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Seasonal Variations in Abundance and Species Composition of Fishes in an Eelgrass Bed in Myoungjuri of Jindong Bay

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A total of 33 fish species were collected by a small beam trawl from an eelgrass bed in Myoungjuri of Jindong Bay, Korea. The dominant fish species were *Hexagrammos otakii, Pholis fangi, Repomucenus valenciennei, Pseudoblennus cottoides, Pholis nebulosa, Rudarius ercodes, Syngnathus schlegeli,* and *Sebastes schlegeli.* These 8 fish species accounted for 79.5% of the total number of individuals collected. The fishes collected in the study area were primarily small fish species or juveniles of large fish species. Seasonal variations in both species composition and abundance were large; higher numbers of fish occurred from April to June 2002, while biomass was the highest in September 2001 and 2002. Seasonal changes in fish abundance corresponded with eelgrass biomass and abundance of food organisms.

Key words : Fish, seasonal variation, species composition, eelgrass bed, eelgrass biomass

Introduction

Zostera marina (eelgrass) is the most common seagrass species in temperate coastal areas and increases habitat complexity and provides living space and shelter for marine animals (Klumpp *et al*., 1989; Rozas and Minello, 1998). Many fish species including many economically important fishes use eelgrass meadows as feeding and nursery grounds (Edgar and Shaw, 1995; Huh and Kwak, 1997; Guidetti and Bussotti, 2000). Recent studies on eelgrass beds in Korea have reported seasonal variations in species compostition and abundance of fishes in Kwangyang Bay, Hamduck around Cheju Island and Angol Bay (Huh and Kwak 1997; Go and Cho 1997; Lee *et al*., 2000) and feeding habits of some fish species (*Acanthogobius flavimanus, Platycephalus indicus, Liparis tanakai and Limanda yokohamae*) in the southern sea, Korea (Huh and Kwak, 1999; Kwak and Huh, 2002, 2003a,b)

In Myoungjuri of Jindong Bay, eelgrass meadows provide a habitat for a variety of invertebrates and small fish, which in turn are the potential food of large fishes. However, environmental disturbances such as red tide and jellyfish blooms have occurred in these eelgrass beds every year due to industrial complex around coastal areas since 1980's (Kang *et al*., 1996; Kim *et al*., 2001). To date the study on the eelgrass bed in Jindong Bay has been confined to the fish community itself (Im, 2004) and feeding habits of common fish species (*Stephanolepis cirrhifer, Rudarius ercodes* and *Sillago japonicus*) (Kwak *et al*., 2003; Kwak and Huh, 2004; Kwak *et al*., 2004) in Daguri close to Myoungjuri of Jindong Bay, but the fish community of these eelgrass beds has not been studied relating to the environmental variations.

The objective of this study was to examine the seasonal variation in species composition and abundance of fishes inhabiting in an eelgrass bed

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in Myoungjuri of Jindong Bay and to determine the relationships between environmental factors and fish abundance.

Materials and Methods

The study area was located in Myoungjuri of Jindong Bay (Fig. 1). The area supports a luxuriant eelgrass, *Zostera marina*, bed which is forming subtidal bands (500～700 m wide) in the shallow waters (< 3 m). The eelgrass bed extended in patches for about 4 km along the shore.

Fish samples were collected monthly by a 5-m beam trawl (1.9-cm mesh wing and body, 0.6-cm mesh liner). Four 6-minute tows in each sampling time were carried out during the day in the eelgrass bed from August 2001 to July 2003. Specimens were preserved immediately in 10% formalin after capture and later transferred to 70% isopropanol. These samples were identified according to Masuda *et al.* (1984) and Yoon (2002), and weighed to the nearest gram in wet weight and their standard length measured to the nearest millimeter in the laboratory.

Water temperature and salinity were measured at each sampling location. Eelgrass biomass was estimated by removal of all plant matter in a $0.01\ m^2$ within each station. The plants were separated into the above-and below-ground parts, dried at 80°C for 24h then weighed to the nearest gram.

