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POLLUTION OF THE RIVER NYSA ŁUŻYCKA IN TUROSZÓW COAL MINING REGION

PART III. ECOLOGICAL CHANGES IN BIOCENOSIS AND SAPROBIAL STATE OF THE RIVER NYSA ŁUŻYCKA

The purpose of the present paper, being the Part III of the evaluation of the river Nysa Łużycka pollution in the Turoszów region, was to determine by hydrobiological investigations the degree of the river water pollution and to establish the effect of pollution on the biocenosis of the river examined. High value of the saprobial state index, characteristic of the α-mesosaprobic zone, has testified a substantial pollution of this river. It has been stated that biocenosis includes high quantities of the representatives of organisms typical of strongly polluted waters, i.e.: *Sphaerotilus* sp., *Thiotrix* sp., *Beggiatoa alba*, *Beggiatoa minima*, *Oscillatoria subtilissima*, and *Flagellata* (*Zoomastigina*). High numbers of sulphuric bacteria and *Cyanophyta* occurring periodically give the evidence to intense biological transformation of sulphur compounds.

The affluents of the river Nysa Łużycka had negative (Miedzianka) and positive (Witka) effects on its pollution state.

1. INTRODUCTION

This work presents a hydrobiological evaluation of the river Nysa Łużycka water pollution in the Turoszów region for the period IX 1976–VIII 1977.

High variety of the existing industrial pollutants significantly influences the biocenosis and all the processes constituting the biological part of self-purification.

Results of physicochemical and bacteriological investigations allowed us to state high contents of such pollution indicators as suspended matter, nitrogen, phosphorus, and iron compounds. Bacteriological examinations have indicated strong organic pollution and bad sanitary conditions of the water.

Right-bank tributaries of the Nysa Łużycka (Biedrzychówka, Miedzianka nad Witka) significantly affected the chemical and biological conditions as a whole. The river Miedzianka substantially deteriorated the quality of Nysa Łużycka water by introducing almost

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entire load of its own non-biodegraded pollutants, whereas Witka, being a clean water river, had a distinctly positive effect, decreasing — through dilution — the concentration of chemical compounds present in Nysa Łużycka water.

2. MATERIAL AND METHODS

Water samples for hydrobiological examinations were taken at the same stations as those for physicochemical analyses [5]. Three complexes of organisms: bioseston, periphyton and benthos were investigated. Bioseston was collected by means of Rutner's scoop and conical plankton net bolting cloth No. 25, thus concentrating the material sampled in 20 dm^3 of water. Thereupon the organisms were determined *in vivo* using suitable keys [1, 2, 7–9, 11, 12]. The results obtained from microbiological examinations were calculated for 1 dm^3 of river water and analysed according to the Pantle-Bucke method, determining the index of saprobial state. Quantitative proportions of systematic groups were presented in form of a spherical curve of LOHMANN [3], computing the radius R of the sphere of a given volume V, equal to the frequency of the given systematic groups:

$$R = \sqrt[3]{\frac{V}{4.19}}\,.$$

Organisms occurring in periphyton were taken by pincers, diluting the material collected in river water in 3:1 voluminous ratio. Benthos organisms were collected by Ekman's benthos sampler. Periphyton and benthos were examined *in vivo*, determining the species by the method given for bioseston. The frequencies of the separate species were estimated by means of Starmach's scale [10].

3. RESULTS AND DISCUSSION

During the whole cycle of investigations the following groups of plankton occurred most frequently: *Bacteria*, *Cyanophyta*, *Chrysophyta*, and *Flagellata*. Their percentages in biocenosis varied both in annual cycle and with the river course.

The number of filamentous bacteria (in the plankton of the river Nysa Łużycka) was very high both at the initial period of investigations (September, October, November) and at the initial segment of the river (stations 3-6) to decrease gradually with its course (figs. 1, 2). These bacteria were represented mainly by the genera *Thiotrix* and *Sphaerotilus* (tab. 1).

