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Characteristics and Structure of Benthic Algal Community in Pohang New Port Area

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Abstract *Community structure and biodiversity of benthic marine algae were studied in the rocky shore of Phohang New Port, Yeoungil Bay. A total of 79 species of marine algae including 8 Chlorophyta, 23 Phaeophyta and 48 Rhodophyta are listed. The dominant algal species were Corallina pilulifera in all seasons, and Sargassum horneri in winter. Lomentaria catenata, Lomentaria hakodatensis, Grateloupia laceolata, Sargassum thunbergii, Chondria crassicaulis, Ulva pertusa, and Hypnea charoides were subdominant at different seasons. The algal biomass per unit area of the benthic algal community in Pohang New Port under construction was 145.06 - 398.93 g dry wt m-2, which means that its annually averaged value is 273.45 g dry wt m-2 . The seasonal change in algal biomass showed highs in winter and spring, and lows in summer and autumn. The algal species diversity (H') based on algal biomass was 2.07 annually in average, with 2.42 in winter, 2.65 in spring, 1.79 in summer and 1.43 in autumn. It was high in winter and spring seasons and low in summer and autumn seasons. It is caused by that spring and winter are the profitable growth time for algae and species components in this study were dominated by the annual or seasonal rather than perennial plants.*

Key words : *Benthic marine algae, Rocky shore, Community structure, Algal species diversity*

1. Introduction

Grasping the characteristics of the benthic algal community of Yeongil Bay is a shortcut to understand the algal distribution of central East Coast, with the bay being an area with abundant algal vegetation. Benthic marine algae usually live in the rocky shore and being marine plants, they are known to be important biological factors that are directly affected by changes in the living environment. Understanding benthic algal community is securing important basic material on restoring algal habitat destroyed by coastal development and reclamation (Yoo, 2003b). Yeongil Bay is being reclaimed and breakwaters are being built as a part of Pohang New Port development. Accordingly, investigating the characteristics of benthic algal community before development is to secure basic materials necessary in restoring destroyed habitat and understand changes of algal species diversity according to coastal development.

Studies on benthic algal flora in the Korean East Coast started off with Okamura's (1915) "On the marine algae of the east coast of Chosen". Then it was followed by Kang (1966) and Kim et al. (1996), and Kim and Lee (1980, 1981), Chung et al. (1991), Lee (1991) and Nam et al. (1996) conducted ecological studies on benthic algal community. As for ecological studies in Yeongil Bay, there have only been Lee and Lee's (1988) and Lee et al.'s (1997) studies in intertidal zone and Yoo's (2003c) report on subtidal zone.

In this study, the characteristics of species diversity and community structure of benthic marine algae living in Yeongil Bay were analyzed to grasp the characteristics of marine algal distribution and provide important basic resource in artificial restoration plan for coastal habitats destroyed by Pohang New Port development.

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Table 1 The number of benthic marine algal species observed at Phohang New Port in Yeoungil Bay

Season \ Division	Chlorophyta	Phaeophyta	Rhodophyta	Total
Winter	5	10	31	46
Spring	5	17	36	58
Summer	2	6	18	26
Autumn	5	10	15	30
Cum*	8	23	48	79

*Cum : Cumulative number of species.

2. Materials and Methods

This research was conducted on February, May, August and November of 2004 in the site Pohang New Port is being built. Benthic marine algae were collected from the intertidal zone and within the depth skin scuba diving was allowed.

Benthic marine algae were collected for a floral study. Samples were fixated with 10% formalin-seawater, then transported to the laboratory. The transported samples were washed with fresh water, then isolated and identified with the aid of a microscope. Algal biomass was measured based on the following method. 50x50cm quadrat was placed randomly and all benthic marine algae in the quadrat were collected and transported to the laboratory in cold storage. The collected algae were sorted by algal species, then packed in aluminum foil and dried for 48 hours in 105℃ dry oven. Then, the dry weight was measured up to 0.01g (U.S. E.P.A., 1973). Species were classified as dominant subdominant species based on the algal biomass ratio in the area, if the ratio was higher than 30%, it was termed as dominant species; the subdominant species referred to that the ratio varied from 10% to 30% in each area.

