The Korean Journal of Phycology
Volume 9(2): 193-203, 1994

Qualitative and Quantitative Analyses of Intertidal Benthic Algal Community in Cheju Island
1. Species Composition and Distributional Patterns

Seon Hong Park[1], Yong Pil Lee, Young Hwan Kim* and In Kyu Lee**

Department of Biology, Cheju National University, Cheju 690-756,
**Department of Biology, Chungbuk National University, Chongju 360-763 and*
***Department of Biology, Seoul National University, Seoul 151-742, Korea*

濟州島 潮間帶 海藻群集의 定性·定量的 分析
1. 種組成과 分布樣式

朴善弘[1]·李龍弼·金英煥*·李仁圭**

(濟州大學校 生物學科·忠北大學校 生物學科*·서울大學校 生物學科**)

Species composition and distributional patterns of intertidal benthic algae in Cheju Island were studied. We examined all species found at four sites monthly over a year (March 1987-February 1988). Of 110 taxa identified, 13 were Chlorophyta, 32 were Phaeophyta and 65 were Rhodophyta. The largest number of algal species (78) was found at Aewol, the northwestern part of the island, whereas the smallest number of species (54) was found from Sagye, the southwestern site. Numbers of species, on the whole, showed highest during the spring and to a lesser extent in late summer; minima were recorded in winter. 33 species were found at all four sites: Chlorophyta, 4; Phaeophyta, 13; Rhodophyta, 16. Of these, two brown algal species appeared throughout the study period: *Hizikia fusiformis* and *Sargassum thunbergii*. A total of 28 taxa occurred at only one site, including 4 Chlorophyta, 5 Phaeophyta and 19 Rhodophyta. The sites in the eastern part of the island were most similar to each other among pairs of sites based on floristic compositions. Differences in the proportions of algal division were generally apparent between the eastern and western coasts. These two coasts show differences in seawater temperatures and salinities, and it therefore seems likely that they can be separated from one another on hydrographic as well as biological grounds.

Key Words: algal community, intertidal zone, Cheju Island, species composition, distributional pattern

INTRODUCTION

Cheju Island (33°35′-33°10′ N and 126°10′-127°00′ E) is located at the southern region of Korea. The island is roughly elliptical, ca. 80 km from east to west, ca. 40 km south to north. There are significant water mass movements in the adja-

[1] Present address: Namnyong High School, Cheju 690-170, Korea

cent seas of the island, such as Tsushima Warm Water and Yellow Sea Warm Water. Under their influence, the benthic marine algae show greater diversity than other parts of Korea.

The knowledge of marine algal distribution of the island was firstly introduced by Kang (1960). He listed 153 species (19 green, 45 brown and 89 red algae) as summer algal flora. Kang (1966), in his study on geographic distribution of marine algae in Korea, divided the Korean coasts into five sections based on water temperature and other hydrological conditions. In this milestone work on Korean marine algae, he separated the area of Cheju Island as an independent section, i.e. Cheju Island Section, and noted that the section was characterized by the influence of warm current which flows throughout the year, while the cold current does not appear. According to him, the floristic composition of Cheju Island Section is as follows: 2% boreal, 74% temperate, 10% subtropical, and 15% cosmopolitan and subcosmopolitan species.

Since the 1970s, the island has received much attention by phycologists in floristic, ecological and taxonomic respects. For instance, there have been several reports on the occurrence of species added newly to the list of marine algae in Korea (Lee, 1977, 1984, 1989; Song and Kang, 1985; Kim and Lee, 1987; Choi, 1993). The ecological studies were carried out mainly by transect method (Lee, 1974; Lee and Lee, 1976, 1982; Kim, 1983). Most work on the taxonomy of marine algae in Cheju Island has been done as part of monographic studies (Lee *et al.*, 1986; Lee, 1987, 1988; Lee and Lee, 1987, 1988, 1989; Oh *et al.*, 1987, 1990). Especially, *Dasysiphonia chejuensis* is the first new genus found from Cheju Island (Lee and West, 1979), and both *Acrochaetium inkyui* (Lee, 1987) and *Leathesia verruculiformis* (Lee and Lee, 1988) are the new species reported from the island. In this respect, Cheju Island is often called a treasure island of marine algal resources (Kim, 1991).

