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Seasonal Variation in Species Composition and Abundance of Fish Assemblage in the Coastal Water off Namhae Island

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ABSTRACT Seasonal variation in species composition and abundance of fishes was determined using monthly samples collected by a fyke net in coastal waters off Namhae Island in 2006. The sampling gear, both-side fyke net, is a widely used commercial fishing gear in shallow waters of the region. A total of 89 fish species was collected, the dominant species were *Konosirus punctatus, Mugil cephalus, Lateolabrax japonicus, Acanthopagrus schlegeli, Sebastes inermis, Nibea mitsukurii, Clupeapallasii, Pampus echinogaster, Sebastes schlegeli* and *Limanda yokohamae*. They accounted for 61.1% of the total number of individuals and 80.3% of the biomass. The dominant species were primarily composed of small individuals or juveniles of large-sized fishes. Abundance in the number of individuals and biomass showed peaks in April, May and September, and was lowest in January. Temporal change in fish abundance was related to the temperature and related factors.

Key words : Both sides fyke net, fish assemblage, Namhae Island

INTRODUCTION

Many fish use the coastal areas as feeding and nursery grounds, including economically important fishes. Fish assemblage in the coastal waters, especially those composing commercial and recreational fish, has been widely studied (Jenkins and Wheatley, 1998; Lazzari *et al*., 1999; Guidetti, 2000; Paperno *et al*., 2001; Kwak and Klumpp, 2004). Seasonal variation in species composition and abundance of fish in the coastal waters of Korea have been studied using samples obtained by a small trawl (Cha and Park, 1997; Huh and Kwak, 1998a; Lee and Gil, 1998; Huh and Chung, 1999; Huh and An, 2000; Oh, 2003), gill net (Kim and Kang, 1991; Hwang *et al*., 1997; Cha, 1999; Han *et al*., 2002), crab pots (An and Huh, 2002), and set nets (Huh and Kwak, 1998b; Lee, 1998; Hwang, 1998; Hwang *et al*., 1998; An and Huh, 2002; Huh and An, 2002; Hwang *et al*., 2006).

The coastal area off Namhae Island is relatively shallow and eelgrass meadows are frequently found. This water provides a habitat for variety of invertebrates and small fishes, which in turn are the potential food of large predators including commercially important fish. The studies on fish assemblages in this water to date have been concentrated on community structure using samples with small trawls and winged stow nets on anchors (Huh and Kwak, 1997, 1998a; Hwang, 2007). However, little is known about the fish assemblage catchable by the fyke net although this net is one of the widely used fishing gears in the region especially in the rocky areas. A few studies have been conducted on fish assemblages with using fyke nets around Korean peninsular. These were included studies on the fluctuation in species composition and abundances of fishes in the coastal off Gadeok-Do, and Dol-san, Yeosu, in Korea (Huh and An, 2002; Jeong *et al*., 2005).

The objective of this study was to examine the seasonal variation in species composition and abundance of fishes with a both sides fyke net in the coastal water off Namhae Island, Korea and to determine the relationship between environmental factors and fish abundance.

MATERIALS AND METHODS

Fish samples were monthly collected by a fyke net in the water off Namhae Island in 2006 (Fig. 1). The sam-

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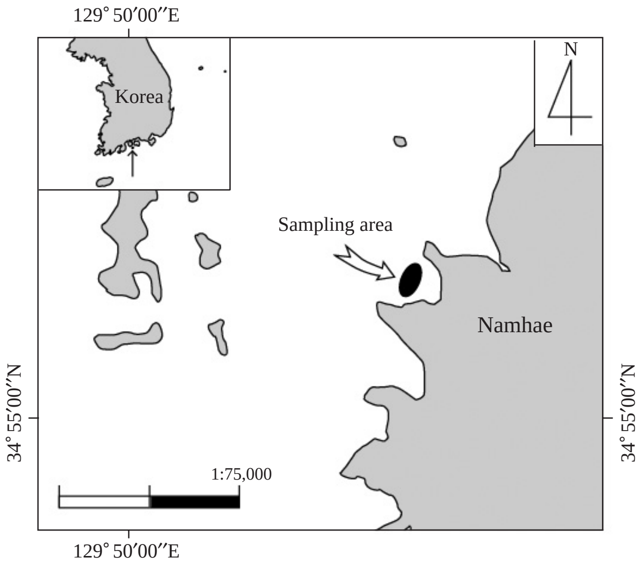

Fig. 1. Location of the study area.

pling gear used, a both-side fyke net, was 12 m long, and two rectangular steel frames of 90 cm wide and 75 cm high with 4 steel hoops in both sides. The stretched mesh size was 7 mm and fishes were collected by two nets on each sampling times. Samples were preserved immediately in 10% formalin after capture and later transferred to 70% isopropanol. The specimens were identified according to Masuda *et al*. (1984), Yoon (2002) and Kim *et al*. (2005). Fish were measured to the nearest mm (standard length SL) and weighed to the nearest gram in wet weight. Water temperature and salinity were measured in each sampling occasion.