The fish data were analysed to obtain the following community variables. Diversity H′ (Shannon and Weaver 1949) was calculated as:

$$H' = -\sum(ni/N)\log(ni/N),$$

where n is the number of individuals of each i species in a sample and N is the total number of individuals. Similarity between fish species, Pianka's index, Aij (Pianka, 1973) was calculated as:

$$A_{ij} = [\sum p_{ih} p_{jh}] / [\sum p^2_{ih} \sum p^2_{jh}]$$

where A_{ij} is the similarity of species *j* on species *i*; p_{ih} is the proportion of individuals of a fish species *i* in a particular month *h*; p_{jh} is the proportion of individuals of a fish species *j* in a particular month *h*. Values for the similarity index may vary between 0, if no similarity occurs, and 1 for complete similarity. The Pianka's index was subjected to an average linkage cluster analysis.

A one-way ANOVA with orthogonal design was used to analyse variations in fish abundance and environmental factors with season and year. Log transformed data were used to satisfy the equal variance assumption of the model. The

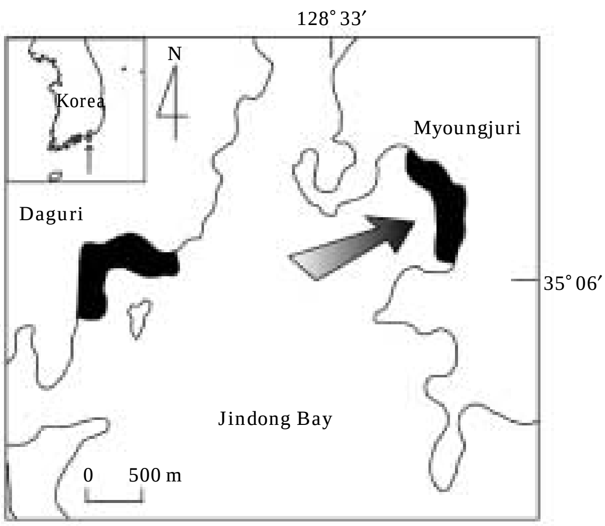

Fig. 1. Location of the study area (The black area is an eelgrass bed).

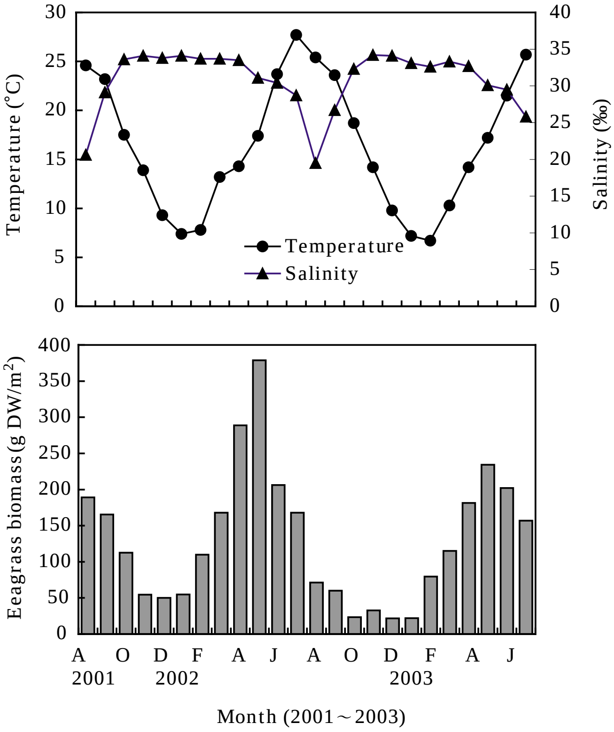

Fig. 2. Monthly variations of temperature, salinity and eelgrass biomass in an eelgrass bed in Myoungjuri of Jindong Bay.

relationships between fish abundance and eelgrass biomass were analysed using Pearson's correlation coefficient.

Results

Temperature, salinity, eelgrass biomass

Temperature at the study site ranged from 6.7 °C to 27.7°C and varied significantly with season (ANOVA, $p<0.05$), but no marked annual variation was observed. The peak of temperature occurred around July 2002, a decline to minimum in February 2003 (Fig. 2). Salinity ranged from 19.5‰ to 34.2‰ and did not vary significantly between years (ANOVA, $p>0.05$) with display a similar pattern except in July, August and September when it dropped markedly (about 20‰) (Fig. 2). This decline occurred soon after heavy rain, which affected the region during summer. The average eelgrass biomass ranged from 21.8 g DW/m^2 to 378.7 g DW/m^2 and varied significantly with season and year (ANOVA, $p<0.05$). The peak of eelgrass occurred around May 2002, and a sharp decline from June 2002 to January 2003, and then increased to May 2003 gradually (Fig. 2).

