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Mineralization of organic matter in bottom sediments of the littoral zones of four Lithuanian lakes

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Investigations on bottom sediments of littoral zones in four Lithuanian lakes (Balsys, Gulbinas, Duobulis and Kreivasis) were conducted during the summer stratification period in August 2001–2002. The amount of organic matter (OM), the intensity and character of its mineralization were found to depend on the type of bottom sediments and surroundings of the banks. C_{org} concentration in bottom sediments of littoral zones varied from 0.1 to 42.2% of dry weight. The lowest amount (0.17%) was determined in bottom sediments of most opened parts of littoral zones and the highest (6.0–42.7%) in profundal sites.

The anaerobic processes prevailed in OM mineralization. The character of terminal mineralization of OM (sulfate reduction and methanogenesis) depends on different ecological conditions such as redox potential, sulfate concentration, organic matter. The intensity of sulfate reduction varied from 0.001 to 2.5 mg S^{2-}/dm^3 d. The highest rates were observed in bottom sediments in the profundal sites of the lakes. In most of the littoral zones (especially in swamp surroundings), ecological conditions in the bottom sediments were favorable for the development of methane-producing bacteria.

Key words: littoral zones of lakes, bottom sediments, organic matter, aerobic and anaerobic mineralization, sulfate reduction, methanogenesis

INTRODUCTION

Intensive farming near lakes may have a determinant influence on the quality of changes in water bodies (eutrophication, increasing bioproductivity). Since the second half of the 20th century, much attention in many countries of the world has been paid to the prevention of these negative consequences and/or restoration of eutrophicated lakes (Eiseltova, 1994; Correl, 1997). Besides farming activities limitation, which eliminates increasing bioproductivity in water bodies, much attention was paid to buffer zones, i.e. water protection belts (broad-leaved and coniferous forests) and other barriers on the banks of water bodies. In Lithuania, the resolution on the legalization of protection belts and zones was passed in 1982. However, besides the protection of water bodies from direct pollution, the broad-leaved and coniferous forests accelerate the bioproductivity of littoral zones and transportation of organic matter to water bodies, *i.e.* it has a negative additional impact. The formation of an organogenous littoral zone accelerates silting processes and diminishes the recreation value of the lakes.

Aerobic and anaerobic microorganisms whose activity depends on the conditions of surroundings (redox potential, pH, organic matter amount, its structure, ect.), mineralize accumulated organic matter in bottom sediments of water bodies (Кузнецов и др., 1985). The investigations on organic matter accumulation and mineralization peculiarities in bottom sediments of Lithuanian lakes until the present time mostly have been carried out in profundal sites (Krevš et al., 2002; Kučinskienė, Paškauskas, 2003).

The aim of the current study was to evaluate the impact of the character of bank zones on organic matter accumulation and peculiarities of its mineralization in different littoral sediments of four Lithuanian lakes located in two different catchment areas, and to compare the intensity of organic matter mineralization in littoral and profundal sediments of these lakes.

STUDY AREA AND METHODS

Investigations of bottom sediments of various littoral zones were conducted in four lakes (Balsys, Gulbinas, Duobulis and Kreivasis) during the summer stratification period (August) of 2001–2002. The lakes are located in the Aukštaičiai Upland (Fig. 1). The glacial channel lakes (Balsys and Gulbinas) are located in the basin of the river Riešė and the thermokarst ones (Duobulis and Kreivasis) – in the basin of the river Stirnė (the left tributarity of the river Lakaja). The largest of