The diversity index H′ (Shannon and Weaver, 1949) was calculated as:

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

where n_i is the number of individuals of each i species in a sample and N is the total number of individuals.

Association of fish species, Pianka's similarity index (Pianka, 1973), A_{ij} 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 i in a particular month h; p_{jh} is the proportion of individuals of j in a particular month h. The Pianka's similarity index was subjected to an average linkage cluster analysis.

A one-way ANOVA with orthogonal design was used to analyze variations in fish abundance and environmental factors with month. The relationships between fish abundance and environmental factors were analyzed using Pearson's correlation coefficient.

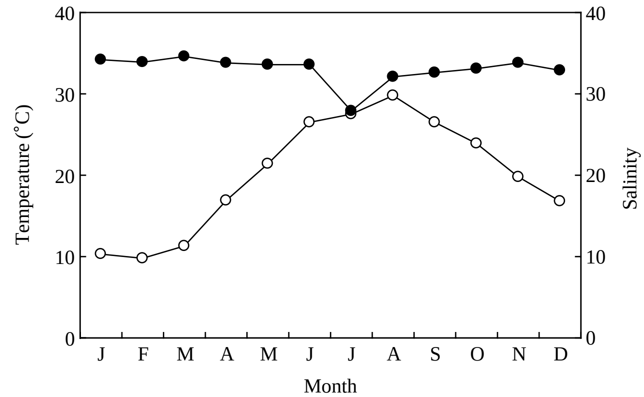

Fig. 2. Monthly variations of temperature and salinity in the coastal water off Namhae Island in 2006 (open circle: temperature, black circle: salinity).

RESULTS

1. Temperature and salinity

Water temperature was low in winter showing a minimum of 9.8°C in February, and raised showing a peak of 29.8°C in August (Fig. 2). Salinity ranged from 27.9‰ to 33.3‰ and did not vary greatly, but it dropped to about 27.9‰ in July.

2. Fish species composition

A total of 4,334 fish belonging to 89 species were collected during the study (Table 1). Numerically dominant fish were *Konosirus punctatus* (15.3%), *Mugil cephalus* (11.1%), *Lateolabrax japonicus* (7.3%), *Acanthopagrus schlegeli* (5.9%), *Sebastes inermis* (5.4%), *Nibea mitsukurii* (4.4%), *Clupea pallasii* (3.4%), *Pampus echinogaster* (3.1%), *Sebastes schlegeli* (2.6%), and *Limanda yokohamae* (2.6%), together accounting for 61.1% of the catch. The numerically dominant fish species made up 80.3% of biomass because of the presence of large *M. cephalus* (35.4% of biomass) which were high in biomass.

The size distributions of principal fish species were depicted in Fig 3. The size ranged 14.1∼19.0 cm SL for *K. punctatus* and 20.1∼50.0 cm SL for *M. cephalus*, *L. japonicus* occurred in size ranged from 10.1∼25.0 cm SL with peak numbers in 12.1∼15.0 cm SL. The frequency was high in size range of 19.1∼20.0 cm SL for *A. schlegeli*, 10.1∼11.0 cm SL for *S. inermis*, 23.1∼24.0 cm SL for *N. mitsukurii*, 20.1∼21.0 cm SL for *C. pallasi*, 14.1∼15.0 cm SL for *P. echinogaster*, 19.1∼20.0 cm SL for *S. schlegeli*, and 18.1∼19.0 cm SL *L. yokohamae.*

3. Seasonal variation in abundance of fish

The number of fish species varied from 19 to 53 spe-

Table 1. Total number of individuals and biomass of fish species collected by a fike net in the coastal water off Namhae Island in 2006

