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Chemical and bacterial autopurification of waters of Sviyazhsk Bay of the Kuibyshev reservoir (Republic of Tatarstan, Russian Federation): the role of hydrobiocenosis. Retrospective study

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Abstract: There are enhanced possibilities for salinization and eutrophication of surface waters. The aim of the present work was to evaluate (in seasonal dynamics) the autopurification ability of natural waters owing to aquatic biocenosis. Region of investigation was located at the left coast of head waters of Sviyazhsk Bay of the Kuibyshev reservoir (Republic of Tatarstan, Russian Federation). There is a group of numerous lotic plants of reed mace and common reed grass. The performed studies suggest on a complex action of macrophytes on water quality in low waters. During the vegetation period, contact with macrophytes resulted in water autopurification in the aquatory of low waters. Aquatic macrophytes acted as mechanical and biological filters.

Key words: Macrophytes · Kuibyshev reservoir · Sviyazhsk Bay · Autopurification · Hydrobiocenosis

INTRODUCTION

Owing to increasing anthropogenic influence and degradation of intra-reservoir ecosystems, especially in shallow regions, there are enhanced possibilities for salinization and eutrophication of surface waters. Even in cases of recycling water supply, arid and non-waste technological schemes, surface-water flows from urban, agricultural and other territories as well as atmospherical condensations will favor to pollution of natural waters. There are two ways to reduce water pollution. First, it is elimination of eutrophication reasons. The basic arrangements should involve reduction of pollutant contents at catchment (including brooks, channels, outlets of small rivers). The second way is consisted in liquidation of consequences of this process owing to stimulation of autopurification processes.

There are no any radical approaches for prevention of pollutant (biogenic components, oil products, heavy metals, other) entering to rivers and other reservoirs. Bioengineering systems using consistent patterns of natural a u t o purification processes seem to be efficient in interception of pollutants [1-3]. It is bioimpoundments and biochannels with aquatic macrophytes [2, 4]. Natural biofilters-brushwoods of macrophytes with separate biocenosis-may play the analogous role. The sanative role of water biocenosis may be used for struggle with pollutants.

The aim of the present work was to evaluate (in seasonal dynamics) the autopurification ability of natural waters owing to aquatic biocenosis.

MATERIALS AND METHODS

Region of Investigation: It was located at the left coast of head waters of Sviyazhsk Bay of the Kuibyshev reservoir (Republic of Tatarstan, Russian Federation). There is a group of numerous lotic plants of reed mace and common reed grass (up to 4 km in length and up to 1.5 km in width) (Fig. 1). This area may be considered as natural biofilter preventing pollutant entering from the adjacent territories and from feeders (rivers Arya and Sviyaga). There are good conditions for warming, small depth, low flow velocity (0.1-0.6 meter per min): these conditions favor to continuous contact between macrophytes and pollutants. Region between section lines Britvino and Isakovo was char acterize by the following geobotanical and hydrological fatures: area of growth-2.8 km^2; projective coverage-80%; dominating species (80-85%)-*Typha angustifolia* C. Linnaeus, density of growth-50-70

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Fig. 1: «Model» consortium of macrophytes in Sviyazhsk Bay

specimen per m^2, h eight of plants-2.0-2.5 m, number of leaves per one plant-8-10, width of a leaf-0.8-1.2 cm, phytomass-4 kg per m^2; speed of water flow-0.1-0.6 m per min; depth of the region-0.5-1.5 m.

The relative difference (in %) of chemical, microbiological and hydrobiological parameters of water quality were assessed according to standard techniques [5-9]. Data is presented as mean and standard deviation. The latter varied from 5 to 10% in hydrochemical parameters and from 10 to 20% in microbiological ones.

RESULTS

Hydrochemical regime of waters in Sviyazhsk Bay, investigated in summer-autumn low water of 1986-1988, s howed the following data (Table 1). Due to introduction of pollutants from agricultural farms and household factories lo cated in the area of Sviyazhsk Bay, there was a growth of the positive balance of mineral compounds, disturbance of the sanitary regime, abnormalities of the gas regime. The situation was critical during lowering water level.

