

Freshwater Benthic Macroinvertebrate Fauna of Jindo Island, Korea

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ABSTRACT

Freshwater benthic macroinvertebrates were investigated from five sampling sites on Jindo Island located in the southwestern end of the Korean Peninsula. A total of 47 species (average 14 ± 3.16 species per site, 40 species in lotic area, and 13 species in lentic area) belonging to 38 families, 14 orders, 5 classes, and 3 phyla were sampled. Coleoptera, Diptera, Ephemeroptera, and Trichoptera were the major groups of benthic macroinvertebrates with relatively high species richness. Species diversity indices (H') and richness indices (RI) of upper streams were relatively higher than those of lower streams, which were affected by agricultural effluent from the paddy fields.

Keywords: freshwater benthic macroinvertebrates, fauna, community composition, Jindo Island, Korea

INTRODUCTION

Jindo Island, belonging to Jindo-gun, Jeollanam-do, is located on the southwestern end of the Korean Peninsula ($34^{\circ}08' - 34^{\circ}35'N$, $125^{\circ}37' - 126^{\circ}28'E$). The island is the third largest (440.1 km^2) in Korea and it geographically demarcates the western and southern coasts of the peninsula. The highest peak of the island is the Mt. Cheomchalsan (elevation 485 m above sea level), which is located in the eastern part of the island. Freshwater systems are relatively well developed on the island.

Faunistic studies on marine invertebrate groups, such as crustaceans (Rho et al., 2005) and mollusks (Kil et al., 2005), were conducted on Jindo Island during the joint field survey in commemoration of the 20th anniversary of the Korean Society of Systematic Zoology in 2005. In the National Natural Environment Survey, faunistic investigations on freshwater benthic macroinvertebrates were conducted on Jindo Island in 1998 (Ministry of Environment of Korea, 1998) and in 2012 (Cho and Park, 2012).

The purpose of this study is to investigate the benthic macroinvertebrate fauna from freshwater systems on Jindo Island. The results of this benthic macroinvertebrate survey can be used as basic data for long-term ecological research

on Jindo Island.

MATERIALS AND METHODS

Benthic macroinvertebrates were collected from 5 sampling sites on Jindo Island during July 7–9 in 2016 (Fig. 1). Four lotic sites were chosen from the upper and middle stream reaches (stream order I–III) of the mountain streams in Mt. Cheomchalsan and Mt. Yeogwisan, along with 1 lentic site from a pond in the agricultural area (Table 1).

For quantitative purposes, benthic macroinvertebrates were sampled using a Surber sampler ($30 \times 30 \text{ cm}$, mesh 0.2 mm) and a Dredge sampler ($40 \times 20 \text{ cm}$, mesh 0.2 mm) (3 Surber samples in lotic area at riffle, run, and pool habitats and 2 Dredge samples in lentic area at marginal habitats with aquatic plants). Additional qualitative samples were taken using a hand net (mesh 1 mm) in a variety of microhabitats.

Sampled materials were kept in 250–500 mL plastic vials with 80% ethanol and brought to the laboratory for sorting of benthic macroinvertebrates. Sorted benthic macroinvertebrates were preserved in 80% ethanol. They were identified to the species level or lowest taxonomic categories using

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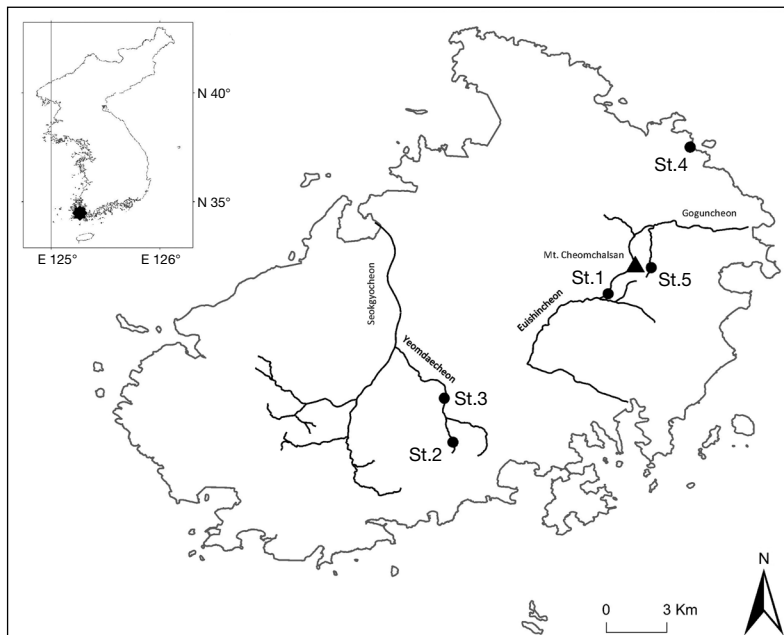


