MAPPING SPATIAL PATTERN AND BIODIVERSITY OF KINGDOM ANIMALIA AT THE ANSEONG RIVER, CHANGWON CITY, KOREA

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ABSTRACT

Biodiversity and water quality were widely used in river ecology and natural animal fauna. The study was described in the spatial patterns of animals for four stations at the Anseong River in Korea during four seasons. Although this area was not wide, but the fauna were very diverse with 35 taxa, representing four kingdoms. Birds (Aves) exhibited the greatest species diversity with 15 taxa identified, followed by invertebrate animals (10 taxa); reptiles/amphibians (Sauropsida/Amphibia) with six taxa, and mammals (Mammalia) represented by five taxon. Fish was absent in this river. Shannon-Weaver indices (H´) of diversity for mammals was 1.120 across regions, varying from 0.562 to 1.517. Shannon-Weaver indices (H´) of diversity for reptiles, and amphibians were also varied among the stations and season. Although richness indices and evenness indices were different from each other, there were not shown significant differences ($P<0.05$). The average value of BOD and COD were 4.55 mg/ l and 4.73 mg/l, respectively. The portion of BOD and COD in the river increased exponentially along the upper-down gradient. Total nitrogen and phosphate were also accumulated downward. Thus there was decreased the number of species in this river. Many artificial actions reduced the water's natural filtration action and eliminated the habitat of fish.

Keywords: Animal fauna, biodiversity, BOD, COD, the Anseong River.

INTRODUCTION

Introduction should be given in this section. Font Size 12, Times New Roman, single spaced. All the subheadings in this section should be in font size 12 Bold, Times New Roman, single spaced. The first letter of each word in subheading should be capital.

Water is one of the most critical necessities to all organisms. Water of sufficient quality and quantity provide ecological and services of critical importance to human societies everywhere (Postel and Richter 2003). The biogeochemical processes and diverse aquatic species that regulate freshwater quantity and quality, as exemplified by pervasive degradation of the world's freshwater resources (Nilsson et al., 2005; Arthington et al., 2009). Increasing human population and growth of technology require human society to devote more and more attention to protection of adequate supplies of water (Rodrigues-Iturbe, 2000). Other effects include an imbalance in healthy natural ecosystems, harm to the food chain, and impaired populations of fish and other wildlife.

These impacts include reduced areas of wetlands, less diverse plant and animal populations, and reduced populations of native fish, birds, macroinvertebrates and aquatic and floodplain plants. Habitat loss and water depletion of fish destroyed and many other species diversity brings with it a reduction of. This report is one of those instances.

The Anseong River is started at the Anseong Reservoir and ends at the Pacific Ocean.. Vegetation of Anseong River provides water purification and flow rate of deceleration, and fish habitat. In addition, water quality is the site of the distribution of fish, birds, amphibians, reptiles, etc.

The structure of the Anseong River was changed during the so-called Direct-stream Rivers Project. This river was eventually dry in the non-rainy season. The purpose of this study is to investigate the fauna on the Anseong River at four regions during four seasons. Therefore, this survey recorded material significance for the future appears in the environment to restore or improve the problem may be.

METHODOLOGY
Surveyed Regions

This study was carried out on the Anseong River, located at Anseong province (upper region: 35°103′104″N/128°796′354″E, low region: 35°102′153″N/128°791′673″E), Changwon city in Korea (Fig. 1). In this region the mean annual temperature is 14.9℃ with the maximum temperature being 26.5℃ in August and the minimum 2.8℃ in January. Mean annual precipitation is about 1545.4 mm with most rain falling period between June and August. The periods of animal samplings were February, May, August, and November 2014.

