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Note

Preference of Physical Microhabitat on the 1st-class Endangered Species, *Gobiobotia naktongensis* inhabiting the Gam Stream, Tributary of the Nakdong River

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The study was conducted in 2007～2008 in order to understand preference of physical microhabitat on the 1st-class endangered species, *Gobiobotia naktongensis* inhabiting the Gam Stream, tributary of Nakdong River. The total number of fish caught from the study sites was 3,671 representing 7 families 24 species. There were 8 Korean endemic species including *Odontobutis platycephala,* and 2 introduced species (*Carassius cuvieri, Micropterus salmoides*) were found. According to investigation and analysis of physical microhabitat on *Gobiobotia naktongensis* caught in the Gam Stream, a total of 57 individuals were found at shallow depth (0.14～0.46 m) and run (0.239～0.585 m sec^{-1}). As a result of sieve analysis, stream beds consisted of about 1% gravel and 99% sand (83.4% coarse sand, 15.6% find sand). Therefore, *Gobiobotia naktongensis* seemed to inhabit shallow-run with coarse sand bed than deep-pool microhabitat. The findings indicate preference of physical microhabitat on *Gobiobotia naktongensis,* and it is important to enhance efficiency of fish conservation and ecological restoration with understanding species-specific characteristics in microhabitat including protected species.

Key words : Gam Stream, physical microhabitat, *Gobiobotia naktongensis,* ecological restoration

Fish investigations have been performed with only catching fish by site in order to understand mainly fish fauna and distribution status in streams/rivers or reservoirs in Korea. Fundamental parameters of water quality such as water temperature, dissolved oxygen, pH, and conductivity with a portable analyzer are occasionally measured in a sampling site, but preferences of physical microhabitat on each species of fish are not considered due to limited time and labor (Seo *et al*., 2008a; Seo, 2009). Because physical, chemical, and biological factors in microhabitat are directly and indirectly related each other, fish community may be influenced by change of those factors. Therefore, insufficient information about ecological characteristics on each species leads civil engineers confused when they make a decision for ecological restoration or environmental flow with target species (Arthington *et al*., 2000; Bunn and Arthington, 2002; Lee *et al*., 2008; Seo *et al*., 2008b).

Fish, which is a top consumer in an aquatic ecosystem, is related with other organisms such as phytoplankton/periphyton and marcoinvertebrate, and it represents biodiversity in a habitat (Seo, 2005). Recently, artificial disturbances such as dam construction, dredging, and stream/river improvement for flood control and various water supply may cause change of fish community and further regional extinction of indigenous or riffle-benthic species (Brown *et al*., 1988; Nelson, 1993; Waters, 1995; Yang *et al*., 1997; Christopher,

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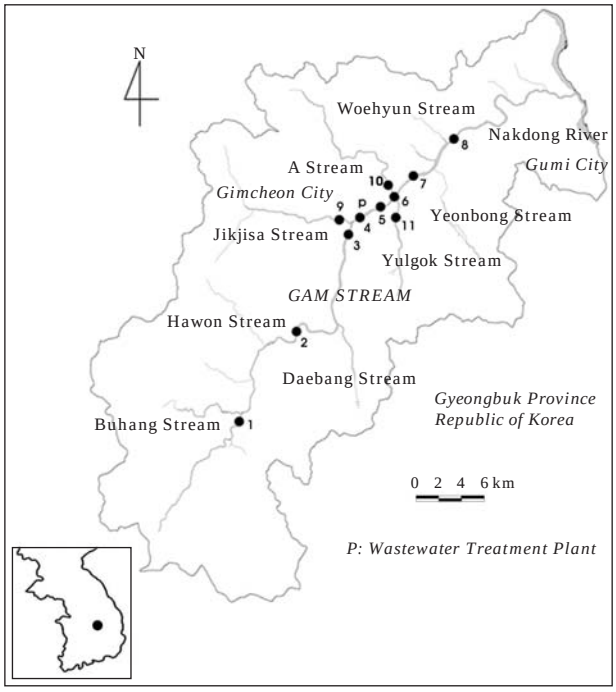

Fig. 1. Sampling sites in the Gam Stream watershed.

