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# Marine Benthic Algal Community at Intertidal Zone in Jinhae Bay

Seok Nam Kwak*
* Marine Eco-Technology Institute Co., Ltd. 485-1 Yongdangdong, Namgu, Busan, 608-830, Korea

# 진해만 해역의 조간대에 서식하는 해조류의 군집 구조

곽 석 남*
* 해양생태기술연구소

**Abstract** : *The species composition and seasonal patterns in marine benthic algal community at intertidal zone in Jinhae Bay were investigated seasonally throughout 2007. A total of 45 species, 6 Chlorophyta, 10 Phaeophyta, and 29 Rhodophyta, were recorded, and dominant species were Ulva pertusa, U. conglobata, Sargassum horneri, Gelidium divaricatum, Gracilaria textorii, and Polysiphonia morrowii during study periods. The number of species were differed with seasons and stations; Higher number of algal species was 42 species in winter, whereas 33 species was lower in summer. The number of algal species were higher at station 1,7,8, while the lower value was at station 2, 3 than other stations. The differences of marine benthic algal composition at each station in MDS ordination due to the physical characteristics and local topography.*

**Key Words** : Marine benthic algal community, Intertidal zone, Jinhae Bay, *Ulva pertusa, U. conglobata, Sargassum horneri, Gelidium divaricatum, Gracilaria textorii, Polysiphonia morrowii*

**요 약** : 진해만 조간대에서 서식하는 해조류 군집 구조를 파악하기 위하여 2007년에 8개 정점을 대상으로 계절별로 조사하였다. 조사기간 동안 총 45종의 해조류가 서식하였으며, 이 중 녹조류 4종, 갈조류 10종, 그리고 홍조류가 29종으로 나타났다. 우점종은 *Ulva pertusa, U. conglobata, Sargassum horneri, Gelidium divaricatum, Gracilaria textorii, Polysiphonia morrowii* 으로 나타났다. 출현종수는 계절 및 정점에 따라 변하였다. 겨울에 가장 많은 42종이 출현하였으며, 여름에는 33종으로 가장 적었다. 정점별로는 정점 1,7,8에서 가장 많았으며, 정점 2와 3에서 가장 낮게 나타났다. 해조류 군집의 공간적 분포를 파악하기 위한 MDS 분석 결과에서는 해조류의 종조성 및 현존량이 각 정점의 물리해양학적인 특징 및 지형적인 차이에 의한 것으로 나타났다.

**핵심용어** : 해조류 군집, 조간대, 진해만, *Ulva pertusa, U. conglobata, Sargassum horneri, Gelidium divaricatum, Gracilaria textorii, Polysiphonia morrowii*

## 1. Introduction

The marine benthic algal community was among the most productive of marine photoautotrophic communities(Wells et al., 2007). The ecological importance of marine benthic algae as high production, food source, and nursery habitats in estuaries and coastal areas throughout the world was well established (Terawaki et al., 2001; Zhuang and Zhang, 2001). Intertidal marine benthic algal community were mainly influenced by physical factors such as temperature, salinity, and light intensity(Duxburg and Duxburg, 1991).

Jinhae Bay have been known one of polluted area where environmental disturbances have occurred every year due to industrial complex around coastal areas. The pollution and disturbance of macroalgal habitats by human impacts reduce species diversity and simplify its community structure(Diez et al., 1999). Thus benthic macroalgal flora and community structures are good indicators for evaluating environmental conditions and monitoring coastal marine ecosystems(Vadas and Steneck, 1988; Wells et al., 2007). Although some ecological studies have been conducted in Jinhae Bay, their interest is confined to plankton, benthic macrofauna, and environmental characteristics(Lim and Shin, 2005; Hong et al., 2007; Oh et al., 2008; Lee et al., 2008), and then few was reported fundamental studies about marine benthic algal community. On the other hand, several studies of marine benthic algal community were described in the southern area, Korea. For example, floristic composition and seasonal variation of marine benthic algae in Odongdo, Dolsando, and Kwangyang Bay(Song, 1986; Choi, 1992; Kim et al., 1996; Choi and Huh, 2008).

The aims of present study was to examine the composition and seasonal variation in marine benthic algal community at

* Corresponding author : seoknam@hotmail.com, 051-611-6200

intertidal zone in Jinhae Bay and to compare results between this study and other areas in the southern sea, Korea.

