第30卷 第6期 水 生 生 物 学 报 Vol. 30, No. 6
2006年11月 ACTA HYDROBIOLOGICA SINICA Nov., 2006

FISH FAUNA OF THE HWAJINPO LAKE, KOREA

JUNKIL Choi[1 *], OSAMU Mitamura[2], YASUSHI Seike[3] and KAORU Fujinaga[3]

(1. *Department of Biological Science, Sangji University 220-702, Korea*; 2. *Limnological Laboratory, School of Environmental Science, University of Shiga Prefecture 522-0057, Japan*; 3. *Faculty of Science and Engineering, Shimane University 690-8504, Japan*)

Abstract: The Fish fauna of the Hwajinpo Lake, one of the lagoons on the east coast of Korea, was investigated during six days between November, 2003 and May, 2004. Fifteen species belonging to eight families and six orders were collected. Among the 15 species recorded, brackish water and/or marine fishes were represented by six species, while three additional species were identified as migratory fish, and six species were purely freshwater fish. During the six months, all of the survey period with six sampling dates, nine species belonging to six families were collected at Station 1, with *Chaenogobius urotaenia* presenting the highest biomass (39%). Twelve species belonging to six families were collected at Station 2, with *Carassiu cuvieri* showing the highest biomass (20%). Five species belonged to three families at Station 3, with *Hemiculter eigenmanni* showing the highest biomass (69%). The dominant and subdominant species were *C. cuvieri* (16%), *Carassius auratus* and *Tribolodon hakonensis* (14%), respectively. Also, diversity indices were 0.95 (Station 3) and 2.08 (Station 2), while the dominant indices were 38.40 (Station 2) and 87.18 (Station 3). The evenness indices were calculated with 0.59 (Station 3) and 0.84 (Station 2).

Key words: Fish fauna; Hwajinpo Lake; Lagoon

CLC number: Q958.15 **Document code**: A **Article ID**: 1000-3207(2006)06-0633-05

There are seven lagoons on the east coast of Korea, including Kyeongpo Lake, Hyang Lake, Mae Lake, Chungcho Lake, Yeoungrang Lake, Songji Lake and Hwajinpo Lake. They are all originally natural and brackish water lakes. Therefore, these lakes are not only historically very important but also have high values for geological, and ecological sciences.

Natural lakes like lagoons are different from man-made lakes. That is, water level in natural lakes is almost constant, cline by waterside is not much, and wet land vegetation is well-developed. Various plants and animals inhabit in these watersides and the biodiversity of there is very high. They can help to clean up polluted materials induced from watershed. However, lagoons in waterside wetland of east coast of Korea are changed into farm land, walking or traffic road and so on. They are constructed around lakes for getting tourists. Therefore, many waterside wetlands were destroyed[1].

On the other hand, domestic sewage and various waste waters from watersheds are drained into lakes, and water pollution is accelerating quickly via release of mineral nutrients from non-point pollution resources. Especially, eutrophication caused by over-loading with nutrients, and subsequent algal blooms followed by fish-kill accidents occur very frequently in several lakes. Therefore, the status of species biodiversity in those lakes is much at risk and declining[1].

Lake area of Hwajinpo Lake covers 2,305km^2, water surface area is 19.94km^2[2]. On average, the water depth ranges between 1.2 and 3.55m; with the southern and northern parts of the lake being the most significant portion. Water depth in the northern part of the lake reaches about 2m, while in the upper region of the southern lake depth ranges between 1.2 and 1.9m. The central region and eastern part of the southern lake is 2—3.3m deep. Moreover, water depth in border region between the north-

Received date: 2004-11-4; **Accepted date**: 2006-3-9

Foundation item: Found of the Sangji University, 2002

Corresponding author: Junkil Choi, E-mail: jkilchoi@mail.sangji.ac.kr

ern and the southern part of the lake is very shallow, reaching around 1m[1].

Much research has been done in the Hwajinpo Lake, but most of the studies focused on water quality surveys and on the flora or fauna, mainly related to plankton research. In this study, we present data on a fish survey in the Hwajinpo Lake. There are not much data available on fish and the data presented here will provide a basis for establishing the background information for the development of ecosystem reservation and management plans for the Hwajinpo Lake.

1 Materials and methods

1.1 Surveyed period Fishes of Hwajinpo Lake were collected during six months (November, 2003 and May, 2004) with one sampling day per month.

1.2 Survey sites The locations of the sampling sites are depicted in Fig. 1. Three sites were selected: Station 1 is located in the northern part of the Hwajinpo Lake which is more affected by sea water, while Station 2 is the border region between the north and south lake. Station 3 represents the south part of the Hwajinpo Lake; it is not affected by sea water.

