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Impacts of mining activity on algae in Le An River

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Abstract — A field study of the impacts of mining activity on algae in Le An River, Dexing County of Jiangxi Province was carried out in 1987—1988. *Chlorophyta* and *Bacillariphyta* are the main hydrobios. Species and quantity of algae decreased obviously in Gukou, and at lower reaches, species and quantity of algae increased gradually. In rainy season, there are more species, and in dry season proportion of *Bacillariphyta* increased slightly. The negative interrelation are presented between logarithm of the water quality index *P* and number of species of *Bacillariphyta*.

Keywords: eco-toxicology; copper mine; wastewater; hydrobios.

INTRODUCTION

Dexing Copper Mine is located at the upper reach of Le An River in Dexing County of Jiangxi Province. Wastewater with large amount of acid drainage containing metals discharge into Dawu River, the coverage with Le An River and finally runs into Poyang Lake. Le An River has a considerably steep slope in its upstream. A rushing flow, comprised of rocks and sand coming downwards, not much sediments have been formed in river bed, and some river courses have been disturbed by dredging for gold in sediments. Planktons are only distributed over upper and lower reaches, without much aquatic vascular plants, benthic invertebrates and fishes.

Identification and characterization of aquatic organisms and species of hydrobios (mainly algae) were undertaken to study of the ecological effects of wastewater from mining activities on the ecosystems. Preliminary study on bioaccumulation of heavy metals was started.

SAMPLING AND LABORATORY WORK

Starting from Haikou, upper reaches of copper mine, sampling sites were selected at Haikou, Fuxikou, Gukou, Zhongzhou, Xiangtun, Daicun, Jiedu, Hanjiadu, Shizhenjie, Caijiawan, Huanglongmiao and Shuanggang along Le An River in 1987—1989 (Fig. 1).

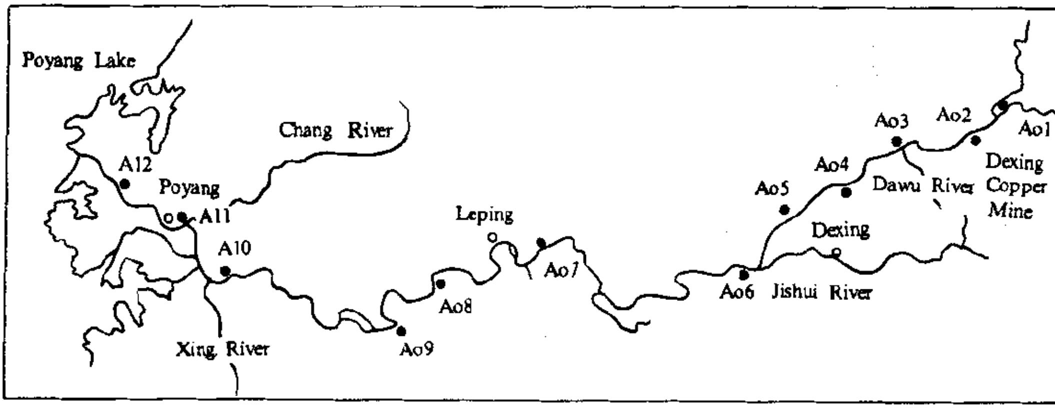

Fig. 1 Sketch of sampling sites along Le An River

A01 Haikou A02 Fuxikou A03 Gukou A04 Zhongzhou
A05 Xiangtun A06 Daicun A07 Jiedu A08 Hanjiadu
A09 Shizhenjie A10 Caijiawan A11 Huanglongmiao A12 Shuanggang

Plankton were trapped by plankton nets and brought back to laboratory. Sediments were excavated by Simpson excavator, sifted by 40 mesh metal sieve and benthic invertebrates fixed with 5% formalin. Aquatic vascular plants were identified and counted at whole plant.

Samples for heavy metal assay were cleaned with distilled water dried at 60℃, weighed after cooling, digested with $HClO_4$ and HNO_3. The residues were dissolved by diluted HCl, the concentration of metal ions were determined.

RESULTS AND DISCUSSION

1. Distribution of algae along Le An River

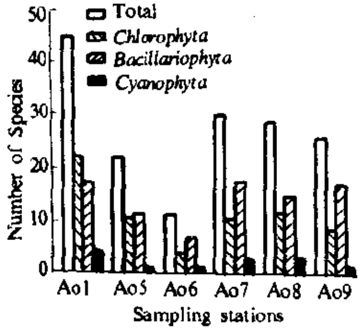

Fig. 2 Distribution of algae community along Le An River at dry season (November 1987)

There were hundreds of sorts of algae, which belonged to 7 phylums, mainly comprised of *Chlorophyta* and *Bacillariphyta* (Institute of Hydrobiology, 1980). In rainy season there were more species, and in dry season proportion of *Bacillariphyta* increased slightly (Fig. 2, 3 and 4).

