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The Role of Aquatic Macrophytes in Hydroecosystems of the Kuibyshev Reservoir (Republic of Tatarstan, Russia)

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Abstract: This article reports on a study to determine the influence of aquatic macrophytes on the formation of phytoplankton and zooplankton communities as well as hydrohemical features in different regions of the Kuibyshev reservoir (Republic of Tatarstan, Russia). It was found that aquatic macrophytes have sanative effect resulting in the reduction amount of some chemical pollutants (petrochemicals, nitrates, ammonium and others). Besides, in those areas of the Kuibyshev reservoir with no deficiency of aquatic macrophytes, there are a decrease numbers of coliform bacteria and algae causing the green scum as well as the increase quantity of zooplankton. The observed phenomenon occurred only during the active vegetation of aqutic macrophytes.

Key words: Aqatic macrophytes % Kuibyshev reservoir % Phytoplankton % Zooplankton % Pollution

INTRODUCTION

Aquatic macrophytes play a significant role in hydroecosystems [1]. While in subtropical and tropical rivers the excessive growth of aquatic macrophytes may provoke some negative effects (causing the disturbance of human use of freshwaters and favoring the distribution of some diseases) [2], the presence of these plants may be desirable in hydroecosystems with intense anthropogenic load (like the Kuibyshev reservoir in Republic of Tatarstan, Russia) because of their capacity to accumulate various pollutants [3-5]. Besides the sanative role, aquatic macrophytes may positively affect on zooplankton communities [6]. Due to the principal positive role of aquatic macrophytes in phytoremediation of polluted freshwaters, this issue needs more attention. The aim of this research work was to evaluate the influence of aquatic macrophytes on hydrochemical and hydrobiological parameters of the Kuibyshev reservoir. The studies were performed in a seasonal dynamics.

MATERIALS AND METHODS

In this research, hydrochemical, phytoplankton and zooplankton samples were taken from 25 river stations (Fig. 1). The first river station was near the Cheboksary city, the next stations were downstream from the city. All the stations belong to water area of the Kuibyshev reservoir. It is the biggest reservoir in the Eastern Europe. At normal reservoir water surface, its volume is 58 km^3 and the area of flat water is 6450 km^2. The mean depth is 9.3 m; depths less 4 m present 31.2% from total area of the reservoir.

2-l water samples were taken every day in July and October using Molchanov's bathometer. Temperature, pH, oxidation-reduction potential and dissolved oxygen were determined using a miniature dissolved oxygen analyzer (Mark-201, VZOR LLC). Chemical analysis of other water components followed standard procedures [7]. Various physicochemical parameters were used for the assessment of water quality.

Phytoplankton and zooplankton samples were taken in parallel to water sampling. An Apshtein net (24 cm diameter; aperture size 90-100 µm) was used for water filtration (10-50 L depending on the water depth in the region). For quantitative analysis, zooplankton organisms were fixed with a 4% formaldehyde solution and identified using a bipolar microscope. The zooplankton and phytoplankton communities were assessed by density and biomass. Paired t-tests were used for statistical analysis; $p<0.05$ was considered to indicate significance; data are presented as mean; standard deviations are omitted in tables, but all had CVs of 5-15%.

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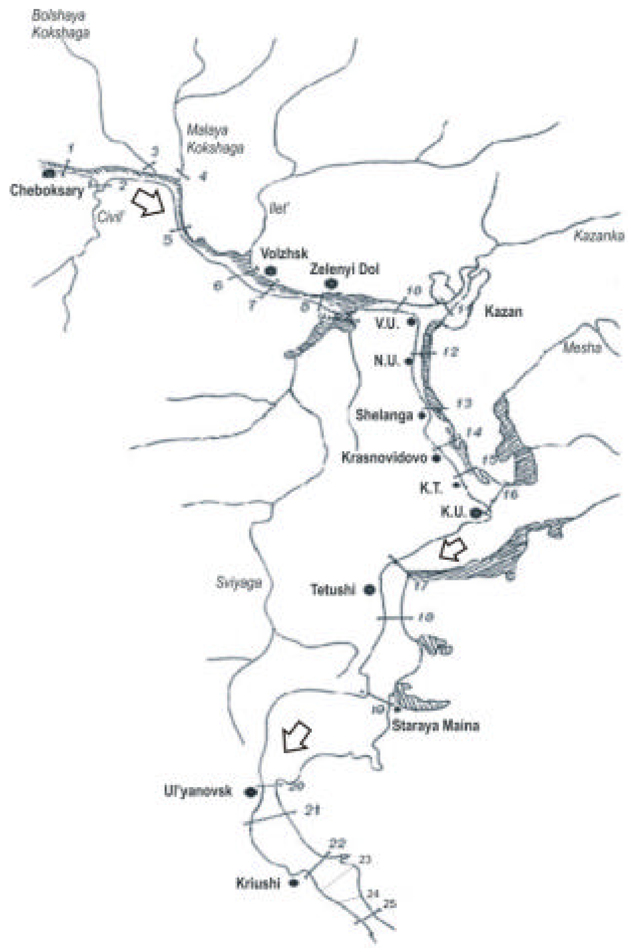