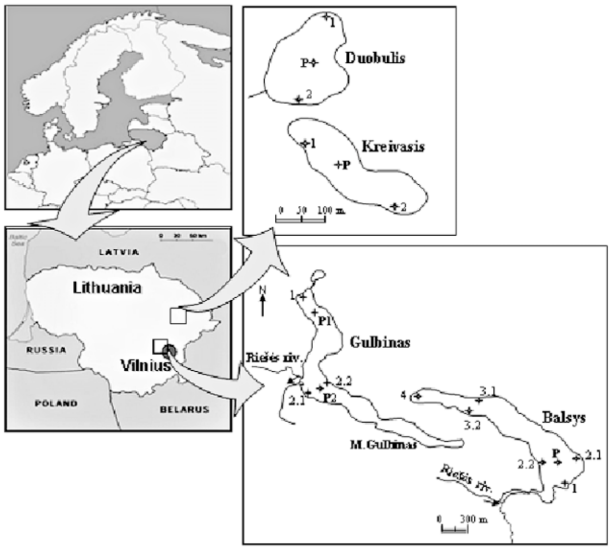

Fig. 1. Location of study area and sites in different profiles of glacial channel lakes (Balsys and Gulbinas) and thermokarst lakes (Duobulis and Kreivasis)

the investigated lakes are Balsys and Gulbinas (Table 1). The length of Lake Balsys bank is 5.2 km, of Gulbinas 4.4 km, while of Duobulis and Kreivasis 0.78 and 0.91 km, respectively. High woodiness (56.8–83.0%) is characteristic of the basins of these lakes. The community of broad-leaved forest has the highest impact on the eutrophication of the lakes and formation of organogenous littoral. The highest area of agricultural land is in the basin of lakes Gulbinas (37.6%) and Balsys (21.8%), while the swamp area – in the basin of Lake Duobulis (8%) (Jodinskaitė, 2002). According to the results of biological and chemical investigations, the study lakes are ascribed to mesotrophic water bodies, while distinct features of eutrophy were recorded in Lake Gulbinas and those of dystrophy in Lake Kreivasis (Taminskas, 2001).

The investigations were carried out in sandy or gravel bottom sediments of open (without macrophytes) littoral zones and in the areas of slow hydrodynamics (overgrown with macrophytes) as well as in silt coves (Fig. 1, Table 2). To compare the intensity of these processes, investigations were carried out in profundal sediments as well.

Ruttner's sampler was used to collect water samples. Bottom samples (0–5 cm) were taken with an Ekman grab. Temperature, pH, redox potential (Eh) were obtained *in situ* with a portable universal MultiLine F/Set-3 meter (WTW). Dissolved oxygen concentrations were measured using Winkler's method (Кузнецов, Дубинина, 1989). Sulfate concentrations in water and bottom sediments were determined using the turbidimetric method (Merkienė, Čeponytė, 1994). This method is based on the formation of $BaSO_4$ crystals in a suspension and subsequent measurement of optical density. Measurements were carried out on a spectrophotometer using a wavelength of 400 nm. The method has a detection limit of about 2 mg/l. The total amount of organic matter in bottom sediments was measured by the dichromate oxidation method. Hydrogen sulfide and acid soluble sulfides (mg/dm^3 natural sediments) were determined by the method of Volkov and Zhabina (Волков, Жабина, 1980). Bottom sediment samples were taken to 100 ml volume flasks and fixed with aquatic $ZnSO_4 + Na_2CO_3$ solution. After treatment with gaseous nitrogen, the sulfides were collected to alkaline $CdSO_4$ solution. Total amounts of hydrogen sulfides and acid soluble sulfides were calculated after titration with sodium tiosulfate. The intensity of aerobic and total (aerobic + anaerobic) organic matter mineralization was determined using the method of isolated columns (Кузнецов, Дубинина, 1989). Undistracted bottom sediment samples (5 cm) were taken to the glass columns. Then the columns with samples and the control column (without bottom sediments) were carefully filled with bottom water and exposed *in situ* all the day. The consumption of oxygen (mg O_2/m^2 d) and the intensity of inorganic carbon release (mg C/m^2 d) were estimated after incubation according to the amount differences between sample and control. Sulfate reduction intensity (mg S^{2-}/dm^3 d) was ascertained using $Na_2{}^{35}SO_4$ tracer technique (Кузнецов, Дубинина, 1989; Сорокин, 1982). 0.1 ml $Na_2{}^{35}SO_4$ solution (Amersham Pharmacia Biotech) of at least 2–3 × 10^6 imp/min radioactivity was added to duplicate or triplicate 20 ml glass tubes, which were pushed 0–5 cm deep into the sediment, so that the sediment layer filled the tube beneath the plunger completely. The tubes were exposed *in situ* all the day. After the chemical treatment of samples, the filters were placed in vials containing 5 ml of Opti Phase Hi Safe 3 scintillation coctail (Wallac Scintillation Products). Radioactivity was determined with a liquid scintillation counter (Beckman Instruments Inc.). The rate of methane genesis was ascertained using gas chromatography (Кузнецов, Дубинина, 1989). Samples for dissolved methane concentrations were set as a control. The samples for the methane production rate were exposed *in situ* all the day.