In addition, as for algal species diversity, Shannon's diversity index (H') was calculated using the computer program, SPDIVERS.BAS (Ludwig and Reynolds, 1988), based on the data on number of species and algal biomass average.

3. Results and Discussion

There were a total of 79 species of benthic marine algae found in Pohang New Port area - 8 Chlorophyta, 23 Phaeophyta and 48 Rhodophyta. As for the number of species that were found in each season, there were many species in winter and spring, and few species in summer and autumn. There were 58 and 46 species, respectively in spring and winter, and 26 and 30 species, respectively in summer and autumn Table 1. The number of species by algal division was in the order of Rhodophyta (60.8%), Phaeophyta (29.1%) and Chlorophyta (10.1%). The change in the distribution ratio of Chlorophyta according to season was in the order of 16.7% in the autumn, 8.6% in the spring and 7.7% in the summer. As for Phaeophyta, its distribution ratio was high in autumn and spring at 33.3% and 29.1%, respectively, and low in the summer and winter at 23.1% and 21.7%, respectively. The distribution ratio of Rhodophyta was low in the autumn at 50.0%, when it was 62.1 - 69.2% during other seasons.

There were 9 species that were collected all the time during the study. They are *Ulva pertusa, Sargassum horneri, Sargassum thunbergii, Gelidium amansii,* Melobesioidean algae, *Corallina pilulifera, Prionitis crispata, Acrosorium polyneurim* and *Chondria crassicaulis*. By algal division, there its constitution was as follows: 1 Chlorophyta, 2 Phaeophyta and 6 Rhodophyta.

The algal biomass per unit area of the benthic algal community in Pohang New Port area was 145.06 - 398.93 g dry wt m^{-2}, which means it is 273.45 g dry wt m^{-2} annually in average. The seasonal change in algal biomass showed highs in winter and spring, and lows in summer and autumn Table 2. The algal biomass distribution ratio of red algae was the highest at 69.4 - 82.9%, and then followed by brown algae at 3.8 - 29.2% and by green algae at 1.4 -13.3%. As for the seasonal change in the biomass, green and red algae were the highest in summer and lowest in winter, but it was the opposite for brown algae. It was the highest in winter and lowest in summer Fig. 1.

The dominant species based on algal biomass was *Corallina pilulifera* with 20 - 63% of total biomass according to season. This species was a dominant species in Pohang New Port all year round. *Sargassum horneri*, a

green alga, was a dominant species in winter. The subdominant species were *Lomentaria hakodatensis* in winter, *Lomentaria catenata*, *Grateloupia lanceorata* and *Sargassum thunbergii* in spring and *Chondria crassicaulis*, *Ulva pertusa* and *Hypnea charoides* in winter Table 3. The algal species diversity (H′) based on biomass was 2.07

Table 2 Biomass value of marine algal species collected at Phohang New Port area

(unit: g-dry wt/m^2)