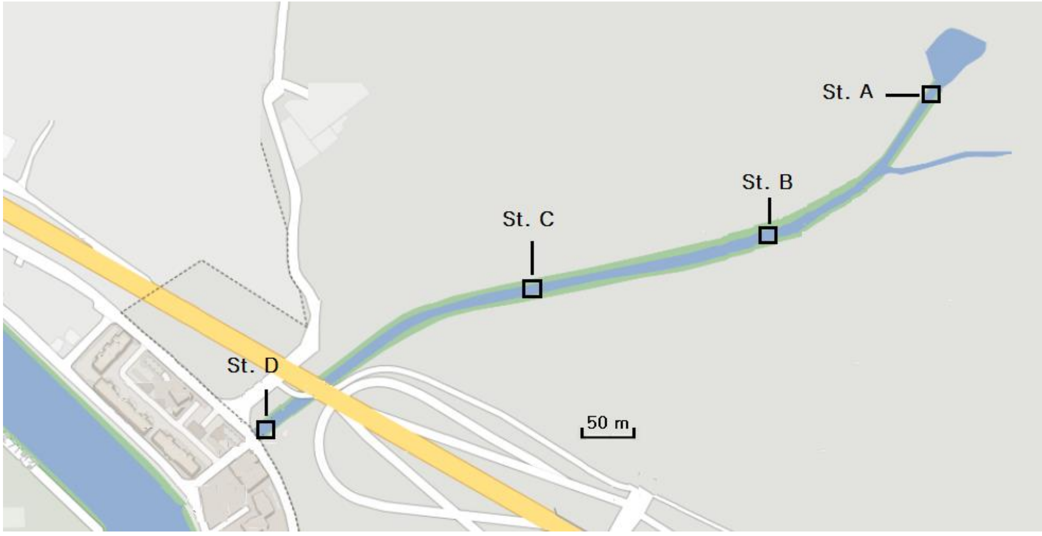

Fig. 1. The four stations at the Anseong River, Jinhae-city, Korea.

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) and Lee et al. (2012), respectively. Identifications of birds were based on Lee et al. (2005) and Yoon (2003), respectively. Identifications of birds and herpetology were based on Lee et al. (2005) and Lee et al. (2012), respectively. Identifications of invertebrates were based on Kim et al. (2013) and Merritt and Cummins (1996)

Biotic Indices

Shannon–Weaver index of diversity (Shannon and Weaver, 1963): the formula for calculating the Shannon diversity index (H') is

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

pi is the proportion of important value of the ith species ($pi = ni$ / N, ni is the important value index of ith 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

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

The species richness of animals was calculated by using the method, Margalef's indices (R1 and R2) of richness (Magurran, 1988).

$$R1 = \frac{S-1}{\ln(n)}$$

$$R2 = \frac{S}{\sqrt{n}}$$

S is the total number of species in a community and n is the total number of individuals observed.

Evenness index was calculated using important value index of species (Pielou, 1966; Hill, 1973).

$$E1 = \frac{H'}{\ln(S)}$$

$$E2 = \frac{e^{H'}}{S}$$

$$E3 = \frac{e^{H'}-1}{S-1}$$

$$E4 = \frac{1/\lambda}{e^{H'}}$$

$$E5 = \frac{(1/\lambda) - 1}{e^{H'} - 1}$$

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 (Sawyer and McCarty, 1978). 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 Anseong River on 2013 was identified with 35 taxa, representing four classes (Table 1). Although this area was not wide, but the fauna were very diverse with 35 taxa, representing four kingdoms. Birds (Aves) exhibited the greatest species diversity with 15 taxa identified. The station D has shown five species which were not shown other stations. These are all marine birds. The followed orders were invertebrate animals (10 taxa), reptiles/amphibians (Sauropsida/Amphibia) with six taxa, and mammals (Mammalia) represented by five taxon. Mammals was absent in the Station D. Fish was absent in this river. The mean number of species within the St. A was 22 taxa and St. B was 19. St. C and St. D were all 21. Mammals and reptiles/amphibians were shown with the relative high individual density or abundance in upper region (station A) of river across areas (Table 1). Birds and invertebrate animals were shown with the relative high individual density in low region (station D).

In order to assess macro-scale spatial variability of the animal community at the Anseong 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 mammals was 1.120 across regions, varying from 0.562 to 1.517 (Table 1). Shannon-Weaver indices (H´) of diversity for reptiles, and amphibians were also varied among the stations and season (Tables 1 and 2). Especially, H´ values of birds for season were different from each other because a lot of migratory birds were included in those regions. Although richness indices and evenness indices were different from each other, there were not shown significant differences ($P<0.05$). Generally, 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 (Noss, 1990).