Species	Total				Species	Total			
	N	%	B	%		N	%	B	%
Konosirus punctatus	665	15.3	94,174.9	10.6	*Pagrus major*	9	0.2	1,036.0	0.1
Mugil cephalus	480	11.1	313,315.6	35.4	*Nibea albiflora*	8	0.2	598.0	0.1
Lateolabrax japonicus	318	7.3	109,712.6	12.4	*Liparis tanakai*	7	0.2	204.3	<0.1
Acanthopagrus schlegeli	255	5.9	80,395.3	9.1	*Parapercis sexfasciata*	7	0.2	294.7	″
Sebastes inermis	236	5.4	34,510.8	3.9	*Chelidonichthys spinosus*	7	0.2	678.1	0.1
Nibea mitsukurii	191	4.4	17,739.4	2.0	*Pseudorhombus pentophthalmus*	6	0.1	662.4	0.1
Clupea pallasii	146	3.4	14,874.0	1.7	*Sphyraena pinguis*	6	0.1	397.8	<0.1
Pampus echinogaster	134	3.1	14,270.7	1.6	*Epinephelus septemfasciatus*	6	0.1	662.6	0.1
Sebastes schlegelii	112	2.6	9,712.3	1.1	*Stephanolepis cirrhifer*	6	0.1	179.9	<0.1
Limanda yokohamae	111	2.6	22,272.4	2.5	*Chirolophis japonicus*	5	0.1	325.1	″
Pleuronichthys cornutus	99	2.3	7,882.2	0.9	*Pholis nebulosa*	4	0.1	109.5	″
Trichiurus lepturus	98	2.3	7,064.3	0.8	*Eopsetta grigorjewi*	4	0.1	288.2	″
Limanda herzensteini	84	1.9	7,861.0	0.9	*Leiognathus nuchalis*	4	0.1	16.5	″
Paralichthys olivaceus	83	1.9	11,990.2	1.4	*Thryssa adelae*	4	0.1	28.0	″
Chelon affinis	80	1.8	42,014.5	4.7	*Pholis fangi*	4	0.1	72.2	″
Scomber japonicus	69	1.6	11,334.8	1.3	*Pseudoblennius marmoratus*	4	0.1	126.9	″
Trachurus japonicus	68	1.6	688.4	0.1	*Thryssa hamiltoni*	4	0.1	29.9	″
Takifugu niphobles	63	1.5	1,514.7	0.2	*Favonigobius gymnauchen*	3	0.1	9.5	″
Takifugu rubripes	61	1.4	6,806.3	0.8	*Amblychaeturichthys hexanema*	3	0.1	8.9	″
Oplegnathus fasciatus	58	1.3	3,745.8	0.4	*Engraulis japonicus*	3	0.1	10.2	″
Kareius bicoloratus	57	1.3	8,128.4	0.9	*Amblychaeturichthys sciistius*	3	0.1	14.7	″
Hexagrammos otakii	56	1.3	3,577.9	0.4	*Chaeturichthys stigmatias*	3	0.1	18.2	″
Larimichthys polyactis	53	1.2	4,499.3	0.5	*Xenocephalus elongatus*	3	0.1	63.7	″
Pennahia argentata	49	1.1	2,376.4	0.3	*Pseudoblennius cottoides*	3	0.1	60.2	″
Hexagrammos agrammus	46	1.1	2,762.0	0.3	*Liparis tessellatus*	3	0.1	179.9	″
Larimichthys crocea	45	1.0	2,778.5	0.3	*Hypodytes rubripinnis*	3	0.1	88.3	″
Ditrema temminckii	44	1.0	2,489.4	0.3	*Glossanodon semifasciatus*	3	0.1	8.8	″
Thryssa kammalensis	40	0.9	798.1	0.1	*Stichaeus grigorjewi*	3	0.1	125.5	″
Hemitripterus villosus	39	0.9	11,628.9	1.3	*Pholis crassispina*	3	0.1	92.1	″
Johnius grypotus	37	0.9	366.1	<0.1	*Rudarius ercodes*	3	0.1	17.6	″
Sebastes pachycephalus	35	0.8	2,134.8	0.2	*Sebastiscus marmoratus*	3	0.1	216.7	″
Lophius litulon	29	0.7	12,913.3	1.5	*Cryptocentrus filifer*	3	0.1	12.8	″
Sebastes thompsoni	28	0.6	2,026.4	0.2	*Tridentiger trigonocephalus*	2	<0.1	8.0	″
Sillago japonica	27	0.6	607.1	0.1	*Acentrogobius pflaumii*	2	″	10.0	″
Apogon lineatus	25	0.6	156.5	<0.1	*Zebrias zebrinus*	2	″	22.3	″
Apogon semilineatus	23	0.5	160.3	″	*Saurida undosquamis*	2	″	43.2	″
Sardinella zunasi	22	0.5	135.6	″	*Takifugu poecilonotus*	2	″	78.0	″
Acanthogobius flavimanus	20	0.5	430.7	″	*Uranoscopus japonicus*	2	″	77.5	″
Zoarces gillii	17	0.4	1,025.0	0.1	*Hyporhamphus sajoti*	2	″	14.2	″
Inimicus japonicus	16	0.4	3,241.5	0.4	*Tribolodon hakonensis*	1	″	213.8	″
Conger myriaster	15	0.3	734.7	0.1	*Pseudaesopia japonica*	1	″	35.9	″
Repomucenus valenciennei	11	0.3	54.3	<0.1	*Syngnathus schlegeli*	1	″	5.5	″
Cynoglossus joyneri	10	0.2	1,162.8	0.1	*Hapalogenys mucronatus*	1	″	25.3	″
Cynoglossus interruptus	10	0.2	1,085.9	0.1	*Ctenotrypauchen microcephalus*	1	″	12.1	″
Platycephalus indicus	10	0.2	1,053.0	0.1	Total	4,334	100	885,390.1	100.0