Fig. 1: A scheme of river stations of the water area under study
Note: populated localities are in bold, rivers are in italics. Areas with aquatic macrophytes are shown with crosshatching. V.U. = Verhniy Uslon, N.U. = Nizhniy Uslon, K.T. = Krasnoe Tenishevo, K.U. = Kamskoe Ust'e. Arrows show the direction of Volga's course

RESULTS

The complex hydrochemical and hydrobiological investigations of water area of the Kuibyshev reservoir were performed. Water samples from 25 river stations were analyzed. The first river station was near the "Novocheboksarskaya" hydroelectric station the following stations included areas of Kazan region of backwater, Sviyazhsk Bay (river stations 1-16), Nizhne-Tetushsky reach (river stations 17-19), Verhne-Ul'yanovskiy reach (river stations 19-20), Nizhne-Ul'yanovskiy reach (river stations 20-25). The following areas were overgrown with aquatic macrophytes: outlets of Bolshaya Kokshaga, Malaya Kokshaga, Ilet', Sviyaga (river stations 1-9) as well as downstream the Verhniy Uslon till Krasnoe Tenishevo (river stations 12-15). In general, aquatic macrophytes wer localized in outlets of rivers and insular archipelagos of the left banks of the Kuibyshev reservoir. There was one exception: outlet of Sviyaga was also characterized with majority of macrophytes (the right bank).There were areas with deficiency of aquatic macrophytes downstream river station 15.

Our results show that, in July, the density of coliform bacteria has more pronounced values in areas with deficiency of aquatic macrophytes (Table 1 and 2). In the same time, the amount of saprophilic bacteria is decreased in these areas. The analogous tendency (but in less) remained in October.

It is clear from Table 2, that the density and biomass of phytoplankton (diatoms, blue-green algae and green algae) is decreased in areas with aquatic macrophytes. In

Table 1: The average characteristics of bacterioplankton in the Kuibyshev reservoir

	Saprophilic bacteria (10^3cells/mL)			Coliform bacteria (cell/mL)		
River station	The left bank	The course	The right bank	The left bank	The course	The right bank
	July					
1*	0.67	0.89	3.48	20.0	40.0	440.0
2*	ND	2.76	ND	ND	120.0	ND
3*	ND	0.62	ND	ND	230.0	ND
4*	ND	1.13	ND	ND	140.0	ND
5*	1.74	1.47	1.45	20.0	90.0	100.0
6*	1.15	0.87	3.04	30.0	110.0	50.0
8*	1.20	5.88	1.18	40.0	30.0	30.0
10	2.68	3.52	0.81	210.0	10.0	120.0
12*	0.35	1.02	0.88	430.0	60.0	320.0
13*	0.33	0.06	0.38	180.0	40.0	130.0
15*	0.71	1.39	2.72	190.0	absent	absent
16	0.23	0.52	0.82	570.0	180.0	30.0
17	0.65	0.15	1.45	350.0	80.0	620.0
18	0.21	0.87	1.21	40.0	230.0	350.0
20	0.24	0.95	1.37	280.0	280.0	350.0
21	0.12	0.81	2.39	250.0	210.0	230.0
23	0.66	1.86	2.58	350.0	330.0	absent
River station	**October**					
1*	1.09	0.83	1.65	0.5	0.3	4.5
2*	absent	1.44	absent	absent	5.6	absent
3*	absent	0.89	absent	absent	0.1	absent
4*	absent	1.60	absent	absent	5.9	absent
5*	3.60	1.62	4.64	1.5	0.8	4.2
6*	0.93	6.60	1.39	1.6	2.7	absent
8*	0.76	1.37	1.29	absent	0.8	absent
9**	1.04	1.43	1.11	absent	0.0	47.0
10	2.05	1.05	0.83	60.0	29.0	74.0
11*	absent	0.35	absent	absent	44.0	absent
12*	1.60	1.43	0.67	61.0	85.0	87.0
13*	1.37	0.66	5.20	63.0	8.0	44.0
14*	0.65	1.46	0.63	14.0	125.0	95.0

