Journal of Environmental Sciences Vol. 7, No. 1, pp. 31－35, 1995 ISSN 1001－0742

Effects of low pH on zooplankton in some suburban waterbodies of Chongqing City

Zhuang Dehui

Institute of Hydrobiology, Chinese Academy of Sciences, Wuhan 430072, China

Abstract—Samples of zooplankton were collected for 4 times from May, 1989 to May, 1992 in some suburban waterbodies of Chongqing City, a heavy acid rain area in the southwest China. The qualitative and quantitative analysis results indicated that the species of zooplankton (y) were found to decline gradually with a reduction of pH value (x) ranging from 4. 01 to 8. 80. The regression equation of relation between them may be expressed as: $y=1.520x-2.488$ ($r = 0.61$, $P<0.01$, $n = 22$) with respect to abundance of zooplankton, the mean density was abundant (3609. 23 ind. /L) at pH ranging from 5. 0 to 8. 8 , but was lower (151. 50 ind. /L) at pH ranging from 4. 0 to 5. 0. The evidence presented suggests that effects of low pH on zooplankton is the greatest below pH 5. 0.

Keywords: acid rain; acidified water; zooplankton.

1 Introduction

Zooplankton are small animals which spend their entire lives suspending in water. They are among the most abundant and widespread animals in fresh water. However, numerous lakes in North America and Scandinavia have been acidified by inputs of atmospheric acid (NRCC, 1981; Wright, 1976). The increased hydrogen ion concentration and greatly altered water physical and chemical characteristics in these lakes affect aquatic ecosystem and therefore, the studies about effects of water acidification caused by acid rain on aquatic organisms at all trophic levels have already been reported (Raddum, 1980; Schindler, 1980; Havems III, 1987). Yan and Strus (Yan, 1980) found that zooplankton biomass in acid clearwater lake (pH 4. 2) was significantly lower than in nearby non - acid lakes of similar trophic status. Roff and Kwiatkowsik (Roff, 1977) found a positive correlation between zooplankton abundance and pH in several lakes. Zooplankton abundance seems to decrease with increasing acidity. Zooplankton species richness is also reduced with acidification. There has been relatively little work done on the impacts of waters acidification on aquatic organisms in China up to now (Wang, 1992). This paper reported only the results of effect of low pH on zooplankton(Rotifera, Cladocera and Copepoda) community.

2 Methods

The six suburban waterbodies of Chongqing City located at Nanshan Mountain and Jiyushan Mountain were surveyed 4 times from May, 1989 to May, 1992. These waterbodies due to acidity can be divided into 3 different types including acid water (pH $<$ 5. 0), less acid water (6. 0

> pH > 5.0) and normal water (pH > 7.0).

Zooplankton quantitative samples were taken with plexiglass picker in these waterbodies at three layers, e. g. surface 0.5 m and one or two time of the Secchi dish (20 cm diameter) depths. Organisms in samples were killed with formalin of Lugol's solution. Rotifera were removed from one litre water samples by setting. Crustacea (Cladocera and Copepoda)were concentrated from ten litre water samples with No. 25 net. Qualitative samples were collected with a No. 25 net. In the laboratory, Rotifera counts were made using a counter with a volume of 0.1 ml and Crustacea were counted totally. Then abundance of zooplankton was standardized to number per litre for density companisons. Some physical and chemical parameters for the six waterbodies are summarized in Table 1.

Table 1 Physical and chemical characteristics for studied waterbodies

Itmes	Acid waters		Less acid waters		Normal waters	
	1*	2	3	4	5	6
pH	4.24	4.69	5.08	5.39	7.00	8.45
	(4.01—4.50)**	(4.63—4.75)	(4.70—5.48)	(5.10—5.65)	(6.10—8.10)	(8.09—8.80)
Area, ha	0.033	0.083	0.100	0.083	1.534	0.333
Depth, m	7.5	5.7	1.8	1.85	15	3.0
Conduc, μs/cm	87.7	79.0	59.3	60.0	55.0	260.0
	(82—92)	(73—86)	(55—64)	(58—62)	(49—59)	(247—273)
Trans, m	5.8	5.1	0.4	0.3	1.0	0.5
	(4.0—7.5)	(4.5—5.7)	(0.4—0.4)	(0.25—0.3)	(0.8—1.3)	(0.5—0.55)
DO, mg/L	8.3	8.2	7.3	7.75	8.85	9.4
	(7.8—8.8)	(6.6—9.8)	(7.0—7.6)	(6.2—9.3)	(8.5—9.2)	(9.1 9.7)
TN, mg/L	5.44	3.65	1.93	1.57	6.24	4.39
NH—N, mg/L	0.031	0.153	0.982	0.743	0.299	0.899
TP, mg/L	0.032	0.025	0.080	0.060	0.075	0.086
NO—N, mg/L	3.48	2.77	0.25	0.44	0.55	0.75
	(2.78—4.26)	(2.27—3.40)	(0.04—0.43)	(0.09—0.96)	(0.36—0.73)	(0.49—1.00)
SO, (mh/L)	19.97	20.87	20.63	17.77	15.10	51.00
	(18.60—21.3)	(19.4—22.7)	(17.4—25.3)	(13.0—22.0)	(14.4—15.8)	(50.0—52.0)
Total alkalinity		0.11	0.12		0.11	
Total hardness		0.44	0.36		0.38	