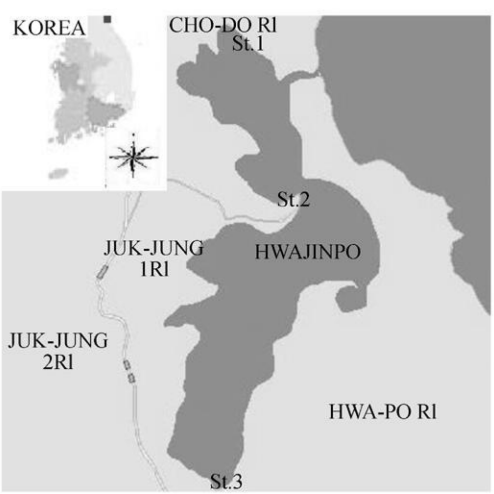

Fig. 1 Map of Hwajinpo Lake showing the position of sampling sites

1.3 Sample collection and identification Collection of fishes was undertaken using a throwing net (mesh size 5mm× 5mm, and 7mm × 7mm), a hand net (mesh size 4mm × 4mm, and 11mm), a gill net (mesh 15mm × 15mm), and fish traps (mesh 3mm×3mm). We also tried to directly investigate the habitat status. Collected fishes were immediately fixed in 10% formalin solution, brought to the laboratory, and then identified. Identification and classification was performed by using methods described by Chung[3], Kim[4], Choi et al.[5], Kim and Kang[6], Kim and Park[7]. The system of classification used was the one published by Nelson[8].

1.4 Community analysis Dominance indices were determined by using the McNaughton's dominance index calculation method[9]. Furthermore, the species diversity index, the Richness index and the Evenness index were calculated using the Shannon-Weaver Function[10] induced by information theory of Magalef[11].

2 Result and dicussion

2.1 Fish fauna

Fifteen species of eight families belonging to five orders were collected at the total sampling sites of Hwajinpo Lake (Tab. 1).

When compared by families, Cyprinidae dominated with six species, while Gobiidae and Mugilidae contributed with two species; Clupeidae, Osmeridae, Plocoglossidae, Gasterosteidae and Channidae were all represented by one species. Counting individuals, among the total of 327 fish collected, Cyprinidae accounted with 185 specimens to 57%; Osmeridae were represented with 40 individuals (12%), while Gobiidae had 39 specimens (12%), Clupeidae were represented by 34 specimens (10.4%), and Mugilidae by 17 individuals (5.2%), Ploglossidae was 7 (2.1%), Gasterosteidae was 4 (1.2%), and Channidae were rare with only one individual caught (0.3%).

Also, among the 15 species, brackish water fishes or marine fishes were represented by six species, while migratory fishes were present with three species, and freshwater fishes again had six species. When counting individuals, brackish water fish and/or marine fish were represented by 94 individuals (28.8%), migratory fishes were accounted for by 93 individuals (28.4%), and freshwater fish were 140 individuals (42.8%). Therefore, this lake area can be considered as a typical brackish water zone connected to the sea, while being greatly affected by freshwater. That is, brackish water fishes or marine fishes inhabit richly the area of gradual salinity change, while individuals of freshwater fishes were also abundant. Therefore, Hwajinpo Lake has well-maintained the characteristics of

Tab. 1　List of fish species and their abundance collected from the Hwajinpo Lake at three sampling sites in 2003—2004

Scientific name	Sites			Total n	Relative abundance(%)
	1	2	3		
Clupeiformes					
Clupeidae					
• *Konosirus punctatus*		34		34	10.39
Cypriniformes					
Cyprinidae					
◎*Cyprinus carpio*		1		1	0.31
◎*Carassius auratus*	1	45		46	14.07
◎*Pseudorabora pavra*	1	13		14	4.28
◎*Carassius cuvieri*		51		51	15.59
□*Tribolodon hakonensis*	2	37	7	46	14.07
◎*Hemiculter eigenmanni*			27	27	8.26
Osmeriformes					
Osmeridae					
□*Hypomesus olidus*		39	1	40	12.23
Plocoglossidae					
□*Plecoglossus altivelis*	4	3		7	2.14
Gasterosteiformes					
Gasterosteidae					
• *Gasterosteus aculeatus*	4			4	1.22
Mugiliformes					
Mugilidae					
• *Mugil cephalus*		2	1	3	0.92
• *Mugil haematocheila*	6	5	3	14	4.28
Perciformes					
Gobiidae					
• *Tridentiger obscurus*	4	8		12	3.67
• *Chaenogobius urotaenia*	15	12		27	8.26
Channidae					
◎*Channa argus*	1			1	0.31
Total n	38	250	39	327	100
Total = 6 orders　8 families　15 species and 327 individuals					

•: Brackish water fish or marine fish　◎: Freshwater fish　□: Migratory fish

brackish water fish fauna. This is due to the fact that the lagoon is not much inundated by the freshwater stream.