The purpose of the present study is to further explore the floristic and ecological aspects of benthic marine algae of Cheju Island. This involved a qualitative and quantitative assessment of algal distribution, especially with regard to hydrographic conditions around the island, and the results are presented in a series of papers. This paper

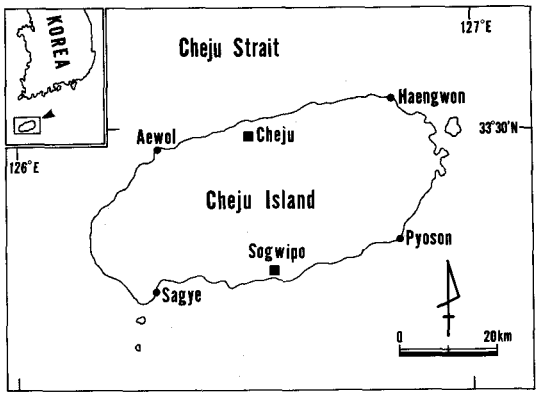

Fig. 1. Map of Cheju Island showing the four investigated localities (●) and two weather stations (■); inset shows location of Cheju Island in relation to the rest of Korea.

describes the temporal and spatial variations of species composition of intertidal benthic marine algae on rocky shores around the island. Multivariate analyses of the data were undertaken to elucidate the general pattern of algal community as related to physico-chemical parameters. These will be presented in a second paper.

STUDY AREA

Cheju Island is roughly elliptical island situated on the South Sea off the Korean Peninsula (Fig. 1). The coastline is rather monotonous and mostly consisted of rocks derived from the lava flow of basalt.

Annual climatic pattern at two weather stations, i.e. Cheju at the northern part of the island and Sogwipo at the southern part (Fig. 1), during March 1987-February 1988 is shown in Fig. 2.

The mean air temperature at Cheju was 15°C, ranging from a high of 27°C during August to a low of 5°C in February. At Sogwipo, the mean air temperature was 16°C, ranging from 26°C during August to 7°C in February. Monthly precipitation showed maximum in summer season (July and August). Monthly total hours of sunshine ranged from 86 hrs in July at Sogwipo to 221 hrs in September at the same weather station (Korea Meteorological Service, 1987-1988).

In the adjacent seas of Cheju Island warm and saline waters are extended northwestward to the

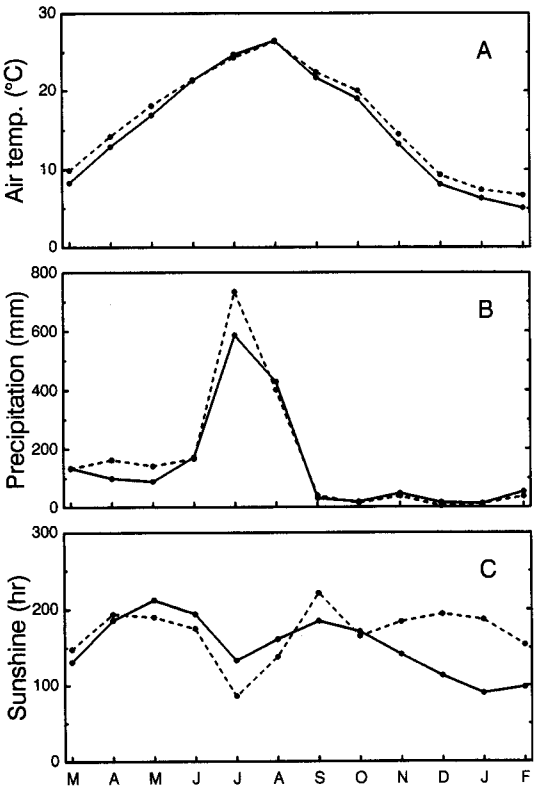

Fig. 2. Annual climatic pattern at Cheju (solid lines) and Sogwipo (broken lines) of Cheju Island, March 1987-February 1988. Location of weather stations shown in Fig. 1. A: mean monthly air temperature (°C), B: monthly precipitation (mm), C: monthly total hours of sunshine (hr). Data from annual climatological reports (Korea Meteorological Service, 1987-1988).