* N: Number of individuals, B: Biomass (g)

cies with months. The number of species was high in spring and autumn (Fig. 4). Number of individuals was also high in spring and autumn (Fig. 4-b) when most of common species, *K. puntatus*, *M. cephalus*, *L. japonicus*, *A. schlegeli*, and *S. inermis* were dominant. Abundance in fish numbers was the lowest in winter. The fish biomass was high in April and September when many large *M. cephalus*, *L. japonicus*, *A. schlegeli* and *N. mitsukurii* were present. The diversity index was relatively higher from April to June ranged from 2.43～3.29.

Monthly abundance of common fish showed different patterns with each fish species (Fig. 5). For *K. punctatus*, *M. cephalus* and *L. japonicus* showed two peaks in spring and autumn. Peak season in abundance was observed in spring for *A. schlegeli*, *S. inermis*, *S. schlegeli* and *L. yokohamae*, in autumn for *N. mitsukurii* and *P. echinogaster*, and in winter for *C. pallasii*.

The dendrogram shows seven clusters which identify

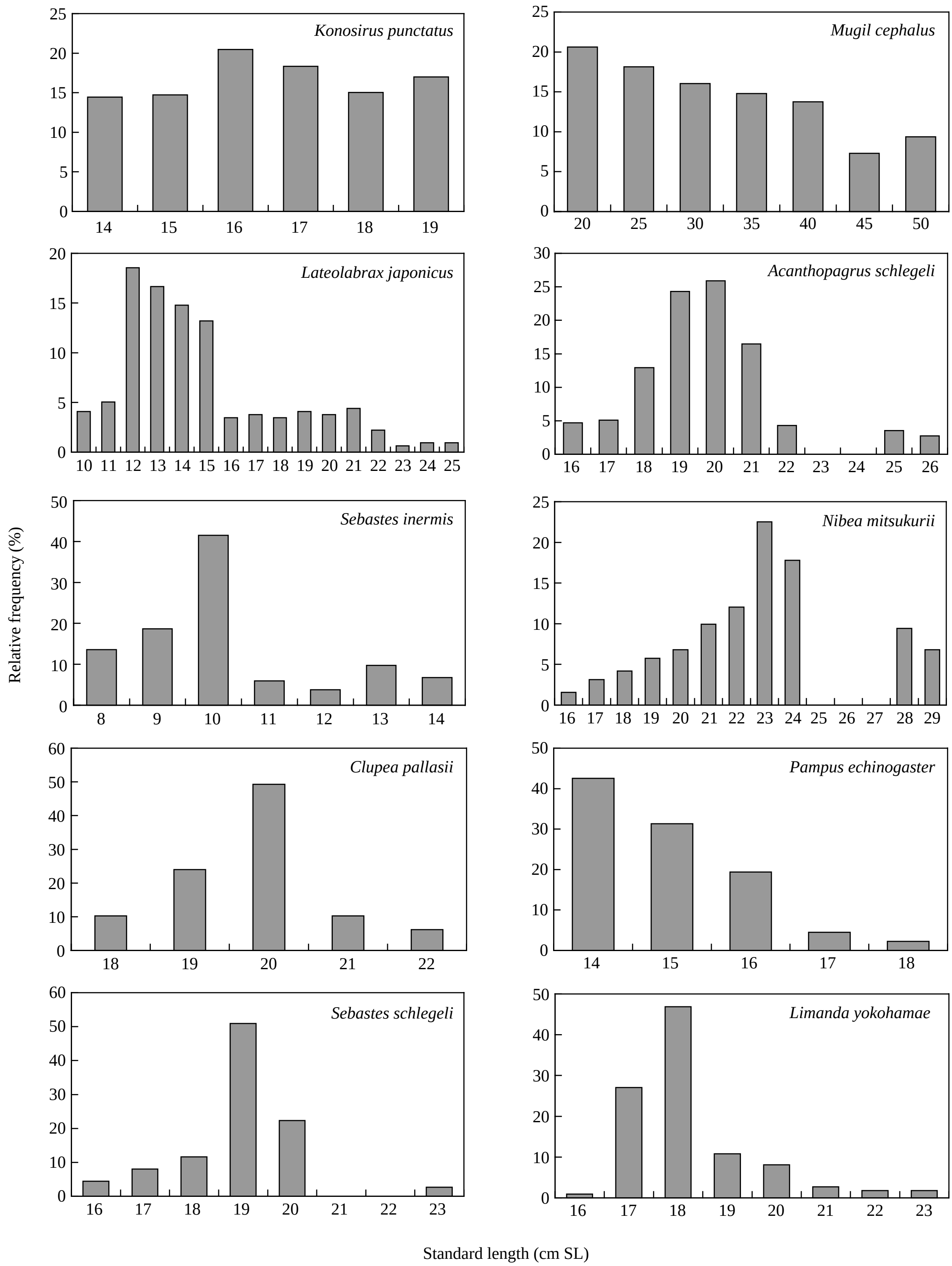

Fig. 3. Size distributions of principal fishes collected by a fyke net in the coastal water off Namhae Islands in 2006.

