Coastal Marine Science 30(1): 162–166, 2006

Study on the seaweeds of Ambon Island, Indonesia

Grevo S. GERUNG[1*], Frijona F. LOKOLLO[2] Janny D. KUSEN[1], and Agustinus P. HARAHAP[1]

[1] *Sam Ratulangi University, Fac. of Fisheries and Marine Science, Manado, Indonesia*
**E-mail: ggrevo@hotmail.com*
[2] *Patimura University, Fac. of Fisheries, Jl Tamaela, Ambon, Indonesia*

Received: 26 August 2005; Accepted: 10 November 2005

Abstract— Ambon island is located in the Eastern Indonesia at 3°33′–3°43′S, 128°0′–128°16′E. A study to find out the structure of the algae community, based on the transect line method by using quadrate sampling techniques, was conducted in 3 stations (Hutumuri, Lateri and Series). Meanwhile, studies on the diversity of macro algae were carried out in 15 stations all over the Ambon's coastal areas (Galela, Latta, Lateri, Passo, Toisapu, Hutumuri, Rutong, Leahari, Hukurila, Amahusa, Frie, Seilale, Aerlow, Latuhalat and Serie).

The results showed that there were 48 species of macro algae belonging to 30 genera, 21 families, 15 orders, 3 classes and 3 divisions. Chlorophyta was represented by *Boergesenia forbesi, Bornetella sphaerica, Caulerpa peltata, Chaetomorpha crassa, C. spiralis, Codium edule, C. geppi, Dictyosphaeria cavernosa, D. verssluysii, Enteromorpha clathrata, E. intestinalis, Halimeda opuntia, Neomeris annulata, Ulva conglobata, U. lactuca, U. reticulata, Valonia aegagrophil.* Phaeophyta was represented by *Padina australis, P. minor, P. tetrastromatica, Sargassum cristaefolium, S. duplicatum, S. polycystum, Turbinaria decurrens, T. ornata.* Rhodophyta was represented by *Acanthophora muscoides, A. spicifera, Acrocystis nana, Actinotrichia fragilis, Amphiroa foliacea, A. rigida, Ceratodictyon spongiostum, Cryptonemia crenulata, Galaxaura arborea, G. filamentosa, Gelidiella acerosa, Gracilaria arcuata, G. edulis, G. salicornia, G. verrucosa, Halymenia durvillaei, H. boergesenii, Hypnea valentiae, Mastophora rosea, Porphyra* sp., *Rhodymenia* sp., *Tricleocarpa fragilis,* and *Zellera tawallina.* The highest number of species was found in Hutumuri (27 species) and the lowest was in Lateri (2 species).

The highest density and relative frequency indices shown by *Ulva reticulata* (2.82 individuals/m^2; 0.42) were found in Hutumuri. The species similarity values varied from 0–50% with the highest value found in Serie and Hutumuri (C=50%). The highest dominance index (D) was found in Lateri (D=1), and the highest species diversity (H′) in Hutumuri (H′=2.86). The species evenness values (E) ranged from 0.849–0.850. The distribution of macro algae species in general showed aggregating pattern.

Key words: seaweeds, morphology, ecology, Ambon, Indonesia

Introduction

Seaweed is one of the marine resources which are abundantly living along 81,000 km coast line and around 17,500 islands in Indonesian waters. Current published reports of major marine biological expeditions to Indonesian waters usually do not contain much information on seaweeds (Verheij 1993). Important background on seaweeds is obtained from reports of earlier expeditions, like the Siboga Expedition in 1899–1900, (Weber-van Bosse 1926, 1928). In addition to Siboga Expedition, some studies on the Indonesian seaweed taxonomy have also been carried out (Hatta and Prud'home van Reine 1991, Verheij 1993, Kadi 1996, Gerung 2001).

Many centuries ago, macro algae have been consumed by human, especially in China and Japan, and have become popular foodstuffs in other Asian countries. In Indonesia, there is no available information on when the macro algae were started to be used as foodstuffs. Even now, macro algae are less popular than fish or shrimp as seafood. World demand for macro algae is expected to keep on increasing due to improvement of processing technology and increased utilization. However, most people in Indonesia are still not aware of the macro algae potential (Gerung 2004)

One of the economically important aquaculture prospects in Indonesia is seaweeds with available cultivation area of 120,000 hectares capable of producing dried seaweeds of approximately 8 tons per hectares per year in 2003. Currently this potential has been developed up to 20% only. This exploitation of this marine biological resource could bring higher income to the country and increase people welfare if it is developed to industrial level. It is only recently that culture of *Gracilaria, Eucheuma* and *Kappaphycus* have started.