2002). There are total 21 protected species of fishes, designated as natural monument and endangered species, and they have been constantly focused on increase of their population and distribution.

The species of *Gobiobotia naktongensis*, which was reported as new species by Mori (1935), is Korean endemic species belongs to Cyprinidae. The species became the 1st-class endangered species in 2005 due to decreased population and distribution (Lee and Noh, 2006). There has been researches on taxonomic position (Choi *et al*., 1990; Zhu, 1995; Kim, 1997), morphological characteristics (Kim, 1997; Kim and Park, 2002; Chae, 2004), and habitat distribution (Jeon and Son. 1983; Choi, 1985, 1986, 1987; Jang *et al*., 2001). However, there is scarcely information reported on characteristics of physical microhabitat (Kang *et al*., 2004).

Objectives of the study were to investigate fish community in the Gam Stream, tributary of the Nakdong River and to understand preference of physical microhabitat such as water depth, velocity, and stream bed on the 1st-class endangered species, *Gobiobotia naktongensis*. It would be able to use as important information for habitat restoration of endangered species which their distribution gets reduced.

The study was conducted in the Gam Stream watershed, which is one of the 1st tributaries of the Nakdong River. The Gam Stream is 69.0 km long and its watershed area is 999.5 km^2, which is 4.3% of whole watershed of the Nakdong River. In order to determine fish fauna and distribution of the 1st-class endangered species, *Gobiobotia naktongensis* at 11 sampling sites including 3 tributaries of the Gam Stream, we collected fishes on May, June, August, and November in 2007 (Fig. 1). Thereafter, we focused an investigation on their preference of physical microhabitat at the 6 sites (St. 3∼St. 8) of the Gam Stream on July and November in 2008. Administrative districts with geological position system by site are as follows;

The Gam Stream

St. 1: Dogok-Ri Jirea-Myeon, Gimcheon (N 35° 58′14″ E 128° 01′21″)
St. 2: Gwangmyeong-Ri Guseong-Myeon, Gimcheon (N 36° 02′17″ E 128° 04′37″)
St. 3: Gimcheon Bridge. Jijwa-Dong, Gimcheon (N 36° 07′04″ E 128° 07′48″)
St. 4: Sinum-Dong, Gimcheon (N 36° 07′38″ E 128° 07′59″)
St. 5: Gaeryeong-Myeon, Gimcheon (N 36° 08′ 30″ E 128° 10′06″)
St. 6: Gaeryeong-Myeon, Gimcheon (N 36° 08′ 54″ E 128° 10′34″)
St. 7: Daedong Bridge, Gaeryeong-Myeon, Gimcheon (N 36° 09′49″ E 128° 11′36″)
St. 8: Gammun Bridge Gaeryeong-Myeon, Gimcheon (N 36° 11′23″ E 128° 13′57″)

Tributaries of the Gam Stream

St. 9: Sinum-Dong, Gimcheon (Jikjisa Stream) (N 36° 07′40″ E 128° 07′43″)
St. 10: Gaeryeong-Myeon, Gimcheon (A Stream) (N 36° 09′08″ E 128° 10′21″)
St. 11: Nam-Myeon, Gimcheon (Yulgok Stream) (N 36° 08′52″ E 128° 10′46″)

Fish investigations were performed along the stream at each site of about 100 m distance during one hour in order to include various microhabitats such as riffle, pool, and run (An *et al*., 2006; Kim *et al*., 2007). For collecting fish, cast net (mesh size 7 × 7 mm) and kick net (mesh size 4 × 4 mm) were used depending on a habitat type. Collected fish were identified and counted by species *in situ*, and then most of them were released

Table 1. A list of fish species and number of individuals caught from the sampling sites from 2007 to 2008.