the fish species (Fig. 6). The first group was composed of *A. schlegeli*, *S. inermis*, *M. cephalus*, *L. japonicus*, *K. punctatus*, *Pleuronichthys cornutus*, *S. schlegeli*, *L. yokohamae*, *Limanda herzensteini*, *Paralichthys olivaceus*, and *Chelon affinis*, which occurred abundantly almost all over the study period. This group can be further divided into two subgroups: subgroup A contains *A. schlegeli*, *S. inermis*, *M. cephalus*, *L. japonicus*, and *K. puncta-*

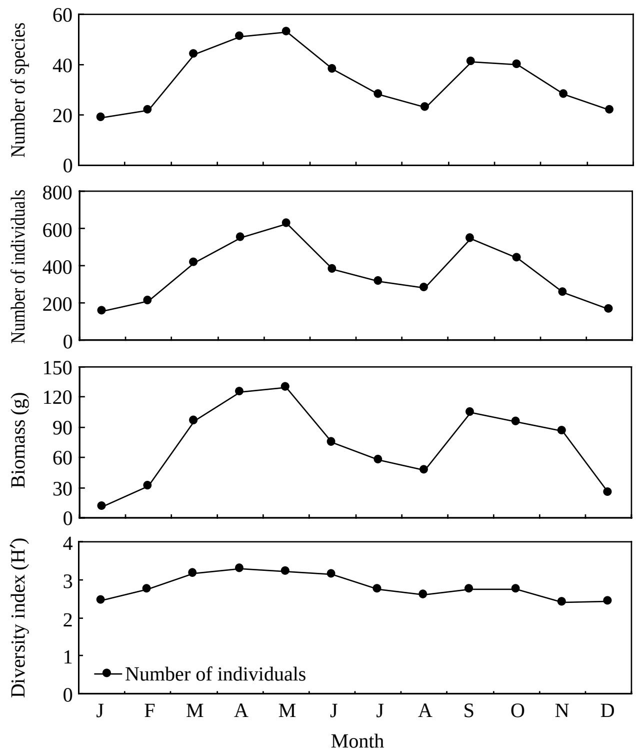

Fig. 4. Monthly variations in number of species, number of individuals, biomass, and diversity index of fish collected by a fyke net in the coastal water off Namhae Islands in 2006.

tus with relatively high abundance during the study period, subgroup B composed of *P. cornutus*, *S. schlegeli*, *L. yokohamae*, *L. herzensteini*, *P. olivaceus*, and *C. affinis* showing a peak abundance from March to May. The second group was composed of *Trichiurus lepturus*, *P. echinogaster*, *N. mitsukurii*, *Scomber japonicus*, *Oplegnathus fasciatus*, *Trachurus japonicus*, and *Larimichthys polyactis*. The fishes in this group were abundantly collected in August and September, while few were collected in other periods. The third group was composed of *Pennahia argentatus*, *Larimichthys crocea*, *Sebastes thompsoni*, *Kareius bicoloratus*, *Hexagrammos otakii*, *Hemitripterus villosus*, and *Johnius gryptopus* showing peak abundance from April to June. The fourth group was consisted of *Conger myriaster, Acanthogobius flavimanus, Apogon semilineatus, Zoarces gillii, Sardinella zunasi*, *Sillago japonicus, Apogon semilineatus, Sebastes pachycephalus*, *Hexagrammos agrammus*, and *Ditrema temminckii* with occurrence from March to June. The fifth group was composed of *Thryssa kammalensis, Cynoglossus joyneri*, *C. inerruptus*, and *Inimicus japonicus* with occurrence from March to May. The seventh group was *Takifugu niphobles*, *T. rubripes*, *C. pallasi*, and *L. litulon* which were present mainly in winter.