Through all the surveyed periods, nine species of six families were collected from Station 1, and *Chaenogobius urotaenia* appeared to have the highest biomass (39.5%) next to *Mugil haematocheila* (15.8%); *Plecoglossus altivelis*, *Gasterosteus aculeatus* and *Tridentiger obscurus*, the three of which accounted for 10.5%. *Tribolodon hakonensis* was represented in the samples with 5.3% of the biomass while *Carassius auratus*, *Pseudorabora pavra* and *Channa argus* accounted for 2.6%. Twelve species of six families collected from Station 2, and *Carassiu cuvieri* had the highest biomass value (20.4%), which was next to *C. auratus* (18%), while others such as *Hypomesus olidus* (15.6%), *T. hakonensis* (14.8%), *Konosirus punctatus* (13.6%), *P. pavra* (5.2%), *C. urotaenia* (4.8%), *Tridintiger obscurus* (3.2%), *M. haematochelia* (2.0%), *P. altivelis* (1.2%), *Mugil cephalus*

(0.8%), and *Cypriuus carpio* (0.4%) represented much lower biomasses as indicated. Also, five species of three families were collected from Station 3, *Hemiculter eigenmanni* represented the highest value of biomass (69.2%); next to *T. hakonensis* (18%) and *M. haematochelia* (7.7%). *H. olidus* and *M. cephalus*, the latter two of which were represented by one individual only (2.6%).

The dominant and subdominant species are shown in Tab. 2 In Station 1, *C. urotaenia* and *M. haematocheila*; in Station 2, *C. cuvieri* and *C. acratu*; in Station 3, *H. eigenmanni* and *T. hakonensis* were the dominant and subdominant species. Dominant and subdominant species differed greatly among surveyed sites. Apparently, the water environment of the surveyed sites is also very different. Also, *C. argus* appeared at Station 1; *K. punctatus*, *C. carpio* and *C. cuvieri* appeared at Station 2; *H. eigenmanni* appeared at Station 3.

There were also seasonal differences in the appearance of species. *P. altivelis* mainly appeared in May (spring); *C. auratus*, *P. pavra*, *T. hakonensis*, and *H. olidus* mainly inhabited at Station 2; *T. obscurus* and *C. urotaenia* mainly inhabited at Station 1 and 2.

K. punctatus broadly inhabits the west-southern part of Korea, and appear in lagoons of the eastern parts of Korea owing to the rise of seawater temperature along the east coast. Therefore, these studies have to be performed over a long period of time to clearly demonstrate trends.

In addition, although we could not fully demonstrate this during the survey, several species such as *Oryzias latipes*, *Misgurnus anguillicaudatus*, *Pungitius sinensis*, *Rhinogobius brunneus* and others may also have inhabit this area as there occurrence is historically known.

Among 15 fish species of eight families collected in this survey, the dominant species was *C. cuvieri* (relative abundance: 15.6%); and the subdominant species were *C. auratus* and *T. hakonensis* (14.1%). The other species that followed were *H. olidus* (12.2%), and *K. punctatus* (10.4%) (Fig. 2).

Tab. 2 Dominant and subdominant species at the three sampling sites. Dominance is expressed in percentage of all species occurring at the site over the entire sampling period

Station	Dominant species	Subdominant species	Dominance Index (%)
1	*Chaenogobius urotaenia*	*Mugil haematocheila*	55.26
2	*Carassius cuvieri*	*Carassius auratus*	38.4
3	*Hemiculter eigenmanni*	*Tribolodon hakonensis*	87.18

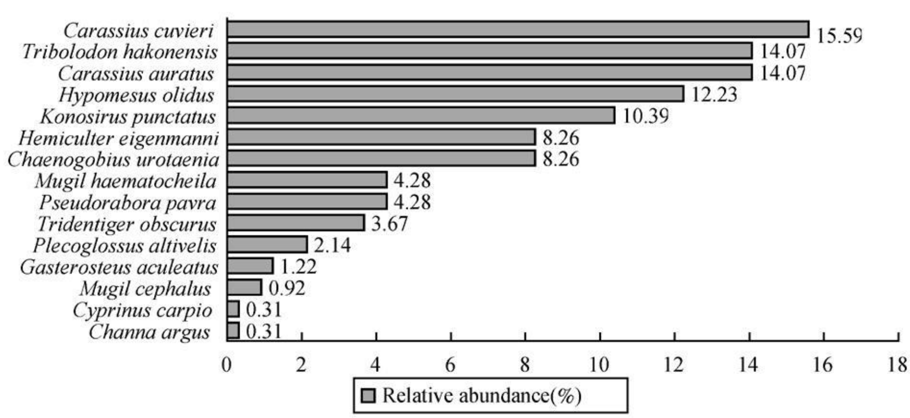

Fig. 2 Species composition of the fish in the Hwajinpo Lake as revealed from samples obtained during the entire sampling period and at the three sampling sites and expressed as percentages

2.2 Community analysis

Species diversity, dominance and evenness indices at three surveyed sites were analyzed and are shown in Fig. 3.

