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Research Article
Biological Diversity of Kingdom Animalia and Water Quality at the Uigokdong River, Jinhae city, Korea

Man Kyu Huh*

Department of Molecular Biology, College of Natural Sciences, Dong-eui University, Eomgwangno 176, Busanjin-gu, Busan 614-714, Korea
*Corresponding Author: *mkhuh@deu.ac.kr*

Keywords

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Abstract

Ecosystem and the communities they contain can be disturbed by human activity in a variety of ways. This study was described in the spatial patterns of animals and biological diversity for four stations at the Uigokdong River in Korea during four seasons. Invertebrate animals exhibited the greatest species diversity with 15 taxa identified, followed by birds (Aves, 10 taxa); reptiles/amphibians (Sauropsida/Amphibia) with seven taxa, and mammals represented by eight taxa. From the overall distribution of animals at different station, the low density of animal individuals was found within the disturbed region by human activity. The oxygen-demand parameters DO, COD, and BOD were within acceptable levels at upper region. The upstream portion represented the uncontaminated state of the river. The water quality of the downstream portion of the river including total nitrogen and phosphate was not within the permissible level complying with the standards in DAO (Denr Administrative Order) 34-class B.

Introduction

Water of sufficient quantity and fresh quality is critical to all organisms including human societies everywhere. Healthy and self-sustaining river systems provide ecological and services of critical importance to human societies everywhere (Postel and Richter, 2003). Nevertheless, many aquatic ecosystems are being severely altered or destroyed at a greater rate than at any other time in human history, and far faster than they are being restored. Now, humans can compromise their health by coming in contact with poor water or ingesting it. Other effects include an imbalance in healthy natural ecosystems, harm to the food chain, and impaired populations of fish and other wildlife.

Physical processes driving species distributions in space and time tend to vary in importance from place to place and vary with the scale of inquiry; and, species respond to these factors in a range of ways. The river continuum concept posited that the physical variables in river systems, from headwaters to mouth, presented a continuous gradient of physical conditions that drive the biological strategies and river system dynamics (Vannote et al., 1980). This was largely argued from the standpoint that energy input, organic matter transport, storage, and use by macroinvertebrates functional feeding groups (i.e. how an organism retrieves its food), may be regulated largely by fluvial geomorphic processes.

The Uigokdong River is started at the Uigokdong Reservoir and ends at the Daejang River. Vegetation of Uigokdong River provides water purification and flow rate of deceleration, and fish habitat. Although, riparian of the Uigokdong River and attach vegetation were the site of the distribution of fish, birds, amphibians, reptiles, etc and is very important to build food networks, the structure of this river was changed during the so-called Direct-stream Rivers Project. The principal factor controlling the distribution of aquatic plants is the depth and duration of flooding. Wildlife in rivers depends on all these floodplain components. For instance, many of the carp species need backswamps and oxbow lakes to spawn. These are also the places where fish fry find food and shelter amongst the water vegetation.

Draining of riparian wetlands or cutting off their link with the river is one of the main reasons that downstream fish population decreases. However, other factors may also control their distribution and abundance, including nutrients, disturbance from waves, grazing, and human activity. The purpose of this study is to investigate the fauna on the Uigokdong River at four regions during four seasons before secondary indirect damages occur in this river by construct of beams. Therefore, this survey recorded material significance for the future appears in the environment to restore or improve the problem may be.

Materials and Methods

Surveyed regions

There were a total of four stations identified for the water quality monitoring of the Uigokdong River, Jinhae-city, Gyeongsangnam-do (Fig. 1). This river located at Anseong province (35°126′139″N/128°80′796″E). Animal samplings were conducted at each station. Geographical ranges of the Uigokdong River were a total length of about 1.0 kilometer from the Uigokdong Mountain to the confluence of the Daejang River. Sampling periods were February, May, August, and November 2014.