The figures above show that there are more than 50 species of algae and sorts of other hydrobios along Haikou to Fuxikou. This site is considered as control spot. At Gukou, no large quantity of hydrobios existed except some species of algae (*Bacillariphyta*). At lower reaches, species

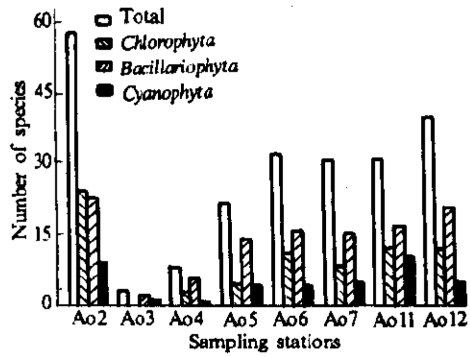

Fig. 3 Distribution of algae community along Le An River at rainy season (May 1988)

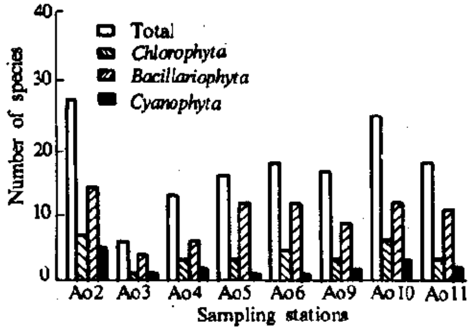

Fig. 4 Distribution of algae community along Le An River at dry season (November 1988)

and quantity of algae increase gradually because of increasing of other river water, domestic sewage and irrigated water. More species of *Bacillariphyta* are found there. Wastewater from copper mine obviously affected the growth of hydrobios while the *Bacillariphyta* are strongly resistant towards acid wastewater.

The species of algae slightly decreased at the river course from Shizhenjie to Caijiawan by the effect of wastewater from small gold mine near Shizhenjie.

Table 1 shows that the *Fragilaria* Lyngby, *Melosira* Ag., *Navicula* Bory., *Asterionella formosa* Hass., *Oedogonium* Link, *Chlorella* Beij., *Cladophora* Kutz., *Lyngbya* Ag. etc. are dominant.

2. Biological productivity of algae

The biological productivity of algae is shown in Fig. 5.

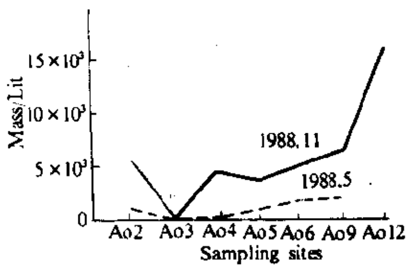

Fig. 5 Biological productivity of algae in Le An River

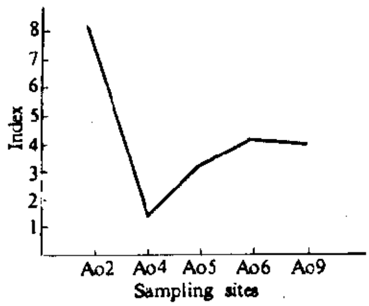

Fig. 6 The water quality index at different sampling sites

Table 1 Distribution of genus of algae along Le An River

Name of genus	Sampling sites							
	H. K.	G. K.	Z. Z.	X. T.	D. C.	J. D.	H.L.M.	S.G.
Bacillariphyta:								
Fragilaria Lyngby	+	+	+	+	+	+	+	+
Melosira Ag.	+		+	+	+	+	+	+
Navicula Bory.	+		+	+	+	+	+	+
Asterionella								
formosa Hass.	+		+	+	+	+	+	+
Surirella Turp	+			+	+	+	+	+
Nitzschia	+			+	+	+	+	+
Synedra Ehr.	+			+	+	+	+	I
Neidium Pfitz	+			+	+	+	+	+
Gomphonema Ag.	+		+	+	+		+	+
Cocconeis Ehr.	+		+		+	+	+	+
Pinnularia Ehr.	+				+	+	+	+
Cymbella Ag.	+				+	+	+	+
Cladophora Kutz.	+				+		+	+
Chlorophyta:								
Oedogonium Link	+	+	+	+	+	+	+	+
Chlorella Beij.	+			+	+	+	+	+
Cladophorà Kutz.	+			+	+	+	+	+
Spirogyra	+				+		+	+
Gonatozygon	+				+	+	-	
Dinobryou								
cylindricum Imb.	+					+	+	+
Mougeotia	+				+	+		+
Chlorococcum Kutz.	+					-	+	
Ankistrodesmus			+	+			+	
Clsteridium	+				-	+		
Pediastrum Meg.				+			+	+
Dactyloeoccus							+	+
Scenedesmus						+		+
Stigeoclouium Kutz.					+	+		
Gellamia	+				+			
Hydrodictyon	+							
Staurastrum					+			
Volvox							+	
Botrydium Wallr					+			
Stauroneis						+		
Cyanphyta:								
Lyngbya Ag.	+		+	+	+		+	+
Oscillatoria Vauch	+				+	+	+	+
Phormidium Kutz.	+			+		+	+	+
Aphanocapsa Nag.	+				+		+	+
Microcystis Kutz.							+	
Gloeocapsc Kutz.							+	
Nostoc Vauch					+			
Pyrrophyta:								
Ceratium hirdinium								
(Mull) Schr.	+							
Xanthophyta:								
Heterotrichales						+		+