Species Composition

A total of 3,570 fish belonging to 33 species

Table 1. Total number of individuals and biomass of fishes collected in an eelgrass bed in Myoungjuri of Jindong Bay

Scientific name	Total				Standard length range (cm)
	N	%	W	%	
Hexagrammos otakii	632	17.7	12,518.3	61.3	4.5～16.3
Pholis fangi	543	15.2	1,694.8	8.3	3.7～15.8
Repomucenus valenciennei	496	13.9	855.6	4.2	2.6～9.8
Pseudoblennius cottoides	406	11.4	489.8	2.4	2.3～7.2
Pholis nebulosa	295	8.3	1,948.6	9.5	4.1～18.6
Rudaris ercodes	168	4.7	246.6	1.2	2.2～5.3
Syngnathus schlegeli	164	4.6	214.1	1.0	9.5～21.3
Sebastes schlegeli	134	3.8	72.9	0.4	1.5～5.6
Hippocampus japonica	118	3.3	61.0	0.3	1.2～7.6
Pseudoblennius percoides	112	3.1	194.6	1.0	3.6～7.1
Sebastes longispinis	99	2.8	245.5	1.2	1.5～4.5
Acanthogobius flavimanus	91	2.5	350.2	1.7	4.2～13.1
Leiognathus nuchalis	66	1.8	315.1	1.5	2.5～6.9
Acentrogobius pflaumi	59	1.7	105.0	0.5	2.2～5.9
Sebastes inermis	43	1.2	201.0	1.0	1.6～4.9
Takifugu niphobles	28	0.8	141.1	0.7	6.2～10.3
Hypodytes rubrippinis	24	0.7	41.5	0.2	2.3～4.2
Acanthopagrus schlegeli	23	0.6	127.7	0.6	2.9～10.2
Upeneus japonicus	11	0.3	40.0	0.2	4.6～7.2
Lateolabrax japonicus	9	0.3	147.4	0.7	2.1～11.1
Chaenogobius heptacanthus	9	0.3	20.7	0.1	3.1～5.7
Sillago japonicus	9	0.3	58.9	0.3	3.7～10.6
Pholis crassispina	7	0.2	31.9	0.2	6.9～13.5
Trachurus japonicus	6	0.2	28.6	0.1	4.8～6.3
Limanda yokohamae	5	0.1	17.4	0.1	6.8～9.7
Conger myriaster	5	0.1	71.0	0.3	15.3～21.7
Siganus fuscescens	2	0.1	1.1	0.0	5.9～6.7
Muraenesox cienrerus	1	0.0	57.9	0.3	23.1
Tridentiger trigonocephalus	1	0.0	0.7	0.0	4.3
Ditrema temmincki	1	0.0	31.2	0.2	8.6
Ernogrammus hexagrammus	1	0.0	7.5	0.0	6.3
Mugil cephalus	1	0.0	77.5	0.4	21.3
Pterogobius elapoides	1	0.0	1.2	0.0	3.8
Total	3,570	100	20,416.4	100	

N: Number of individuals, W: Biomass (g).

were collected from the eelgrass bed in Myoungjuri of Jindong Bay (Table 1). Numerically dominant fish were *Hexagrammos otakii* (17.7%), *Pholis fangi* (15.2%), *Repomucenus valenciennei* (13.9%), *Pseudoblennius cottoides* (11.4%), *Pholis nebulosa* (8.3%), *Rudarius ercodes* (4.7%), *Synganthus schlegeli* (4.6%) and *Sebastes schlegeli* (3.8%). These 8 fish species accounted for 79.5% of total number of indivals individuals collected during the study period. The numerically dominant fish species made up 88.4% of biomass because of the presence of large *H. otakii* (61.3% of biomass) which were high in biomass. These were primarily small fish species or early juveniles of large fish species. Only about 10% exceeded 8 cm standard length.