The increasing level of marine algae exploitation has to be equally supported by increasing effort to understand their species diversity and ecology, both are substantial for management programs. Information on algae in Ambon still lacking and it is necessary to conduct substantial studies on morphology as well as the ecology.

Ambon Island is located in the Eastern Indonesia at

3°33′–3°43′S, 128°0′–128°16′E. The water condition in Ambon Bay is strongly influenced by the physics and biology of the ocean, the island, and the climate. This unique interaction among ocean and land condition affected the productivity and quality of the natural resources.

This study on the biodiversity and ecology of seaweeds in Ambon Island is similar to collect baseline information on the seaweed resources for management purpose.

Material and Methods

The studies took place in Ambon Island water. Three sites were selected for ecology studies ie. 1) Lateri site, estuary area in side the Ambon Bay, 2) Series, area exposed to open ocean Banda Sea, and 3) Hutumuri, representing intertidal area.

In each site, several stations were selected for biodiversity studies: Seven stations in Lateri (Lateri, Latta, Galala, Amahusu, Erie, Seilale and Passo), three stations in Series (Series, Air Louw and Latuhalat) and five stations in Hutumuri (Hutumuri, Hukurila, Leahari, Rutong and Toisapu). Specimens were randomly collected during low tide. Herbarium specimens were made and deposited in collection room of Faculty of Fisheries and Marine Science Sam Ratulangi University, Manado, Indonesia.

Samples for ecology studies were collected from the three sites (Lateri, Serie, and Hutumuri) by using transect line methods and quadrate sampling technique (Dawes 1981, Krebs 1999). On each site, transect line was placed vertically in 100 m distance. Ten unit by 1 m^2 quadrate were placed on the transect lines in 10 m distance.

To provide description on the structure of seaweed communities, the measured parameters are relative density, frequency and relative frequaency (Cox 1967), dominance index (Krebs 1999), diversity index (H′) and distribution pattern (Ludwig and Reynold 1988, Krebs 1999).

Results and Discussion

The results showed that there were 48 species of seaweeds belonging to 30 genera, 21 families, 15 orders, 3 classes and 3 divisions distributed along Ambon Island. Chlorophyta was represented by *Boergesenia forbesi*, *Bornetella sphaerica*, *Caulerpa peltata*, *Chaetomorpha crassa*, *C. spiralis*, *Codium edule*, *C. geppi*, *Dictyosphaeria cavernosa*, *D. verssluysii*, *Enteromorpha clathrata*, *E. intestinalis*, *Halimeda opuntia*, *Neomeris annulata*, *Ulva conglobata*, *U. lactuca*, *U. reticulata*, *Valonia aegagrophil*. Phaeophyta was represented by *Padina australis*, *P. minor*, *P. tetrastromatica*, *Sargassum cristaefolium*, *S. duplicatum*, *S. polycystum*, *Turbinaria decurrens*, *T. ornata*. Rhodophyta was represented by *Acanthophora muscoides*, *A. spicifera*, *Acrocystis nana*, *Actinotrichia fragilis*, *Amphiroa foliacea*, *A. rigida*, *Ceratodictyon spongiostum*, *Cryptonemia crenulata*, *Galaxaura arborea*, *G. filamentosa*, *Gelidiella acerosa*, *Gracilaria arcuata*, *G. edulis*, *G. salicornia*, *G. verrucosa*, *Halymenia durvillaei*, *H. boergesenii*, *Hypnea valentiae*, *Mastophora rosea*, *Porphyra* sp., *Rhodymenia* sp., *Tricleocarpa fragilis*, and *Zellera tawallina*. The highest number of species was found in Hutumuri (27 species) and the lowest was in Lateri (2 species).

All of the sites were dominated by Rhodophyta species, especially in Leitimur beach where so many crevices and cracks for sea water flows created by the energy of water of Banda Sea. The energy of the waves has also created caves along the beach and Rhodophyta can easily be found on crevices or caves as their habitat in which they are protected from direct waves.