At the same time the total number of bacteria ranged from 65×10^4 to 83×10^5 per cm^3, the coli titre varied within 10^{-3}–10^{-9} [5]. The fact that the number of filamentous bacteria and the total number of bacteria decrease with the river course gives the evidence

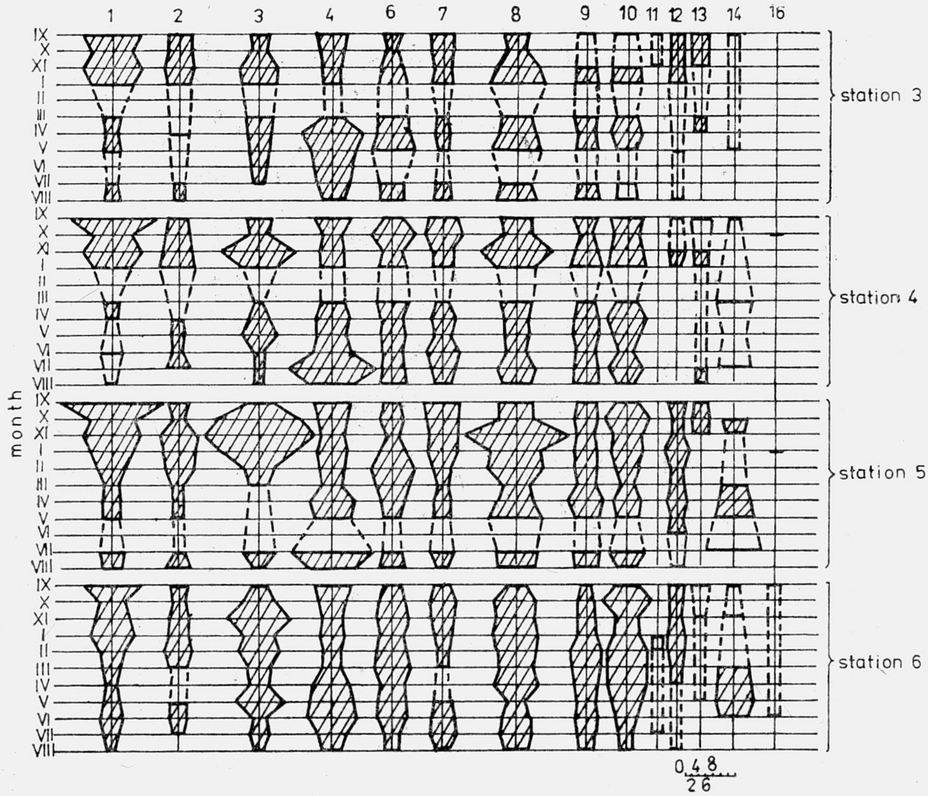


Fig. 1. Quantitative proportions of systematic groups of plankton organisms in the river Nysa Łużycka at the stations 3, 4, 5, and 6 during one-year cycle

1 — filamentous bacteria, *2* — *Fungi*, *3* — *Cyanophyta*, *4* — *Chrysophyta*, *5* — *Pyrrophyta*, *6* — *Euglenophyta*, *7* — *Chlorophyta*, *8* — *Flagellata*, *9* — *Rhizopoda*, *10* — *Ciliata*, *11* — *Suctoria*, *12* — *Rotatoria*, *13* — *Nematoda*, *14* — *Crustacea*, *15* — *Oligochaeta*, *16* — *Insecta*

Rys. 1. Stosunki ilościowe grup systematycznych organizmów planktonowych Nysy Łużyckiej na stanowiskach 3, 4, 5 i 6 w cyklu rocznym

1 — bakterie nitkowate, *2* — *Fungi*, *3* — *Cyanophyta*, *4* — *Chrysophyta*, *5* — *Pyrrophyta*, *6* — *Euglenophyta*, *7* — *Chlorophyta*, *8* — *Flagellata*, *9* — *Rhizopoda*, *10* — *Ciliata*, *11* — *Suctoria*, *12* — *Rotatoria*, *13* — *Nematoda*, *14* — *Crustacea*, *15* — *Oligochaeta*, *16* — *Insecta*

to the proceeding self-purification process, thus to the biodegradation of organic pollutants, the presence of which caused the growth of the said biocenosis components. This fact refers solely to the segment of the river Nysa Łużycka enclosed within the estuary of the river Miedzianka, below which the number of bacteria rapidly decreased.