Yellow Sea in winter and retreated back southeastward in summer. Thus the island is under the influence of Tsushima Warm Water throughout the winter and spring. However, Yellow Sea Warm Water extends to the western part of the island in summer and reaches the northern coast in autumn (Pang *et al.*, 1992).

Seawater temperatures around coast line of Cheju Island varied from 11°C in February to 26°C in August, with higher values (2-4°C) at the southern coast of the island than at the north. The annual salinity range around the island was 30-34‰; lowest during summer and highest during winter (Choi *et al.*, 1989).

MATERIALS AND METHODS

The study was carried out monthly during the period from March 1987 to February 1988. Four sites around Cheju Island were selected for the study; Aewol, Haengwon, Sagye and Pyoson. The location of the study site is shown in Fig. 1.

Each site was visited monthly over periods of spring tides during the study period. Samples of algae were taken back to the laboratory for identification. This study is restricted to the benthic Chlorophyta, Phaeophyta and Rhodophyta. Voucher specimens were deposited at the herbarium of Cheju National University.

To assess the floristic resemblance between the investigated localities, percentage similarities between pairs of sites based on pooled data matrix by sites were calculated using the Dice Index (Ludwig and Reynolds, 1988); DI = 2a / (2a + b + c), where a = the number of species common to both sites, b = the number of species occurred only at one site, and c = the number of species observed only at the other site. This similarity coefficient has been used very widely for expressing resemblance when the data consists of species presence-absence data (e.g. Goodall, 1973; Ludwig and Reynolds, 1988).

RESULTS

Spatio-temporal Variations of Species Richness

A total of 110 taxa was recorded from four sites, including 13 Chlorophyta, 32 Phaeophyta and 65 Rhodophyta (Table 1). The largest number of marine algal species (78) was found at Aewol, the northwestern part of the island, followed closely by Pyoson (75) and Haengwon (74). The smallest number of species (54) was found from Sagye, the southwestern site (Table 2).

The seasonal patterns of total numbers of species found at each site are shown in Fig. 3. Numbers of macroalgal species in the intertidal zone, on the whole, showed highest during the spring and to a lesser extent in late summer; minima were recorded in winter. Sagye where the lowest number of species was identified, however, was an exception, for here minimal species richness was noted during autumn.

Table 1. Summary of benthic marine algal taxa observed at four investigated sites in Cheju Island during 1987-1988

Taxa	Aewol												Haengwon											
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
Chlorophyta																								
Enteromorpha clathrata																								
Enteromorpha compressa				+	+																			
Enteromorpha linza							+	+										+			+	+	+	
Ulva conglobata	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ulva pertusa	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cladophora albida	+	+																						
Cladophora sakaii	+	+	+													+		+						
Cladophoropsis zollingeri																	+							
Bryopsis hypnoides						+																		
Bryopsis plumosa	+														+									
Codium adhaerens	+	+	+	+	+	+	+						+								+	+	+	
Codium coactum	+	+	+		+									+	+		+	+						
Codium fragile		+	+	+		+	+							+			+	+						
Phaeophyta																								
Acinetospora crinita														+										
Ectocarpus arctus																								
Hincksia mitchelliae																								
Ishige okamurae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+			
Ishige sinicola	+	+	+	+	+	+				+	+		+	+	+									
Leathesia difformis						+											+							
Petrospongium rugosum		+	+	+	+	+	+	+	+	+	+	+					+	+	+	+				
Colpomenia bullosa	+	+	+																					
Colpomenia sinuosa	+	+	+	+	+	+	+		+				+	+	+	+	+	+						
Endarachne binghamiae	+	+	+								+													
Petalonia fascia	+	+	+													+								
Hydroclathrus clathratus				+	+	+																		
Scytosiphon lomentaria	+	+	+																					
Myelophycus simplex	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+						
Undaria pinnatifida	+	+	+	+	+								+	+	+		+							
Ecklonia cava																								