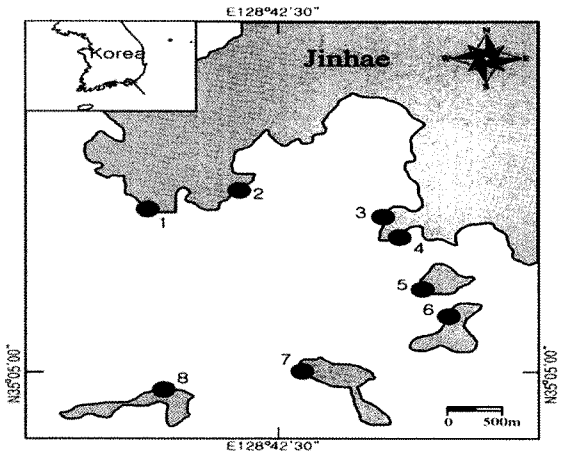


Fig. 1. Map showing the sampling sites.

## 2. Materials and Methods

The sampling sites was exposed to open sea with a little steep slope in upper part but gentle in mid to lower part at intertidal zone in Jinhae Bay(Fig. 1). Water temperature was from 7.4℃ in February to 26.8℃ in August 2007, whereas mean salinity was 33.8 psu throughout 2007. The difference of mean sea level between ebb and flow tides was 0.2 m to 0.6 m.

The marine benthic algae was investigated seasonally throughout 2007 with a quadrat method along a vertical transect line set across the intertidal zone perpendicularly to the coastal line. Additional collections for flora were carried out on each sampling occasions. The specimens collected except for crustose coralline algae were fixed in 5~10% formaline-seawater solution and carried to the laboratory. These samples were cleaned and then were identified according to Lee and Kang(1986, 2001). The marine benthic algae data was analysed to obtain the following community variables for local characteristics of algal community; R/P(Feldmann, 1937), C/P(Segawa, 1956), (R+C)/P(Cheney, 1977). Especially these index were used to determine between algal community and temperature. Non-metric multi-dimensional scaling ordination (MDS) plotted each sample as a point on an ordination plot. The extent to which the composition of the different stations were either similar or different was examined visually. This was applied by PRIMER computer package.

## 3. Results and Discussions

A total of 45 species, 6 Chlorophyta, 10 Phaeophyta, and 29 Rhodophyta, were recorded at intertidal zone in Jinhae Bay(Table 1). These species occurred 42 species in winter, 38 spring, 34 summer, and 33 fall, respectively. Especially number of species was higher in winter with 6 Chorolphyta, 8 Phaeophyta, and 28 Rhodophyta(Fig. 2). Higher percentage of Chlorophyta was in summer, whereas Rhodophyta was higher in winter. Round (1981)

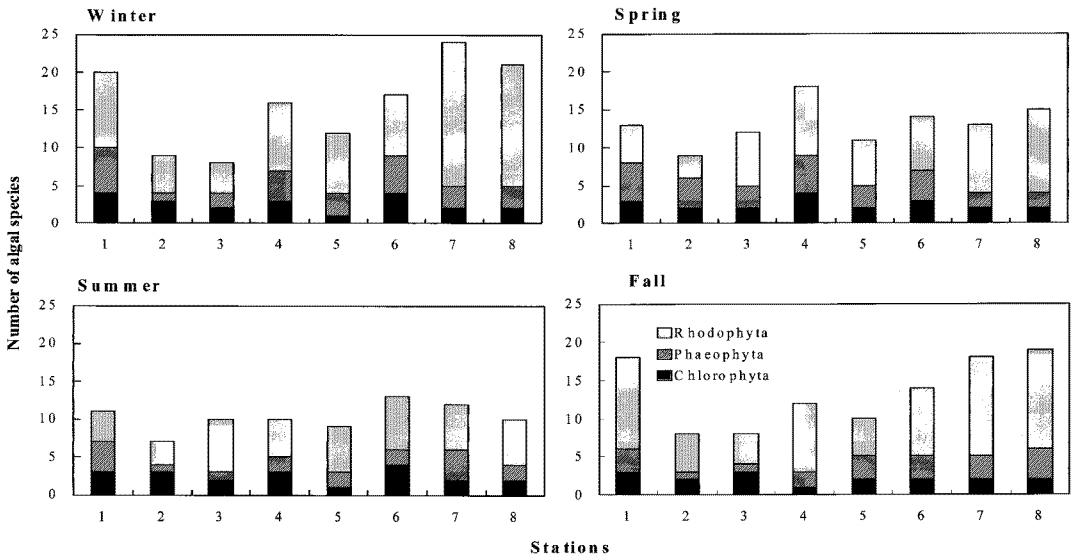


Fig. 2. Seasonal variation in number of algal species and floristic composition at intertidal zone in Jinhae Bay.

