragilis*	4.87	0.07	6.67	0.14	1.47	0.02	1.67	0.01	2.90	0.02
3	*Amphiroa fragilissima*	7.73	0.11	1.87	0.04	3.60	0.05	8.73	0.06	7.00	0.05
4	*Amphiroa* sp	3.73	0.06	3.13	0.06	4.27	0.06	-	-	3.90	0.03
5	*Avrainvilea erecta*	-	-	1.60	0.03	-	-	2.07	0.01	-	-
6	*Bornetella nitida*	-	-	-	-	-	-	0.80	0.01	1.90	0.01
7	*Caulerpa racemosa*	1.80	0.03	-	-	-	-	7.07	0.05	2.90	0.02
8	*Chaetomorpha crassa*	-	-	-	-	5.00	0.07	-	-	-	-
9	*Codium edule*	-	-	2.40	0.05	5.40	0.07	-	-	3.40	0.03
10	*Dictyota bartayresiana*	1.33	0.02	-	-	-	-	4.67	0.03	6.10	0.05
11	*Eucheuma denticulatum*	-	-	-	-	0.47	0.01	-	-	-	-
12	*Galaxaura rugosa*	-	-	0.73	0.02	-	-	8.67	0.06	4.90	0.04
13	*Galaxaura subfruticulosa*	2.47	0.04	2.27	0.05	4.53	0.06	5.00	0.04	4.30	0.03
14	*Gracilaria coronopifolia*	-	-	-	-	2.07	0.03	6.20	0.04	-	-
15	*Halimeda borneensis*	9.47	0.14	4.87	0.10	8.53	0.11	9.07	0.06	6.00	0.05
16	*Halimeda cunneata*	2.27	0.03	-	-	-	-	9.67	0.06	3.80	0.03
17	*Halimeda cylindraceae*	1.60	0.02	-	-	-	-	10.20	0.07	17.50	0.13
18	*Halimeda laccunalis*	-	-	-	-	3.53	0.05	-	-	-	-
19	*Halimeda macroloba*	8.93	0.13	2.07	0.04	-	-	6.33	0.04	2.90	0.02
20	*Halimeda macrophysa*	1.67	0.02	4.60	0.09	8.60	0.12	15.07	0.10	12.30	0.09
21	*Halimeda opuntia*	9.80	0.14	3.73	0.08	7.93	0.11	17.27	0.11	9.10	0.07
22	*Hydroclathrus clatratus*	-	-	-	-	-	-	7.20	0.05	10.00	0.07
23	*Padina australis*	-	-	-	-	-	-	19.60	0.12	20.30	0.15
24	*Padina minor*	3.27	0.05	6.33	0.13	10.13	0.14	-	-	-	-
25	*Sargassum polycystum*	-	-	2.80	0.06	2.53	0.03	-	-	-	-
26	*Turbinaria ornata*	-	-	-	-	-	-	5.00	0.03	7.80	0.06
27	*Ulva reticulata*	3.67	0.05	-	-	6.53	0.09	8.27	0.05	3.50	0.03
28	*Valonia ventricosa*	2.27	0.03	-	-	-	-	2.07	0.01	2.10	0.02
	Total	**68.07**	**1.00**	**49.07**	**1.00**	**74.59**	**1.00**	**156.67**	**1.00**	**134.6**	**1.00**
	Total average	**4.25**	**0.062**	**3.50**	**0.071**	**4.97**	**0.067**	**7.46**	**0.048**	**6.41**	**0.048**

Source : Primary data, 2011.

Diversity index (H′), Evenness index (E) and Dominance index (C)

The diversity, evenness, and dominance index in Manokwari coastal area can be seen in the table below. Those index showed no significantly difference value among all stations.

Table 7 The diversity (H'), evenness (E), and dominance (D) index value in the five chosen stations

Station	Indexes		
	Diversity (H')	Evenness (E)	Dominance (C)
Arfai	2,561	0,924	0,092
Rendani	2,500	**0,947**	0.091
Pasir Putih	2,539	**0,937**	0,087
Mansinam island	**2,832**	0,930	**0,068**
Lemon island	**2,800**	0,920	**0,075**

Source : Primary data, 2011.