The second dominating group of plankton consisted of algae belonging to *Cyanophyta* (figs. 1, 2). The observed variations in their frequencies were, in general, consistent with the annual cycle (intense development in autumn). Some perturbations were observed only in the late spring, since then the maximum growth of these algae was observed again. *Oscillatoria subtilissima* was the main species, since its domination (61.57% of the total plankton) was noted at the station 6 in November 1976 (tab. 1).

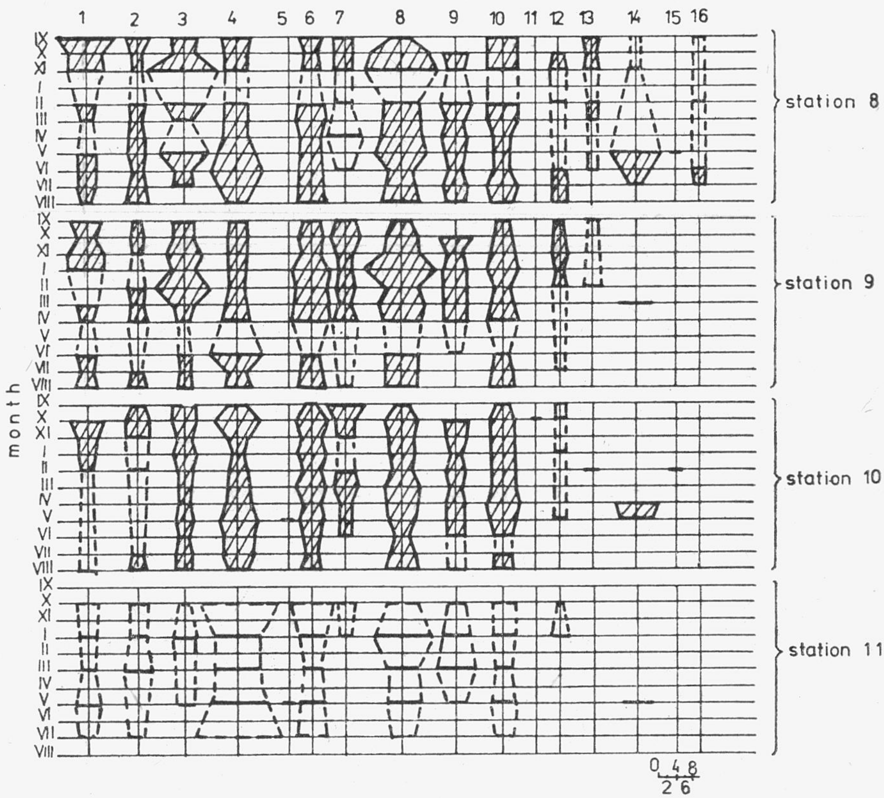


Fig. 2. Quantitative proportions of systematic groups of plankton organisms in the river Nysa Łużycka at the stations 8, 20, 21, and 26

For explanations see fig. 1

Rys. 2. Stosunki ilościowe grup systematycznych organizmów planktonowych Nysy Łużyckiej na stanowiskach 8, 20, 21 i 26 w cyklu rocznym

Objaśnienia jak na rys. 1

In autumn the populations of diatoms were not significant, their frequency increased not earlier than in spring, decreasing, however, along the river course. Despite high frequency of this genus no dominance of separate species was observed, except for the stations 4 and 5 in July and August, where grat numbers of the representatives of *Melosira granulata* var. *angustissima* were stated (tab. 1).

A different situation was observed in station 26 (figs. 1, 2), where the number of diatoms increased. It seems that it was due to the dilution of polluted water of the river Nysa Łużycka with a clean water from the reservoir "Witka" situated on the river Witka.

Mastigophorans occurring in plankton were represented numerously during all the seasons of the year. The growth maxima observed at the stations 4, 5 and 20 in autumn and winter gave the evidence to a strong pollution of the water examined.