Table 1. Total list of marine benthic algal species observed at intertidal zone in Jinhae Bay throughout 2007

| Species | Winter | Spring | Summer | Fall |
|---|---|---|---|---|
| Chlorophyta | | | | |
| *Enteromorpha intestinalis* | + | + | + | + |
| *Enteromorpha linza* | + | + | + | + |
| *Ulva conglobata* | + | + | + | + |
| *Ulva lactuca* | + | + | | + |
| *Ulva pertusa* | + | + | + | + |
| *Codium fragile* | + | + | + | |
| Phaeophyta | | | | |
| *Ishige okamurae* | | | | + |
| *Colpomenia sinuosa* | + | + | + | + |
| *Undaria pinnatifida* | + | + | + | |
| *Hizikia fusiformis* | + | + | + | |
| *Sargassum horneri* | + | + | + | + |
| *Sargassum miyabei* | + | + | + | |
| *Sargassum nigrifolium* | | + | + | + |
| *Sargassum piluliferum* | + | + | + | |
| *Sargassum thunbergii* | + | + | + | + |
| *Sargassum* sp. | + | + | + | + |
| Rhodophyta | | | | |
| *Helminthocladia ustralis* | + | | | + |
| *Gelidium amansii* | + | + | + | + |
| *Gelidium divaricatum* | + | + | + | + |
| *Dumontia simplex* | + | + | + | |
| *Amphiroa beauvoisii* | + | | | + |
| *Corallina pilulifera* | + | + | + | + |
| *Carpopeltis affinis* | + | + | + | + |
| *Carpopeltis cornea* | + | | + | + |
| *Carpopeltis prolifera* | + | + | + | + |
| *Carpopeltis okamurae* | + | + | + | + |
| *Grateloupia filicina* | + | + | + | + |
| *Grateloupia sparsa* | + | | | |
| *Grateloupia turuturu* | + | + | + | + |
| *Pachymeniopsis elliptica* | + | + | + | + |
| *Pachymeniopsis lanceolata* | | + | + | + |
| *Hypnea saidana* | + | | | |
| *Plocamium telfairiae* | + | + | + | |
| *Gracilaria textorii* | + | + | + | + |
| *Gymnogongrus flabelliformis* | + | | + | |
| *Chondrus crispus* | + | + | | + |
| *Chondrusocellatus* | + | + | + | + |
| *Gigartina tenella* | + | + | + | + |
| *Gigartina intermedia* | + | + | | + |
| *Gigartina teedii* | + | + | | + |
| *Champia parvula* | + | + | | + |
| *Acrosorium polyneurum* | + | + | + | |
| *Chondria crassicaulis* | + | + | + | + |
| *Laurencia undulata* | + | + | | |
| *Polysiphonia morrowii* | + | + | + | + |
| Total number of species | 42 | 38 | 34 | 33 |

Table 2. The comparisons between R/P, C/P, (R+C)/P value in this study and those of other studies in southern area, Korea

| value /study area | Jinhae Bay (This study) | Gwangyang Bay (Song, 1986) | West-southern coast (Choi, 1992) | Daedo in Gwangyang Bay (Kim et al., 1996) | Gwangyang Bay (Choi and Huh, 2008) |
|---|---|---|---|---|---|
| R/P | 2.90 | 3.48 | 4.10 | 2.68 | 2.82 |
| C/P | 0.60 | 0.77 | 0.90 | 0.53 | 0.76 |
| (R+C)/P | 3.50 | 4.26 | 5.00 | 3.21 | 3.59 |