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The values of ß-diversity for animals were varied from 0.313 for mammals to 0.250 for invertebrates (Fig. 2). For the community as a whole, the values of ß-diversity were the low (from 0.256 for St. C to 0.178 for St. D) (Fig. 3). They indicated that heterogeneity in species compositions among the replicates were not high. The parameters paired similarity between season and stations testified. 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, distribution of biological diversity and richness showed a statistically significant upper-low regions different (p <0.05).

The average value of pH at four stations was 7.32 mg/l (Table 3). The average value of BOD and COD were 4.57 mg/ l and 6.29 mg/l, respectively. The portion of suspended solids (SS), total nitrogen (T-N), and phosphate (T-P) in the river increased exponentially along the upper-down gradient.

In particular, SS has a significant influence on the two points (St. C and St. D). T-N also has a significant influence at the St. D. They are important as pollutants in water system. 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).

Many cement blocks were creating instead river grasslands by Direct-stream Rivers Project. This artificial action reduced the water's natural filtration action and eliminated the habitat of many animals. Thus there was decreased the number of species in mammals and reptiles/amphibians at St. C and St. D.

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Table 1. Diversity index for mammals and birds in the studied areas

Indices	Mammal				Bird			
	St. A	St. B	St. C	St. D	St. A	St. B	St. C	St. D
Richness								
No. of species	5	4	2	-	6	4	7	9
R1	1.161	1.303	0.721	-	1.3846	1.251	2.038	2.308
R2	1.443	1.265	1.000	-	1.549	1.206	1.606	1.591
Diversity								
H'	1.517	1.280	0.562	-	1.714	1.295	1.809	2.055
N1	4.559	3.956	1.755	-	5.552	3.649	6.105	7.808
N2	6.000	4.500	2.000	-	7.500	4.583	7.435	8.552
Evenness								
E1	0.943	0.923	0.811	-	0.957	0.934	0.930	0.935
E2	0.912	0.899	0.877	-	0.925	0.912	0.872	0.868
E3	0.890	0.865	0.755	-	0.910	0.883	0.851	0.851
E4	1.316	1.251	1.140	-	1.351	1.256	1.218	1.095
E5	1.405	1.348	1.325	-	1.428	1.353	1.260	1.109

Table 2. Diversity index for reptile/amphibians and invertebrates in the studied areas

Indices	Reptile /Amphibian				Invertebrates			
	St. A	St. B	St. C	St. D	St. A	St. B	St. C	St. D
Richness								
No. of species	6	3	4	2	5	7	8	10
R1	1.595	0.869	1.108	0.721	1.412	1.842	2.233	2.424
R2	1.251	0.949	1.033	1.000	1.213	1.373	1.668	1.562
Diversity								
H'	1.730	1.030	1.362	0.562	1.579	1.855	1.994	2.133
N1	5.642	2.800	3.906	1.755	4.851	6.392	7.345	8.360
N2	0.940	0.933	0.976	0.877	5.440	7.558	9.370	8.723
Evenness								
E1	0.966	0.937	0.983	0.811	0.981	0.953	0.959	0.922
E2	0.940	0.933	0.976	0.877	0.970	0.913	0.918	0.836
E3	0.928	0.900	0.969	0.755	0.963	0.899	0.906	0.818
E4	1.180	1.148	1.222	1.140	1.121	1.182	1.276	1.043
E5	1.219	1.230	1.298	1.325	1.153	1.216	1.319	1.049

Table 3. Water quality at four stations in the studied areas

Item	St. A	St. B	St. C	St. D
pH	7.42±0.24	7.49±0.22	7.22±0.34	7.17±0.19
BOD (㎎/L)	3.56±0.28	4.03±0.64	5.31±0.27	5.40±0.12
SS (㎎/L)	17.45±1.63	18.13±1.53	20.45±3.08	23.64±1.02
DO (㎎/L)	6.78±0.50	6.51±1.14	6.19±0.55	5.69±0.57
COD (㎎/L)	3.42±0.31	3.85±0.37	5.73±0.68	6.23±1.03
T-N (㎎/L)	2.02±0.22	2.31±0.28	2.98±0.82	3.49±0.251
T-P (㎎/L)	0.11±0.04	0.11±0.02	0.11±0.02	0.12±0.02