Species	English name	Sampling site											Total	RA	RE
		1	2	3	4	5	6	7	8	9	10	11			
Cyprinidae															
Cyprinus carpio	Common carp					3			1				4	0.11	
Carassius auratus	Crusian carp			3	2	2	1	4	11	13	2	1	39	1.06	
Carassius cuvieri	Crusian carp								1				1	0.03	I
Pseudorasbora parva	False dace			1	2				3				6	0.16	
Coreoleuciscus splendidus	Korean shinner	109	22	3									134	3.63	K
Squalidus japonicus coreanus	Short barbel gudgeon			4	4	10		2		5			25	0.68	K
Squalidus gracilis majimae	Korean slender gudgeon	10	2										12	0.33	K
Hemibarbus labeo	Steed barbel					2							2	0.05	
Pseudogobio esocinus	Goby minnow			9	1	11	12	3	18	7		1	62	1.68	
Abbottina rivularis	Chiness false gudgeon								1				1	0.03	
Gobiobotia naktongensis	−			12	2	9	5	10	19				57	1.54	E, K
Microphysogobio yaluensis	−			1									1	0.03	K
Rhynchocypris oxycephalus	Chiness minnow	112	7									1	120	3.25	
Zacco koreanus	Korean chub	456	18										474	12.84	K
Zacco platypus	Pale chub	32	119	280	357	395	185	179	142	331	338	122	2,480	67.19	
Opsariichthys bidens	Korean piscivorous chub			19	18	34	38	37	14			21	181	4.90	
Cobitidae															
Misgurnus anguillicaudatus	Muddy loach		1	7	3		2	1	2		1	5	22	0.60	
Cobitis sinensis	Spine loach	6	5	1					1				13	0.35	
Bagridae															
Pseudobagrus fulvidraco	Korean bullhead			1	2	2	2	2	4	1			14	0.38	
Pseudobagrus koreanus	Black bullhead			1									1	0.03	K
Odontobutidae															
Odontobutis platycephala	Korean dark sleeper	1	5	2	4	3	6	3	1	2			27	0.73	K
Belontiidae															
Macropodus chinensis	Round tailed paradise fish											3	3	0.08	
Gobiidae															
Rhinogobius brunneus	Common freshwater goby			1				2	1				4	0.11	
Centrarchidae															
Micropterus salmoides	Largemouth bass								8				8	0.22	I
Number of familiy		3	3	5	4	3	4	5	6	3	2	3	7		
Number of species		7	8	15	10	10	8	10	15	6	3	7	24		
Number of individual		726	179	345	395	471	251	243	227	359	341	154	3,691		

E: Endangered species, K: Korean endemic species, I: Introduced species, RA: Relative abundance, RE: Remark

immediately after fish sampling in a site. Some small-sized fish, which were not able to be identified immediately, were fixed with 10% formalin solution and brought to a laboratory. The identification was performed according to Kim (1997) and Kim and Park (2002), and classification system was arranged by Nelson (1994).

A total length of *Gobiobotia naktongensis* was measured when caught. In order to determine preference of physical microhabitat on the species, water depth and velocity were measured in the spot they were found immediately. In addition, substrates in the sites were sampled and brought to a laboratory, and then its composition was estimated based on sieve analysis.

In the Gam Stream, total 3,691 of fish representing 7 families 24 species were caught from the investigation period. Among them, Cyprinidae was dominant in species number (16 species, 66.7%) and relative abundance (3,599 individuals, 97.5%), whereas other 6 families had one or two species and less than 1.0% of relative abundance (Table

1). Pale chub (*Zacco platypus*, 2,480 individuals, 67.2%) was dominant species at all sites except St. 1, and subdominant species was Korean chub (*Zacco koreanus*, 474 individuals, 12.8%) mostly found at St. 1 (96.2%) in 2007.

The 1st-class endangered species, *Gobiobotia naktongensis* was caught in mid to lower region of the Gam Stream with 1.5% of relative abundance (Table 1). There were 8 Korean endemic species (33.3% in species number), higher than 25.9% indigenous frequency reported by Kim (1995). Five species (*Coreoleuciscus splendidus*, *Squalidus gracilis majimae*, *Microphysogobio yaluensis*, *Zacco koreanus*, and *Pseudobagrus koreanus*) were found mostly in upper region of the stream, whereas *Squalidus japonicus coreanus* and *Gobiobotia naktongensis* were caught in mid to lower region. The species of *Odontobutis platycephala* inhabited in most sites (Table 1). There were 2 introduced species (*Carassius cuvieri*, *Micropterus salmoides*) found in only St. 8. In particular, only 8 individuals of *Micropterus salmoides* were caught even if we could see more than that. This species was classified as an ecological disturbing fish by the Ministry of Environment, Korea so that it is important to make a countermeasure for conserving fish community and population of *Gobiobotia naktongensis* from the species of fish having rapid propagation power.