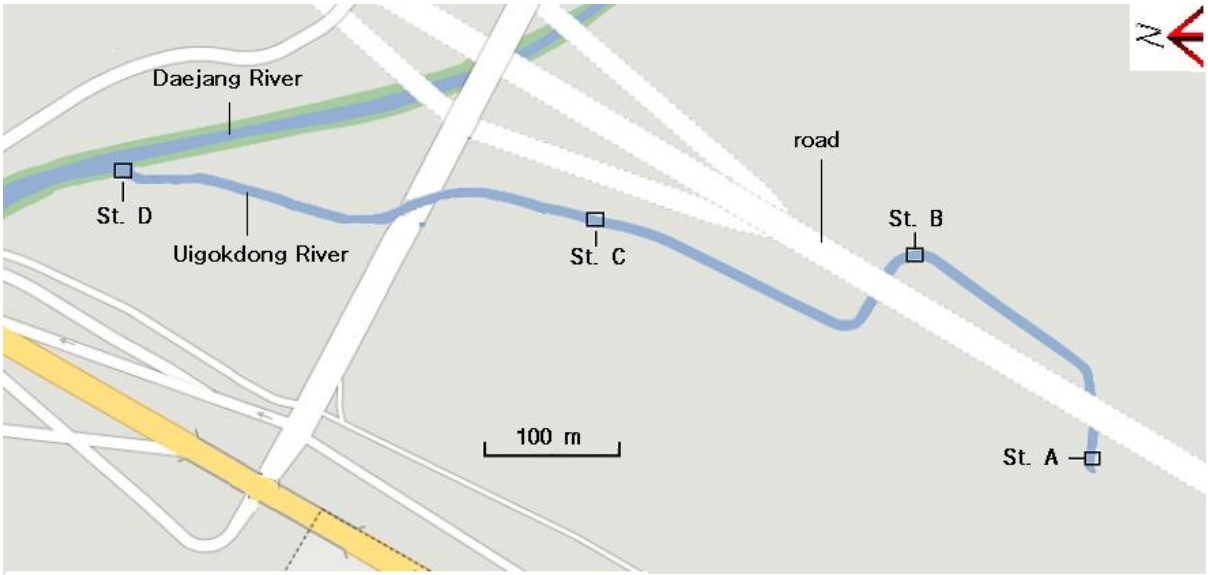

Figure 1: The four stations at the Uigokdong River, Jinhae city, Korea.

Identification of animals

Animal identification using a means of marking is a process done to identify and track specific animals. Identifications of mammals and herpetology were based on Weon (1967). Identifications of birds and herpetology were based on Yoon (2003) and Lee et al. (2012), respectively. Identifications of invertebrates were based on Merritt et al. (1996) and Kim et al. (2013).

Biotic indices

The Shannon diversity index (*H'*) is an index that is commonly used to characterize species diversity in a community (Shannon and Weaver, 1963).

$$H' = -\Sigma\, pi \ln pi$$

*p*i is the proportion of important value of the *i*th species (*p*i = *n*i / N, *n*i is the important value index of *i*th species and N is the important value index of all the species).

$N1 = e^{H'}$
$N2 = 1/\lambda$

Where λ (Simpson's index) for a sample is defined as

$$\lambda = \sum \frac{ni(ni-1)}{N(N-1)}$$

Two richness indices (R1 and R2) of animals were calculated by using Margalef's diversity index (Magurran, 1988).

Evenness indices (E1~E5) were calculated using important value index of species (Pielou, 1966; Hill, 1973).

ß-diversity is species diversity between ecosystems. ß-diversity index was calculated using the method of Tuomisto (2010).

$ß = \gamma/\alpha$

Here γ is the total species diversity of a landscape, and α is the mean species diversity per habitat.

The homogeneity of variance or mean values to infer whether differences exist among the stations samples or seasons was tested (Zar, 1984). Except where stated otherwise, statistical analyses were performed using the SPSS software (Release 21.0) (IBM Corp. Released, 2012).