Seasonal Variation in Fish Abundance

The number of fish species (7～17 species) varied with season (ANOVA, $p<0.05$), but there was no marked annual variation (Fig. 3-a). High number of fish species occurred in September 2001 and 2002. Number of individuals varied significantly with both season and year (ANOVA, $p<0.05$, Fig. 3-b). Higher number of fish individuals occurred from April to June 2002 which were dominated *P. fangi*, *Sebastes schlegeli*, *P. nebulosa*. *P. ercoides*, and *P. cottoides*, and lowest numbers occurred in January 2003 (Appendix). The fish biomass differed substantially between different seasons and years (ANOVA, $p<0.05$, Fig. 3-c). Highest biomass occurred September 2001 and 2002 when a few relatively large *H. otakii*, *P. cottoides*, *R. valenciennei*, *Lateolabrax japonicus* were present (Appendix). Significant seasonal difference was observed for the diversity index (ANOVA, $p<0.05$, Fig. 3-d), but annual difference was not significant. The range of index were 0.86～3.62, and higher value occurred in September 2001, and from May to July 2002. The similar values of diversity, in general, suggesting that the number and relative abundances of fishes were similar over the study period.

The dendrogram shows four clusters which identify the fish species groups regardless of year

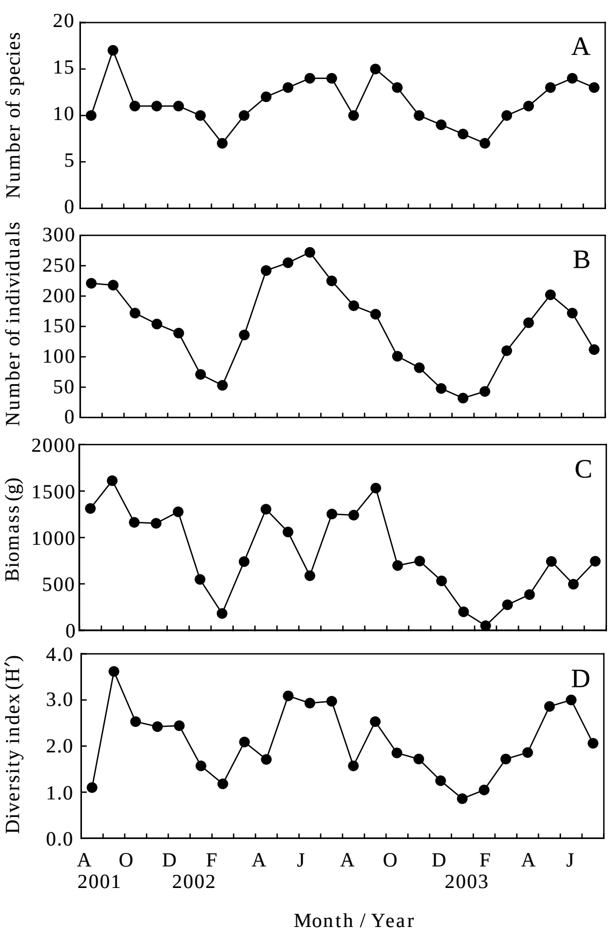

Fig. 3. Monthly variations in (A) number of species, (B) number of individuals, (C) biomass, and (D) diversity index of fish species in an eelgrass bed in Myoungjuri of Jindong Bay.

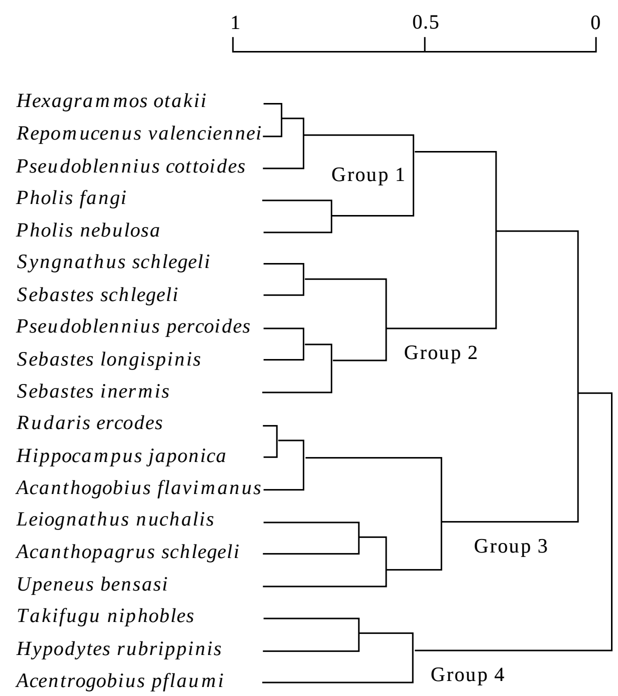

Fig. 4. Dendrogram illustrating the species associations of common fishes in an eelgrass bed in Myoungjuri of Jindong Bay.