Considering the level of the dissolved oxygen [9], waters in the region were classified as polluted and dirty (1986), pure and satisfactory pure (1987) and pure and polluted (1988). The revealed differences might be related to yearly features of precipitation regime. There were many precipitates in summer period of 1986. There were no many precipitates in 1988 and this might favor to accumulation of pollutants in the waters. Data on chemical consumption of oxygen (CCO) confirm this assumption. For example, in July of 1986 the parameter reached 143.9 mg O_2 / L («extremely dirty»), in October-90.3 mg O_2 / L («very dirty»); in 1987, respectively, 58.8 mg O_2 / L («dirty») and 97.7 mg O_2 / L («very dirty»); in August of 1988-74.6 mg O_2 / L («very dirty »), in October-67.1 mg O_2 / L («dirty») (Table 1).

At Isakovo cross section (where macrophytes are situated), the value of autopurification ability of water from hardly oxidable organics was in July of 1986-53.1% (in surface layer), in benthal area-83.0%; in 1987-52.2% (in surface layer) (Table 2). During summer of 1988, aquatic macrophytes were destroyed due to shallowing waters. The amount of hardly oxidable organics was increased till 210.6 mg O_2 / L (in surface area) and till 98.3 mg O_2 / L (in benthal area). Results obtained in period of Autumn are not ambiguous. For example, in October of 1986, there was a high level of autopurification (59.7%) while this parameter was 4.4% in 1988 and it was absent in 1987 (Table 2).

The average autopurification ability concerning hardly oxidable organics was 35.7% (on CCO) during active vegetation (Table 3); in October, it increased up to 13.4% in surface area and up to 83.7% in benthal area.

It was found that all water samples contained increased concentrations of oil products. For example, in summer period before contact with macrophytes the concentration of oil products was 4.2 mg per L (surface area) while it reduced till 0.34 mg per L after contact with aquatic plants (autopurification value of 91.9%). During Autumn, the autopurification effect reduced till 50.1% in surface area while it remained high in benthal area (82.9) probably due to activity of root system.

Table 1: Seasonal hydrochemical parameters of water in Sviazhsk Bay of the Kuibyshev reservoir

		Year of observation						
		1986		1987			1988	
Units of measure	Parameter	July	October	July	August	October	August	October
mg/L	Cl^-	16.8±1.5	70.8±6.8	82.3±7.6	74.3±5.9	82.8±7.9	34.6±3.2	34.8±2.5
mg/L	SO_4^{2-}	153.2±11.2	114.6±8.6	198.6±15.2	333.0±25.5	297.2±22.6	435.5±32.3	300.7±2.8
mg/L	HCO_3^-	110.3±7.8	258.0±18.1	239.2±19.5	275.1±21.2	293.0±23.3	224.5±19.6	217.8±17.7
mg/L	Ca^{2+}	36.0±3.8	76.8±8.2	70.5±5.9	91.4±7.2	88.6±8.7	92.2±7.4	91.5±6.3
mg-eq./L	Total hardness	2.54±0.3	5.30±0.48	5.00±0.43	6.50±0.58	6.20±0.59	7.40±0.68	5.85±5.9
mg/L	Total mineralization	316.3±25.2	520.2±42.0	600.6±48.7	773.8±53.9	771.6±59.2	787.5±58.8	724.8±6.9
mg/L	Fe total.	0.120±0.016	0.230±0.03	0.120±0.010	0.087±0.011	0.120±0.010	ND	ND
mg/L	PO_4^{3-}	0.44±0.03	0.42±0.055	0.72±0.066	0.25±0.015	0.26±0.030	0.44±0.036	0.38±0.32
mg/L	NO_3^-	1.78±0.25	1.95±0.26	0.49±0.045	0.33±0.028	1.30±0.09	3.70±0.40	1.67±0.12
mg/L	NH_4^+	0.77±0.09	3.35±0.38	0.72±0.078	0.14±0.009	0.48±0.02	0.70±0.059	0.18±0.013
mg Î$_2$/L	CCO	143.9±11.5	90.3±0.75	58.8±4.9	50.2±4.2	97.9±8.2	74.6±5.2	67.1±5.8
%	dissolved O_2	63.2±4.3	47.4±3.9	102.3±8.7	83.6±6.8	107.1±8.5	56.9±4.4	54.4±49.2

Note: ND-not detected

Table 2: Autopurification ability of water of various areas of Sviyazhsk Bay of the Kuibyshev reservoir