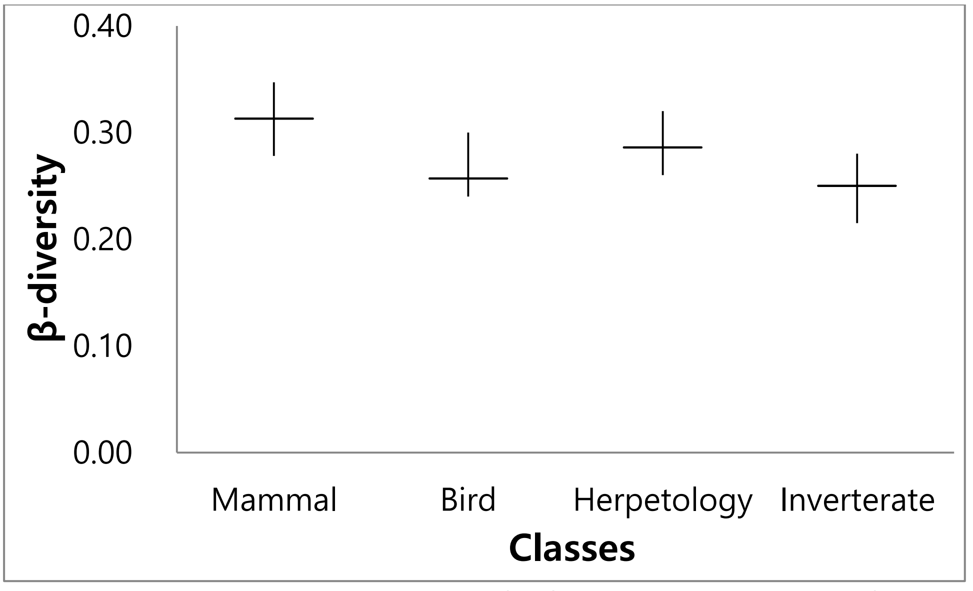

Fig. 2. Occurrence index (β-diversity) for four animal kingdoms at four stations.

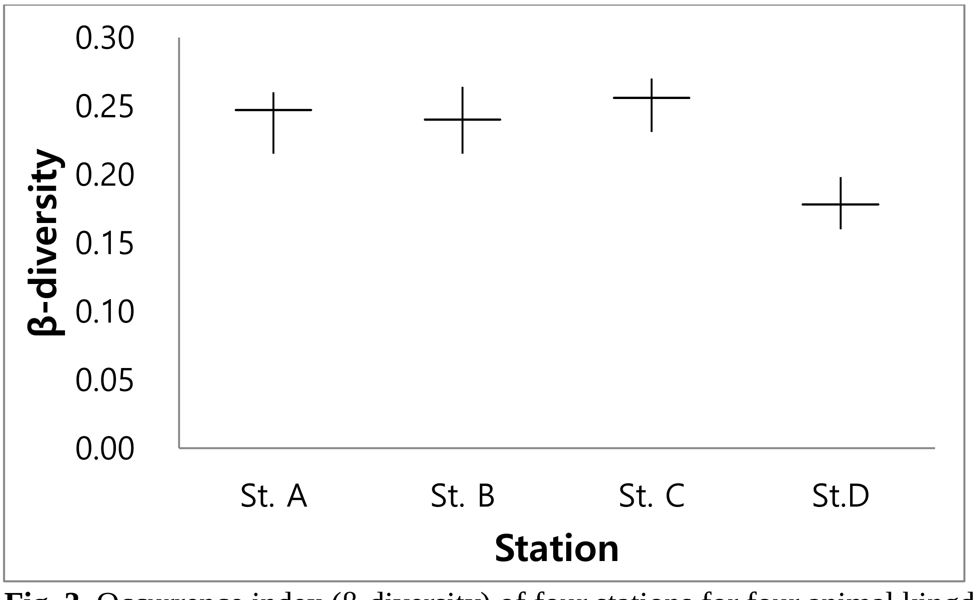

Fig. 3. Occurrence index (β-diversity) of four stations for four animal kingdoms.

CONCLUSIONS

Although the fauna community at the Anseong River on 2013 was not wide, but the fauna were very diverse with 35 taxa, representing four kingdoms. However, many artificial actions in this river and near lands reduced the water's natural filtration action and eliminated the habitat of many animals.

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