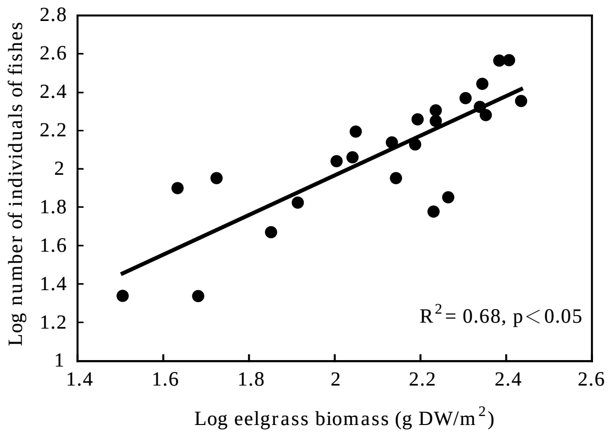

Fig. 5. Relationships between number of individuals of fishes and eelgrass biomass in an eelgrass bed in Myoungjuri of Jindong Bay.

(Fig. 4). The first group was composed of *H. otakii, P. fangi, R. valenciennei, P. cottoides,* and *P. nebulosa* with occurring predominantly over study periods. This group can be further divided into two sub-groups: subgroup A contains *P. fangi* and *P. nebulosa* with high occurrence from March to May when high eelgrass biomass was shown in the study area, while subgroup B was composed of *H. otakii, R. valenciennei,* and *P. cottoides* with peak numbers from June to August. The second group was composed of *S. schlegeli, Sebastes schlegeli, P. percodes, S. longispinis,* and *S. inermis*. This group showed high numbers from May to July, however, few individuals in other periods. The third group was composed of *R. ercode, H. japonicus, A. flavimanus, L. nuchalis, A. schlegeli,* and *U. bensasi* which showed peak numbers from September to November. This periods coincide with low eelgrass biomass. The fourth group was consisted of *T. niphobles, H. rubripinnis,* and *A. pflaumi* with high numbers from December to February.

Eelgrass biomass variation corresponded closely with seasonal variation of the abundance of fishes over the study period (Fig. 5). Numbers of individuals of fish species ($r^2 = 0.68$, $p < 0.05$) were strongly correlated with eelgrass biomass.

Discussion

A total of 33 fish species were collected from an eelgrass bed in Myoungjuri of Jindong Bay, and among these *H. otakii, P. fangi, R. valenciennei, P. cottoides, P. nebulosa, R. erodes, Syngnathus schlegeli* and *Sebastes schlegeli* were numerically dominant. *H. otakii, Pholis nebulosa* and *Sebastes schlegeli* were the commercially important fishes in Korean waters (Kim and Kang, 1993; Yoon, 2002). Broad scale surveys of fish communities in the eelgrass beds from other regions of Korea suggest a similar community structure. *H. otakii, P. fangi, P. cottoides, Syngnathus schlgeli* and *P. nebulosa* also dominated the fish community from Daguri of Jindong Bay (Im, 2004) and Kwangyang Bay (Huh and Kwak, 1997), *Syngnathus schlgeli, P. nebulosa* in Angol Bay (Lee *et al*., 2000), and *R. ercodes, Syngnathus schlegeli, P. nebulosa* in Hamduck around Cheju Island (Go and Cho, 1997). On the other hand, the genera *Pseudoblennius, Rudarius, Syngnathus* were important groups in the Japanese eelgrass beds (Kikuchi, 1966, 1974; Horinouchi *et al*., 1998).

Although species composition of fish species in the eelgrass bed in Myoungjuri of Jindong Bay did not varied with year, abundance of *L. nuchalis* increased with year was remarkable characteristics. Recent studies have demonstrated that the number of individuals of small sized *L. nuchalis* has been increased in southern coastal areas such as Kwangyang, Namhae Island and Nakdong River Estuary (Huh and Kwak, 1998; Huh and An, 2000; Kwak and Huh, 2003c) Lee *et al*. (1997) reported that the variation in abundance of *L. nuchalis* was due to occurrence of environmental disturbances in Chonsu Bay.