Environmental factors

Laboratories and equipment were used to measure a range of water quality parameters including pH, suspended solids (SS), dissolved oxygen (DO), biochemical oxygen demand (BOD), chemical oxygen demand (COD), total phosphate, and total nitrate. The change in DO concentration is measured over a given period of time in water samples at a specified temperature. The test for BOD is a bioassay procedure that measures the oxygen consumed by bacteria from the decomposition of organic matter (Mittelbach, et al., 2001). The method for BOD was used to a standard method of the American Public Health Association (APHA) and is approved by the U.S. Environmental Protection Agency (USEPA). COD is a widely known parameter used to measure water quality using the 910 colorimeter (YSI Incorporated, Ohio, USA). It is a measure of water pollution resulting from organic matter. Total phosphorus and nitrogen in river were evaluated the use of alkaline peroxodisulfate digestion with low pressure microwave, autoclave or hot water bath heating (Maher et al., 2002). Total suspended solids (SS) were determined by membrane filtration (0.1 um polycarbonate filters).

Results and Discussion

The fauna community at the Uigokdong River on 2013 was identified with 40 taxa, representing four classes (Table 1). Invertebrate animals exhibited the greatest species diversity with 15 taxa identified, followed by birds (Aves, 10 taxa); mammals represented by eight taxa, and reptiles/amphibians (Sauropsida/Amphibia) with seven taxa.

Upper regions of river were shown with the relative high animal density or abundance across areas (Table 1).

Table 1: Diversity index for mammals and birds in the Uigokdong River

Indices	**Mammal**				**Bird**			
	St. A	**St. B**	**St. C**	**St. D**	**St. A**	**St. B**	**St. C**	**St. D**
Richness								
No. of species	8	6	7	3	10	8	8	4
R1	2.203	1.803	1.895	1.116	2.976	2.377	2.422	1.303
R2	1.633	1.500	1.604	1.125	2.000	1.835	1.886	1.265
Diversity								
H'	1.990	1.721	1.635	1.011	2.190	1.986	1.937	1.280
N1	7.319	5.592	5.128	2.749	8.933	7.288	6.939	3.596
N2	9.200	8.571	8.273	3.750	11.538	10.059	9.000	4.500
Evenness								
E1	0.957	0.961	0.912	0.921	0.951	0.955	0.932	0.923
E2	0.915	0.932	0.855	0.916	0.893	0.911	0.867	0.899
E3	0.903	0.918	0.826	0.875	0.881	0.898	0.848	0.865
E4	1.257	1.651	1.613	1.364	1.292	1.380	1.297	1.251
E5	1.298	1.792	1.762	1.572	1.329	1.441	1.347	1.348

In order to assess macro-scale spatial variability of the animal community at the Uigokdong River, I analyzed distributions of species richness, diversity, and evenness of large taxonomic groups as well as four station compositions along a geographic distances (Tables 2 and 3). Shannon-Weaver indices (*H´*) of diversity for mammal were not varied among the stations and season. Most reptiles and amphibians hibernate for part or all of the winter. Thus, they were varied among the stations and season However, *H´* values of birds for season were different from each other because a lot of migratory birds were included in this region. Shannon-Weaver indices of diversity of St. B were similar to those of St. C (Tables 1 and 2). Richness indices and evenness indices were same trend. Vertebrate composition of St. D was less diverse than that of St. A. This decreasing trend was supported mainly by an increase of artificial disturbances such as road or house construction. The mean number of species within the St. A was 40 taxa and St. B, St. C, and St. D had 30, 28, and 17 species, respectively.