		Year of observation						
		1986		1987			1988	
Parameters	Region of river	July	October	июль	August	October	August	October
CCO	I-II surface	53.1±5.1	59.5±53.3	52.2±4.3	0.0		14.3±1.2	4.4±0.41
	I-II bottom	83.0±7.6	0.0	ND	ND	0.0	ND	ND
	II-III surface	0.0	0.0	0.0	29.4±2.2	58.7±5.2	0.0	0.0
	II-III bottom	0.0	0.0	0.0	0.0	49.4±4.8	ND	ND
PO_4^{3-}	I-II surface	12.5±0.9	4.3±0.33	25.8±2.1	50.0±5.3	30.0±3.3	0.0	0.0
	I-II bottom	33.3±2.7	13.2±0.8			0.0	32.8±3.3	0.0
	II-III surface	0,0	13.6±1.2	0.0	17.6±1.4	0.0	18.4±1.3	51.5±4.3
	II-III bottom	0,0	0.0	ND	ND	0.0	9.3±0.7	58.7±5.2
NH_4^+	I-II surface	30.2±2.8	0.0	0.0	62.5±6.4	4.3±0.23	0.0	7.8±8.1
	I-II bottom	0.0	0.2±0.015	ND	ND	14.2±1.5	ND	ND
	II-III surface	0.0	32.0±2.7	0.0	0.0	0.0	31.0±2.7	0.0
	II-III bottom	ND	46.6±0.41	ND	ND	0.0	ND	ND
NO_3^-	I-II surface	58.3±4.4	15.7±1.2	0.0	50.0±4.2	0.0	36.9±3.3	0.0
	I-II bottom	38.6±3.2	0.0	ND	ND	32.7±2.9	75.5±6.9	0.0
	II-III surface	0.0	0.0	8.3±0.65	0.0	0.0	54.8±5.1	0.0
	II-III bottom	0.0	13.2±1.4	ND	ND	ND	0.0	32,3±2.8
NO_2^-	I-II surface	6.2±0.55	47.2±4.8	49.5±4.6	0.0	32.2±2.4	43.7±3.9	0.0
	I-II bottom	0,0	11.8±0.08	ND	ND	75.7±6.8	7.7	0.0
	II-III surface	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	II-III bottom	66.7±4.8	0.0	ND	ND	0.0	38.9±4.1	27.1±2.4
SO_4^{2-}	I-II surface	45.5±4.6	0.0	32.1±2.8	28.1±2.2	0.0	9.2±0.85	0.0
	I-II bottom	46.1±4.1	0.0	ND	ND	0.0	ND	0.0
	II-III surface	0.0	0.0	2.5±0.22	9.8±0.8	21.7±1.6	32.8±3.4	36.8±3.1
	II-III bottom	0.0	0.0	ND	ND	22.7±2.4	ND	ND

Table 2: Autopurification ability of water of various areas of Sviyazhsk Bay of the Kuibyshev reservoir

		Year of observation						
		1986		1987			1988	
Parameters	Region of river	July	October	июль	August	October	August	October
Total	I-II surface	15.4±1.2	0.0	8.8±0.75	4.9±0.4	2.8±0.24	0.0	16.9±1.3
hardness	I-II bottom	0.0	0.0	ND	ND	0.0	ND	ND
	II-III surface	0.0	32.3±2.9	53.2±4.9	41.0±3.6	22.6±2.0	37.5±32.3	1.7±0.12
	II-III bottom	7.4±0.59	31.7±2.5	ND	ND	23.3±1.9	ND	ND
HCO_3^-	I-II surface	0.0	13.5±1.25	8.4±0.77	3.5±0.27	23.7±2.1	0.0	0.0
	I-II bottom	48.7±4.3	0,0	19,2±1.5		1.0±0.08	ND	0.0
	II-III surface	56.0±5.1	0.9±0.05	29.2±2.8	32.1±2.9	12.6±1.3	30.4±2.6	21.1±1.8
	II-III bottom	7.7±0.53	16.7±1.4	30.7±2.5	ND	25.5±2.8	ND	ND
Cl^-	I-II surface	46.3±4.2	2.5±0.13	3.1±0.27	8.2±0.78	17.9±1.5	20.7±1.7	0.0
	I-II bottom	0.0	2.0±0.12	ND	ND	16.2±1.4	ND	ND
	II-III surface	0.0	0.0	11.9±0.7	9.7±0.82	9.1±0.8	0.0	13.8±1.1
	II-III bottom	17.8±1.3	0.0	ND	ND	5.0±0.37	ND	ND
Ca^{2+}	I-II surface	4.2±0.35	0.0	21.3±1.8	8.7±0.89	0.0	2.8±0.1	22.7±2.3
	I-II bottom	0.0	0.0	ND	ND	0.0	ND	ND
	II-III surface	0.0	28.2±2.2	52.6±4.9	48.4±4.3	30.2±2.2	35.3±3.1	3.7±0.5
	II-III bottom	8.9±0.63	27.8±2.1	ND	ND	34.2±3.3	ND	ND