* and **- river stations with aquatic macrophytes on the left bank and on the right bank, respectively. SDs omitted, but all had CVs of 5-15%. ND = no data

Table 2: The influence of aquatic macrophytes and their deficiency on the density and biomass of some aquatic organisms of the Kuibyshev reservoir

		Regions with aquatic macrophytes		Regions with deficiency of aquatic macrophytes	
Time of observation	Organism	Density	Biomass	Density	Biomass
July	Coliform bacteria	118.0 (cell/mL)	ND	263.0 (cell/mL)	ND
	Phytoplankton	101.1 (×1000/L)	0.065 (mg/L)	1106.5 (×1000/L)	0.471 (mg/L)
	Zooplankton	273.4 (×1000/m^3)	1265.3 (mg/m^3)	155.0 (×1000/m^3)	237.1 (mg/m^3)
October	Coliform bacteria	22.0 (cell/mL)	ND	ND	ND
	Phytoplankton	142.3 (×1000/L)	0.259 (mg/L)	233.9 (×1000/L)	0.583 (mg/L)
	Zooplankton	15.7 (×1000/m^3)	65.1 (mg/m^3)	24.8 (×1000/m^3)	60.7 (mg/m^3)

SDs omitted, but all had CVs of 5-15%. ND = no data

Table 3: The average characteristics of phytoplankton in the Kuibyshev reservoir

	Diatoms		Blue-green algae		Green algae		Total	
River station	Density (×1000/L)	Biomass (mg/L)	Density (×1000/L)	Biomass (mg/L)	Density (×1000/L)	Biomass (mg/L)	Density (×1000/L)	Biomass (mg/L)
	July							
1*	22.3	0.045	37.4	0.02	13.0	0.041	72.7	0.106
2*	3.8	0.005	8.6	0.0003	21.6	0.07	34.0	0.0753
3*	30.0	0.07	8.6	0.002	33.8	0.03	72.4	0.102
4*	16.4	0.011	18.6	0.0015	3.4	0.005	38.4	0.0175
5*	25.3	0.08	30.8	0.02	2.4	0.004	58.5	0.104
9**	12.4	0.025	71.8	0.01	ND	ND	84.2	0.035
10	166.9	0.06	99.8	0.04	ND	ND	266.7	0.1
12*	ND	ND	16.0	0.03	190.6	0.02	206.6	0.05
13*	10.3	0.01	18.4	0.0024	8.2	0.009	36.9	0.0214
15*	ND	ND	138.0	0.03	2.6	0.005	140.6	0.035
16	45.2	0.19	135.2	0.005	28.5	0.06	208.9	0.255
18	147.7	0.25	2127.6	0.045	13.4	0.05	2288.7	0.345
19	32.2	0.4	1778.2	0.8	ND	ND	1810.4	1.2
21	5.4	0.02	106.3	0.0045	6.2	0.06	117.9	0.0845
River station	**October**							
1*	19.0	0.037	ND	ND	ND	ND	19000.0	0.037
2*	42.0	0.17	ND	ND	ND	ND	42000.0	0.17
3*	814.0	0.51	39.0	0.08	99.4	0.17	952.4	0.76
4*	17.0	0.03	27.8	0.08	3.4	0.007	48.2	0.117
5*	0.2	0.00001	5.7	0.001	ND	ND	5.9	0.00101
6*	15.4	0.041	5.0	0.0012	3.0	0.004	23.4	0.0462
9**	98.6	0.56	16.6	0.0014	ND	ND	115.2	0.5614
10	2.0	0.0015	ND	ND	ND	ND	2000.0	0.0015
13*	40.2	0.15	ND	ND	7.4	0.03	47.6	0.18
15*	53.8	0.066	ND	ND	113.9	0.65	167.7	0.716
16	81.1	0.022	ND	ND	48.6	0.11	129.7	0.132
18	472.6	1.77	4.2	0.000004	16.2	0.03	493.0	1.800004
19	37.2	0.11	ND	ND	110.4	0.13	147.6	0.24
21	32.2	0.07	50.6	0.01	ND	ND	165.6	0.16