Fig. 1. Sampling sites on Jindo Island, Jindo-gun, Jeollanam-do in South Korea.

Table 1. Geographic data of sampling sites on Jindo Island, Jindo-gun, Jeollanam-do in South Korea

Site	Location	Stream order	Altitude (m)
St.1	Upper stream of Euisincheon (34°28'04.97"N, 126°18'28.66"E)	I	100
St.2	Upper stream of Yeomdaecheon (34°24'07.78"N, 126°14'20.72"E)	II	110
St.3	Middle stream of Yeomdaecheon (34°25'18.10"N, 126°14'06.95"E)	III	10
St.4	Byeokpa-ri, Gogun-myeon (34°31'59.36"N, 126°20'39.80"E)	Lentic	0
St.5	Upper stream of Goguncheon (34°28'46.68"N, 126°19'37.62"E)	I	230

available references (Kim, 1973, 1977; Kwon, 1990; Yoon, 1995; Jung, 2011). Materials were deposited in the Korea University Entomological Museum, Seoul.

The Shannon diversity index (H'), McNaughton's dominance index (DI), and Margalef's richness index (RI) were calculated using the quantitative sampling data (per 1 m²) (Magurran and McGill, 2011).

RESULTS AND DISCUSSION

On the basis of quantitative and qualitative sampling, a total of 47 species belonging to 38 families, 14 orders, 5 classes, and 3 phyla were identified from the study sites on Jindo Island (Appendix 1). Forty species belonging to 32 families, 14 orders, 5 classes, and 3 phyla were sampled from the lotic sites, whereas 13 species belonging to 13 families, 5 orders, 3 classes, and 3 phyla were sampled from the lentic site (Table 2).

Non-insect benthic macroinvertebrates consisted of An-

nelida (4 species, 8.5%), Mollusca (3 species, 6.4%), and Malacostraca (4 species, 8.5%), and accounted for 23.4% of the total species richness. Aquatic insects included Diptera (8 species, 17.0%), Ephemeroptera (7 species, 14.9%), Trichoptera (6 species, 12.8%), Coleoptera (5 species, 10.6%), Plecoptera (4 species, 8.5%), Hemiptera (4 species, 8.5%), and Odonata (2 species, 4.3%), and accounted for 76.6% of species richness. Ephemeroptera, Diptera, and Trichoptera were the major benthic macroinvertebrate taxa showing a high degree of species richness in the lotic sites, whereas Hemiptera and Mollusca were the major taxa in the lentic site.

On the basis of quantitative sampling (per 1 m²), aquatic insects (Ephemeroptera, 1,019 individuals, 12.9%; Odonata, 348 individuals, 4%; Plecoptera, 45 individuals, 0.6%; Hemiptera, 56 individuals, 0.7%; Coleoptera, 284 individuals, 3.6%; Diptera, 2,014 individuals, 25.5%; Trichoptera, 1,218 individuals, 15.4%) represented 63.2% of the total individual number of benthic macroinvertebrates collected from

Table 2. Species richness of benthic macroinvertebrates on Jindo Island based on quantitative and qualitative sampling data