Notes: 0.0-autopurification is absent

I-region between outlet of Arya river and Isakovo; II-the left bank at Isakovo (macrophytes downstream);

III-region between cross section of Isakovo (macrophytes downstream) and outlet of Sviyaga river

ND-not detected

Table 3: Alteration of amounts of various compounds (in %) after water contact with biofilter

	Period of observation			
	July-August		October	
Parameter	surface	bottom	surface	bottom
CCO	* 35.7±2.8	without changes	** 13.4±1.1	** 83.7±6.3
Oil products	* 91.9±8.6	* 82.3±6.3	* 50.1±3.9	* 82.9±7.2
SO_4^{2-}	* 32.2±2.3	without changes	** 10.1±0.7	* 9.6±0.7
HCO_3^-	* 24.2±1.8	without changes	* 6.0±0.2	** 2.0±0.03
Cl^-	* 18.1±0.7	without changes	* 9.2±0.6	** 12.9±0.5
Ca^{2+}	* 9.9±0.3	without changes	** 6.8±0.6	** 3.9±0.09
Total mineralization	* 21.2±1.2	without changes	* 4.5±0.3	without changes
PO_4^{3-}	* 18.9±1.1	* 22.2±1.3	** 10.7±0.8	** 15.7±1,2
NH_4^+	* 28.9±2.2	without changes	** 10.4±0.7	** 48.5±2,4
NO_3^-	* 33.9±2.6	* 33.1±2.9	* 21.3±1.5	** 10.1±0.8
NO_2^-	** 33.2±2.8	* 16.0±0.9	* 2.5±0.1	** 27.8±2.3

