◆ 제 3 주제 ◆

Reconnaissance study on the Water Quality of Miomotegawa River for the evaluation of the impacts of acid pollution

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(국 립 환 경 과 학 원)

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Abstract

We decided Miomotegawa river was the object of our investigation since it is one of the most important salmon rivers in Japan. A great number of salmonshave returned to the river, and it was expected to contain relatively lower cation concentrations since granite is widely distributed in the river catchment area. The concentration of calcium and magnesium were less than a half of that of other major rivers. The concentration of analyzed parameters indicating water quality effect on salmons, NO_3, SO_4 and NH_4, were 1.37, 4.08 and 0.01mg/l, respectively. Most parameters down stream were greater in concentration than in the upper stream.

Key words : Miomotegawa river, Acidification, Buffering capacity, Salmon

1. Introduction

In northern Europe and America, acidification of freshwater has wiped out populations of salmonid fishes such as the Atlantic salmon *Salmo salar*, brown trout *Salmo trutta* and brook trout *Sulvelinus fontinalis*from a great number of lakes and rivers (Schofield, 1976). Acute exposure to low pH directly kills fish by means of a discharge of sodium and chloride ions from body fluid.

The cause of pH decline is believed to have been deposition of acidic substances into lakes in excess of their neutralization or buffering capacity (The second Interim Scientific Advisory Group meeting of acid deposition monitoring network in East Asia, 2000). At present, rapidly expanding industrial activities in East Asia have led to a continuous increase in the amount of emission of acidic pollutants (Ikuta et al., 2001).

Rain at acidic level of pH 4 has often precipitated through Japan, but acidification of Japan's lakes and rivers by acidic deposition has not yet been observed, due to the country's soil buffering capacity. However, it has been clarified that extremely weak acidity such as in the pH6 range is sufficient to depress prespawning behavior of land-locked sockeye salmon *Oncorhynchus nerka* (Kitamura and Ikuta, 2000). Additionally, juveniles of chum salmon *O. keta* significantly avoid areas of pH lower than 5.8.

Basic cations released from soil by chemical weathering neutralize acid derived from atmospheric pollution or produced by the decay of organic matter. They are also taken up by plants and discharged into streams (Nakano et al., 2001). It is known that there are many mountainous inland watersheds that are sensitive to acid deposition in Japan, but in this result, only a part of the whole area was investigated, also not enough information of anion and cation concentrations or even basic alkalinity data of inland watershed have been accumulated. We would like to construct a database of pollution parameters of acid deposition effect on inland water proceeded step by step, over a couple of years through this research project.

In Niigata prefecture region, located near the Sea of Japan, a forest ecosystem is affected by wet&dry acid deposition and long-range trans boundary air pollutants from the Chinese continent because of northwest seasonal wind during the winter. We decided Miomotegawa river in Niigata prefecture was the object of our investigation since it is one of the most important salmon rivers, a couple of hundred thousand population has been caught and much more salmon population are returned every year. Also, most area of the catchment of Miomotegawa river, a widely distributed zone along the riverside, is surrounded by granite that has lower acid-neutralization capacity (Fig. 1).

Furthermore, there are many fresh rivers (Kajigawa, Ochiborigawa, Tainasigawa, Aragawa and Katsugigawa) and lakes (Okumiomotegawa and Sarutako) in Niigata prefecture, so called water city, will be surveyed in FY 2002.

According to official salmon catch statistics, 197,999 fish were caught in 1880, but only 18,805 fish in the year 2000. A dramatic increase was observed from 1946, when only a few thousand fish were caught annually for 3 decades. The fish catch recovered from 1980 to approximately 20,000 fish per year.

Water quality data for 12 years (1988″` 1999) analyzed by Environmental Science Research Niigata, discussed in section 4, was examined to verify the effect on the aquatic environment of the water quality of Miomotegawa River (by Iyoboyanosato Development Corp. of Murakami city, 1997). Average concentration of T-N and T-P were 0.25 and 0.007 mg/l, respectively, and conductivity 49 us/cm, pH 7.0 and water temperature 18.3C.

Nutrients standard is necessary to determine T-N and T-P concentration to prevent damages in water use caused by eutrophication of lakes and reservoirs. Salmon and trout are common in oligotrophic lakes in Japan, but carp and roach are known to be abundant in eutrophic lakes. Fishery class 1 in terms of T-P, corresponds to the water quality to maintain the population of salmon and trout. The standards for fisheries class 1 were established as T-P 0.01, T-N 0.2mg/l based on the T-P and T-N in lake Chuzenjiko and Biwako in which trouts are being maintained (Okada and Peterson, 2000).