Species \ Season	Winter	Spring	Summer	Autumn	Aver.
Corallina pilulifera	56.32	96.92	64.31	131.43	87.25
Sargassum thunbergii	26.14	40.93	0.35	12.64	20.02
Sargassum horneri	59.78	7.06	0.02	11.94	19.70
Lomentaria catenata	26.75	48.7		0.84	19.07
Grateloupia lanceolata	23.12	42.48	8.72		18.58
Lomentaria hakodatensis	53.09	2.14		0.04	13.82
Myagropsis myagroides	13.72	15.04		20.4	12.29
Chondria crassicaulis	21.32	4.14	20.7	0.05	11.55
Ulva pertusa	4.9	7.95	18.42	4.68	8.99
Sargassum fulvellum		22.76		4.66	6.86
Chondracanthus tenellus	21.23	0.78	0.14		5.54
Laurencia intermedia		20.81	0.77		5.40
Chondrus ocellatus	2.58	12.66	4.79		5.01
Hydroclathrus clathratus	0.33	18.88			4.80
Hypnea charoides			17.28	0.51	4.45
Grateloupia elliptica	17.18		0.51		4.42
Symphyocladia latiuscula	1.56	15.76			4.33
Gelidium amansii	1.88	9.64	0.86	3.69	4.02
Colpomenia sinuosa	0.33	0.93		8.92	2.55
Amphiroa zonata		0.73		7.88	2.15
Prionitis cornea	5.18	1.58	0.09		1.71
Mastocarpus pacificus	1.09	3.68			1.19
Sargassum nigrifolium			4.24		1.06
Laurencia undulata		3.71		0.36	1.02
Chondracanthus intermedius		3.66			0.92
Polysiphonia morrowii	2.22	0.85			0.77
Ahnfeltiopsis flabelliformis	0.03	2.92			0.74
Acrosorium polyneurum	1.66	0.79	0.39	0.03	0.72
Dictyopteris prolifera		2.62			0.66
Undaria pinnatifida		2.58			0.65
Codium adhaerens		2.01			0.50
Mean	341.16	398.93	145.06	208.63	273.45

Species which had a negligible biomass(average<0.5g) were removed from the list.

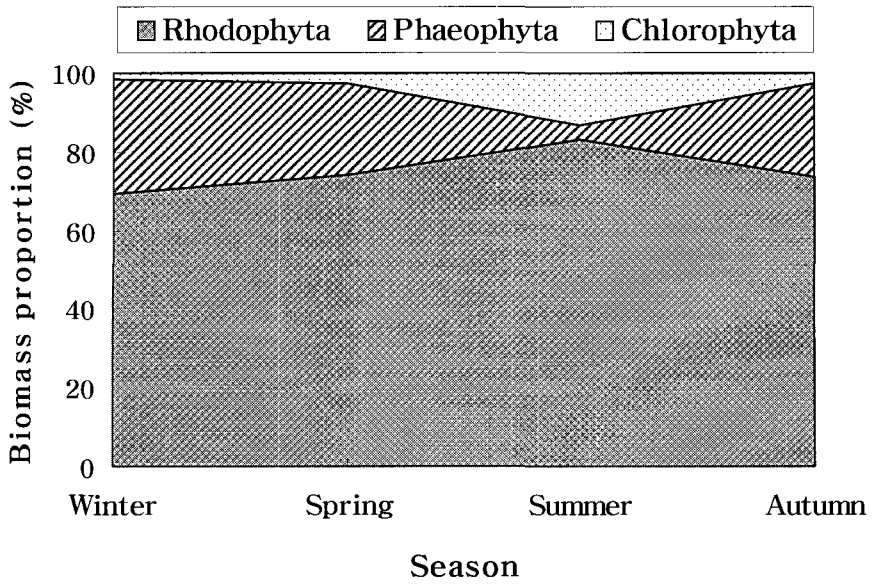

Fig. 1 Seasonal variation of composition of benthic marine algae by biomass proportion in Phohang New Port area.

Table 3 The dominant species of benthic marine algae according to season, based on biomass at Phohang New Port area

Unit: biomass ratio (%)

Seasons	Winter	Spring	Summer	Autumn
Dominant species	Sarg hor (21) Cora pil (20) Lome hak (18)	Cora pil (24) Lome cat (12) Grat lan (11) Sarg thu (10)	Cora pil (44) Chon cra (14) Ulva pera (13) Hypn cha (12)	Cora pil (63)

Abbreviations for speices: Chon cra: *Chondria crassicaulis*, Cora pil: *Corallina pilulifera*, Grat lan: *Grateloupia lanceolata*, *Hypn cha: Hypnea charoides*, Lome cat: *Lomentaria catenata*, Lome hak: *Lomentaria hakodatensis*, *Sarg hor: Sargassum horneri*, *Sarg thu: Sargassum thunbergii*, *Ulva per: Ulva pertusa*.

annually in average, being 2.42 in winter, 2.65 in spring, 1.79 in summer and 1.43 in autumn. It was high in winter and spring seasons and low in summer and autumn seasons. It is caused by that spring and winter are the profitable growth time for algae and species components in this study were dominated by the annual or seasonal rather than perennial plants.