Table 1. **Morphometry of lakes (Taminskas, 2001)**

Lake	Area, ha		Depth, m		Length of lake bank, km	Woodenness (%)	Swamp area (%)
	basin	lake	max	mean			
Balsys	327	55.0	38.8	15.2	5.2	56.8	0.9
Gulbinas	8000	36.8	11.8	4.2	4.4	22.0	1.8
Duobulis	19	3.8	16.0	6.6	0.78	70.6	8.0
Kreivasis	35	3.6	17.1	3.1	0,91	83.0	2.6

Table 2. **Co-ordinates of different investigation sites and general characteristics of the study lake banks**

Lake	Profile	Station	Coordinate	Bank characteristics
Balsys	1	1	54° 47'01N; 025°20'15E	Open bank, a beach area
	2	2.1	54°47'14N 025°20'18E	Steep bank, overgrown with mixed forest, sunny zone
		2.2	54°47'13N; 025°19'57E	Steep bank, overgrown with mixed forest, shadow zone
		P	54°47'15N; 025°20'03E	Pelagic zone
	3	3.1	54°47'39N; 025°19'42E	Bank is low, overgrown with broad-leaved forest; in littoral zone *Phragmites australis* prevail
		3.2	54°47'34N; 025°19'29E	Flat bank, overgrown with broad-leaved forest, in littoral zone prevail reeds, water-lilies, charophytes
	4	4	54°47'43N; 025°18'56E	Swampy bank, reeds, water-lilies, charophytes form the communities
Gulbinas	1	1	54°48'18N; 025°18'02E	Swampy bank, the littoral zone is overgrown with reeds, rushd, water-lilies
		P1	54°48'14N; 025°18'03E	Pelagic zone
	2	2.1	54°47'39N; 025°18'03E	Flat and open bank
		2.2	54°47'42N; 025°18'20E	Flat bank, overgrown with mixed forest
		P2	54°47'40N; 025°18'05E	Pelagic zone
Duobulis	1	1	55°17'12,9N; 025°36'59,3E	Steep bank; open littoral zone
		2	54°47'45,5N; 025°17'56,9E	Steep bank, overgrown with forest, the coastal zone is swampy
		P		Pelagic zone
Kreivasis	1	1		Steep bank, overgrown with forest, in littoral zone macrophytes prevail
		2	54°47'34,0N; 025°18'21,7E	Swampy bank, in littoral zone macrophytes prevail
		P		Pelagic zone