Table 1. Variations of Water Quality of Miomotegawa River during July for 12 years

year / parameters	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	Avg
Temp(°C)	16.1	18.7	21.0	17.0	19.2	14.9	17.1	20.0	15.5	20.1	18.6	21.6	18.3
Transparency (cm)	30	30	30	30	30	30	30	30	50	50	50	50	36.7
Turbidity (NTU)	2	1	2	ND	1	4	10	1	1	3.0	0.5	2.0	2.7
EC (us/cm)	45	48	65	42	49	52	46	51	39	47	47	62	49
PH	7.2	7.2	7.2	6.8	7.3	7.1	6.9	7.1	7.0	7.0	6.8	6.7	7.0
DO (mg/l)	9.5	9.4	9.0	9.6	9.8	10.0	9.7	9.5	10.0	10.0	10.0	9.4	9.7
BOD (mg/l)	1.1	1.0	0.7	ND	1.2	0.5	0.7	1.0	0.5	0.5	0.5	0.8	0.7
COD (mg/l)	2.0	2.9	2.0	2.5	2.3	1.6	3.5	1.2	2.0	0.8	1.0	2.1	2.0
SS (mg/l)	2	3	1	2	ND	3	10	2	1	1	1	3	2.4
T-N (mg/l)	0.18	0.29	0.16	0.15	0.28	0.20	0.39	0.22	0.26	0.23	0.25	0.42	0.25
T-P (mg/l)	.008	.007	.008	.010	.006	.007	.012	.005	.004	.006	.004	.010	.007
E-coli. (CG/10ml)	790	240	2200	490	79	490	3500	490	490	490	790	4900	1246
Chlorophyll-a	-	-	-	-	-	<1.0	<1.0	<1.0	-	-	-	-	<1.0

* Reported by Miomotegawa river Development Office of Niigata Prefecture
and Environmental Science Research Niigata, 1988″` 1999)

2. Sampling site

Table 2. Description of Sampling Stations

Station #	Location	Remark
1	The sea of Japan of the estuary	Saline water
2	Downstream of Miomotegawa river	
3	A streamlet of north Murakami	
4	A tributary of Miomotegawa river	
5	Midstream of Miomotegawa river	
6	Miomotegawa dam	
7	Takijinja fall	
8	Sediment of Miomotegawa dam	

8 sampling stations were chosen, as shown in Table 2 and Figure 1. 4 were upstream (4,5,6,8) and 2 downstream in Miomotegawa River. Station 1 was estuarine and station 3 was a streamlet not connected to Miomotegawa River.

3. Analyzing parameters

Analyzing parameters, method and its apparatus are shown in Table 3.Acid-buffering capacity was estimated by the pH decrease on adding acidic solution of 0.005mol/l and 0.05mol/l in the samples step-by-step acid-neutralization. The change of pH by adding 0.005 and 0.05mol/l sulfuric acid is just indication ofdecreased pH and pH value when sulfuric acid is added that is easier and simpler method than that of alkalinity of standard method.

Table 3. Analyzing parameters

Parameters	Analytical method	Apparatus
pH	pH meter	Horiba, LOT 7120679
Conductivity	Conductivity meter	"
Cl	Ion chromatography	Dionex500 Ion chromatography
NO_3	"	"
Na	"	"
K	"	"
Mg	"	"
Ca	"	"
HCO_3	-	-
H_4SiO_4	-	-
Alkalinity	-	-

4. Results of water analysis

The anion and cation concentrations in the water collected from Miomotegawa River and from the other sampling sites are shown in Table 4.

Table 4. Results of water quality analysis

Station#	Na	K	Mg	Ca	NH_4	Cl	NO_3	SO_4
St. 1	6470	260	772	250	0.00	10100	33.2	1450
St. 2	8.61	1.06	1.84	4.47	0.04	14.5	2.99	5.31
St. 3	16.0	1.22	3.42	4.22	0.00	29.5	5.70	5.70
St. 4	6.68	0.72	2.13	3.48	0.00	11.89	2.89	4.23
St. 5	4.83	0.89	1.09	3.91	0.01	6.64	1.37	4.08
St. 6	4.25	0.76	1.04	4.17	0.01	5.70	1.05	3.73
St. 7	19.8	1.13	3.03	2.79	0.00	34.4	3.86	6.64

5. Discussion

We have expected that Miomotegawa river water has lower acid-neutralization capacity and lower cation concentration even though pH is typically around 7, with no seasonaldepression, since a huge size of granite is widely distributed in the river catchments as shown in Figure 1. It was in accord with the result of sampled water analysis, the concentration of calcium and magnesium were much lower, approximately one third only at Station 5, than in other major rivers and lakes in this country.