Table 1

Significant populations of plankton organisms occurring in the river Nysa Łużycka water during one-year cycle (percentage of total number of plankton)

Organizmy planktonowe występujące w znaczących ilościach w cyklu rocznym w wodzie Nysy Łużyckiej (% ogólnej liczby planktonu)

Month	Genus and species	Station 3	4	5	6	8	20	21	26
I	II	III	IV	V	VI	VII	VIII	IX	X
IX 1976	*Sphaerotilus natans* Kütz.	24.61	70.74	82.34	64.31	54.05	35.04		
	Thiothrix nivea (Rab). Winogr.	24.22							
	Oscillatoria tenuis Adardh.						10.00		
	Melosira granulata var. *angustissima* (Müll.) Hust.							72.86	
X 1976	*Sphaerotilus natans* Kütz.	18.0							
	Zooglea ramigera Itzigsohnem Blöch	30.25	10.21						
	Oscillatoria subtilissima Kütz			65.39					
	Melosira granulata var. *angustissima* (Müll.) Hust.							33.94	71.51
	Petalomonas mediocanellata Stein		15.38						
	Chlamydomonas proboscigera Kors.		17.57						
	Bodo fusiformis (St-Okes) Lemm.					15.03			
	Cercobodo crassicauda (Alex.) Lemm.					42.88			
	Oicomonas termo (Ehr.) Kent.						10.79		
	Pelomyxa villosa Greff.						23.68		
	Holophrya simplex Sevi.				10.10				
XI 1976	*Microscilla agilis* Pringshemm	16.39					12.14		
	Sphaerotilus natans Kütz.						14.19		
	Thiothrix nivea (Rab.) Winogr.	10.57							
	Mycetes sp.							10.43	
	Oscillatoria subtilissima Kütz	15.12	34.27	42.73	61.57	36.67			
	Oscillatoria putrida Schmidle.						17.43		
	Bodo edax Klebs.						17.43		
	Monas vulgaris (Cienk.) Senn.							12.88	
	Monosiga ovata			31.97					

I	II	III	IV	V	VI	VII	VIII	IX	X
XI 1976	*Oicomonas termo* (Ehr.) Kent.		36.46	14.06		37.74			
I 1977	*Microscilla agilis* Pringsheim	10.33							
	Oscillatoria subtilissima Kütz.			40.70				15.17	
	Petalomonas pusilla Skoja							20.98	
	Cercobodo crassicauda (Alex.) Lemm.	14.45	10.86		12.28		61.69	11.63	
	Monas arhabdomonas Mayer				20.97				
	Oicomonas termo (Ehr.) Kent								38.32
II 1977	*Oscillatoria putrida* Schmidle				16.09	35.04			
	Oscillatoria subtilissima Kütz						57.26		
	Cercobodo crassicauda (Alex.) Lemm.			20.68					
	Tachysoma pelionella (Ofm.) Stein.							13.60	
III 1977	*Oscillatoria putrida* Schmidle	11.95							
	Mycetes sp.								13.33
	Anisonema acinus Dujardin		11.43					13.24	
	Anisonema ovale Klebs			23.95					
	Bodo edax Klebs					10.05		18.74	
	Cercobodo crassicauda (Alex.) Lemm.				11.52	14.65			
	Monas vulgaris (Cienk.) Senn.	12.59							
	Oicomonas termo (Ehr.) Kent.						25.23		
	Loxocephalus ellipticus Khall.				14.63	10.05			
	Cyphoderia ampula Ehr.								27.13
	Cyclops strenuus Fischer		41.94	14.18	12.76	23.02	19.42		
IV 1977	*Diatoma hiemale* (Lyngb.) Heib.	27.81							
	Chlamydomonas ehrenbergii Goros.					27.18			
	Cercobodo crassicauda (Alex.) Lemm.			10.24	11.29	33.88			
	Loxocephalus ellipticus Khal.		32.07		22.55			11.57	
	Cyclops strenuus Fischer			12.30	14.47			45.81	