Fish collected from the eelgrass bed in the study area appeared to be dominated by small fish species and juveniles of most species. This indicated that the eelgrass bed in Myoungjuri of Jindong Bay functions as nursery areas. Such conclusions are in general agreement with other studies of eelgrass beds (Huh and Kwak, 1997; Rozas and Minello, 1998; Lee *et al*., 2000; Im, 2004; Kwak and Klumpp, 2004). A significantly greater abundance of fish juveniles than that of adults in this study site in Myoungjuri of Jindong Bay confirmed that these species were likely to be dependent on eelagrass beds for shelter and survival during the early life cycle stages (Brook, 1977; Bell *et al*., 1989; Edgar and Shaw, 1995).

Fish abundance in seagrass meadows are often correlated with eelgrass biomass (Klumpp *et al*., 1989). The temporal pattern of fish abundance in the eelgrass bed at Myoungjuri of Jindong Bay correlated with temporal variations in eelgrass biomass. From the data available it is not possible to determine whether variation in eelgrass biomass, directly or indirectly, determined these changes in fish abundance in the study area or whether faunal activities had an affect on the eelgrass biomass. However, there is evidence for both types of interaction occurring in the seagrass beds (Adams, 1976; Baelde, 1990; Blaber *et al*., 1992; Williams and Heck, 2001; Kwak and Klumpp, 2004).

Eelgrass biomass in Jindong Bay reached a peak in May 2002 when light and water temperature are increasing, and then decreased rapidly to a minimum in the period from November 2002 to January 2003. This decrease in eelgrass biomass was assumed by the complex functions such as annual variation, the occurrence of red tide and high jellyfish abundance due to environmental disturbance (Kwak, personal observation). The interactions between these factors and eelgrass biomass were no examined in this study and need further examination. Numbers of fishes, in particular small sized individuals, in Myoungjuri of Jindong Bay, were high during periods when eelgrass biomass was high. The high shoot density and length produced by *Zostera marina* in Myoungjuri of Jindong Bay would seem to provide fishes with an effective refuge from predators. Indeed, a positive correlation between fish richness and abundance and the aboveground biomass of seagrass beds has been suggested (Bell and Pollard, 1989; Connolly *et al*., 1999; Guidetti and Bussotti, 2000). Other studies have shown similar patterns of variable faunal abundance in fish communities of eelgrass beds, Korea. For example, the fish abundance increased with increasing eelgrass biomass and temperature in Angol Bay (Lee *et al*., 2000), and similarly in Hamduck off Jeju Island (Go and Cho, 1997). Huh (1986) have demonstrated that seasonal variation of fish abundance in Hansilpo, Chungmu was correlated positively with temperature.

While eelgrass biomass in Jindong Bay seems to be an important factor influencing abundance of the fish community, prey availability may also directly or indirectly control fish abundance. High eelgrass biomass provides good shelters and food resources for small organisms such as epiphytic fauna (amphipods, isopods, tanaids etc.). Small fishes such as dominant fish species in Jindong Bay fed mainly on small amphipods and isopods. The temporal abundance of epiphytic fauna coincided with these groups of dominant fishes during the study period. These common fish species changed diets from gammarid amphipods and copepods to decapods such as caridean shrimps and crabs as they increased in size (Kwak *et al*., 2003; Kwak and Huh, 2004; Kwak *et al*., 2004). Huh and Kwak (1997) demonstrated that the abundance of dominant fishes in an eelgrass bed of Kwangyang Bay was positively correlated with seagrass biomass and prey availability. Hence we suggest that the high abundance of epiphytic fauna were responsible for the maintenance of fish abundance through predator-prey interactions in these eelgrass bed.

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진동만 명주리 잘피밭에 서식하는 어류의 종조성 및 계절변동

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진동만 명주리 잘피밭에 서식하는 어류의 종조성 및 계절변동을 조사하기 위해서 2001년 8월부터 2003년 7월까지 소형 비임트롤을 이용하여 어류를 매월 채집하였다. 조사기간 동안 어류는 총 33종이 채집되었다. 쥐노래미, 흰베도라치, 실양태, 가시망둑, 베도라치, 그물코쥐치, 실고기, 그리고 조피볼락이 많이 채집되었는데, 이들은 채집된 총 개체수의 79.5%를 차지하였다. 본 조사해역에서 채집된 어류는 대부분이 평균 15 cm 이하의 소형 어종이거나 대형 어종의 유어들로 구성되어 있었다. 잘피밭 어류군집은 뚜렷한 계절변동을 보였는데, 채집 개체수는 2002년 4월에서 6월사이에 아주 높았으나, 생체량은 2001년과 2002년 9월에 각각 가장 높은 수치를 나타내었다. 대체적으로 겨울철에서는 채집 개체수 및 생체량이 모두 낮았다. 어류 군집의 계절변동은 잘피의 현존량 및 먹이생물의 양적변동과 관계가 있었다.