Total 29 individuals of *Gobiobotia naktongensis* were collected in 2007. Among them, 13 individuals were caught at St. 3, 5, 6, and 7 on May. However, no one was found on June because of increased discharge by rainfall. Thereafter, there were 8 individuals caught at St. 3 and 7 on August, and then 8 of them were caught at St. 8 on November, which had very low discharge. As a result of measurement on physical microhabitat where they were found, it ranged from 0.14 to 0.49 m on water depth (mean: 0.30 m) and from 0.239 to 0.644 m s^{-1} (mean: 0.437 m s^{-1}) (Fig. 2).

In 2008, we concentrated investigation in mid- to lower region (St. 3～St. 8) of the Gam Stream, which the species were mostly caught in the previous year.

There were total 28 individuals caught, and we also found the species at St. 4 which the species was not found in 2007. On July, 14 individuals were collected in broad region (St. 3～St. 7), whereas another 14 individuals were caught in lower region (St. 7～St. 8) on November. As a result of measurement on total length of the species caught

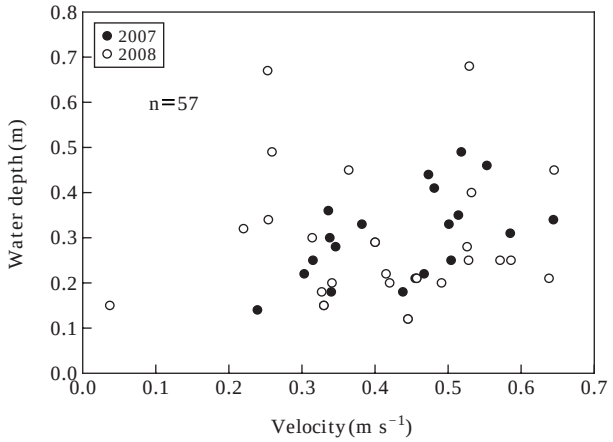

Fig. 2. Water depth and velocity of microhabitats *Gobiobotia naktongensis* inhabited in the Gam Stream.

in 2008, size of the species on November (mean: 51 mm, range: 41～57 mm) was higher than mean on July (28 mm, 12～45 mm) so that the finding indicated their seasonal growth. Meanwhile, they inhabited from 0.12 to 0.68 m on water depth (mean: 0.29 m) and from 0.037 to 0.645 m s^{-1} (mean: 0.411 m s^{-1}), and there was no relationship between the fish size and depth or velocity (Fig. 2).

With sieve analysis of stream bed in the sampling sites, we determined substrate composition in the Gam Stream. Compared with the results on June and August 2007, there was no difference occurred in the upper region (St. 1～St. 2). Even though change of substrate composition could be caused in the mid- to lower region (St. 3～St. 8) of the stream due to fluctuation of water depth and velocity by rainfall, no drastic change of substrate composition was not found, overall. Meanwhile, particle size on August in the tributaries (St. 9, 10, 11) seemed to be increased compared to the size on June (Fig. 3).

Based on the results of substrate composition and distribution of *Gobiobotia naktongensis*, the species seemed to prefer shallow run (0.14～0.46 m, 0.239～0.585 m s^{-1}) microhabitat than deep pool. In addition, they prefer about 1% of gravel (>4.74 mm), 83.4% coarse sand (>0.425 mm), and 15.6% fine sand (>0.075 mm), based on analysis of substrate composition that they were found.