DISCUSSION

The fyke net is set in shallow water perpendicular to shore such that the net mouth is covered by about 1 meter of water when possible. Fyke net is a common fishing gear collecting a wide size range of pelagic fish which use shallow habitat forming school. A total of 89 fish species was recorded from the coastal water off Namhae Islands and *K. punctatus*, *M. cephalus*, *L. japonicus*, *A. schlegeli*, *S. inermis*, *N. mitsukurii*, *C. pallassi*, *P. echinogaster*, *S. schlegeli*, and *L. yokohamae* were numerically dominant. Most of fish species are pelagic fishes forming schooling, and these fishes were important in commercial and recreational fishery. For example *A. schlegeli*, *S. inermis*, *S. schlegeli*, and *L. yokohamae* had high economic value as live fish, and *K. punctatus*, *M. cephalus*, *L. japonicus*, *N. mitsukurii*, *C. pallassi*, and *P. echinogaster* were harvested as a food fish (Kim and Kang 1993; Yoon, 2002). Compared with the studies of fish assemblages in the some coastal areas nearby the study area, non-commercial fishes such as *Acentrogobius pflaumii*, *Chaeturichthys hexanema*, *C. sciistius*, *Repomucenus valenciennei*, *T. kammalensis*, *Leiognathus nuchalis*, *Ilisha elongata*, *J. grypotus*, and *Cryptocentrus filifer* were dominated in the trawl catch in the coastal water off Namhae Islands (Huh and Kwak, 1998a), and Kwangyang Bay (Oh, 2003), whereas commercial fishes (e.g. *K. punctatus, M. cephalus, A. schlegeli, Engraulis japonicus, T. lepturus, S. zunasi* etc.) were abundant in the catch by both-side fyke nets and set nets in the coastal water off Namhae Islands, Dolsan Islands, and Wan Islands (Huh and Kwak, 1998b; Kim *et al*., 2002; Kim *et al*., 2003; Jeong *et al*., 2005; Hwang *et al*., 2006). These results indicated that higher numbers of commercial fish species were collected with set nets including fyke nets. Such conclusions are in general agreement with other studies of fish assemblages in the coastal area, Korea. *Trachurus japonicus*, *K. punctatus*, *M. cephalusand*, and *S. japonicus* were common fish species in the coastal water off Gadeok Islands (Huh and An, 2002). Both-side fyke nets were widely used along the shore in the coastal water off Namhae Islands because pelagic fish such as *K. punctatus*, *M. cephalus*, *L. japonicus*, *A. schlegeli*, *N. mitsukurii*, and *C. pallassi* were effectively caught in the net by the strong tidal current. Hence we suggested that both-side fyke net was a reasonable gear for studies on commercially important pelagic fishes in the coastal area.

Each dominant fish species exhibited a distinct seasonal occurrence pattern and different time of peak abundance. Peak abundance was observed in September for *K. punctatus*, *N. mitsukurii* and *P. echinogaster*, in May for *M. cephalus* and *L. japonicus*, *A. schlegeli*, *S. inermis*, and in April for *L. yokohamae*, in December 2006