*parameter is reduced in comparison with region upstream biofilter

**parameter is increased in comparison with region upstream biofilter

ND-not detected

Table 4: Number of saprophiles, 1000 x cells/mL

		Year of observation						
		1986		1987			1988	
Area of investigation	Region of river	July	October	July	August	October	August	October
Outlet of Bua river	khor surface	ND	ND	ND	2.9±0.46	ND	10.5±1.36	3.96±0.51
	khor bottom	ND	ND	ND	ND	ND	1220±134	8.6±1.6
Sobolevskoe	khor surface	ND	ND	42.8±6.84	6.2±0.86	28.3±5.92	1460±200	20.2±2.8
	khor bottom	ND	ND	61.5±12.9	8.4±1.84	63.1±11.9	2.2±0.37	0.69±0.12
Outlet of Arya river	khor surface	7.7±1.20	1.3±0.26	32.5±5.85	0.5±0.09	26.5±5.52	810±121	5.56±0.67
	khor bottom	2.6±0.50	0.1±0.018	104.5±19.8	1.8±0.21	52.5±9.97	6.0±1.08	3.96±0.59
Britvino	khor surface	0.4±0.06	ND	25.3±3.04	30.5±3.97	3.36±0.40	ND	0.77±0.16
	khor bottom	3.1±0.37	ND	18.2±3.8	0.5±0.11	14.4±1.73	ND	5.96±1.01
	left bank, surface	0.5±0.09	2.54±0.55	19.2±2.88	0.8±0.096	5.9±1.12	ND	0.5±0.09
	left bank, bottom	28.8±3.5	1.06±0.13	70.6±12.7	ND	28.4±3.69	ND	ND
	right bank, surface.	6.3±0.88	1.44±0.21	19.9±2.98	ND	19.7±3.15	ND	0.56±0.07
	right bank, bottom	5.2±1.2	1.52±0.31	36.9±8.48	ND	63.3±8.86	ND	ND
	upstream macrophytes, surface	ND	ND	ND	ND	36.8±5.52	ND	ND
	upstream macrophytes, bottom	ND	ND	ND	ND	58.7±12.8	ND	ND
	downstream macrophytes, surface	ND	ND	ND	ND	2.6±0.46	ND	ND
	downstream macrophytes, bottom	ND	ND	ND	ND	4.0±0.68	ND	ND
	right bank, surface.	180.5±37.9	4.16±0.49	ND	ND	ND	ND	ND
	right bank, bottom	1.5±0.24	1.87±0.22	ND	ND	ND	ND	ND
Isakovo	khor surface	48.2±9.2	2.57±0.48	9.5±1.61	ND	ND	0.7±0.08	0.79±0.14
	khor bottom	5.5±1.54	2.37±0.36	0.4±0.06	ND	ND	56.0±10.1	3.96±0.51
	left bank, surface	16.3±4.7	3.44±0.82	*28.2±3.1	0.4±0.048	ND	**2.6±0.36	**0.62±0.09
	left bank, bottom	41.0±8.61	1.56±0.34	**2.9±0.4	0.26±0.042	ND	ND	ND
	left bank, macrophytes	ND	ND	11.0±1.76	ND	ND	ND	ND
	right bank, surface.	27.4±4.1	1.52±0.31	97.7±11.7	1.4±0.21	ND	148±25.1	3.32±0.59
	right bank, bottom	7.5±1.71	1.91±0.34	52.2±9.9	0.5±0.06	ND	ND	ND
Emelkina Yama	khor surface	46.7±8.4	2.24±0.31	55.7±7.8	1.9±0.46	7.3±1.51	89.6±15.2	9.2±1.3
	khor bottom	1.85±0.42	3.63±1.01	42.8±6.4	6.4±1.53	33.7±4.71	152±31.8	20.0±2.2
	left bank, surface	0.4±0.06	2.59±0.54	12.6±2.4	0.6±0.084	7.0±1.33	8.6±1.5	9.84±1.57
	left bank, bottom	1.65±0.37	2.55±2.71	60.8±6.7	3.6±0.64	49.1±5.89	ND	ND
	right bank, surface.	25.5±5.36	1.48±0.22	42.4±8.9	2.8±0.42	1.7±0.27	380±57	1.37±0.19
	right bank, bottom	3.7±0.67	2.04±0.34	90.4±13.6	3.2±0.44	32.9±5.26	ND	ND
Outlet of Sviyaga	khor surface	0.5±0.07	0.94±0.18	32.4±5.8	0.34±0.04	13.2±1.58	3.4±0.4	2.27±0.38
	khor bottom	0.4±0.09	2.53±0.48	40.0±6.1	1.07±0.12	24.2±38.7	48.4±8.7	1.25±0.23
	left bank, surface	3.95±1.02	5.08±0.55	47.2±8.9	0.34±0.05	1.9±0.28	8.6±1.03	4.48±0.53
	left bank, bottom	0.1±0.014	1.42±0.25	89.7±11.6	9.7±1.26	5.4±1.02	26.0±4.4	ND
	right bank, surface.	0.5±0.09	3.53±0.52	8.1±1.5	3.3±0.49	9.3±1.48	78.0±14.1	0.05±0.009
	right bank, bottom	0.1±0.015	1.44±0.21	58.4±8.8	1.8±0.31	13.7±1.64	ND	ND