The results are similar with general information provided by Kang *et al.* (2004). The species is bottom dwelling fish such as Goby minnow (*Pseudogobio esocinus*), which feeds on microorganism by filtering substrate material. According to the

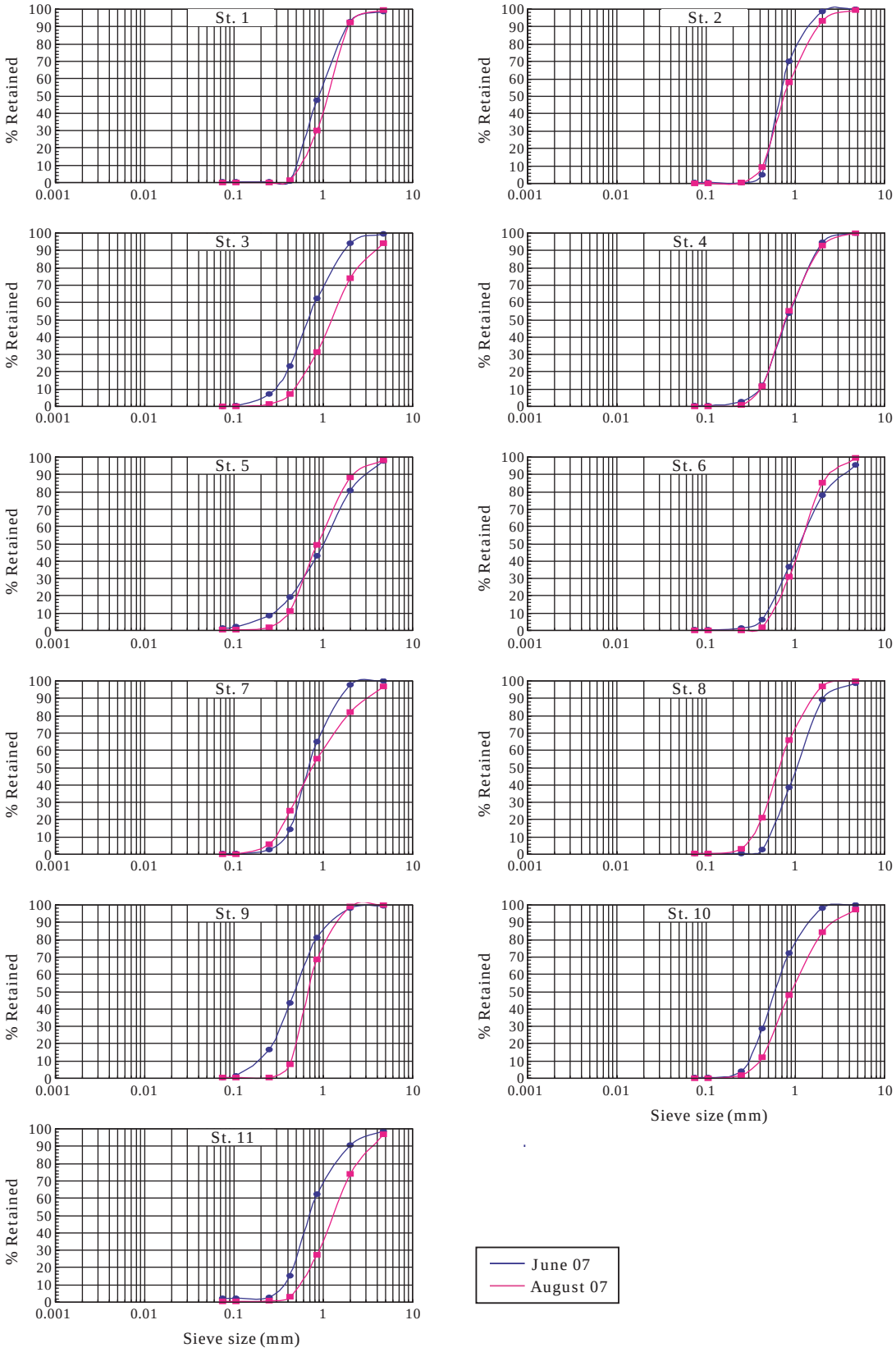

Fig. 3. Curves of particle size by sieve analysis in the sampling sites, Gam Stream.

results, we also found *Pseudogobio esocinus* in most sites *Gobiobotia naktongensis* were caught, but they are not always found simultaneously in other watersheds. The species may need more limited requirement on their microhabitat. Therefore, it is important to understand why they inhabit shallow run with sandy bottom and furthermore to enhance efficiency of fish conservation and ecological restoration with understanding species-specific characteristics in microhabitat including protected species.

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