Taxa	Sagye												Pyoson											
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
Chlorophyta																								
Enteromorpha clathrata						+																		
Enteromorpha compressa																								
Enteromorpha linza		+			+	+	+	+	+	+	+	+												
Ulva conglobata	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+						+	+
Ulva pertusa	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cladophora albida						+																		
Cladophora sakaii						+										+								
Cladophoropsis zollingeri																								
Bryopsis hypnoides																								
Bryopsis plumosa																+								
Codium adhaerens		+											+	+	+	+								
Codium coactum															+		+							
Codium fragile															+		+							
Phaeophyta																								
Acinetospora crinita	+	+	+								+											+	+	+
Ectocarpus arctus																						+	+	+
Hincksia mitchelliae																						+	+	
Ishige okamurae	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ishige sinicola	+	+	+	+	+								+	+	+	+	+	+	+					+
Leathesia difformis		+	+	+	+								+	+	+		+		+	+	+			
Petrospongium rugosum						+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Colpomenia bullosa	+											+	+	+								+	+	
Colpomenia sinuosa		+	+	+	+	+		+	+	+	+	+	+	+	+	+	+		+			+	+	+
Endarachne binghamiae													+	+		+						+	+	+
Petalonia fascia													+											
Hydroclathrus clathratus													+	+		+								
Scytosiphon lomentaria													+	+	+									+
Myelophycus simplex													+	+	+	+	+	+						
Undaria pinnatifida													+		+	+	+							+
Ecklonia cava														+	+		+	+	+					

Table 1. (Continued)

Taxa	Aewol												Haengwon												Sagye												Pyoson											
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
Dictyota dichotoma	+	+	+					+	+	+	+	+															+	+		+	+						+				+	+		+	+	+	+			
Pachydictyon coriaceum																																					+													
Padina arborescens																	+	+	+								+	+	+			+	+	+																
Padina japonica																														+																			
Hizikia fusiformis	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sargassum confusum	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sargassum fulvellum	+	+	+			+																															+	+											
Sargassum hemiphyllum	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+															+											+
Sargassum horneri	+	+	+																						+	+	+										+	+	+										
Sargassum miyabei													+																								+	+	+										
Sargassum micracanthum																			+																				+											
Sargassum patens			+	+	+	+		+	+	+	+	+																																					
Sargassum ringgoldianum						+																									+																	
Sargassum sagamianum						+		+					+		+											+	+										+	+											
Sargassum siliquastrum								+					+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+								
Sargassum thunbergii	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Rhodophyta																																																	
Porphyra ishigecola		+	+			+							+	+	+	+	+		+	+	+	+	+	+		+	+	+												+	+									
Dermonema pulvinatum						+	+	+	+	+	+	+																		+	+	+	+	+	+													
Galaxaura falcata														+			+		+																														
Galaxaura oblongata															+																																	
Scinaia japonica																																						+											
Acanthopeltis japonica		+	+										+			+	+																																
Gelidium amansii		+	+	+	+	+			+				+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+		+	+		
Gelidium divaricatum		+				+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+		+	+		+	+	+	+	+	+	+	+
Gelidium pusillum																	+												+																			
Gelidium vagum														+	+	+			+	+	+	+	+																+											
Hildenbrandtia rubra						+		+																																								
Fosliella zostericola								+																																								
Heteroderma sargassi						+	+		+																																						
Lithophyllum okamurae						+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+						+	+	+	+	+	+	+		+	+	+		+	+	+	+	+	+	+

Table 1. (Continued)