Appendix. Monthly variation in number of individuals and biomass of fishes collected in an eelgrass bed in Myoungjuri of Jindong Bay from August 2001 to July 2003

Species	Aug. (2001)		Sep.		Oct.		Nov.		Dec.		Jan. (2002)		Feb.		Mar.	
	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W
Hexagrammos otakii	37	906.5	39	1,072.5	31	883.5	26	741.1	35	997.5	28	434.1	5	22.5	15	112.5
Pholis fangi							6	7.9	25	21.5	12	13.9	24	41.1	56	391.4
Repomucenus valenciennei	136	267.9	15	113.4			8	19.6	24	53.5	4	0.7	4	0.6	9	22.7
Pseudoblennius cottoides	22	62.5	24	145.2	7	38.6	7	1.4	6	12.9			3	0.1	9	3.3
Pholis nebulosa							29	218.1	11	74.5	7	48.4	11	78.3	21	170.9
Rudaris ercodes	5	4.9	31	4.7	45	140.9	44	44.9	6	6.9	4	6.3				
Syngnathus schlegeli	3	3.2	11	12.2	26	15.1										
Sebastes schlegeli																
Hippocampus japonica			22	2.2	21	2.5									4	1.7
Pseudoblennius percoides																
Sebastes longispinis			1	1.0	21	11.9									8	21.1
Acanthogobius flavimanus	7	47.5	26	8.1			16	96.8	11	62.9	4	24.9				
Leiognathus nuchalis	2	8.2	5	12.8	5	0.6	7	5.8								
Acentrogobius pflaumi	6	6.9	2	14.9			9	4.8	5	2.6	3	0.7			9	5.1
Sebastes inermis			17	28.7												
Takifugu niphobles					9	50.4	1	10.8	12	40.1						
Hypodytes rubrippinis							1	1.4			7	11.6	4	7.1	4	5.7
Acanthopagrus schlegeli			8	39.8	1	8.9										
Upeneus japonicus			6	23.1	2	7.7										
Lateolabrax japonicus			4	89.6												
Chaenogobius heptacanthus									3	0.4	1	1.1			1	5.3
Sillago japonicus			2	0.9	4	1.7										
Pholis crassispina																
Trachurus japonicus																
Limanda yokohamae	1	3.1	2	2.9					1	2.5						
Conger myriaster			3	40.2									2	30.8		
Siganus fuscescens	2	1.1														
Muraenesox cienrerus																
Tridentiger trigonocephalus																
Ditrema temmincki																
Ernogrammus hexagrammus											1	7.5				
Mugil cephalus																
Pterogobius elapoides																
Total	221	1,311.8	218	1,612.2	172	1,161.8	154	1,152.6	139	1,275.3	71	549.2	53	180.5	136	739.7