I	II	III	IV	V	VI	VII	VIII	IX	X
V 1977	*Oscillatoria putrida* Schmidle					24.67			
	Oscillatoria subtilissima Kütz		24.08		32.91				
	Diatoma hiemale (Lyng.) Hieb.								10.04
	Melosira granulata var. *angustissima* (Müll.) Hust.								14.68
	Anisonema ovale Klebs	11.48							
	Bodo edax Klebs	12.01							
	Cercobodo crassicauda (Alex.) Lemm.	17.40		39.09		24.67			
	Difflugia globulosa Dujardin			26.03					
	Cyclops strenuus Fischer		10.51	17.27	14.47	25.95		26.85	10.90
VI 1977	*Synedra ulna* (Nitzch.) Ehr.					10.18			
	Synedra vaucheriae var. *capitellata* Grun.						12.70	14.01	
	Melosira granulata var. *angustissima* (Müll.) Hust.							11.53	
	Chlamydomonas ehrenbergii Goros.		17.79						
	Cercobodo crassicauda (Alex.) Lemm.						10.95		
	Cyclops strenuus Fischer				13.27	12.07			
VII 1977	*Oscillatoria tenuis* Agardh.							11.05	
	Melosira granulata var. *angustissima* (Müll.) Hust.		77.21	55.46				31.47	80.51
	Nitzschia paleacea Grun.	23.89							
	Cercobodo crassicauda (Alex.) Lemm.	13.01			26.96	11.82	27.38		
	Cyclops strenuus Fischer			19.10					
VIII 1977	*Zoophagus insidians* Sommerstorff					13.84			
	Anisonema ovale Klebs					11.15			
	Bodo minimus Klebs	28.37			23.42			16.45	
	Cercobodo crassicauda (Alex.) Lemm.		14.66			25.88	27.13	23.36	
	Monas arhabdomonas H. Meyer			11.76					
	Monas vulgaris (Cienk.) Senn	11.14							
	Cyphoderia ampula Ehr.				10.58				

Total numbers of plankton organisms are presented in figs. 3, 4 and 5. From the investigations performed it may be stated that their growth was strongly inhibited. During the investigation cycle the population of this group increased with the river course at its initial segment (stations 3, 4, and 5) due to a mass growth of the representatives of *Bacteria* and

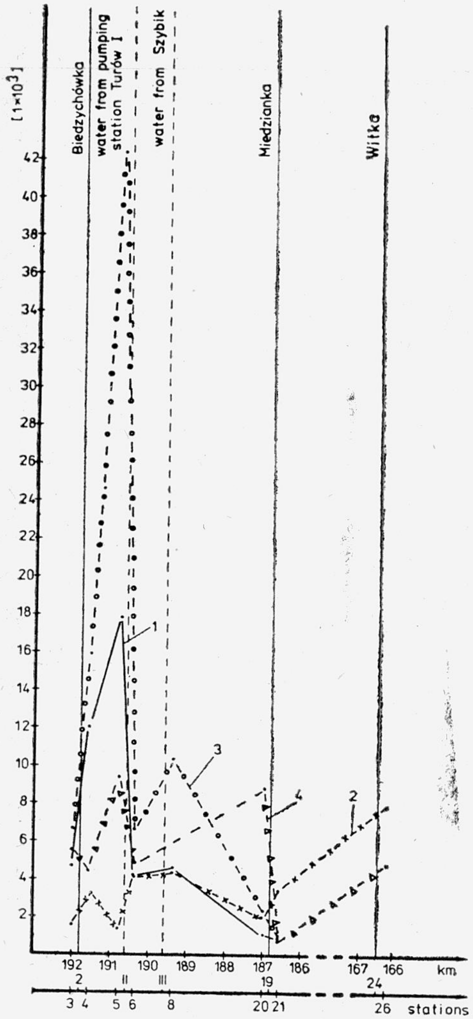


Fig. 3. Total number of plankton organisms in the river Nysa Łużycka from September 1976 to January 1977

1 — September, *2* — October, *3* — November, *4* — January

Rys. 3. Ogólna liczba organizmów planktonowych Nysy Łużyckiej w okresie od września 1976 do stycznia 1977