Taxa	Aewol												Haengwon												Sagye												Pyoson											
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
Alatocladia modesta	+	+	+																																													
Amphiroa beauvoisii						+	+	+	+	+	+	+	+			+			+						+		+		+	+	+	+	+	+	+	+		+		+				+					
Amphiroa dilatata	+	+																+		+	+	+							+	+	+		+			+	+	+										
Amphiroa ephedraea	+	+	+				+					+	+	+		+		+		+						+	+					+		+			+	+	+		+			+	+	+	+	
Amphiroa pusilla																										+											+	+	+		+	+	+	+	+			
Corallina pilulifera	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+
Jania adhaerens							+						+																																			
Jania ungulata						+																																										
Marginisporum aberrans																														+							+											
Yamadaea melobesioides						+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+						+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Carpopeltis affinis						+							+	+	+	+	+	+	+	+	+	+	+	+														+		+	+								
Carpopeltis cornea																	+	+	+																		+												
Carpopeltis crispata		+				+		+			+	+	+	+			+	+	+																					+									
Grateloupia filicina			+										+	+	+										+	+									+		+	+										
Grateloupia turuturu		+	+	+									+	+							+	+	+	+													+	+	+	+	+							
Pachymeniopsis elliptica	+		+			+							+	+	+						+	+																+	+	+	+								
Gloiopeltis complanata																+									+	+																						
Gloiopeltis furcata	+	+	+	+	+									+	+	+	+								+												+	+	+	+		+							
Gloiopeltis tenax		+	+	+	+																																											
Callophyllis japonica														+	+		+		+	+																													
Schizymenia dubyi	+	+	+	+	+									+																										+	+	+							+
Sebdenia agardhii	+												+																																			
Caulacanthus okamurae							+												+	+																			+	+	+	+	+					
Plocamium telfairiae																		+																														
Hypnea charoides																	+																								+						
Hypnea saidana													+	+		+		+	+	+	+																					+	+	+	+				
Gracilaria textorii													+	+	+	+	+					+	+			+	+												+	+	+	+	+					+
Gracilaria verrucosa				+	+																																										+
Gymnogongrus flabelliformis	+	+	+			+	+					+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+			+	+	+			+	+	+	+		+		+		+
Chondrus ocellatus		+	+	+	+								+	+	+	+	+	+	+	+	+	+	+			+												+	+	+	+						
Chondrus pinnulatus														+		+																															
Gigartina intermedia	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Table 1. (Continued)

Taxa	Aewol												Haengwon												Sagye												Pyoson											
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
Gigartina tenella		+	+	+	+								+	+	+	+	+	+	+	+	+	+	+	+													+											+
Chrysymenia wrightii																	+	+																														
Lomentaria catenata			+										+	+		+																																
Lomentaria hakodatensis	+	+	+																																		+											
Champia parvula	+	+				+							+	+	+								+														+	+	+	+	+	+	+	+				
Centroceras clavulatum							+										+	+	+	+	+																											
Ceramiopsis japonica		+	+																																												
Ceramium tenerrimum			+	+															+	+																		+	+			+			+			
Acrosorium yendoi																																						+										
Martensia denticulata																			+	+	+																											
Chondria crassicaulis		+	+	+	+	+									+	+																							+	+	+	+	+				+		
Chondria expansa		+				+																																									
Herposiphonia parca													+						+	+																						+		+				
Herposiphonia subdisticha						+		+																																							
Laurencia intermedia	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+																				+	+	+	+	+	+			+		
Laurencia okamurae	+	+	+	+	+	+	+						+	+	+	+	+	+	+	+	+	+	+	+																+	+	+	+	+	+	+	+			
Laurencia pinnata														+	+																										+	+	+	+	+	+	+	+	+	
Laurencia undulata															+		+	+	+	+	+																											
Laurencia venusta	+	+					+	+		+	+	+																												+	+	+		+	+				

Table 2. Total number of taxa observed at four investigated sites in Cheju Island

Division	Sites				Total
	Aewol	Haengwon	Sagye	Pyoson	
Chlorophyta	11	9	7	6	13
Phaeophyta	23	18	24	29	32
Rhodophyta	44	47	23	40	65
Total	78	74	54	75	110

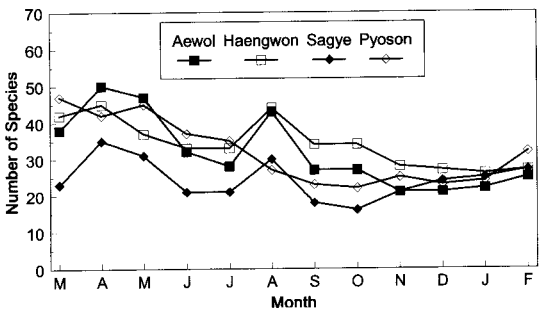

Fig. 3. Monthly occurrence of benthic marine algal taxa observed at four investigated localities in Cheju Island during 1987-1988.