N : number of individuals, B : biomass in grams

Appendix. Continued

Species	Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.	
	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W
Hexagrammos otakii	26	247.1	42	609.1	11	181.5	52	1,014.1	35	1,088.6	37	851.9	21	556.5	24	660.1
Pholis fangi	119	486.7	22	66.9	18	58.6							31	27.6	16	20.8
Repomucenus valenciennei	2	16.8	2	3.1	4	14.2	47	14.1	100	86.9	53	115.7	27	20.8	12	11.4
Pseudoblennius cottoides	22	6.8	49	31.9	71	32.1	28	7.1	22	4.4	16	69.3	3	16.5	2	1.1
Pholis nebulosa	46	434.7	32	220.2	28	161.6									8	14.2
Rudaris ercodes									6	4.8	9	14.8	2	7.1	12	2.2
Syngnathus schlegeli	9	14.5	32	37.7	7	74.0	22	23.3	3	4.6			5	5.8		
Sebastes schlegeli			11	4.5	71	32.1	11	11.6								
Hippocampus japonica	8	6.1	11	5.1	21	25.8	9	10.1			1	1.4	2	0.2		
Pseudoblennius percoides			42	67.2	15	25.1	22	38.1								
Sebastes longispinis	2	5.2	3	9.4	18	59.4	21	71.6					1	0.5		
Acanthogobius flavimanus									5	19.5	14	49.1	1	2.5	4	24.4
Leiognathus nuchalis							6	46.7	4	32.4	20	165.4	4	30.9	1	0.8
Acentrogobius pflaumi	2	0.4	1	0.4	2	0.9	2	0.9	3	1.3	2	58.8			2	1.6
Sebastes inermis	4	77.5	7	2.2	4	13.5	2	7.6								
Takifugu niphobles													2	11.6	1	8.8
Hypodytes rubrippinis	1	2.4			1	2.3	1	3.1								
Acanthopagrus schlegeli							1	1.1	3	4.3	9	72.5				
Upeneus japonicus											2	5.7	1	3.5		
Lateolabrax japonicus									3	33.7	2	24.1				
Chaenogobius heptacanthus	1	5.3			1	4.6	1	3.9								
Sillago japonicus											2	54.0	1	2.3		
Pholis crassispina																
Trachurus japonicus																
Limanda yokohamae											1	8.9				
Conger myriaster																
Siganus fuscescens																
Muraenesox cienrerus											1	57.9				
Tridentiger trigonocephalus																
Ditrema temmincki											1	31.2				
Ernogrammus hexagrammus																
Mugil cephalus																
Pterogobius elapoides			1	1.2												
Total	242	1,303.5	255	1,058.9	272	685.7	225	1,253.3	184	1,280.5	170	1,580.7	101	685.8	82	745.4

Appendix. Continued

Species	Dec.		Jan. (2003)		Feb.		Mar.		Apr.		May		Jun.		Jul.	
	N	W	N	W	N	W	N	W	N	W	N	W	N	W	N	W
Hexagrammos otakii	15	397.5	13	175.5	7	24.5	22	121.1	19	123.5	34	391.1	17	229.5	41	676.5
Pholis fangi	10	32.7	9	15.6	18	4.7	52	208.5	71	229.3	38	12.9	16	54.7		
Repomucenus valenciennei	8	50.7	5	0.9	3	0.5	6	12.7	3	18.4	2	4.2			22	6.8
Pseudoblennius cottoides	2	5.1			3	0.1	6	2.2	23	6.1	37	15.2	41	27.1	3	0.8
Pholis nebulosa	5	19.2	1	1.8	9	16.1	11	30.3	26	171.1	28	234.6	22	54.6		
Rudaris ercodes	3	7.6	1	1.5												
Syngnathus schlegeli									3	4.6	26	13.1	6	3.8	11	2.2
Sebastes schlegeli											9	10.1	25	13.1	7	1.5
Hippocampus japonica							2	1.6	2	1.1	8	1.4	4	0.9	3	0.9
Pseudoblennius percoides											12	18.1	12	30.7	9	15.4
Sebastes longispinis							4	10.1	1	2.4	1	2.7	9	26.6	9	23.6
Acanthogobius flavimanus	1	5.5	1	4.5									1	4.5		
Leiognathus nuchalis													9	8.1	3	3.4
Acentrogobius pflaumi	2	1.1	1	0.4			3	1.6	1	0.6	1	0.4	2	1.2	1	0.4
Sebastes inermis									3	29.3	3	23.3	2	13.6	1	5.3
Takifugu niphobles	2	13.6													1	5.8
Hypodytes rubrippinis					2	3.6	3	4.3								
Acanthopagrus schlegeli															1	1.1
Upeneus japonicus																
Lateolabrax japonicus																
Chaenogobius heptacanthus			1	0.1												
Sillago japonicus																
Pholis crassispina									4	16.5	3	15.4				
Trachurus japonicus													6	28.6		
Limanda yokohamae																
Conger myriaster																
Siganus fuscescens																
Muraenesox cienrerus																
Tridentiger trigonocephalus					1	0.7										
Ditrema temmincki																
Ernogrammus hexagrammus																
Mugil cephalus							1	77.5								
Pterogobius elapoides																
Total	48	533.0	32	200.3	43	50.2	110	469.9	156	602.9	202	742.5	172	497.0	112	743.7