Taxa	St.1	St.2	St.3	St.4	St.5	Whole area
Phylum Mollusca	–	–	1	3	–	3
Phylum Annelida	2	2	4	–	–	4
Phylum Arthropoda						
Class Malacostraca	3	3	–	1	2	4
Class Insecta						
Order Ephemeroptera	2	1	4	–	3	7
Order Odonata	2	1	–	–	2	2
Order Plecoptera	1	1	–	–	2	4
Order Hemiptera	–	1	–	4	–	4
Order Coleoptera	1	–	–	2	2	5
Order Diptera	2	2	1	3	4	8
Order Trichoptera	2	1	1	–	4	6
Total	15	12	11	13	19	47

Table 3. Total number of species and individuals, first and second dominant species, diversity index (H'), dominance index (DI), and richness index (RI) of benthic macroinvertebrates based on quantitative sampling data (per 1 m²) on Jindo Island

Site	No. of species	No. of individuals	First dominant species (%)	Second dominant species (%)	H'	DI	RI
St.1	15	842	<i>Gammarus sobaegensis</i> (30.04)	<i>Asellus</i> sp. (26.48)	2.58	0.57	2.08
St.2	12	373	Chironomidae spp. (45.84)	<i>Gammarus sobaegensis</i> (17.69)	2.30	0.64	1.86
St.3	11	539	<i>Cheumatopsyche</i> KUa (56.59)	Chironomidae spp. (28.01)	1.80	0.37	1.59
St.4	10	86	<i>Cardina denticulata denticulata</i> (73.26)	<i>Asellus</i> sp. (12.79)	1.59	0.86	2.02
St.5	19	315	Chironomidae spp. (26.35)	Psephenidae sp. (19.37)	3.17	0.46	3.13

the sampling sites, whereas non-insect benthic macroinvertebrates (Annelida, 20 individuals, 0.3%; Mollusca, 534 individuals, 6.8%; Malacostraca, 2,347 individuals, 29.8%) represented 36.8%. In general, the benthic macroinvertebrate communities inhabiting Jindo Island were dominated by *Gammarus sobaegensis* or Chironomidae spp. in the upper stream reaches, and *Cheumatopsyche* KUa and *Cardina denticulata denticulata* in the lower stream reaches and lentic area, respectively (Table 3).

The H', DI, and species RI were within the following ranges (mean \pm SD): 1.59–3.17 (2.29 \pm 0.63), 0.37–0.86 (0.58 \pm 0.19), and 1.59–3.13 (2.14 \pm 0.59), respectively (Table 3). The diversity index (H') was the highest at site 5, followed by sites 1, site 2, and site 3, representing high-quality ecological habitat conditions at site 5.

In a series of faunistic investigations on freshwater benthic macroinvertebrates on Jindo Island from the National Natural Environment Survey, a total of 48 species belonging to 32 families, 12 orders, 6 classes, and 4 phyla were recorded in 1998 (Ministry of Environment of Korea, 1998) and a total of 29 species belonging to 23 families, 12 orders, 5 classes, and 4 phyla were recorded in 2012 (Cho and Park, 2012). No certain tendency for fluctuation of fauna could be inferred because of the lack of unity in investigating methods as well as in the number of sampling sites.

As agriculture is the major land use type on Jindo Island,

freshwater systems, particularly in the lower reaches of the streams, are channelized and affected by agricultural effluents from the paddy fields. Comparatively, the upper reaches of the streams, especially sites 1 and 5 located in the Mt. Cheomchalsan, are relatively well preserved.

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Appendix 1. Density of freshwater benthic macroinvertebrates (per 1 m²) on Jindo Island