* and **- river stations with aquatic macrophytes on the left bank and on the right bank, respectively. SDs omitted, but all had CVs of 5-15%.
ND = no data

Table 4: The average characteristics of zooplankton in the Kuibyshev reservoir

	Density, ×1000/m^3					Biomass, mg/m^3				
River station	The left bank	The course	The right bank	Mean	Total	The left bank	The course	The right bank	Mean	Total
	July									
1a*	4.3	ND	25.0	9.8	29.3	87.5	ND	1102.8	396.8	1190.3
1*	48.6	73.2	36.8	52.9	158.6	240.7	557.3	68.6	288.9	866.6
3*	ND	205.8	ND	205.8	205.8	ND	4675.9	ND	4675.9	4675.9
5*	53.6	8.4	53.2	38.4	115.2	68.2	4.5	22.1	31.6	94.8
7*	33.6	12.2	10.0	18.6	55.8	34.2	50.9	4.2	29.8	89.3

Table 4: Continued

	Density, ×1000/m^3					Biomass, mg/m^3				
River station	The left bank	The course	The right bank	Mean	Total	The left bank	The course	The right bank	Mean	Total
8*	33.8	ND	84.5	59.2	118.3	43.6	ND	32.9	38.3	76.5
9**	239.7	120.0	325.1	228.3	684.8	1564.0	1234.4	339.5	1046.0	3137.9
11*	134.2	54.0	125.4	104.5	313.6	103.7	24.0	242.3	123.3	370.0
12*	120.0	49.8	26.4	65.4	196.2	595.4	50.4	263.5	303.1	909.3
13*	495.9	51.0	106.0	217.6	652.9	759.5	208.8	137.6	368.6	1105.9
15*	118.0	47.3	311.8	159.0	477.1	206.5	55.1	1140.0	467.2	1401.6
20	79.5	74.0	54.6	69.4	208.1	63.4	138.5	23.6	75.2	225.5
21	53.1	62.0	17.8	44.3	132.9	235.0	218.1	6.9	153.3	460.0
24	22.0	48.9	52.7	41.2	123.6	5.1	30.2	22.8	19.4	58.1
25	13.4	50.6	91.6	51.9	155.6	20.7	116.4	67.7	68.3	204.8
River station	**October**									
1*	3.0	15.7	3.5	7.4	22.2	110.0	101.0	8.9	73.3	219.9
2*	ND	7.2	ND	7.2	7.2	ND	16.8	ND	16.8	16.8
3*	ND	16.0	ND	16.0	16.0	ND	46.8	ND	46.8	46.8
4*	ND	9.2	ND	9.2	9.2	ND	99.2	ND	99.2	99.2
5*	3.0	6.9	4.0	4.6	13.9	1.8	8.6	78.7	29.7	89.1
6*	7.0	6.8	7.0	6.9	20.8	38.1	21.8	32.0	30.6	91.9
8*	3.0	9.4	3.0	5.1	15.4	2.9	3.4	14.4	6.9	20.7
10	7.0	13.1	1.0	7.0	21.1	20.7	8.3	3.2	10.7	32.2
12*	1.0	5.6	1.0	2.5	7.6	2.1	0.5	0.2	0.9	2.8
13*	5.5	21.7	4.0	10.4	31.2	7.7	35.0	3.0	15.2	45.7
15*	2.0	5.8	1.0	2.9	8.8	46.9	0.6	3.2	16.9	50.7
16	2.0	24.8	4.0	10.3	30.8	1.1	24.5	7.1	10.9	32.7
17	5.0	9.1	10.0	8.0	24.1	1.5	2.8	36.1	13.5	40.4
18	10.6	8.9	1.7	7.1	21.2	165.4	4.3	0.6	56.8	170.3
19	3.0	15.1	2.0	6.7	20.1	10.5	17.3	0.8	9.5	28.6
20	1.0	23.3	2.0	8.8	26.3	1.1	23.4	0.1	8.2	24.6
21	9.5	20.1	1.0	10.2	30.6	13.9	5.6	0.4	6.6	19.9
23	2.0	15.8	3.0	6.9	20.8	0.2	106.7	1.6	36.2	108.5