RESULTS AND DISCUSSION

The main physical-chemical parameters evaluated in different zones of the lakes during the stratification period are presented in Table 3. The surface water temperature in littoral and pelagial zones of the lakes varied from 19.8 to 23.0 ˚C and was characteristic of our latitude water basins during the summer period. Thermal stratification was characteristic of deeper lakes (Balsys, Gulbinas and Duobulis). In these lakes water temperature near the bottom of pelagial zones during the study period varied from 5.5 to 17.7 ˚C. The pH in the surface water of littoral and pelagial zones was slightly alkaline – optimal for the development of most microorganisms. Only the water in surface and near the bottom of Lake Kreivasis, due to the influence of humic acids from swamp surroundings, was a little acid (6.7–6.9 and 6.08). High positive Eh values (+419 – +192 mV) were determined in the water of littoral zones. Markedly lower values of Eh (up to –61 mV) were characteristic of the water near the bottom of lake pelagial zones. Numerous investigations showed that in OM decomposition high positive Eh values are favorable for the prevalence of aerobic and negative values for anaerobic microorganisms (Кузнецов и др., 1985; Беляев и др., 1979). Negative Eh values (from –3 to –229 mV) detected in bottom sediments of the study sites had a positive influence on the activity of anaerobic microorganisms. A high concentration of oxygen (8.2–14.2 mg/l) was characteristic of surface water in littoral and pelagial zones. Anoxic conditions with accumulation of reductive products of anaerobic decomposition were formed in the deepest layers of the stratified lakes Balsys, Gulbinas and Duobulis.

The intensity of OM decomposition in bottom sediments depends not only on the physical-chemical conditions of the environment, but also on the amount and structure of organic matter. Anaerobic terminal processes of OM decomposition (sulfate reduction and methanogenesis) depend on electron donors, – not on the total

Table 3. **Physical-chemical parameters in the water and bottom sediments of littoral and pelagic zones of lakes in August 2001–2002 (average of two years)**

Lake	Sample site (depth, m)	T, ˚C	pH	Eh, mV	O_2, mg/l
Balsys	**1** (0.7)	23.0	8.25	356	10.88
	2.1 (0.7)	23.4	8.47	373	11.68
	2.2 (0.7)	23.1	8.34	381	11.36
	3.1 (0.7)	23.4	8.47	333 / 192(–73)	11.04
	3.2 (0.7)	22.7	8.16	380	12.32
	4 (0.7)	23.9	8.51	351 / (–124)	15.0
	P (25–36)	22.9 / 5.5	8.27 / 7.11	374 / 112(–229)	11.36 / 0.41
Gulbinas	**1** (0.7)	22.3	8.2	374	10.72
	2.1 (1.0)	20.3	8.38	392	10.24
	2.2 (1.0)	20.7	8.48	366	10.72
	P1 (11.5)	21.3 / 7.8	8.3 / 7.1	– / 61(–103)	10.4 / 0
	P2 (4–5)	22.8 / 17.7	8.30 / 7.89	375 / 367(–26)	2.48 / 7.24
Duobulis	**1** (~1)	22.4	8.37	362 / 351	9.6
	2 (~1)	22.2	8.35	369 / 281(–114)	8.80
	P (13.5)	22.7 / 6.8	8.35 / 6.64	333 / –3(–121)	9.12 / 0
Kreivasis	**1** (0.5–1)	21.7	6.9	358 / 273	8.20
	2 (~1)	21.8	6.88	357 / 355	8.32
	P (0.7)	21.5 / 8.6	6.75 / 6.08	310 / –	8.32 / 0.37

Notes: in brackets – in bottom sediments, „–“ – the data are absent, **P** – pelagic zone (in denominator – in the upper water layer, in numerator – in the bottom water layer).