Table 1 showed the distribution of seaweeds in 15 stations along Ambon Island. In site 3 (Hutumuri, Hukurila, Leahari, Rutong and Toisapu) as many as 27 species were found, followed by site 2 Series (Series, Air Louw and Latuhalat) with 23 species. In site 1 (Lateri, Latta, Galala, Amahusu, Erie, Seilale and Passo), only 2 species were found (*Gracilaria salicornia* and *Padina minor*). Each site has different substrate as habitats for seaweed growth. Seaweeds play very important roles in structuring the marine community as they are the dominant primary producers, but environmental factor such as substrate and water current play an important role affecting the growth of seaweed population (Kong and Put 2004, Wong and Phang 2004). In Lateri site, and also in other stations in inner Ambon Bay (Lateri, Latta, Galala, Amahusu, Erie, Seilale and Passo), slow current and relatively small wave contributed to heavy sedimentation in the area. In this area various physical stresses that could be easily indentified are: sedimentation, domestic wastes that picking up along the beach and various liquid that directly disposed into the bay.

This study showed that Ambon Island a comparably high species richness compare with other studies around Ambon Island: Hatta et al. (1991) in Kei island 76 spesies, Hatta (1993) in Trangan island 48 spesies, Annakota (1999) in Aru Archipelago 23 species, Dangeubun (2000) in Ameth waters 17 species, Matruty (2003) in Sila waters 19 species.

There was no seaweed culture in Ambon Island, but some people have been consuming *Ulva* and *Porphyra* harvested directly from nature. As human population and markets continue growing, a larger number of seaweed species will probably be farmed in the future. The farming of seaweeds is presently one of the most productive and environmental friendly forms of livelihood among coastal population (Santelices 1999)

The seaweeds densities found in the three sites ranged from 0.02–2.82 ind./m^2. Lateri site which only *Gracilaria*

Table 1. Distribution of seaweeds in Ambon Island.

Taxa	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CHLOROPHYTA															
Boergesenia forbesii								v		v	v		v		
Bornetella sphaerica													v		
Caulerpa peltata								v					v		
Chaetomorpha crassa													v		v
Chaetomorpha spiralis													v		
Codium edule										v					
Codium geppi										v					
Dictyosphaeria cavernosa								v							
Dictyosphaeria verssluysii							v	v	v	v	v	v	v		
Enteromorpha clathrata										v		v			v
Enteromorpha intestinalis			v	v		v	v	v					v		v
Halimeda opuntia				v	v	v							v		v
Neomeris annulata					v								v		
Ulva conglobata					v		v	v	v	v					
Ulva lactuca			v					v				v			
Ulva reticulata			v					v			v	v	v		
Valonia aegagrophila								v		v					
PHAEOPHYTA															
Padina australis			v	v											
Padina minor	v	v	v					v	v			v	v		v
Padina tetrastromatica				v	v	v					v				v
Sargassum cristaefolium								v							
Sargassum duplicatum							v	v	v	v	v	v	v		v
Sargassum polycystum								v			v	v			v
Turbinaria decurrens							v	v	v	v	v	v	v	v	
Turbinaria ornata							v	v	v	v	v	v	v	v	v
RHODOPHYTA															
Acanthophora muscoides								v					v		
Acanthophora spicifera								v	v				v		
Acrocystis nana							v	v					v		
Actinotrichia fragilis		v										v			
Amphiroa foliacea		v													v
Amphiroa rigida													v		
Ceratodictyon spongiostum		v				v									v
Cryptonemia crenulata								v							
Galaxaura arborea				v	v	v									
Galaxaura filamentosa						v	v								
Gelidiella acerosa		v										v			
Gracilaria arcuata													v		
Gracilaria edulis		v									v		v		
Gracilaria salicornia	v							v					v		
Gracilaria verrucosa						v							v		
Halymenia durvillaei					v			v	v						
Hypnea boergesenii													v		v
Hypnea valentiae													v		
Mastophora rosea									v		v	v	v		
Porophyra sp.							v			v					
Rhodymenia sp.								v							
Tricleocarpa fragilis				v	v			v	v		v	v	v		v
Zellera tawallina											v		v		