Species	Sampling sites				
	St.1	St.2	St.3	St.4	St.5
Phylum Mollusca					
Class Gastropoda					
Order Basommatophora					
Family Lymnaeidae					
<i>Radix auricularia</i>	–	–	4	13	–
Family Physidae					
<i>Physa acuta</i>	–	–	–	⊙	–
Family Planorbidae					
<i>Polypylis hemisphaerula</i>	–	–	–	3	–
Phylum Annelida					
Class Oligochaeta					
Order Archiologochaeta					
Family Tubificidae					
<i>Limnodrilus</i> spp.	396	11	67	–	–
Naididae sp.	–	–	15	–	–
Class Hirudinea					
Order Arhynchobdellidae					
Family Erpobdellidae					
<i>Erpobdella lineata</i>	26	8	8	–	–
Order Rhynchobdellida					
Family Glossiphoniidae					
<i>Alboglossiphonia lata</i>	–	–	4	–	–
Phylum Anthropoda					
Class Crustacea					
Order Decapoda					
Family Cambaridae					
<i>Cambaroides similis</i>	4	23	–	–	4
Family Atyidae					
<i>Cardina denticulata denticulata</i>	–	–	–	158	–
Order Amphipoda					
Family Gammaridae					
<i>Gammarus sobaegensis</i>	938	245	–	–	127
Order Isopoda					
Family Asellidae					
<i>Asellus</i> sp.	826	26	–	–	–
Class Insecta					
Order Ephemeroptera					
Family Baetidae					
<i>Baetis fuscatus</i>	133	–	170	–	41
Family Caenidae					
<i>Caenis nishinoae</i>	–	–	22	–	–

Appendix 1. Continued

Species	Sampling sites				
	St.1	St.2	St.3	St.4	St.5
Family Ephemeroidea					
<i>Ephemera orientalis</i>	–	–	11	–	–
<i>Ephemera strigata</i>	–	–	–	–	130
Family Heptageniidae					
<i>Ecdyonurus dracon</i>	244	–	–	–	–
<i>Ecdyonurus kibunensis</i>	–	158	–	–	100
<i>Ecdyonurus levis</i>	–	–	4	–	–
Order Odonata					
Family Gomphidae					
Gomphidae sp.	4	223	–	–	92
<i>Davidius lunatus</i>	7	–	–	–	22
Order Plecoptera					
Family Nemouridae					
Nemouridae sp.	–	–	–	–	4
<i>Nemura</i> KUa	–	11	–	–	–
Family Perlidae					
<i>Kamimuria</i> KUa	–	–	–	–	15
<i>Neoperla quadrata</i>	15	–	–	–	–
Order Hemiptera					
Family Corixidae					
Corixidae sp.	–	19	–	28	–
Family Aphelocheiridae					
Aphelocheiridae sp.	–	–	–	3	–
Family Notonectidae					
<i>Notonecta</i> sp.	–	–	–	3	–
Family Gerridae					
Gerridae sp.	–	–	–	3	–
Order Coleoptera					
Family Hydrophilidae					
<i>Hydrochara affinis</i>	–	–	–	3	–
<i>Amphiops</i> sp.	7	–	–	–	–
Family Helodidae					
Helodidae sp.	–	–	–	⊙	–
Family Elmidae					
Elmidae sp.	–	–	–	–	49
Family Psephenidae					
Psephenidae sp.	–	–	–	–	226
Order Diptera					
Family Tipulidae					
<i>Antocha</i> KUa	–	–	–	–	11
<i>Ormosia</i> sp.	–	–	–	–	4
Family Simuliidae					
Simuliidae sp.	14	–	–	–	–
Family Ceratopogonidae					
Ceratopogonidae sp.	–	–	–	⊙	–
Family Chironomidae					
Chironomidae spp.	471	633	559	–	307
Family Athericidae					
Athericidae sp.	–	–	–	3	4
Family Syrphidae					
Syrphidae sp.	–	–	–	3	–
Family Muscidae					
Muscidae sp.	–	4	–	–	–
Order Trichoptera					
Family Philopotamidae					
<i>Dolophilodes</i> KUa	–	–	–	–	15
Family Polycentropodidae					
<i>Plecotrocnemis</i> KUa	22	–	–	–	4
Family Hydropsychidae					

Appendix 1. Continued

Species	Sampling sites				
	St.1	St.2	St.3	St.4	St.5
<i>Cheumatopsyche</i> KUa	–	22	1,129	–	–
<i>Diplectrona</i> KUa	–	–	–	–	4
Family Rhyacophilidae					
<i>Apsilochorema</i> KUa	11	–	–	–	–
Family Glossosomatidae					
<i>Agapeus</i> KUa	–	–	–	–	11
Total number of species	15	12	11	13	19
Total number of individuals	3,118	1,383	1,997	220	1,170

The species occurred only from qualitative sampling are marked as ©.