* and **- river stations with aquatic macrophytes on the left bank and on the right bank, respectively. SDs omitted, but all had CVs of 5-15%.

ND = no data

areas with deficiency of aquatic macrophytes, blue-green algae were the dominant group (93.7% in density, and 45% in biomass). Oppositely, blue-green algae present 44.3% (in density) and 24.2% (in biomass) in areas with aquatic macrophytes (Table 3). Also, it is interesting to note that the density and biomass in July was less in areas with aquatic macrophytes (in comparison with its deficiency). In October, the situation changed inversely (Table 2). In October, diatoms were dominant group (82.6% and 76.6% in density; 62.9% and 39.8% in biomass in areas with aquatic macrophytes and its deficiency, respectively). The amount of blue-green algae present (7% and 17.6% in density; 8.3% and 1% in biomass in areas with aquatic macrophytes and its deficiency, respectively).

The density and biomass of zooplankton was increased in areas with aquatic macrophytes in July (Table 2 and 4). In October, there was no a significant difference in density and biomass of zooplankton between areas with aquatic macrophytes and without them (Table 4).

Besides the phytoplankton and zooplankton analysis, a hydrochemical one was also performed. The obtained data suggest that during the active vegetation of aquatic macrophytes (in July) autopurification characteristics of water were more expressed (Table 5-7).

Table 5: Hydrochemical characteristics of the river stations under study (in July) in the Kuibyshev reservoir

River station	BCO2/5 days			Petrochemicals			Nitrates			Ammonium			Phosphorus			Fe total			CCO			Total mineralization		
	LB	C	RB	LB	C	RB	LB	C	RB	LB	C	RB	LB	C	RB	LB	C	RB	LB	C	RB	LB	C	RB
1*-5*	21.4	A	8.8	A	A	A	38.2	85.7	A	A	27.2	25	12.5	A	A	80	46.1	A	A	A	A	19.6	A	19.1
5*-6*	23.7	A	8.1	35.8	50	A	31.7	A	36.7	61.5	A	A	21.4	A	64	A	A	29.2	ND	ND	ND	A	3.5	A
5*-8*	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	14.8	38.3	A	ND	ND	ND
6*-7*	24.4	A	38.6	100	A	A	63.6	50	A	A	53.9	82.5	1	38.4	A	A	A	A	ND	ND	ND	3.7	0.3	A
6*-9**	A	A	A	100	A	ND	75.9	23.3	A	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7*-8*	33.3	16.7	A	100	A	A	60	A	A	53.9	33.3	A	53.9	22.2	A	51.3	65.9	A	ND	ND	ND	A	A	5.2
8*-9**	37.5	A	42.9	100	50	100	75.9	A	A	A	A	A	25	A	A	62.5	20	A	49.7	19.4	37.7	A	A	A
9**-10	22.8	A	51.1	100	A	100	81.3	A	68.4	A	A	A	5	93.3	84.9	13	A	7.7	A	50.3	6.7	25	20.9	36.5
10-12*	29.6	A	A	100	A	A	13.3	A	A	A	33.3	A	A	A	A	10.8	A	A	37.3	ND	ND	A	A	A
12*-13*	15.8	5.4	A	84	A	A	A	A	A	100	A	100	28.5	A	A	37.7	A	A	A	ND	ND	7.4	3.2	A
13*-15*	4.8	A	A	100	A	A	A	A	A	A	A	A	30	63.2	50	71.3	34.4	A	59.6	41.2	ND	A	A	A
15*-16	42.1	69.6	37.6		70.9	A	A	A	5.2	100	A	100	A	23.6	14.9	A	A	5	ND	ND	ND	5.2	8.25	5.4
15-20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	A	ND	A	ND	ND	ND	ND	ND
16-18	ND	ND	ND	100	A	A	13.4	A	A	A	A	A	A	A	A	A	46.8	57.1	ND	ND	ND	ND	ND	ND
16-23	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
18-19	ND	ND	ND	A	A	69.5	20.7	64.9	49.2	A	A	A	A	A	18.5	A	23.5	A	ND	ND	ND	ND	ND	ND
19-21	ND	ND	ND	ND	85	A	63	82.3	A	27.8	A	100	21.3	75.9	65.9	40	29	82.2	ND	ND	ND	ND	ND	ND
20-21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	A	7.6	22.7
21-22	ND	ND	ND	ND	A	94.7	A	A	18.6	A	A	A	8.4	A	A	A	A	A	ND	ND	ND	ND	ND	ND
22-23	ND	ND	ND	A	9.1	A	A	A	A	100	A	55	50.9	62.5	10	66.4	85.9	74.1	ND	ND	ND	ND	ND	ND
24-25	ND	ND	ND	ND	ND	ND	A	ND	ND	ND	33.3	A	A	A	62.5	ND	ND	ND	A	A	13.3	A	A	A