*upstream macrophytes

**downstream macrophytes

ND-not detected

Table 5: A number of coliform bacteria, 1000 x cells/mL

		Year of observation						
		1986		1987			1988	
Area of investigation	Region of river	July	October	July	July	October	July	July
Outlet of Bua river	khor surface	ND	ND	ND	4.8±0.64	ND	13.1±1.83	3.44±0.58
	khor bottom	ND	ND	ND	ND	ND	128±14.1	1.72±0.27
Sobolevskoe	khor surface	ND	ND	1.0±0.18	1.7±0.32	56.5±9.04	152±24.3	11.36±1.38
	khor bottom	ND	ND	46.2±5.5	10.5±1.71	37.9±4.55	0.6±0.09	0.62±0.093
Outlet of Arya river	khor surface	30.0±4,2	0.06±0.007	30.9±4.3	0.8±0.09	9.6±1.63	396±47.5	4.88±0.63
	khor bottom	6.1±1.1	0.17±0.02	59.7±10.1	0.8±0.17	13.5±2.16	4.0±0.76	3.6±0.61
Britvino	khor surface	11.6±2.32	ND	20.3±3.8	1.2±0.19	0.03±0.004	ND	1.52±0.24
	khor bottom	3.4±0.44	ND	9.8±1.5	9.6±1.25	0.34±0.064	ND	6.08±1.09
	left bank, surface	3.9±0,46	4.7±0.9	19.7±2.6	0.52±0.08	0.22±0.035	ND	3.72±0.56
	left bank, bottom	10.4±1.97	0.62±0.09	31.9±4.5	ND	1.0±0.18	ND	ND
	right bank, surface.	1.4±0.21	0.13±0.01	31.4±5.3	ND	0.09±0.017	ND	0.36±0.061
	right bank, bottom	120±11.6	0.45±0.08	28.6±5.4	ND	0.03±0.006	ND	ND
	upstream macrophytes, surface	ND	ND	ND	ND	13.6±2.45	ND	ND
	upstream macrophytes, bottom	ND	ND	ND	ND	6.0±0.84	ND	ND
	downstream macrophytes, surface	ND	ND	ND	ND	0.2±0.024	ND	ND
	downstream macrophytes, bottom	ND	ND	ND	ND	0.2±0.038	ND	ND
Pump station	khor bottom	11.3±1.9	2.67±0.51	ND	ND	ND	ND	ND
	right bank, surface.	13.5±1.6	6.43±1.09	ND	ND	ND	ND	ND
	right bank, bottom	2.3±0.41	0.57±0.10	ND	ND	ND	ND	ND
Isakovo	khor surface	11.2±1.79	1.39±0.17	31.4±5.0	ND	ND	1.8±0.23	0.98±0.15
	khor bottom	9.7±2.1	2.17±0.33	0.8±0.16	ND	ND	8.4±1.18	2.42±0.36
	left bank, surface	10.0±1.6	1.79±0.28	*0.3±0.03	*0.01±0.002	ND	**1.0±0.19	**2.04±0.24
	left bank, bottom	11.7±2.4	0.01±0.001	** 0.0	**0.14±0.02	ND	ND	ND
	right bank, surface.	7.5±0.97	0.86±0.11	15.5±2.9	3.4±0.58	ND	30.0±4.2	6.0±1.08
	right bank, bottom	20.2±3.6	1.96±0.29	30.0±4.5	1.66±0.22	ND	ND	ND
Emelkina Yama	khor surface	19.5±3.7	0.03±0.004	34.7±4.5	8.12±1.54	0.4±0.08	11.3±1.42	9.92±1.38
	khor bottom	11.4±0.7	0.61±0.12	28.7±4.6	0.1±0.018	0.7±0.11	59.0±9.44	18.2±2.36
	left bank, surface	9.3±1.1	0.35±0.05	21.5±2.7	0.4±0.056	0.2±0.026	1.6±0.27	1.8±0.27
	left bank, bottom	18.8±2.8	0.73±0.11	48.3±9.1	0.15±0.024	0.21±0.032	ND	ND
	right bank, surface.	11.4±2.1	0.2±0.03	8.7±1.2	0.1±0.017	6.1±1.04	30.0±5.4	1.96±0.25
	right bank, bottom	2.8±0.58	1.55±0.2	11.8±2.2	0.1±0.012	5.3±1.00	ND	ND
Outlet of Sviyaga	khor surface	2.7±0.29	2.65±0.45	20.7±4.5	3.4±0.37	0.18±0.022	0.1±0.012	3.04±0.57
	khor bottom	14.7±2.2	0.0	10.3±1.6	2.3±0.46	0.5±0.085	33.0±4.29	1.22±0.20
	left bank, surface	19.8±3.1	4.68±0.66	25.7±3.3	0.03±0.0045	0.5±0.070	1.6±0.30	1.48±0.25
	left bank, bottom	0.5±0.08	0.13±0.017	41.3±4.5	0.06±0.0108	0.21±0.04	33.0±6.93	ND
	right bank, surface.	0.4±0.04	0.18±0.037	37.0±6.3	0.3±0.039	3.1±0.40	59.2±8.28	1.12±0.16
	right bank, bottom	4.7±0.8	3.07±0.58	38.0±5.3	0.5±0.075	0.2±0.028	ND	ND