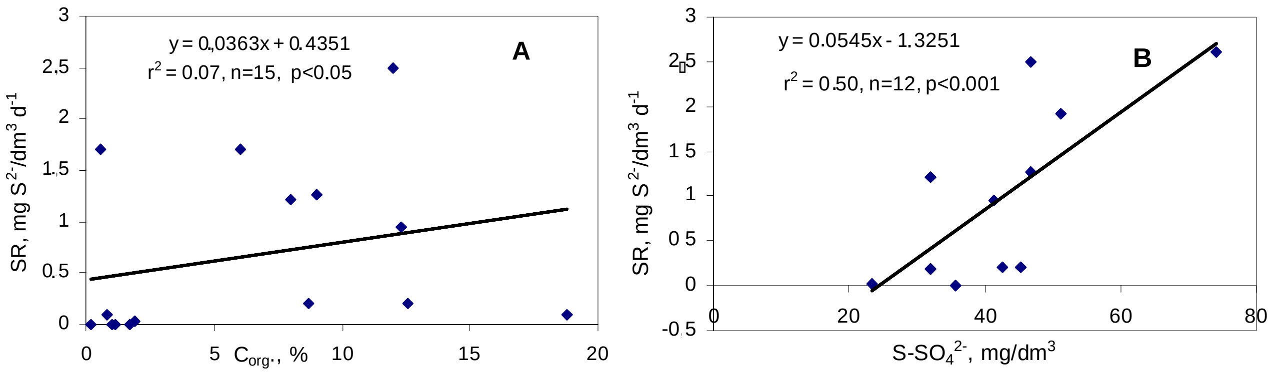

Fig. 2. Correlation between the content of C_{org} and intensity of sulfate reduction (A), the content of sulfates and intensity of sulfate reduction (B) in bottom sediments of the lakes

amount of OM, but mainly on its soluble substrate and especially on the composition and concentration of organic acids, which are necessary for the development of these anaerobic bacteria. The correlation between the total amount of OM and the intensity of sulfate reduction was not determined in bottom sediments of the lakes (Fig. 2, A), implying that mostly the composition of organic matter was not available for the development of SRB. The domination of anaerobic terminal processes of OM decomposition (sulfate reduction or methanogenesis) depends on sulfate concentration as well (Cook, 1992). The content of sulfate ions in bottom sediments varied from 10.6 to 74.0 mg/dm^3. A positive correlation (r^2 = 50) between the amount of sulfates and the intensity of sulfate reduction was determined in sediments of the glacial channel lakes Balsys and Gulbinas (Fig. 2, B). The-

Table 4. **Content of organic matter ($C_{org.}$) and intensity of its mineralization in bottom sediments littoral and profundal zones of lakes in August 2001–2002 (average of two years)**

Lake	Sample site	Humidity, %	$C_{org.}$, %	OM mineralization			
				aerobic		anaerobic, mg C/m² d	total, mg C/m² d
				mg O_2/m² d	mg C/m² d		
				Littoral			
Balsys	1	35	0.17	342	150	399	549
	2.1	28	12.6	211	93	1021	1128
	2.2	22	1.9	739	325	607	896
	3.1	46	0.6	768	338	1123	1440
	3.2	80	9.0	192	85	996	1080
	4	83	8.7	1344	591	849	1440
Gulbinas	1	85	12.3	336	148	1472	1620
	2.1	20	1.0	384	169	191	360
	2.2	27	0.8	317	139	57	196
Duobulis	1	23	1.16	347	153	963	1116
	2	36	1.7	51	22	554	576
Kreivasis	1	90	28.1	912	401	0	0
	2	95	41.2	603	265	–	174
	(depth, m)				**Profundal**		
Balsys	2 (25–36 m)	86	6.0	0	0	1768	1768
Gulbinas	1 (11.5 m)	90	8.0	0	0	990	990
	2 (4–5 m)	90	12.0	512	225	543	768
Duobulis	1 (13.5 m)	91	18.8	40	18	1782	1800
Kreivasis	1 (0.7 m)	95	42.7	464	204	144	348

Table 5. **Intensity of sulfate reduction and methanogenesis in bottom sediments of littoral and profundal zones of lakes in August 2001–2002 (average of two years)**