The numbers of species found at all four sites were: Chlorophyta, 4; Phaeophyta, 13; Rhodophyta, 16 (Table 1). Of these commonly distributed species, two brown algal species appeared throughout the study period: *Hizikia fusiformis* and *Sargassum thunbergii*.

On the contrary, a total of 28 taxa occurred at only one site, including 4 Chlorophyta, 5 Phaeophyta and 19 Rhodophyta. Highest numbers of species found at only one site were noted at Aewol (11) where the largest number of species richness was found; whereas only two species were recorded only from Sagye.

Comparison of Sites by Algal Division

Percentage occurrence of algal species by division varied from site to site (Fig. 4).

We found the largest proportion of Chlorophyta at Aewol (13% in average) and the least at Pyoson (7% in average). Highest proportion of Phaeophyta were noted at Sagye (49% in average) where the lowest number of species was identified; minimum proportion was observed at Haengwon (27% in

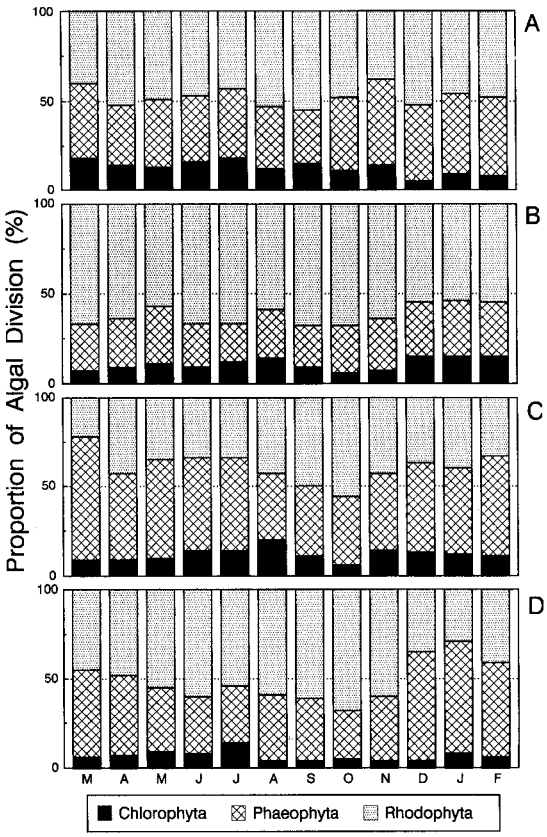

Fig. 4. Changes in percent occurrence of algal species in each division. A: Aewol, B: Haengwon, C: Sagye, D: Pyoson.

average). In contrast, at Haengwon where brown algal proportion was the lowest of any site, that of red algae was higher (62% in average) than any other sites.

The results show rather obvious relationship between the investigated sites. In general, green algal proportions are higher in the western part of

Table 3. *Matrix of percentage similarity between pairs of investigated sites based on species composition*

	Aewol	Haengwon	Sagye	Pyoson
Aewol	100			
Haengwon	68	100		
Sagye	67	61	100	
Pyoson	73	76	71	100

the island (Aewol and Sagye) than in the eastern part (Haengwon and Pyoson). Conversely, larger proportions of red algae are found in the eastern part than in the west of island. Especially, Haengwon which located in the northeastern part of Cheju Island displayed the largest proportion of Rhodophyta and the least of Phaeophyta among the investigated sites.

Similarity between Sites

Percentage similarities between pairs of sites based on species richness are shown in Table 3.

Based on these comparisons, Haengwon and Pyoson located both in the eastern part of the island were most similar (76%). Pyoson was also similar to Aewol (71%) and Sagye (71%). The least similar sites based on species composition were Haengwon and Sagye (61%).

Thus, based on species composition, sites in the eastern part of the island were more similar to each other than any other pairs of sites.