The number of species of marine algae in Yeongil Bay coast studied in the intertidal zone was reported as 134 species in the inner bay area and 144 species in the outer bay area by Lee and Kim (1988), 144 species in the outer bay area by Nam et al. (1996) and 83 species in the inner bay area and 103 species in the outer bay area by Lee et al. (1997). Yoo (2003c) reported 52 species in Gangsa, an outer bay area, and 66 species in Masan, an inner bay area, as a result of studying subtidal zone.

The average annual biomass in the study area was 273.45 g dry wt m^{-2}, which was higher than Garorim Bay (Lee and Lee, 1982) of 185.8 g dry wt m^{-2}, Muchangpo (Yoo and Kim, 1990) of 90.43g dry wt m^{-2}, Woldo (Song, 1984) of 148.0-194.5 g dry wt m^{-2}, Gwangyang Bay of South Coast (Lee et al., 1975) of 19.6-356.0 g dry wt m^{-2}, 164.9-206.9 g dry wt m^{-2} in Galnam of East Coast (Chung et al., 1991) and Guman-ri, Daebo-myeong, Yeongil-gun (Nam et al., 1996) of 93.7-267.3 g dry wt m^{-2}. The biomass of benthic marine algae in Pohang New Port under construction was higher than that of other districts. This result could mean that there are abundant marine algae in the district, but it was because *Corallina pilulifera*, a calcareous alga took up 31.9% of the algal biomass. Calcareous alga, such as *Corallina pilulifera* is a causative species of Gaesnokeum (=Whitening), therefore the domination of this species in the study area is not preferable in the environmental ecological standpoint.

In former studies, the dominant species of benthic marine algae in Yeongil Bay were reported to be *Ulva pertusa, Gelidium amansii* and *Symphyocladia latiuscula* in intertidal zone by Nam et al. (1996), and *Sargassum horneri, Undaria pinnatifida* and *Sargassum thunbergii* in subtidal zone by Yoo (2003c). However, there was marked difference in this study, *Corallina pilulifera* being found to be the dominant species.

The comparison of algal species diversity could be different according to difference in research method. The quantitative data in Korea until today have been obtained in the name of frequency, coverage, biomass and importance value, and there have been many difficulties in comparison with studies, because the standards were used different. Yoo (2003a) reported that the algal species diversity was high when the sum of frequency and coverage and frequency were made to be the standard. Kim (1983) reported annual average algal species diversity of 1.34 in Kampo, 1.28 in Muchangpo, 1.34 in Samcheonpo and 1.59 in Jeju Island based on coverage, Yoo (2003b) reported 1.67 in Gwangyang Bay, Yoo (2003a) reported 1.81 in Seoam, Busan, whereas Yoo and Kim (2003) reported 0.51- 1.39 algal biomass in Hakampo, around Taean Thermal Power Plant. The algal species diversity in this study was relatively high (2.07) based on biomass. As for the algal species diversity by season, it was high in winter and spring at 2.42 - 2.65, and low in summer and autumn at 1.79 - 1.43. This shows that benthic marine algae can be easily destroyed by external stress as their stability in high water temperature is low.

Yeongil Bay coast is an area of optimal habitat for benthic algal community. However, coastal development such as the construction of Pohang New Port not only takes away the living space of other organisms that live with the benthic algae as a habitat, but also removes the marine ecosystem of the important primary producer. Accordingly, this study will provide basic material to restore the rocky shore ecosystem by monitoring the changes in benthic algal community before and after the coastal development.

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