Lake	Sampling site	$*CH_4$, µl/l	S/SO_4^{2-}, mg/dm³	$H_2S + HS^-$, mg/dm³	Sulfate reduction, mgS^{2-}/dm^3 d	Methanogenesis, ml CH_4/dm^3 d
				Littoral		
Balsys	1	–	10.6	0	0	–
	2.1	121.3	42.6	128.0	0.20	–
	2.2	128.6	23.3	8.0	0.03	859.8
	3.1	86.8	51.3	326.0	1.7	231.4
	3.2	–	46.7	192.0	1.27	–
	4	14796.3	45.3	8.0	0.20	–
Gulbinas	1.1	254.7	41.3	96.01	0.95	–
	2.1	106.7	35.6	0	0	–
	2.2	–	32.0	37.5	0.1	–
Duobulis	1	–	92.0	8.0	0.001	84.9
	2	–	29.3	40.0	0.003	–
Kreivasis	1	–	16.0	8.0	0.03	312.0
	2	–	21.3	64.0	0.07	
	(depth, m)			**Profundal**		
Balsys	2 (25–36 m)	948.4	74.0	892	1.7	117.8
Gulbinas	1 (11.5 m)	28137.3	32.0	168.0	1.22	–
	2 (4–5 m)	17343.3	46.7	200.0	2.50	–
Duobulis	1 (13.5 m)	28501.1	46.7	176	0.09	–
Kreivasis	1 (0.7 m)	38082.4	14.7	72.0	0.13	6.9

$*CH_4$, µl/l – methane content in the bottom water layer, „–“ – data are absent.

refore no such dependence was determined in littoral and profundal sediments of the thermokarst lakes Duobulis and Kreivasis.

The amount of organic matter (C_{org}.) in bottom sediments of the lakes varied from 0.1 to 42.2% of dry sediments and depended on littoral biotopes and the impact of surrounding banks (Table 4). The least amount of $C_{org.}$ (up to 0.17%) was registered in sandy or gravel-pebble deposits of open littoral zones of lakes Balsys (1 st.) and Gulbinas (2.1 st.). Active hydrodynamic processes due to steep banks or narrow littoral zones and intensive mixing of water and bottom sediments took place there as well. The rates of aerobic (308–342 mg O_2/m^2 d) and total (135–549 mg O_2/m^2 d) mineralization of OM matter were low, too. Sulfate reduction and methanogenesis were not registered in those littoral zones (Table 5).

Not a high amount of C_{org}. (0.4–1.9%) was also determined in sandy or gravel with silt bottom sediments of littoral zones with woody surroundings (Duobulis 1, Balsys 2.2, 3.1 st.) as well as in bottom sediments covered with non-mineralized OM – fallen branches and leaves from the bank trees and submarine plants (Duobulis 2; Gulbinas 2.2 st.) (Tables 2, 4). From 51–317 mg O_2 (bottom sediments with high amount of non-mineralized OM) to 347–768 mg O_2 (sandy or gravel with silt bottom sediments) was consumed per 1 m^2 of bottom sediments. From 196 to 1440 mg of inorganic C per day was released to water in those biotopes as well (Table 4). In bottom sediments of the above discussed littoral zones, the prevalence of terminal anaerobic OM mineralization processes depended on redox potential, sulfate concentration and the qualitative structure of the substrate. The intensity of sulfate reduction varied in a rather wide range – from 0.001 to 1.70 mg S^{2-} dm^3/ d. Anaerobic mineralization of OM was about twice higher than aerobic in sandy-gravel bottom sediments located in the western part of lake Balsys surrounded by steep banks and woods (2.2 st). Methanogenesis dominated in terminal mineralization of OM in bottom sediments of these littoral zones. The intensity of this process made up 859.8 ml CH_4/dm^3 d. The amount of OM was about 3.2 times lower in gravel with silt bottom sediments located in the north-eastern part of this lake (3.1 st). The reason for this phenomenon might be the intensive motion of bottom sediments in the surroundings of steep banks and in the bathing place as well. Anaerobic microorganisms, including sulfate-reducing and methane-producing bacteria, played a major role in OM decomposition there. The reductive environment and probably a sufficient amount of easily oxidative OM evoked the activity of the latter bacteria. However, the intensity of sulfate reduction was about 57 times higher, whereas mehanogenesis was 3.7 times lower in this local littoral zone in comparison with the western, above-mentioned part of Lake Balsys. Such character of OM mineralization could be determined by a higher sulfate content (2.2 times) and probably by the OM structure more favorable for the development of sulfate-reducing bacteria.