BCO2/5 days = biological O_2 consumption over 5 d; CCO = chemical consumption of oxygen. * and **-river stations with aquatic macrophytes on the left bank and on the right bank, respectively. LB= the left bank; C=course; RB= the right bank. SDs omitted, but all had CVs of 5-15%. A- changes are absent; ND = no data

Table 6: Hydrochemical characteristics of the river stations under study (in October) in the Kuibyshev reservoir

River station	BCO2/5 days			Nitrates			Ammonium			Phosphorus			Fe total			Total mineralization		
	LB	C	RB	LB	C	RB	LB	C	RB	LB	C	RB	LB	C	RB	LB	C	RB
1*-5*	38.2	HeT	40.6	5.9	A	A	A	A	11.1	A	A	29	A	A	A	A	A	A
5*-7*	64.7	85.9	A	A	11.3	54.4	34.8	A	6.2	A	A	A	10.9	A	21.6	A	2	1.9
7*-8*	86.7	A	A	A	A	25.8	26.6	33.3	A	A	A	30	31.7	A	A	A	A	0.93
8*-9**	A	A	A	A	7.3	A	A	A	A	66.7	A	14.3	42.8	55.6	42.2	8.5	4.8	A
9**-10	86.9	80.5	61.2	55	47	35.5	A	A	31	A	100	A	A	A	A	A	A	5.7
10-12*	A	A	A	25	A	55	A	A	5	70	A	A	8.9	A	A	5.2	6.1	A
12*-13*	49.2	45.6	A	A	62.8	A	27.8	A	47.4	A	69.6	A	30.5	30.2	A	A	A	1
13*-14*	31.2	40.5	62.8	A	A	A	A	60	A	A	A	A	A	A	35.6	A	5.4	A
14*-15*	ND	ND	ND	50.9	18	30.8	46.1	10	A	A	45.2	43.9	ND	ND	ND	A	A	1
15*-16	ND	ND	ND	50	49.4	A	42.8	32.2	6	28.3	5.9	A	ND	ND	ND	6.4	5.2	6.4
16-17	ND	ND	ND	A	A	23	A	ND	A	A	A	A	ND	ND	ND	8.9	13.3	A
17-18	10	9.1	A	28	70.7	A	33.3	ND	A	23.4	39.5	33	ND	ND	ND	A	A	23.5
18-19	A	25.7	24.3	5.7	11.4	44.6	A	ND	A	A	44.3	19.4	ND	ND	ND	14.1	19.7	A
19-20	75.8	27.9	14.6	97.6	85.5	69.7	16.7	A	15	75.8	35.3	88.9	ND	ND	ND	A	A	A
20-21	A	60	26.8	A	A	A	26.7	33.3	29.4	33.3	A	A	ND	ND	ND	A	A	14.2
21-22	A	A	A	A	A	A	A	A	15.4	A	50.9	A	ND	ND	ND	11.8	12.6	17
22-23	48.1	A	65	A	27.8	A	64	11.1	A	17.6	38.5	A	ND	ND	ND	1.8	4.7	3.5
24-25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