Remarks: 1. Lateri, 2. Latta, 3. Galala, 4. Amahusu , 5. Erie, 6. Seilale, 7. Air Louw, 8. Latuhalat, 9. Serie, 10. Hukurila, 11. Leahari, 12. Rutong, 13. Hutumuri, 14. Toisapu, 15. Passo.

salicornia has 0.32 ind./m^2. Series site with 15 species has seaweed densities ranged from 0.03–2.1 ind./m^2 with an average of 0.79 ind/m^2. Hutumuri site with 29 species has densities ranged from 0.02–2.82 ind./m^2 with an average 1.34 ind./m^2. The seaweed with the highest density was *U. reticulata* 2.82 ind./m^2 followed by *T. deccurens* 2.22 ind./m^2.

Further anlysis showed that the seaweed frequencies in all site were ranged from 0.02–0.82. In Lateri only *G. salicornia* found was 0.06. In Seris site, the frequencies were ranged from 0.02–0.42 with the average of 0.23. The seaweed with the highest frequency in this site was *U. conglobata* 0.42 followed by *Padina minor* 0.4 and *T. ornata* 0.4. In Hutumuri site, the frequencies were ranged from 0.02–0.82 with the averaged of 0.24. The highest frequency was shown by *U. reticulata* 0.82 followed by *Hypnea valentiae* 0.58.

This study also showed that species similarity between Serie and Hutumuri site was 50%, in which 11 similar species of seaweeds were found in both sites: *Actinotrichia fragilis*, *Dictyosphaeria verssluysii*, *Enteromorpha intestinalis*, *Gelidiella acerosa*, *Gracilaria edulis*, *Hypnea valentiae*, *Padina minor*, *Sargassum duplicatum*, *Tricleocarpa fragillis*, *Turbinaria deccurrens* and *T. ornata*. Meanwhile between Lateri and Hutumuri site only one similar species was found in location (*G. salicornia*). Between Lateri and Series sites, there was no similar species found living in both sites.

Species similarity among sites depends on various factors, such as differences in substrate variation among sites, especially in Lateri site that was very different from the any other site. In Lateri site, the only substrate found was muddy substrate because it was a closed water that mud from the river was heavily contributed to the sedimentation in this area. On the other hand, Series and Hutumuri had similar substrate variation, i.e. consisting of rocky sand, coral rubbles and patches of coral reef. Both sites were open water affected by Banda Sea which contributed to the species diversity of these two sites compare with that in Lateri site.

Species dominance index in Lateri site was higher than that in the other two sites, but this is mainly attributed to the fact that only one (*G. salicornia*) species was found in this site. Meanwhile between Serie and Hutumuri sites, a relatively higher dominance index was found in Serie (D=0.116) with mainly attributed to the presence of *T. ornata* in much higher number. Meanwhile, lower dominance index found in Hutumuri site (D=0.068) was apparently caused by the fact that only few most species were dominantly living in this area, such as *Ulva reticulata*, *Turbinaria deccurrens* and *T. ornata*. While the most species were present in low number of individuals.

Hutumuri site showed higher species diversity index than other two sites. This higher species diversity index in Hutumuri site (H′=2.86) was apparently attributed to the selectively flat beach topography and high varieties of substrate in the area that supported the growth of varieties species. For similar reason, Serie site that showed a lower species diversity index (H′=2.301) dominated mostly by coral reef and rocks. Most of the species found in this area had strong holdfast capability to attach themselves to the substrates and to survives the waves. Because this area are directly open to the Banda sea.

The distribution pattern of the seaweeds depends on the ecology of each site. In Series site, all species were distributed in aggregation. Similar situation was also found in Hutumuri in which almost all of the species were distributed in aggregation and only the species such as *Amphiroa rigida*, *Bornetella sphaerica*, *Caulerpa peltata*, *Chaetomorpha crassa*, and *Halymenia durvillaei* were randomly. Species distribution pattern was assumed to be related to the suitability of substrate type to attach their thallus, as well as adaptation strategy and the results of biological interaction among population living as a community in the area. (Pole 1974).

Indonesian seaweed exploration through biodiversity and ecology studies should be encouraged to find the economically important species and to turn the high biodiversity of macro algae into the welfare of the community, and at the same time to keep endemic species in conservation.