*upstream macrophytes

**downstream macrophytes

ND-not detected

Table 6: A number of oil-oxidizing microorganisms, 100 x cell / mL

		Year of observation				
		1986		1987		
Area of investigation	Region of river	July	October	July	August	October
Sobolevskoe	khor surface	ND	ND	0.7±0.11	6.0±0.84	11.0±0.43
	khor bottom	ND	ND	5.94±0.83	10.1±1.9	37.0±5.55
Outlet of Arya river	surface	68.7±10.3	0.91±0.14	2.55±0.48	3.0±0.33	22.9±2.52
	bottom	29.2±3.5	0.33±0.04	1.72±0.25	10.1±1.51	8.9±1.16
Britvino	khor surface	29.7±3.3	ND	4.82±0.77	14.8±2.52	0.01±0.0019
	khor bottom	111.7±14.5	ND	2.35±0.28	1.40±0.18	5.6±0.88
	left bank, surface	62.6±8.8	4.6±0.55	1.65±0.29	3.3±0.59	3.2±0.54
	left bank, bottom	1020±122.4	1.42±0.22	2.27±0.38	ND	1.6±0.20
	right bank, surface.	50±5.5	0.6±0.072	0.88±0.12	ND	1.1±0.15
	right bank, bottom	226±38.4	1.68±0.28	2.27±0.34	ND	3.5±0.66
	upstream macrophytes, surface	ND	ND	ND	ND	3.7±0.52
	upstream macrophytes, bottom	ND	ND	ND	ND	18.2±2.36
	downstream macrophytes, surface	ND	ND	ND	ND	13.3±2.12
	downstream macrophytes, bottom	ND	ND	ND	ND	1.9±0.22
Pump station	khor bottom	37.4±4.86	3.17±0.47	ND	ND	ND
	right bank, surface.	54.8±8.22	2.3±0.41	ND	ND	ND
	right bank, bottom	30.9±3.1	1.0±0.12	ND	ND	ND
Isakovo	khor surface	110.4±16.5	0.96±0.12	6.8±1.3	ND	ND
	khor bottom	856±77	1.68±0.31	3.61±0.68	ND	ND
	left bank, surface	6.2±0.74	0.98±0.15	*51.0±6.63	*1.1±0.18	ND
	left bank, bottom	36.4±5.1	1.5±0.19	**0.0	**0.5±0.08	ND
	left benk, macrophytes	ND	ND	2.2±0.36	ND	ND
	right bank, surface.	131±14.4	2.18±0.32	4.22±0.5	1.3±0.18	ND
	right bank, bottom	80.8±9.8	2.56±0.33	3.21±0.38	2.4±0.43	ND
Emelkina Yama	khor surface	93.3±10.2	1.21±0.18	4.07±0.65	9.7±1.35	5.9±0.76
	khor bottom	86.7±13.0	0.64±0.076	4.53±0.67	4.2±0.71	9.1±1.54
	left bank, surface	1.3±0.22	1.41±0.22	6.54±0.72	2.0±0.24	0.95±0.13
	left bank, bottom	10.6±1.16	0.69±0.13	3.15±0.59	5.4±1.02	21.6±3.45
	right bank, surface.	71.6±9.30	0.46±0.07	2.22±0.37	5.9±0.82	4.5±0.58
	right bank, bottom	43.3±6.3	1.4±0.18	4.53±0.58	8.4±0.92	20.7±3.93
Outlet of Sviyaga	khor surface	24.2±3.40	0.1±0.012	2.52±0.35	1.4±0.21	19.5±3.31
	khor bottom	51.6±6.2	0.29±0.04	1.72±0.37	2.8±0.50	5.3±0.63
	left bank, surface	96.3±10.6	1.42±0.28	5.55±0.99	2.1±0.33	6.8±1.29
	left bank, bottom	13.9±2.08	1.08±0.14	2.52±0.30	1.8±0.32	6.6±1.38
	right bank, surface.	4.95±0.74	0.63±0.11	3.68±0.44	0.85±0.10	6.9±1.04
	right bank, bottom	21.6±3.6	1.12±0.13	4.49±0.71	7.2±1.22	2.1±0.25

*upstream macrophytes

**downstream macrophytes

ND-not detected

Table 7: A number of bacterioplankton, 100 x cell / mL (data of 1986)