At Haikou biological productivity was greater than that in Gukou where algae were almost exterminated. Then it gradually increased and even exceeded in the unpolluted spot at Caijiawan. This suggested that algae were controlled by the effect of wastewater from copper mine. With the joining of other tributaries at lower reaches, especially the dilution of irrigated water and domestic sewage, the growth of algae were improved by the nutrients N and P. The greater productivity showed the improvement of the nutrition level. The decreased species might belong to the increase of toxic factors for algae (Patrick, 1976).

Based on the concentration of Fe, Cu, Mn, Cd, Pb, Zn and As, the determined index *P* was calculated (Wang, 1981) according to the commonly used methods of environmental water quality assessment (Fig. 6, 1975).

The results showed that more serious pollution sites caused by higher concentration of heavy metals, had the larger index *P*, and less the number of *Bacillariphyta*. The number and species of hydrobios decreased at the polluted river section. Plot logarithm of the water quality index against the ratio of number of species (*Bacillariphyta*) in each spots for comparison (Fig. 7). The calculated results indicated that negative interrelation was presented between logarithm of the water quality index *P* and number of species of *Bacillariphyta* (May, 1981).

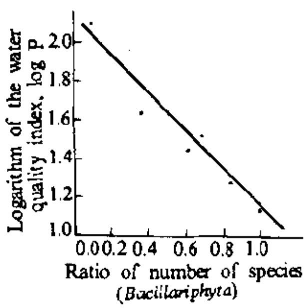

Fig. 7 Relationship between specific number of *Bacillariphyta* and logarithm of the qualitative index (P)

3. Bioaccumulation of metals

Hydrobios in Le An River include fish, algae and aquatic vascular plants and so on. But their quantities are less, and it is difficult to obtain large amount of samples of fish and algae. Though generally there were not the same species at each site, as roots of aquatic vascular plants growed into the sediment, and their growth period was longer, aquatic vascular plants were collected and assayed for concentration of Cu, Zn and other metals. At the same time, the concentration of Cu and Zn was also determined in water and sediments (Table 2). It was shown that the concentrations of some heavy metals in hydrobios were higher than that in water, even the same as that in sediments. Hydrobios have accumulated heavy metals but it was hard to get the regularity for different species from those "instant" samples. Still the trend of copper concentration in the hydrobios can be shown which was higher in the polluted river section than that at the unpolluted site. Copper concentration was found to be one thousand times higher at Xiangtun than at the unpolluted site. The accumulative metals decreased gradually at the lower reaches.

From the field study and laboratory work, it showed that the number and species of hydrobios in Le An River decreased obviously by the wastewater discharged from Dexing Copper Mine. Most seriously polluted at Gukou almost no hydrobios were found. Pollution Index *P* were negatively related with the number and species of *Bacillariphyta.* Some hydrobios have ability to accumulate metals. So far it is difficult to find the quantitative relationship between wastewater from copper mine and the aquatic organisms as the amounts of organic matter was low and hydrobios less, under different current flow and large variation of wastewater discharge. Further observation is necessary.

Table 2 Bioaccumulation of heavy metals in some hydrobios (ppm)

Sampling sites	Samples	Heavy metal, ppm				
		Cu	Cd	Pb	Zn	As
Haikou	Sediment	38.31	–	89.84	155.0	15.04
	Riverwater	0.0094	0.0017	0.0906	0.0472	0.0057
	Potamogeton malanus	1.187	1.222	1.288	995.0	0.257
Xiangtun	Sediment	1984	–	61.78	310.0	14.37
	Riverwater	0.0986	0.0004	0.0555	0.0128	0.0440
	Potamogeton malanus	920.8	0.525	13.01	210.0	0.563
	Hydrilla varticilla'a	2728	0.435	10.47	192.0	0.148
Daicun	Sediment	978.6	–	57.28	217.2	16.99
	Riverwater	0.0678	0.0005	0.0714	0.0101	0.0260
	Potamogeton malanus	6.293	3.061	4.133	782.0	2.001
Jiedu	Sediment	116.7	–	68.26	261.4	17.75
	Riverwater	0.0110	0.0057	0.0732	0.0404	0.0588
	Potamogeton malanus	1.447	3.059	14.47	12.54	0.201
Caijiawan	Sediment	111.3	–	31.48	124.6	17.25
	Riverwater	0.0192	0.0067	0.069	0.1392	0.0889
	Corbicula fluminea	1.85	2.20	0.725	6.70	0.179

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