As mentioned above, not in all cases the content of sulfates had a direct influence on the intensity of sulfate reduction. For instance, despite a high for freshwater ecosystems content of sulfates (92.0 mg/l), methanogenesis dominated in bottom sediments of open, with steep littoral zones (1 st.) lake Duobulis (Table 5). It suggests that OM substrate was more usable for methane producing bacteria or production of methane occurred reducing CO_2 by hydrogen (Беляев и др., 1979).

Silt bottom sediments with dead parts of plants were characteristic of local accumulation zones or inlets with not very high banks surrounded with mixed forest and littoral zones overgrown with reeds, water-lilies and charophytes (Balsys 2.1; 3.2; 4; Gulbinas 1). In these local zones the amount of OM was rather high – from 8.7 to 12.6 % C_{org}. The aerobic and anaerobic decomposition of OM ran intensively as well. However, anaerobic processes prevailed and on the average varied from 849 to 1472 mg C/m^2 d; the intensity of sulfate reduction was from 0.2 to 1.27 mg S^{2-} dm^3/ d (Tables 4, 5). The highest amounts of sulfides (up to 192 mg/ dm^3) were registered in bottom sediments where the most active process took place. The amount of dissolved CH_4 in water near the bottom ranged from 121.3 to 14796.3 μl/l. It suggest an intensive methanogenesis.

The most productive phytocenosis found in the northern part of Lake Balsys surrounded by swamps (4 st.) influences the formation of organogenous littoral (Balevičienė et al., 2004). The reductive environment in bottom sediments and the composition of organic substrate determined the activity of methane-producing bacteria, while sulfate reduction was weak and the amount of sulfides low (Table 5).

The highest amount of organic matter (28–41% C_{org}) due to humic acids from swamp environment was registered in bottom sediments of Lake Kreivasis. In slightly acid littoral sediments of this lake, an intensive aerobic decomposition of OM took place (Table 4). The low concentration of sulfates (16.0–21.3 mg/l) as well as the slowly decomposing OM of humic origin indicates a weak sulfate reduction in littoral sediments. The content of acid-soluble sulfides was low as well (8.0–64.0 mg/dm^3). The weak sulfate reduction was balanced by methanogenesis – up to 312.0 ml CH_4/dm^3 d (Table 5).

The accumulation of OM occurs in bottom sediments of deep lake areas due to its transportation from the places of intensive hydrodynamic processes (open littoral, steep banks). For this reason and the sedimentation of dead plankton, the highest amount of OM (6.0–42.7%) was registered in the profundal sediments of lakes (Table 4). Anaerobic conditions near the bottom, negative redox potential in sediments as well as a high amount of soluble OM determined the high activity of anaerobic bacteria there. The most intensive anaerobic OM decomposition (1768–1782 mg C/m^2 d) was registered in profundal sediments of lakes Balsys and Duobulis. The most intensive sulfate reduction was found there as well (Table 5). In profundal sediments of lakes Balsys, Gulbinas and Kreivasis the intensity of sulfate reduction on the average was 2–5 times, while in Lake Duobulis almost 45 times higher than in littoral sediments. Rather high contents of methane (17343.3–38082.4 µl/l) were obtained near the bottom of profundal sites of lakes Gulbinas, Duobulis and Kreivasis as well, while the highest levels of sulfides (892 mg/dm^3) were registered in profundal sediments of Lake Balsys.

Thus, according to our investigations, the accumulation, intensity and character of OM decomposition in bottom sediments during the summer stratification period depended mainly on the eulittoral zones of the lakes. The least amount of OM was obtained in open littoral zones where, due to steep banks or a narrow littoral, active hydrodynamic processes took place. These materials are being transported to deeper places where their accumulation occurs. For this reason the highest amount of OM was registered in profundal sediments.

In littoral zones located near swamps (the northern part of lakes Balsys and Gulbinas) or in the low water circulation zones (little coves, areas overgrown with macrophytes) (Balsys, 2.1; 3.2) the amount of OM (due to its accumulation) was 12–53 times higher in comparison with open zones (Balsys, 1; Gulbinas, 2.1; Duobulis, 1).