Table 2: Diversity index for reptile/amphibians and invertebrates in the Uigokdong River

Indices	**Reptile /Amphibian**				**Invertebrates**			
	St. A	**St. B**	**St. C**	**St. D**	**St. A**	**St. B**	**St. C**	**St. D**
Richness								
No. of species	7	5	4	3	15	11	9	7
R1	2.003	1.477	1.207	1.243	3.636	2.970	2.551	1.971
R2	1.565	1.291	1.155	1.342	2.188	2.043	1.877	1.528
Diversity								
H'	1.848	1.547	1.358	1.055	2.637	2.255	2.115	1.823
N1	6.346	4.699	3.888	2.872	13.975	9.537	8.287	6.188
N2	7.917	5.833	2.750	5.000	18.965	11.599	11.000	7.241
Evenness								
E1	0.950	0.961	0.980	0.960	0.974	0.929	0.962	0.937
E2	0.907	0.940	0.972	0.957	0.932	0.867	0.921	0.884
E3	0.891	0.925	0.963	0.936	0.927	0.854	0.911	0.865
E4	1.247	1.241	0.707	1.741	1.357	1.216	1.327	1.170
E5	1.294	1.307	0.606	2.137	1.385	1.242	1.372	1.203

Table 3: Water quality at four stations in the Uigokdong River

Item	**St. A**	**St. B**	**St. C**	**St. D**
pH	7.51±0.13	6.91±0.37	7.40±0.18	7.00±0.22
BOD (㎎/L)	3.60±0.24	5.09±0.57	5.01±0.27	5.56±0.32
SS (㎎/L)	18.39±1.15	21.56±2.88	26.75±2.12	27.68±1.71
DO (㎎/L)	6.03±0.33	5.35±0.66	5.44±0.64	4.94±0.39
COD (㎎/L)	3.79±0.33	4.46±0.75	4.55±0.70	5.24±0.36
T-N (㎎/L)	2.241±0.15	2.854±0.24	3.667±0.62	4.339±0.30
T-P (㎎/L)	0.111±0.02	0.124±0.03	0.130±0.02	0.133±0.02

The values of ß-diversity for fauna were similar to each other (from 0.250 for bird to 0.269 for reptile/amphibian) (Fig. 2). They indicated that heterogeneity in species compositions among the replicates were not high. There were high taxonomic homogeneity of the fauna community in between four seasons and similar trends in seasonal development of animals at riparian and channels of the same river. However, for the stations, the values of ß-diversity showed a statistically significant upper-low regions different ($p < 0.05$) (Fig. 3).

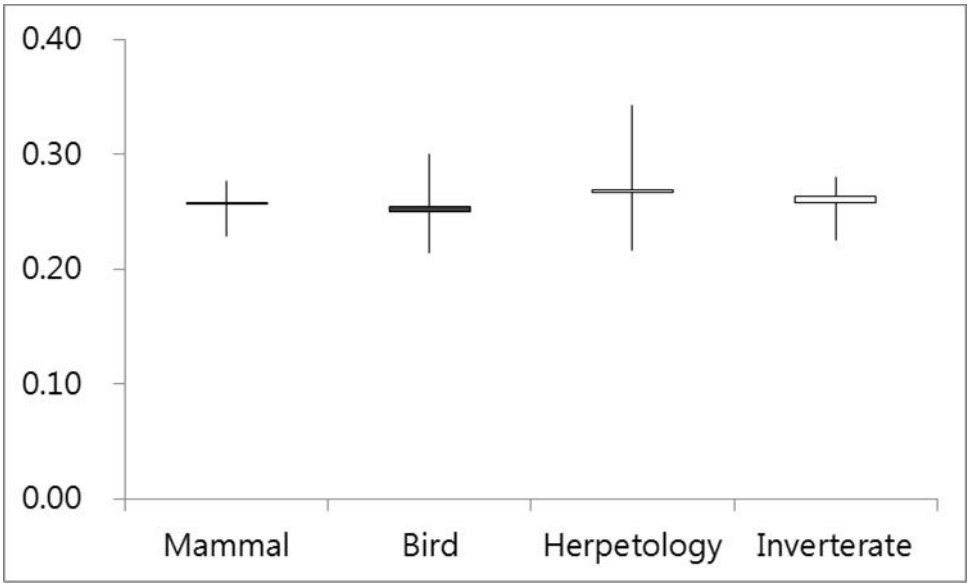

Figure 2: Occurrence index (β-diversity) for four animal kingdoms at four stations.