Area of investigation	Region of river	July	October
Outlet of Arya river	surface	10136,0	1380,0
	bottom	3248,0	10640,0
Britvino	khor surface	6216,0	ND
	khor bottom	5096,0	ND
	left bank, surface	2800,0	14220,0
	left bank, bottom	4928,0	15230,0
	right bank, surface.	1120,0	1620,0
	right bank, bottom	2800,0	5640,0
Pump station	khor bottom	4760,0	20340,0
	khor surface	ND	5430,0
	left bank, surface	ND	7500,0
	left bank, bottom	ND	9460,0
	right bank, surface.	4592,0	6120,0
	right bank, bottom	4256,0	13730,0
Isakovo	khor surface	3584,0	3300,0
	khor bottom	9800,0	3360,0
	left bank, surface	3584,0	4590,0
	left bank, bottom	7392,0	7000,0
	right bank, surface.	8008,0	5710,0
	right bank, bottom	12288,0	18480,0
Emelkina Yama	khor surface	6272,0	7000,0
	khor bottom	2912,0	22120,0
	left bank, surface	12672,0	4420,0
	left bank, bottom	5544,0	90640,0
	right bank, surface.	5264,0	4750,0
	right bank, bottom	17492,0	7000,0
Outlet of Sviyaga	khor surface	5602,0	3740,0
	khor bottom	4984,0	4930,0
	left bank, surface	4704,0	4200,0
	left bank, bottom	5963,0	16970,0
	right bank, surface.	9072,0	6830,0
	right bank, bottom	3806,0	14730,0

ND-not detected

There were significant amounts of nitrate-nitrogen and ammonia-nitrogen. For example, in July 1986, average concentration of ammonia ions was 0.77 mg / L that according to classification of Zhukinsky [9] corresponds to gradation "slightly polluted", in October-3.35 mg / L ("dirty"). In 1987, we detected the following situation with the compound: in July-0.72 mg / L ("slightly polluted"), in August-0.14 mg / L ("satisfactorily pure"), in October-0.48 mg / L. In 1988 the situation was as follows: in August-0.7 mg / L ("slightly polluted"), in October-0.18 mg / L ("satisfactorily pure") (Table 1).

Bacteriological investigation of water in Sviyazhsk Bay in 1986-1988 revealed high levels of saprophiles, coliform and oil-oxidizing microflora (Tables 4-7). This was a consequence of polluting this region that agreeded to hydrochemical data. Microbial autopurification of water during autumn is mediated by excretas of plants having inhibitory effect to bacteria (10-12). In 1988, microbial autopurification persisted despite reducing a number of macrophytes. This might be explained by significant development of zooplankton that uses bacteria as food [13].

DISCUSSION

The performed studies suggest on a complex action of macrophytes on water quality in low waters. During the vegetation period, contact with macrophytes resulted in water autopurification in the aquatory of low waters. Aquatic macrophytes acted as mechanical and biological filters. Contrary to microphytes, macrophytes may withhold chemical compound within tissues and organs of the plants during all vegetation period. It may improve gas regime of water masses owing to oxygen producing at photosynthesis. Aquatic macrophytes may form periphytic formation that favor to contact between microflora and pollutants. The obtained data suggest that a major part of bacteria participating in degradation of pollutants is situated in macrophyte foulings: the concentration of the microorganisms in the basic mass of water flowing through macrophytes is significantly lower. Possibly, the situation was detected due to the ability of macrophytes to produce stimulators of bacterial growth [10] and to consume the corresponding inhibitors [14]. The presence of symbiotic link between aquatic macrophytes and concurrent microflora is one of the mechanisms in the work of natural biofilter [12, 13, 15].

The sanative role of biofilter was not evident during the late Autumn when fluctuations of the water level occurred. To prevent the secondary pollution of waters, it is necessary to eliminate moribund plants after finishing the vegetation period. Acute fluctuations of water level are not allowable for normal functioning natural biocenosis. The proper utilization of these regions in river outlets may prevent the following distribution of pollutants for long distances downstream.

The obtained results may be used for forecasting amount of organic compounds and biogenic elements in reservoirs of Middle area of Russia. Also, it may be used for comparative studies with the aim to reveal the modern tendencies in functioning the reservoirs.

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