1 — wrzesień, *2* — październik, *3* — listopad, *4* — styczeń

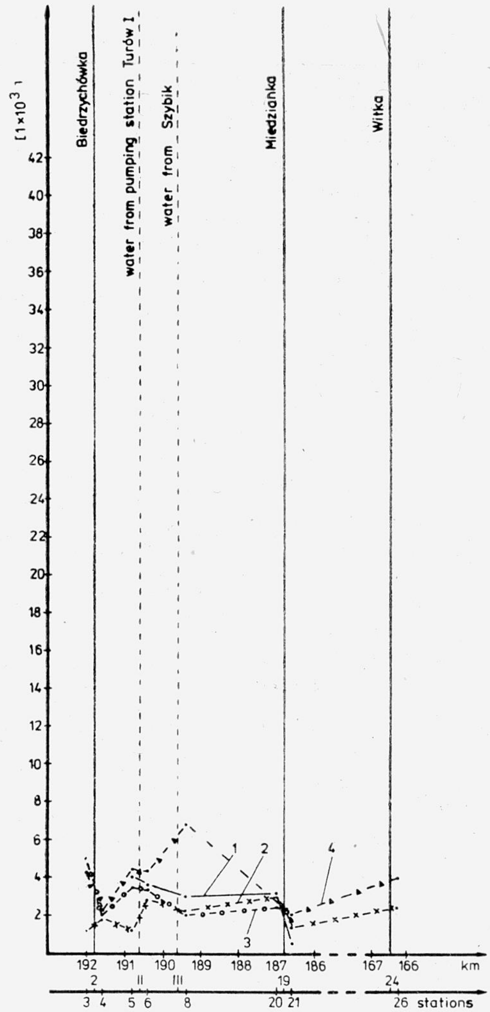


Fig. 4. Total number of plankton organisms in the river Nysa Łużycka from February to May 1977

1 — February, *2* — March, *3* — April, *4* — May

Rys. 4. Ogólna liczba organizmów planktonowych Nysy Łużyckiej w okresie od lutego do maja 1977

1 — luty, *2* — marzec, *3* — kwiecień, *4* — maj

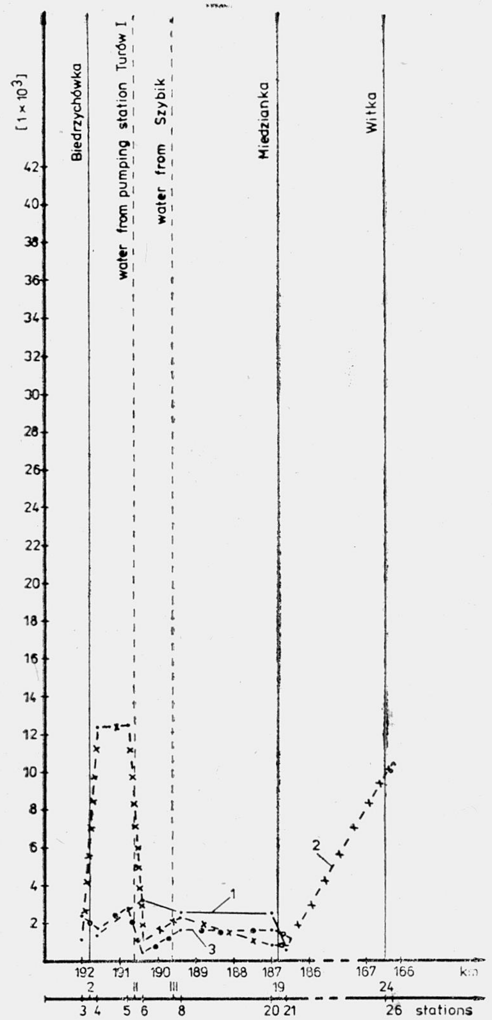
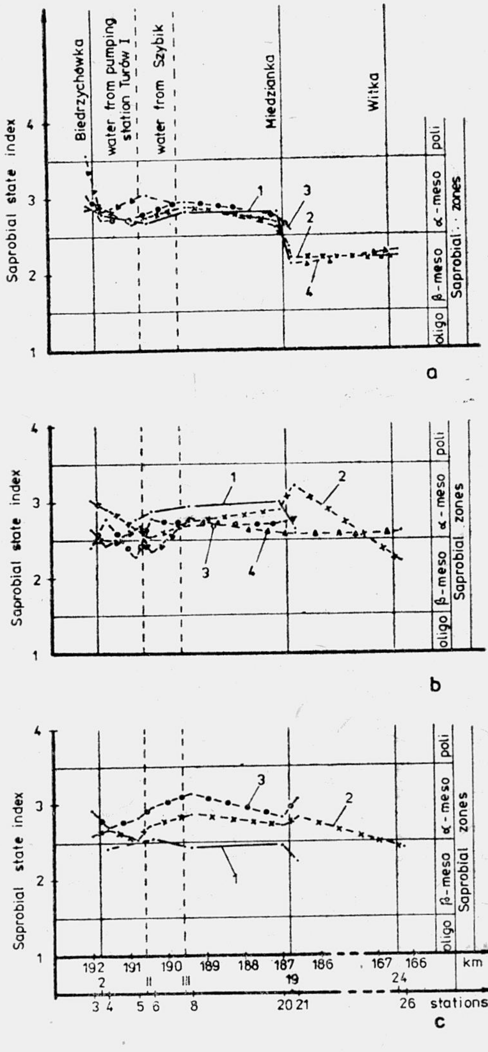