BCO2/5 days = biological O_2 consumption over 5 d; CCO = chemical consumption of oxygen. * and **-river stations with aquatic macrophytes on the left bank and on the right bank, respectively. LB= the left bank; C=course; RB= the right bank. SDs omitted, but all had CVs of 5-15%. A- changes are absent; ND = no data

Table 7: The influence of aquatic macrophytes (river stations 1-15) and their deficiency (river stations 6-25) on the hydrochemical regime of the Kuibyshev reservoir

		The left bank		The course		The right bank	
		River station		River station		River station	
Time of observation	Hydrochemical characteristics	1-15	16-25	1-15	16-25	1-15	16-25
July	BCO2/5 days	29.1	ND	8.3	ND	10.3	ND
	Petrochemicals	85.0	33.3	15.5	18.9	0.0	32.8
	Nitrates	39.1	16.2	14.4	29.5	4.6	13.5
	Ammonium	31.5	25.6	14.8	5.0	38.4	25.8
	Phosphorus	21.8	13.4	24.0	23.0	16.1	26.1
	Fe_{total}	27.8	21.3	16.6	37.0	4.3	42.7
	CCO	22.8	ND	29.8	ND	ND	13.3
	Total mineralization	8.1	ND	3.6	3.8	3.7	11.3
October	BCO2/5 days	41.8	22.3	31.5	20.45	17.2	13.1
	Petrochemicals	ND	ND	ND	ND	ND	ND
	Nitrates	18.5	18.7	19.5	39.6	20.7	19.6
	Ammonium	17.4	20.7	13.5	11.1	9.4	8.5
	Phosphorus	14.9	21.4	22.0	29.8	12.8	20.2
	Fe_{total}	16.7	ND	10.7	ND	9.5	ND
	CCO	ND	ND	ND	ND	ND	ND
	Total mineralization	2.1	5.2	2.3	7.2	1.4	8.3

BCO2/5 days = biological O_2 consumption over 5 d; CCO = chemical consumption of oxygen. SDs omitted, but all had CVs of 5-15%. ND = no data

However, by the end of the vegetation period (in October), the sanative role of aquatic macrophytes was decreasing.

DISCUSSION

The concentration of industrial, energy and agricultural potential of Russia for many years in Volga basin resulted in degradation of terrestrial and aquatic ecosystems in these areas. Hydroecosystems present itself the terminal members where the concentration of pollutants is occurred. In this connection, the monitoring of biodiversity and hydrochemical regime of artificial reservoir under anthropogenic load seems an important for forecasting the changes in hydroecosystems for the maintenance and restoration of homeostasis.

The total areas of aquatic macrophytes in the Kuibyshev reservoir is appraised as 8000-10000 hectares [8]. As it was noted before, the dominant part of them are attributed to the left bank of the reservoir. Therefore, it is reasonable to state that the stimulation of the zooplankton reproduction and the inbibition of algal flora (as well as coliform bacteria) was bound to the presence of aquatic macrophytes in the studied regions. The observed phenomenon may be connected for two reasons. First, direct detoxication of water might favor the increase of zooplankton owing to the reduction of harmful components. Second, water pollutants transformed by plant enzymes into more benign components may be used for plankton feeding. This fact can be connected with the different phytodegradation capability of plants [9].

Aquatic macrophytes in the studied regions of the Kuibyshev reservoir were predominantly presented by reed mace, common reed grass and manna. All these macrophytes are characterized with vegetation period in the middle of the summer. It is not surprising, therefore, that the effect of improvement of the water quality after contact with aquatic plants was detected in July. The analogous season-dependent effect of phytoremediation of freshwaters was reported for other aquatic macrophytes [10].

In sum, the efficient regulation of hydrochemical and hydrobiologicl regimes in the Kuibyshev reservoir was revealed in this study. It is mediated by the vital activity of aquatic macrophytes. The advantageous effects of the plants (the stimulation of the zooplankton reproduction, the inhibition of green scum, purification from bacterial and chemical pollutants) are season-dependent.

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