As shown in Figure 2, analyzed concentration of calcium and magnesium of Miomotegawa Riverwere lowest values that are 3.91mg/l and 1.09mg/l, respectively. In the case of calcium; Tonegawa13.3, Ishikarigawa 9.4, Shinanogawa 10.2, Yoneshirogawa 8.3, Nakagawa 15.8, that is greatest one in 13 rivers, Chikugogawa river 9.2, Yuragawa 6.4, Kinogawa 12.9, Yoshiigawa river 7.4, Biwako lake 8.5, Kasumigaura lake 16.6 and Yamanaka river 8.3mg/l. In the case of magnesium, Kasumigaura lake water greatest as 5.9mg/l, and next was 4.3mg/l of Nakagawa River. It was found that calcium and magnesium concentrations of Miomotegawa Riverwere one third and half value of other rivers and lakes'.

NH_4, NO_3 and SO_4 concentration were 0.04, 2.99 and 5.31 at St. 2 of downstream but at St. 5 of upstream, the concentration analyzed in Acid Deposition and Oxidant Research Center (ADORC) were 0.01, 1.37 and 4.08, respectively, which are relatively lower concentration than that of downstream. Most of parameters of St. 6 at Miomotegawa dam, upper stream, were relatively lower concentration, it means that some dry deposition of acidic pollutant have flowed into the water body.

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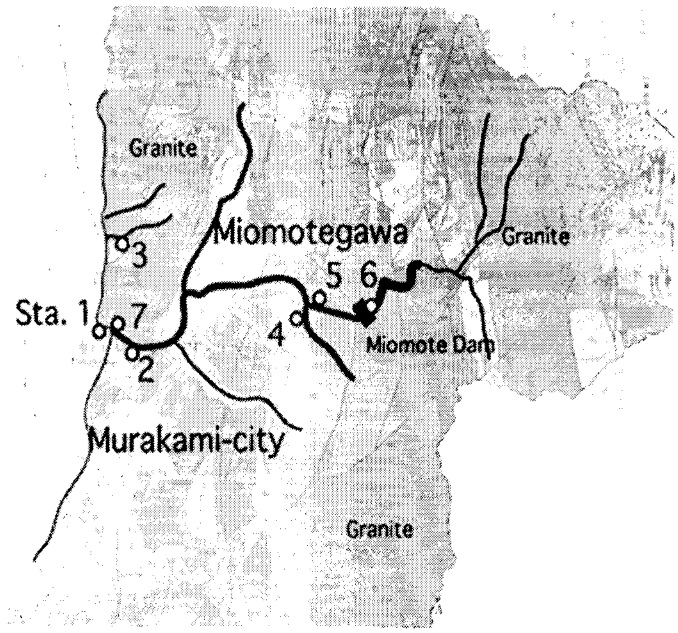

Figure 1. Sampling site

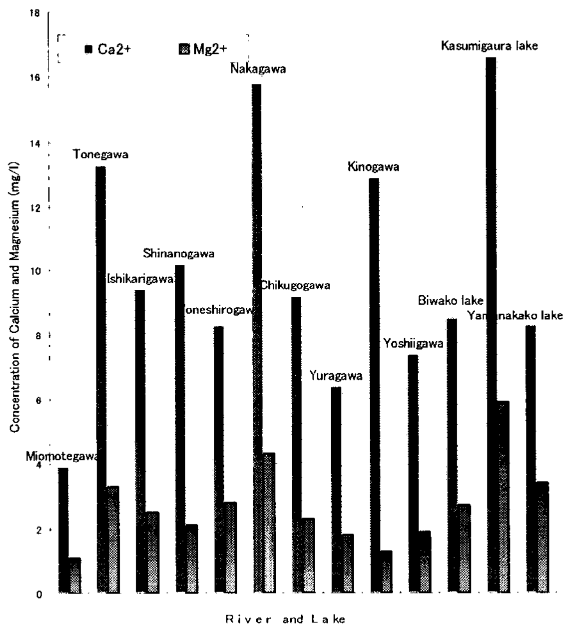

Figure 2. Concentration of Cations, calcium and magnesium

* Data obtained in Chronological Scientific Table 2001
(National Astronomical Observatory, Chronological Scientific Table 2001, National Astronomical Observatory, 2000)