Fig. 5. Total number of plankton organisms in the river Nysa Łużycka from June to August 1977
1 — June, *2* — July, *3* — August

Rys. 5. Ogólna liczba organizmów planktonowych Nysy Łużyckiej w okresie od czerwca do sierpnia 1977
1 — czerwiec, *2* — lipiec, *3* — sierpień



Rys. 6. Variations in the values of saprobial state index of the river Nysa Łużycka from September 1976 to August 1977
a) *1* — September, *2* — October, *3* — November, *4* — January
b) *1* — February, *2* — March, 3 — April, *4* — May
c) *1* — June, *2* — July, *3* — August

Rys. 6. Zmiany wskaźnika saprobowości Nysy Łużyckiej w okresie od września 1976 do sierpnia 1977
a) *1* — wrzesień, *2* — październik, *3* — listopad, *4* — styczeń
b) *1* — luty, *2* — marzec, 3 — kwiecień, *4* — maj
c) *1* — czerwiec, 2 — lipiec, 3 — sierpień

Cyanophyta. Below this segment of the river — up to the mouth of the river Miedzianka — the population decreased gradually to reach its minimum at the station 21. The observed increase of plankton population at the station 26 was probably due to the dilution of the river Nysa Łużycka water with clean water of the river Witka.

In autumn periphyton was dominated by the sulphur bacteria (*Thiotrix* and *Spiryllum*) (tab. 2). Their presence gave the evidence to intense transformation of sulphur compounds. In spring (April) diatoms were prevailing. In May the representatives of this group decreased in number, giving place (in June) to the species such as *Beggiatoa alba* and *Oscilla-*

Table 2

Significant populations of benthos occurring in the river Nysa Łużycka waters during one-year cycle (4 — mean, 5 — much, 6 — very much)

Organizmy peryfitonu występujące w wodzie Nysy Łużyckiej w znaczących ilościach w cyklu rocznym (4 — średnio, 5 — dużo, 6 — bardzo dużo)