Despite the variety of biotopes, the anaerobic processes in the decomposition of OM prevailed. In gravel-pebble deposits of open littoral zones, OM mineralization occurred via aerobic and anaerobic respiration. Sulfate reduction and methanogenesis were not registered in those littoral zones.

In bottom sediments of local accumulation zones or inlets, a particularly high intensity of total OM mineralization (up to 1620 mg C/m^2 d) was registered. Anaerobic bacteria including sulfate-reducing and methane-producing bacteria dominated. The latter contribution to OM mineralization depended on the peculiarities of ecological conditions as well as on the structure and amount of OM. In most littoral zones (especially in swamp surroundings) ecological conditions were more favorable for methane-producing bacteria. From 7.5 to 72.0 C/m^2 d of OM was mineralized via sulfate reduction, what amounted to 0.5–8.3% of total anaerobic decomposition. The most favorable conditions for sulfate reducers formed in profundal sediments of lakes and especially in the glacial channel lakes Balsys and Gulbinas. The most intensive sulfate reduction and the highest amounts of acid-soluble sulfides were detected there as well.

Not the total OM amount but its qualitative composition determined the intensity and character of OM mineralization in bottom sediments with a high content of slowly decomposing humic OM as well as covered with fallen branches and leaves from the bank trees and submerged plants (Duobulis 2; Gulbinas 2.2 st.). OM mineralization was not intensive in those biotopes, and methanogenesis dominated in its terminal stage.

Accumulation of high OM contents and its intensive aerobic and anaerobic mineralization took place in local littoral sediments during the summer period. Therefore, biogenic regeneration as well as excretion of terminal products of anaerobic decomposition (methane and hydrogen sulfide) occur in bottom water. This phenomenon intensifies eutrophication processes and may have a negative effect on the benthic fauna of lakes.

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ORGANINIŲ MEDŽIAGŲ MINERALIZACIJA KETURIŲ LIETUVOS EŽERŲ ATABRADO DUGNO NUOSĖDOSE

S a n t r a u k a

Tyrimai buvo atliekami įvairių atabrado zonų dugno nuosėdose keturiuose ežeruose – Balsyje, Gulbine, Duobulyje ir Kreivajame 2001–2002 m. vasaros stagnacijos metu. Nustatyta, jog organinių medžiagų (OM) kiekis, jų mineralizacijos intensyvumas, pobūdis bei eiga priklausė nuo dugno nuosėdų tipo bei jį supančio kranto tipo ir aplinkos.

$C_{org.}$ kiekis atabrado dugno nuosėdose kito nuo 0,1 iki 42,2% orasausių nuosėdų svorio. Mažiausias (iki 0,17%) jos kiekis buvo nustatytas atviriausių atabrado dalių, o didžiausias – profundalių dugno nuosėdose (6,0–42,7%). Nepaisant atabrado biotopų įvairovės, OM mineralizacijoje daugeliu atvejų vyravo anaerobiniai procesai. Terminių anaerobinių OM skaidymo procesų (sulfatų redukcijos ir metanogenezės) pobūdį bei vyravimą atabrado dugno nuosėdose lėmė įvairūs faktoriai, tarp jų oksidacinė-redukcinė aplinka, sulfatų koncentracija bei organinis substratas. Daugelyje atabradų (ypač užpelkėjusių pakrančių) ekologinės sąlygos dugno nuosėdose buvo palankesnės metaną produkuojančių bakterijų vystymuisi. Intensyviausia sulfatų redukcija nustatyta profundalinių ežerų dalių dugno nuosėdose, kuriose buvo susikaupę didžiausi divandenilio sulfido bei rūgštyje tirpių sulfidų kiekiai.

Raktažodžiai: ežerų atabradai, dugno nuosėdos, organinės medžiagos, aerobinė ir anaerobinė mineralizacija, sulfatų redukcija, metanogenezė