DISCUSSION

Since Kang (1960) firstly introduced the marine algal distribution of Cheju Island, several reports dealing with floristic studies have been made. Of the 425 macroalgal species earlier enumerated from the island (Boo, 1988), we found about a quarter in our collections. Almost all the taxa of marine algae collected were those reported previously to occur in Cheju Island by other workers. However, two species (brown alga *Padina japonica* Yamada and red alga *Chondrus pinnulatus* (Harvey) Okamura) were collected for the first time in the island. These two species have been known to occur only in the southern coast of Korean Peninsula (Kang, 1966).

At all sites the number of macroalgal species in the intertidal zone was higher during the spring than in other seasons. Our observation coincides well with the result reported by Lee and Lee (1982). Nevertheless, it is worthwhile to note that relatively high species richness is also found in August with the exception of Pyoson (Fig. 3). Several opportunistic ephemerals, such as *Enteromorpha clathrata* and *Cladophora albida*, were found to occur in August (Table 1). This high species richness in the late summer could have been a consequence of high water temperature.

Large numbers of marine algal species identified from the present study displayed little or no seasonality. In several cases, however, seasonal differences were striking. For example, *Petalonia fascia* and *Alatocladia modesta* appeared only in spring; *Enteromorpha clathrata, E. compressa, Padina japonica, Gelidium pusillum* and *Chrysymenia wrightii* were found merely in summer; whereas, *Ectocarpus arctus* and *Hincksia mitchelliae* occurred only in winter. Two brown algae, *Scytosiphon lomentaria* and *Colpomenia bullosa*, were found from winter through spring. The phenology of marine algae revealed from the present study was very similar to that described earlier by Lee and Lee (1982).

Floras have been classified by comparing the number of species in one division with those in another (Cheney, 1977; Villalard-Bohnsack and Harlin, 1992). Differences in the proportions of algal division on the eastern and western coasts can probably be related to local environmental factors. It should also be noted that the sites in the eastern part of the island were most similar to each other among pairs of sites based on species richness. Choi *et al.* (1989) have described differences in seawater temperatures and salinities between these two coasts, and it therefore seems likely that they can be separated from one another on hydrographic as well as biological grounds. This explanation will be further discussed in a second paper using the results of multivariate analyses of the algal cover

data.

The most important contribution of the present study have been to understand the biogeographic characteristics and phenology of intertidal benthic marine algae.

ACKNOWLEDGEMENTS

We are grateful to Dr. Ki Wan Lee and Dr. Won Taek Kim of Cheju National University for their helpful discussions and comments on an earlier draff this paper. We also thank Dr. Joon Baek Lee of Cheju National University and Dr. Hosung Chung of Korea Ocean Research & Development Institute for providing the oceanographic data.

REFERENCES

Boo, S.M. 1988. Distribution of marine algae from shore area of Chejudo. *J. Cheju Studies* **5:** 97-114.

Cheney, D.P. 1977. R&C/P-a new and improved ratio for comparing seaweed floras. *J. Phycol.* **13(Suppl.):** 12.

Choi, D.S. 1993. Taxonomic accounts of *Jania* (Rhodophyta, Corallinaceae) in Korea. *Korean J. Bot.* **36:** 151-157.

Choi, Y.C., Y.B. Go and J.B. Lee. 1989. Sea water characteristics around coast line of Cheju Island from June 1987 to April 1988. *Jour. Korean Earth Science Society* **10:** 54-61.

Goodall, D.W. 1973. Sample similarity and species correlation. pp. 105-156. *In*, R.H. Whittaker (ed.). Handbook of Vegetation Science. Part V. Ordination and Classification of Communities. Dr. W. Junk bv Publ., The Hague. 737 pp.

Kang, J.W. 1960. The summer algal flora of Cheju Island (Quelpart Island). *Bull. Pusan Fish. Coll.* **3:** 17-23.

Kang, J.W. 1966. On the geographical distribution of marine algae in Korea. *Bull. Pusan Fish. Coll.* **7:** 1-125.

Kim, H.S. and I.K. Lee. 1987. Morphology and reproduction of *Griffithsia venusta* Yamada (Ceramiaceae, Rhodophyta). *Korean J. Phycol.* **2:** 51-60.