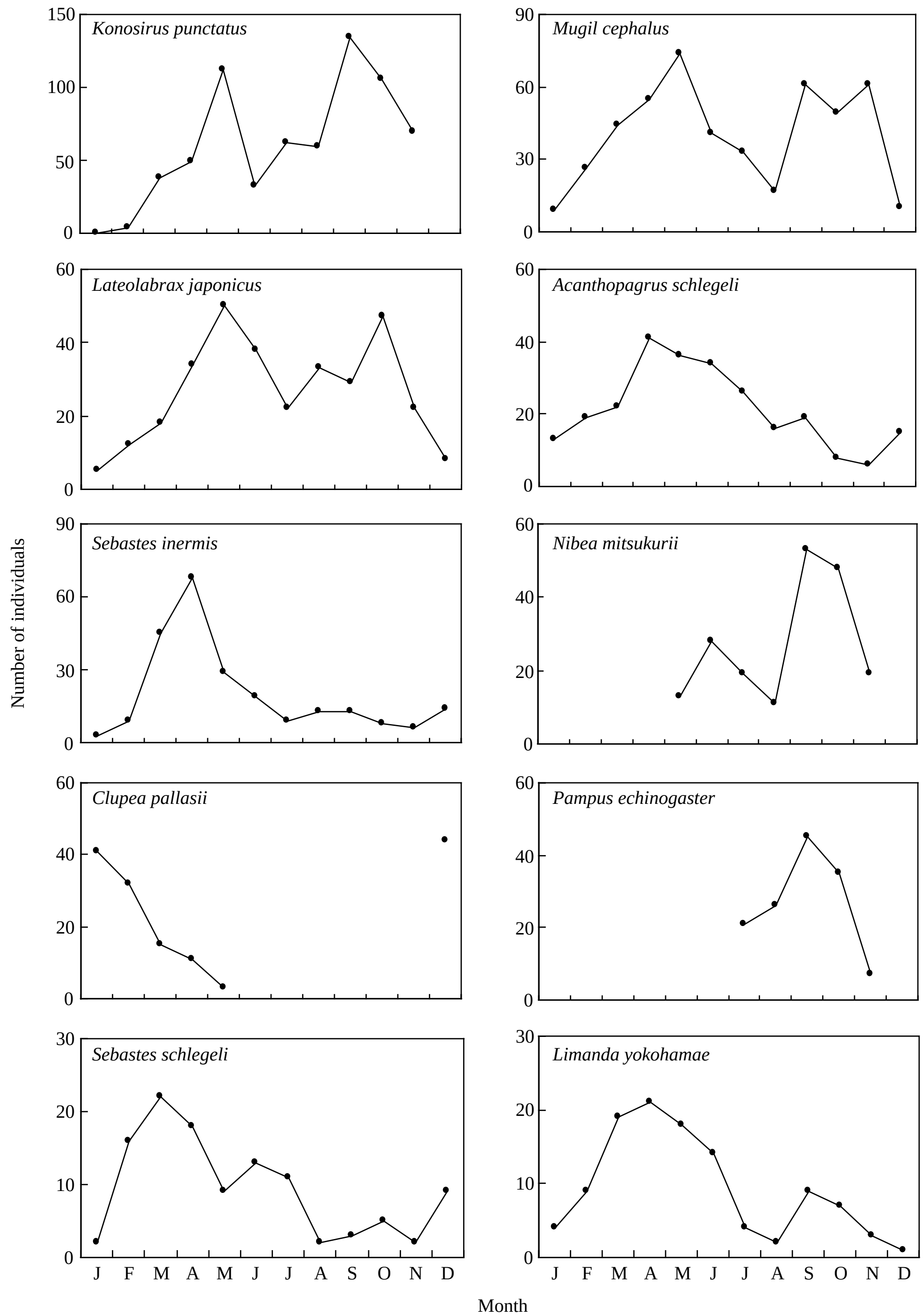

Fig. 5. Monthly variations in number of individuals of 10 common fish species collected by a fyke net in the coastal water off Namhae Islands in 2006.

for *C. pallasii*, and in March 2006 for *S. schlegeli*. These results indicate that life history pattern differ according to the fish in the study area. Peak recruitment and abundance of one species was separated several months from other species, with some overlap with another species. After one fish population increased rapidly, it sustained peak abundance for several months and then decreased sharply. Subsequently, another fish population increased and reached peak abundance. Hence the coastal area off Namhae Islands was partitioned temporally by domi-