Acknowledgements

The first author wish to thank the JSPS for funding that enabled to attend the 2nd Joint Seminar on Coastal Oceanography. We also thank to Mr. Reza Rumbajan and Mr. Douglas Wattimury Sam Ratulangi University for the field works and identification.

References

Anakotta, J. J. 1999. Makro Alga in East Coast of Trangan Island, Aru Archipelago. Faculty of Fisheries, Patimura University, Ambon. Indonesia. 128 pp.

Ching, L. W. and Phang, S. M. 2004 Biomas production of two Sargasum species at cape Rachado, Malaysia. Hydrobiologia 512: 79–88.

Cox, G. W. 1967. Laboratory Manual of General Ecology. Wm.C. Brown Company Publishers. USA. 324 pp.

Dangeubun, D. W. 2000. Optimalisation and Utilization of Marine Resources in Ameth, Central Maluku. Graduate School of Sam Ratulangi University, Manado, Indonesia. 203 pp.

Dawes, J. C. 1981. Marine Botany. Wiley Interscience Publication, John Wiley and sons. New York. 624 pp.

Gerung, G. S. 2001. Study on Indonesian Gracilariaceae (Rhodophyta, Gigartinales). Ph.D. Thesis. Faculty of Fisheries, Hokkaido University, Japan. 312 pp.

Gerung, G. S. 2004. Biodiversity of Indonesian Seaweeds. *In* Marine Science: Into The New Millenium: New Perspectives & Challenges, Phang Siew Moi, Chong Ving Ching, Ho Sinn Chye, Noraieni, Jillian ooi Lean Sim eds., University of Malaya, Maritime Research Centre. pp 47–54.

Hatta, A. M. and Prud'homme van Reine, W. F. 1991. A taxonomic revision of Indonesian Gelidiales (Rhodophyta). Blumea 35: 347–380.

Hatta, A. M., Papalia, S. and Yulianto, K. 1991. Potensi and Natural Biomas of Seaweeds in Small Kei Island, Maluku. Indonesia Research Institute of Ambon Station, Indonesia. 30 p.

Hatta, A. M. 1993. Systematic and Ecology of Chlorophyta from Maluku Waters. Indonesia Research Institute of Ambon Station, Indonesia. 37 pp.

Hopley, D. and Suharsono 2000. The Status of Coral Reefs in Eastern Indonesia. Australian Institute of Marine Science, Cape Ferguson, Australia. 68 p.

Kadi, A. 1996. Introduction to Chlorophyta from Indonesia. Indonesia Research Institute, National Oceanology Section, Jakarta. Indonesia, 114 p.

Kong, S. L. C and Ang, P. O. 2004. Seasonal occurrence and reproduction of *Hypnea charoides* (Rhodophyta) in Tungg Ping Chau, N.Y.T. Hong Kong SAR. China. Hydrobiologia 512: 63–78.

Krebs, C. J. 1999. Ecological Methodology. Second Edition. Addison Wesley Longman, Inc. New York, 576 pp.

Ludwig, J. A. and Reynolds, J. F.. 1988. Statistical Ecology. A primer in methods and computing. John Wiley and Sons. New York, 476 pp.

Matrutty, D. D. P. 2003. Study on the Management of Coastal Area Bio-Resources. Graduate School of Sam Ratulangi University, Manado, Indonesia, 147 pp.

Poole, R. W. 1974. An Introduction to Quantitative Ecology. McGraw-Hill Book Co. New York, 426 pp.

Santelices, B. 1999. A conceptual framework for marine agronomy. Hydrobiologia 398/399: 15–23.

Verheij, E. 1993. Marine plants on the reefs of the Spermonde archipelago, SW Sulawesi, Indonesia: Aspects of taxonomy, floristics, and ecology. Rijkherbarium/Hortus botanicus, Leiden, Netherlands, p. 185–187.

Weber-van Bosse, A. 1926. Algues de l'expedition danoise aux Kei. Papers from Dr. Th. Mortensen's Pacific Expedition 1914–1916. Vidensk. Meddr. Dansk Naturh. Foren. XXXIII. 81: 57–155.

Weber-van Bosse, A. 1928. Liste des algues du Siboga IV, Rhodophyceae, troisieme partie, Gigartinales et Rhodymeniales. Siboga-Expeditie LIX d.: 393–533.