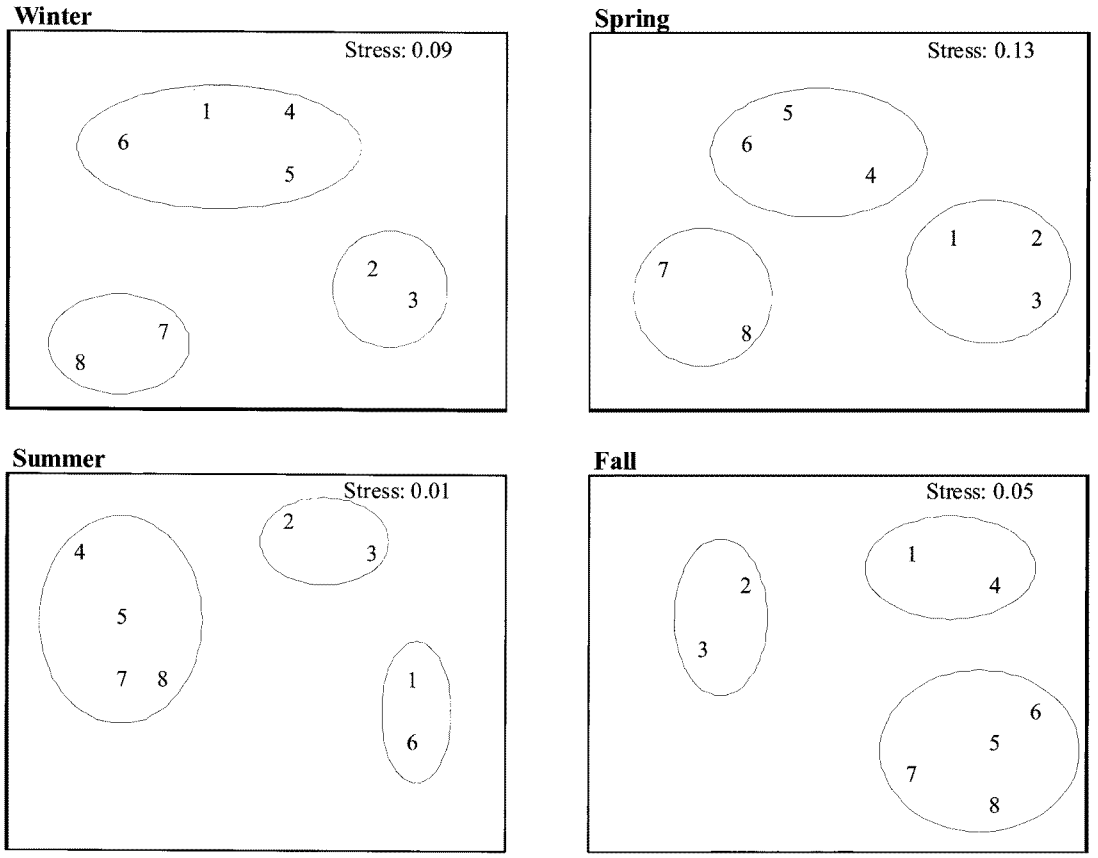


Fig. 3. The spatial MDS ordination in composition and occurrence of marine benthic algal species among stations at intertidal zone in Jinhae Bay.

demonstrated that number of algal species were higher in winter and spring in temperate areas worldwide. The number of algal species were also differed with stations. Overall higher number of species were station 1, 7, 8 except station 4 in summer, while station 2, 3 was the lower than other stations. The total number of species was the lower in the study area than those of in other areas. For example, 93 and 78 species at intertidal zone, and 171 species at subtidal zone in Gwangyang Bay(Lee and Kim, 1977; Song, 1986; Choi and Huh, 2008). These results might it be explained to different topography of intertidal zone, physical factors, and human impacts. Choi and Huh(2008) have demonstrated that the lower of number of algal species was due to change environmental characteristics with increasing industrial complex around Gwangyang Bay.

The dominant algal species were *Ulva pertusa, U. conglobata, Sargassum horneri, Gelidium divaricatum, Gracilaria textorii,* and *Polysiphonia morrowii* during study periods. These species were occurred at intertidal zone in Jinhae Bay regardless of seasons. Broad-scale surveys of marine benthic algal communities from other regions in southern area, Korea suggest a similar community structure. *Ulva pertusa, Sargassum horneri, Gelidium divaricatum, Gracilaria textorii,* and *Polysiphonia*

*morrowii* dominated the algal community in Gwangyang Bay (Kim et al., 1996; Choi and Huh, 2008), genus *Sargassum, Gracilaria, Gelidium* and *Polysiphonia* at Myodo in Gwangyang Bay and west-southern coast, Korea(Lee et al., 1975; Choi, 1992). The R/P and C/P value was 2.90, 0.60, and (R+C)/P was 3.50 in the study area, and then this value indicated typical temperate marine benthic algal composition(Table 2). Compared with other areas, higher R/P was than those of in Daedo and Gwangyang Bay, while C/P and (R+C)/P was lower except Daedo in Gwangyang Bay. Several studies have described that the variation of R/P value was correlated with water temperature(Choi, 1992; Choi and Huh, 2008). For example, higher R/P value was especially influenced by higher water temperature in the southern sea, while the R/P ranged from 0.5 to 2.0 always occurred in the eastern sea, Korea.

The difference between the species composition of each stations was enhanced by the spatial MDS ordination(Fig. 3). The eight stations appear separated from each other, and stress was deviation of each station. The distance between the stations reflect the extent of differences in marine benthic algal composition; three groups occurred regardless of seasons. Group 1 was consisted of station 2 and 3 where were in coastal waters, whereas group 2 was composed of station 7 and 8 where were at intertidal zone of islands with strong current in the open sea.

On the other hand, group 3 was other stations with moderate current. In the case of algal composition, *Ulva* in Chlorophyta, and *Gracilaria, Polysiphonia* in Rhodophyta mainly occurred at station 7 and 8, while *Sargassum, Undaria* in Phaeophyta at station 2 and 3. Such conclusion was in agreements with other studies(Shepherd and Womersley, 1981; Choi and Huh, 2008). Hence the patterns of species composition in marine benthic algal community were due to physical characteristics and local topography.

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