Kim, Y.H. 1983. An ecological study of algal communities in intertidal zone of Korea. Ph.D. thesis. Seoul National Univ., Seoul. 175 pp.

Kim, Y.H. 1991. Marine algal resources in Cheju Island. *J. Cheju Studies* **8:** 137-156.

Korea Meteorological Service. 1987-1988. Annual Climatological Report. Seoul.

Lee, I.K. and J.A. West. 1979. *Dasysiphonia chejuensis* gen. et sp. nov. (Rhodophyta, Dasyaceae) from Korea. *Syst. Bot.* **4:** 115-129.

Lee, I.K., Y.P. Lee and Y.S. Ahn. 1986. Flora of marine algae in Cheju Island 1. Ulvaceae. *Korean J. Phycol.* **1:** 157-167.

Lee, K.W. 1974. Survey of marine algal distribution and vegetation at marine laboratory of Cheju University near Seogwipo. *Cheju Univ. J.* **6:** 269-284.

Lee, K.W. 1977. Unrecorded marine algae from Korea. *Bull. Korean Fish. Soc.* **10:** 171-172.

Lee, K.W. 1984. Unrecorded marine algae from Korea III. *Bull. Mar. Resour. Res. Inst., Cheju Nat. Univ.* **8:** 65-67.

Lee, K.W. 1989. Unrecorded marine algae from Korea IV. *Bull. Korean Fish. Soc.* **22:** 9-18.

Lee, Y.P. 1987. Taxonomy of the Rhodochortonaceae (Rhodophyta) in Korea. *Korean J. Phycol.* **2:** 1-50.

Lee, Y.P. 1988. Taxonomic studies on the Gelidiaceae (Rhodophyta) in Cheju Island I. Some members of *Gelidium. Kor. J. Plant Tax.* **18:** 95-113.

Lee, Y.P. and I.K. Lee. 1976. On the algal community in the intertidal belt of Jeju Island 1. Algal community of spring season. *Korean J. Bot.* **19:** 111-118.

Lee, Y.P. and I.K. Lee. 1982. Vegetation analysis of marine algae in Jeju Island. *Proc. Coll. Natur. Sci., SNU* **7:** 73-91.

Lee, Y.P. and I.K. Lee. 1987. Notes on *Sphacelaria* (Phaeophyta) from Cheju Island. *Korean J. Bot.* **30:** 311-321.

Lee, Y.P. and I.K. Lee. 1988. Marine algae of Cheju Island : The Leathesiaceae. *Korean J. Bot.* **31:** 317-332.

Lee, Y.P. and I.K. Lee. 1989. Notes on *Galaxaura* (Rhodophyta) from Cheju Island. *Korean J. Phycol.* **4:** 1-9.

Ludwig, J.A. and J.F. Reynolds. 1988. Statistical Ecology : A Primer on Methods and Computing. John Wiley & Sons, N.Y. 337 pp.

Oh, Y.S., Y.P. Lee and I.K. Lee. 1987. A taxonomic study on the genus *Codium*, Chlorophyta, in Cheju Island. *Korean J. Phycol.* **2:** 61-72.

Oh, Y.S., I.K. Lee and Y.P. Lee. 1990. Taxonomic remarks on three marine species of *Cladophora* (Cladophoraceae, Chlorophyta) from Cheju Island. *Korean J. Bot.* **33:** 127-134.

Pang, I.C., H.K. Rho and T.H. Kim. 1992. Seasonal variations of water mass distributions and their causes in the Yellow Sea, the East China Sea and the adjacent seas of Cheju Island. *Bull. Korean Fish. Soc.* **25:** 151-163.

Song, C.B. and J.W. Kang. 1985. Notes on some unrecorded marine algae in Korea. *Ocean Res.* **7:** 1-

13.
Villalard-Bohnsack, M. and M.M. Harlin. 1992. Seasonal distribution and reproductive status of macroalgae in Narragansett Bay and associated waters, Rhode Island, U.S.A. *Bot. Mar.* **35:** 205-214.

(Accepted September 7, 1994)