* the waterbodies No. ** range

3 Results and discussion

3.1 Composition of zooplankton species

Species distribution and species numbers of zooplankton (Rotifera, Cladocera, Copepoda) in studied waterbodies are showed in Table 2, 3 and 4. It can be seen clearly that the obvious trends in composition of zooplankton species in studied waterbodies are associated with pH. There are 18.5 species in normal waters, 16 species in less acid waters, and 6 species in acid waters only. In one pH 4.01 acid water, many species are eliminated and even tolerant ones become progressively rarer until a single species (*Brachionus urceus*) remains. The species of zooplankton (y) were found to decline gradually with a reduction of pH value (x), which ranges from 4.01 to 8.80. The regression equation of relations between them may be expressed as:

$$y=1.520x-2.488 \quad (r=0.61,\ p<0.01,\ n=22)$$

Table 2 The species composition and the distribution of Rotifera in some suburban waterbodies of Chongqing city

Species	Acid waters		Less acid waters		Normal waters	
	1*	2	3	4	5	6
Asplanchna girodi			+			+
A. priodonta					+	
Brachionus angularis			+	+		+
B. calyciflorus			+			+
B. forficula					+	+
B. urceus	+	+	+		+	+
Diurella sp.				+		
Euchlanis calpidia					+	
Keratella cochlearis		+	+	+		+
K. valga		+				
Monostyla sp.				+		
Platyias quadricornis						+
Ploesoma hudsoni				+	+	
Polyarthra trigla			+	+	+	+
Pompholyx sp.						+
Schizocerca diversicornis		+				+
Trichcerca cylindrica				–	+	
T. pusilla				–		+
T. sp			+	+		

* the waterbodies No.

Table 3 The species composition and the distribution of Cladocera and Copepoda in some suburban waterbodies of Chongqing City

Species	Acid waters		Less acid waters		Normal waters	
	1	2	3	4	5	6
Cladocera						
Alone guttata		+	+	+	+	
A. rectangula						+
Alonella excisa		+				
Bosmina longirostris					+	+
Bosminopsis deitersi					+	
Chydorus sphaericus		+	+	+	+	+
Diaphanosoma brachyurus			+	+	+	+
Disparalone rostrata					+	
Moina micrura			+			
Pleuroxus hamulatus					–	
Scapholeberis kingi					+	
Sida crystallina			+			
Copepoda						
Ectocyclops phaleratus					+	
Eucyclops serrulatus		+	+			
Mesocyclops leuckarti					+	
Neodiaptomus schmackeri			+	+	+	+
Sinodiaptomus sarsi			+	+		
Thermocyclops brevifurcatus			+			
T. dybowskii	+	+				
T. taihokuensis			+	+		+
Tropocyclops prasinus					+	
Copepodid stage	+	+	+	+	+	+
Nauplius	+	+	+	+	+	+

Table 4 The distribution of the numbers of zooplankton species from some suburban waterbodies of Chongqing City at different pHs

Classifcation	Acid waters	Less acid waters	Normal waters
Rotifera	2.5	8	9
	(1—4)*	(7—9)	(7—11)
Cladocera	1.5	4	6
	(0—3)	(3—5)	(4—8)
Copepoda	2	4	3.5
	(2—2)	(3—5)	(3—4)
Total	6	16	18.5

* range

3.2 Abundance of zooplankton

Abundance of three groups of zooplankton in studied waterbodies is showed in Table 5. The mean density was abundant(2903.7 ind./L) in less acid and normal water (pH ranging from 5.0 to 8.8), but was lower(151.5 ind./L) in acid waters (pH ranging from 4.0 to 5.0), and Rotifers were the important group only, and Cladoceran and Copepond were less than 1% of the total zooplankton.

The evidence presented suggests that effects of low pH on zooplankton is the greatest below pH 5.0.

Table 5 The abundance of three groups of zooplankton from some suburban waterbodies of Chongqing City at different pHs(ind./L)

Classification	Acid waters	Less acid waters	Normal waters
Rotifera	151.43	4718.86	1740.0
	(0.0—600.0)*	(0.0—27200.0)	(300.0—6300.0)
Cladocera	0.01	1.79	473.96
	(0.0—0.1)	(0.0—6.0)	(0.0—2366.0)
Copepoda	0.06	103.29	180.56
	(0.0—0.3)	(15.1—477.0)	(0.6—492.0)
Total	151.50	4823.94	2394.52

* range

Reduced abundance and numbers of zooplankton species imply that a smaller range of particle sizes will be ingested with possible effects on the phytoplankton and bacterial communities. There is some suggestion that from direct effects on the plankton by virtue of the effects on fish, would disrupt normal competitive interactions leading to accelerated changes in zooplankton communities. Until more is know about the effects of perturbation on aquatic ecosystems.

Acknowledgments—I am indebted to Prof. Wang Deming for kindly reviewing this manuscript, and to Prof. Chen Shouzhong for fervent assist and with identification of the species.

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(Received January 7, 1993)