Diversity index in a community can explain the stability level of a community. Both the individual number of a species and the total individual of all species influence diversity index value. Diversity index value of the five chosen stations in Manokwari coastal area involved to moderate diversity, ranged between 1 and 3. Eventhough diversity index was moderate among all stations, outland coastal areas were higher than mainland coastal areas. It can be seen from the figure 4 below that diversity index value of outland coastal areas, Mansinam island and Lemon island, was approximately 2.8, whereas of mainland coastal areas, Arfai, Rendani, and Pasir Putih, was around 2.5. The higher diversity index in outland coastal areas indicated that macroalga community was relative stable and the existence of macroalga species was balance in comparing to mainland coastal areas. The higher diversity index value in outland coastal areas also described that macroalga species tended to distribute equally and had no dominated species in these stations. In mainland coastal area, conversely, diversity index was lower, which macroalga species ditributed uneqally and a certain macroalga species tended to be dominant.

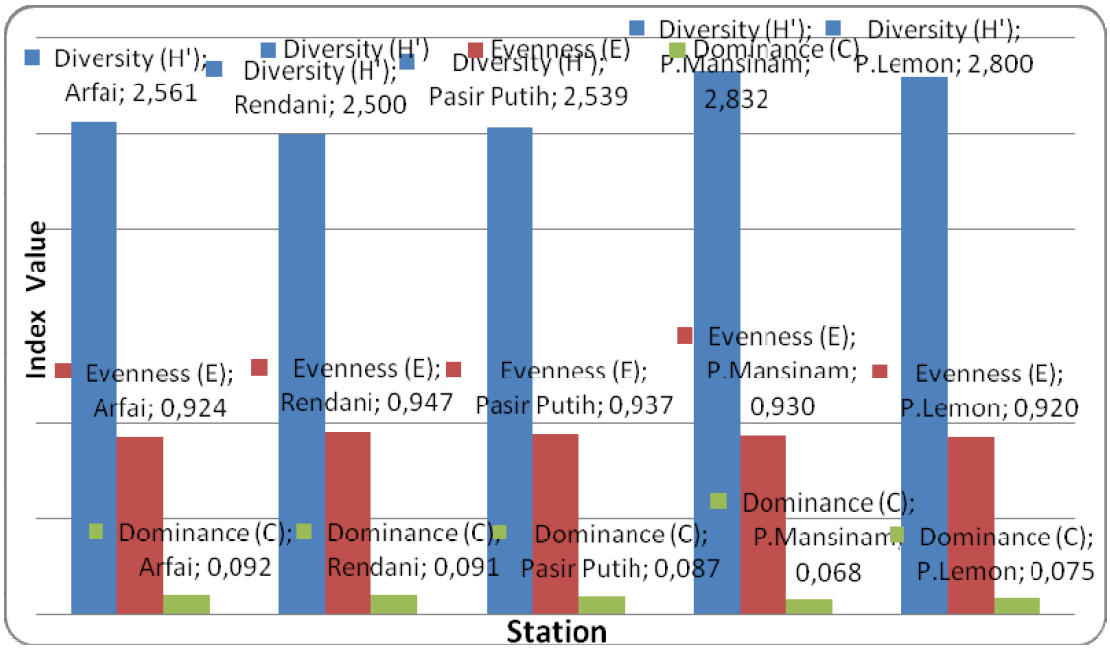

Figure 4. The histogram of the diversity (H'), evenness (E), and dominance (D) index value in the five chosen stations.

CONCLUSION

According to the result and discussion, it can be concluded that:

1. Twenty eight macroalga species were identified and consisted taxonomically of three divisions, three classes, eleven orders, sixteen families, and nineteen genus. Three divisions of macroalga species were green alga (*Chlorophyta*), red alga (*Rhodophyta*), and brown alga (*Phaeophyta*), which each division comprised with 14 species, 8 species, and 6 species respectively.
2. The total of average density of macroalga species showed significantly difference between mainland and outland coastal areas, which the density and relative density of macroalga species were generally higher in outland coastal areas than mainland coastal areas.
3. The diversity, evenness, and dominance index in Manokwari coastal area showed no significantly difference value among all stations. Diversity index value in Manokwari coastal area was involved to moderate diversity. However, outland coastal areas were higher than mainland coastal areas. The higher diversity index in outland coastal areas indicated that macroalga community was relative stable as well as the existence of macroalga species was balance in comparing to mainland coastal areas.

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