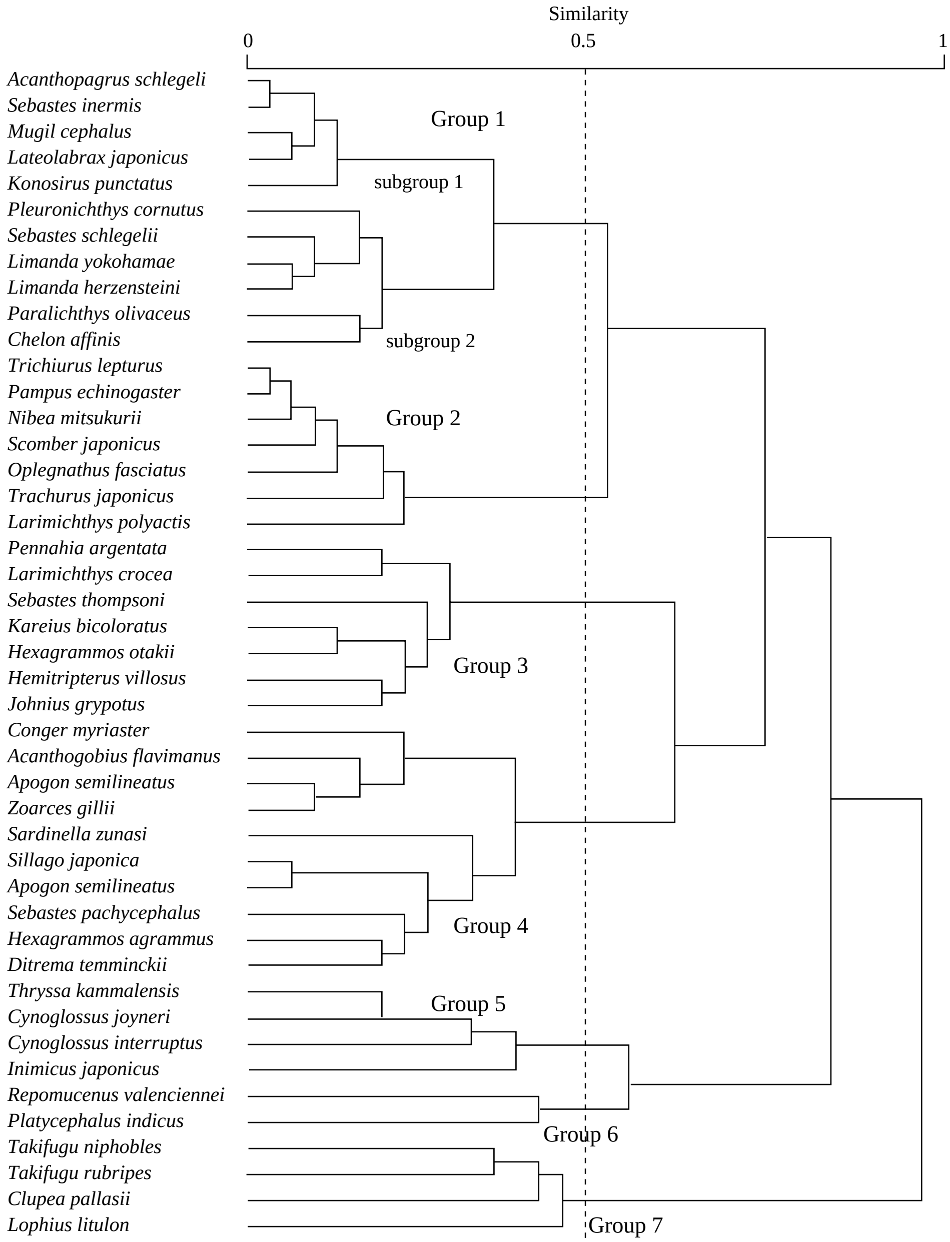

Fig. 6. Dendrogram illustrating the species associations of fishes collected by a fyke net in the coastal water off Namhae Island in 2006.

nant fish species in this way. Other studies have shown similar patterns of seasonal variation in fish assemblages of coastal areas, Korea (Huh and Kwak, 1997; 1998a, b; Huh and Chung, 1999; An and Huh, 2003; Kwak *et al*., 2006; Kwak and Huh, 2007). For example, peak abundance was in spring for *M. cephalus*, in summer for *T. japonicus*, in fall for *K. punctatus*, and in winter for *T. niphobles* in the coastal water off Gadeok Islands (Huh and An, 2002).

Both species composition and abundance of fishes greatly varied with season. Fish were abundant in the study area were higher during spring and summer (e.g. May 2006, and September 2006) when temperature was high. Compared with other studies of fish assemblages collected by set nets close to the study area, fluctuations in abundance and species composition of fishes correlated with temperature in the coastal water off Dolsan Islands. For example, higher number of individuals and biomass were recorded from spring to summer when temperature was high (Jeong *et al*., 2005). Temperature effect was clear in the anchovy catch analyzed using samples by bag set net off Wando Islands (Kim *et al*., 2002). Several other studies have also demonstrated a positive correlation between temperature and fish abundance (Edgar and Shaw, 1995; Huh and Kwak, 1998b; Huh and Chung, 1999; Lazzari *et al*., 1999; Paperno *et al*., 2001; Huh and An, 2002; Oh, 2003; Kwak *et al*., 2006; Hwang, 2007; Kwak and Huh, 2007). In conclusion, the temperature and related factors are the major factor to determine the seasonal variation in species composition of fish in the southern coastal water of Korea.

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남해도 연안해역에서 서식하는 어류군집의 종조성 및 계절변동

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요 약 : 남해도 연안해역에서 이각망을 이용하여 어류군집의 계절에 따른 종조성 및 출현량 변동을 조사하였다. 조사기간 동안 총 89종이 출현하였으며, 우점종은 전어(*Konosirus punctatus*), 숭어(*Mugil cephalus*), 농어(*Lateolabrax japonicus*), 감성돔(*Acanthopagrus schlegeli*), 볼락(*Sebastes inermis*), 동갈민어(*Nibea mitsukurii*), 청어(*Clupea pallassi*), 덕대(*Pampus echinogaster*), 조피볼락(*Sebastes schlegeli*), 문치가자미(*Limanda yokohamae*)였는데, 이들 어종은 전체 개체수의 61.6%와 총 생체량의 80.3%를 차지하였다. 어류 종조성 및 출현량은 계절 변동이 뚜렷하였는데, 출현 개체수 및 생체량은 4월, 5월 및 9월에 높았으며, 1월에 가장 낮았다. 수온 및 이와 관련된 요인이 어류군집의 종조성 및 출현량 변동에 가장 큰 영향을 주는 요인이었다. 이각망은 연안해역을 이용하는 다양한 크기의 부어성 어류를 어획하는 데 유용한 어구였으며, 특히 상업성 어종의 어획에 효율적이었다.

찾아보기 낱말 : 이각망, 어류군집, 남해도