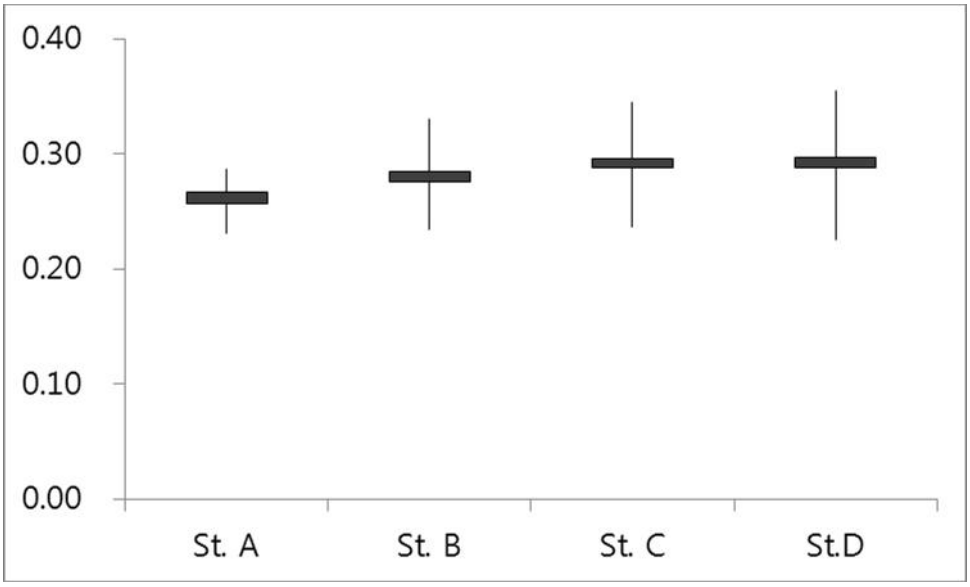

Figure 3: Occurrence index (β-diversity) of four stations for four animal kingdoms

The oxygen-demand parameters DO, COD, and BOD except St. D were within acceptable levels at upper region (Table 3). Thus, the upstream portion represented the uncontaminated state of the river. The portion of DO and COD in the river increased exponentially along the upper-down gradient. pH trends were similar to BOD trends in that St. B had a much lower magnitude trend than upper and low regions. Total nitrogen and phosphate were also accumulated downward. The water quality of the downstream portion of the river including total nitrogen and phosphate was not within the permissible level complying with the standards in DAO (Denr Administrative Order) 34-class B No (34 Section 68). SS (Suspended solids) has a significant influence on the three points (St. B, St. C, and St. D). Suspended solids are important as pollutants in water system. Thus middle and low regions remained in

suspension in water. Stone dust was carried on the surface of particles and stone powders might cover the gills of the fish. It could be affected as one indicator of mortality of fishes (EPA, 2002). In addition, Roads, highways, and bridges are a source of significant contributions of pollutants to the Uigokdong River. Contaminants from vehicles and activities associated with road and highway construction and maintenance are washed from roads and roadsides when it rains (Abechi et al., 2010). A large amount of this runoff pollution is carried directly to water bodies.

All the river basins in Korea are under the influence of monsoon climate. About 80% of the annual precipitation occurs during the summer monsoon and fall typhoon which usually lasts for about three months from mid-June to mid-September. In general, the precipitation above 800 to 1000 m falls as snow during the rainy season. Many cement blocks (between St. A and St. B) were creating instead river grasslands by Direct-stream Rivers Project. The dry season is winter. St. A and St. B were dried in winter and fishes concentrate in the shallows (St. C and St. D).

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