The highest diversity index was obtained at Station 2 (2.08), followed by Station 1 (1.8), and Statopm 3 with 0.95. Therefore, Station 3 can be considered as a poor fish habitat. The dominance index was the highest at Station 3 (87.2), while Station 1 was lower with 59.3, and Station 2 was lowest with 38.40, while the total average for the dominance index over all species was 60.3 (Tab 2).

In contrast the highest evenness index was obtained at Station 2 (0.84), while at Station 1 this index was with 0.82 somewhat lower, and at Station 3 was 0.59. Total average of the evenness index over all three stations was 0.75 (Fig. 3).

In conclusion, just two species (13.33%) among 15 were considered to be common species at all surveyed sites of the Hwajinpo Lake. This indicates that habitat and environmental conditions are very different among surveyed sites within the Hwajinpo Lake.

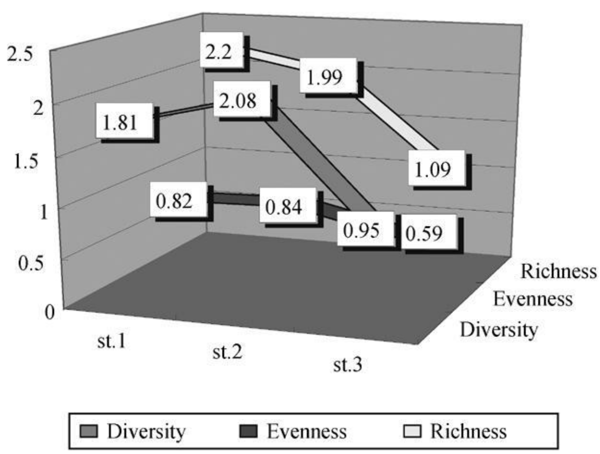

Fig. 3 Calculated indices for Diversity, dominance and evenness, calculated as indicated in the Material and Methods. Data show values for each of the three sampling stations (St) at the collected stations

3 Conclusion

Fish fauna of the Lake Hwajinpo was investigated for 6 days in November, 2003 and May, 2004, which represents one of the lagoons of east coast of Korea. Fifteen species belonging to 8 families of 6 orders were collected, and the dominant and subdominant species were identified with *C. cuvieri* (15.59%), *C. auratus* and *T. hakonensis* (14.07%).

Also, diversity indices ranged between 0.95 and 2.08, while the dominance index varied between 38.40 and 87.18, and the evenness index ranged from 0.59 to 0.84. Therefore, the fish fauna of Hwajinpo Lake showed drastic differences among surveyed sites.

References:

[1] Wonju regional environmental office, 2003. Study Reports of Lagoons III: 507

[2] Wonju regional environmental office, 2001. Study Reports of Lagoons II: 405

[3] Chung M K, 1961. Illustrated encyclopedia. The fauna of Korea (2). Fishes. Chungang publishing Co., Seoul: 81—696

[4] Kim, I. S., 1997. Illustrated encyclopedia of fauna and flora of Korea. Vol. 37. freshwater fishes. Ministry of education. Samhwa Publishing Co., Seoul: 133—520

[5] Choi, K. C., S. L. Jon, I. S. Kim & Y. M. Son, 1990. Coloured illustrations of the freshwaterfishes of Korea. Hyangmunsa, Seoul: 17—219

[6] Kim, I. S. & E. J. Kang, 1993. Colored fishes of Korea. Academy Publishing Co., Seoul: 115—450

[7] Kim, I. S. & J. Y. Park, 2002. Freshwater fishes of Korea. Kyo-Hak Publishing Co., Seoul: 1—465

[8] Nelson, J. S., 1994. Fishes of the world. John Wiely & Sons, New York: 1—600

[9] McNaughton, S. J., 1967. Relationship among functional properties of California Glassland. Nature 216: 168—144

[10] Pielou E. C., 1966. The measurement of diversity in different types of biological collections. Journal of Theoretical Biology 13: 131—144

[11] Margalef, R., 1958. Information theory in ecology. General Systems 3: 36—71