Month	Genus and species	Station							
		3	4	5	6	8	20	21	26
I	II	III	IV	V	VI	VII	VIII	IX	X
	Thiotrix nivea (Rab.) Winogr.	5	4	5	6				
	Spirillum sp.					4			
	Zooglea ramigera Itzigsohn em. Blöch	4							
	Mycetes sp.			5					
	Navicula cryptocephala Kütz.				4				
	Navicula radiosa Kütz.				4				
	Navicula rhynchocephala Kütz.				4				
	Navicula vulpinata Kütz.				4				
	Nitzschia linearis Wsm.				4				
	Nitzschia gracilis Hantzsh				4				
	Nitzschia sp.				4				
IX	*Pinnularia appendiculata* (Ag.) Cl.				4				
1976	*Pinnularia* sp.				4				
	Chlamydomonas sp.			4					
	Bodo angustus (Duj.) Bütsch.					5			
	Bodo edax Klebs				4	5			
	Cercobodo bodo (Meyer) Lemm.					5			4
	Cercobodo longicauda (Stein) Senn.					5			4
	Cercobodo sp.			4	4				
	Helkesimastix faecicola Woodcock-Lapoze					4			
	Mastigamoeba invertens Klebs					5			
	Monas cylindrica Skuja				4				
	Monas minima H. Meyer				4	5			
	Monas vulgaris (Cienk.) Senn.				4	5			
	Oicomonas sp.			5		5			

I	II	III	IV	V	VI	VII	VIII	IX	X
	Rhynchomonas nasuta (Stokes) Klebs					4			
	Clathrostoma viminale Penard			4					
	Frontonia acuminata Ehr.			6					
	Holosticha sp.			4	4				
IX	*Loxodes rostrum* (O. F.) Müller			4					
1976	*Nassula* sp.			5					
	Paramecium caudatum Ehr.				4				
	Paramecium sp.			4					
	Saprophilus agitatus Khal			4					
	Stichotricha secunda Perty			4					
	Spirillum sp.	5				5			
	Thiothrix nivea (Rab.) Winogr.	6				4			
	Zooglea ramigera Itzigsohn em. Blöch								
	Sphaerotilus dichotomus (Cohn) Migula						5		
	Sphaerotilus natans Kütz.						5		
	Oscillatoria subtilissima Kütz.					5			
	Melosira varians Ag.								4
	Melosira granulata (Ehr.) Ralfs								4
	Navicula cryptocephala Kütz.	4							4
	Navicula exiqua (Greg.) Müll.	4							
	Navicula lanceolata (Ag.) Kütz.								4
	Navicula radiosa Kütz.								4
	Navicula rhynchocephala Kütz.								4
	Nitzschia gracilis Hantzsch	5							
	Nitzschia palea (Kütz.) W.Sm.								4
X	*Nitzschia paleacea*	4				4			
1976	*Nitzschia recta* Hantzsch								4
	Synedra ulna (Nitzsch) Ehr.								4
	Pedinomonas minor Korsh	5					6		
	Chlamydomonas kutenikowi Goros						6		
	Chlamydomonas proboscigera Kors						5		
	Chlorosarcina minor Gerneck						5		
	Dispora crucigenioides Printz						4		
	Eiermsporapsis exultans Korsikov						5		
	Bodo edax Klebs				5			5	6
	Bodo globosus Stein								5
	Bodo minimus Klebs	5						5	
	Bodo putrinus Lemm.	4						5	
	Bodo caudatus (Duj.) Stein				5				
	Cercobodo crassicauda (Alex.) Lemm.				6				
	Cercobodo longicauda Stein	4			5				
	Cercobodo radiatus Lemm.				5				
	Monas arhabdomonas Himeyer	4							5
	Monas vivipara Ehr.								5
	Monas vulgaris (Cienk.) Senn.	4							
	Oicomonas mutabilis Łent.	4							

I	II	III	IV	V	VI	VII	VIII	IX	X
	Pleuromonas jaculans Perty								5
X	*Rhynchomonas nasuta* (Stokes) Klebs	4							
1976	*Euplotes muscicola* Khal.	4							
	Paramecium caudatum Ehr.	5							
	Uronema griseolum Maupas					4			
	Sphaerotilus dichotomus (Cohn.) Migula		5			4			
	Sphaerotilus natans Kütz.					4			
	Spirillum sp.		4	5	5				
	Microscilla agilis Pringshemm		5	6	6	6			
	Thiothrix nivea (Rab.) Winogr.			5	5	6			
	Mycetes sp.			5		4			
	Oscillatoria brevis (Mütz.) Gom.					4			
	Oscillatoria subtilissima Kütz.					4			
	Navicula exiqua (Greg.) Müll.					4			
	Nitzschia amphibia Grun.					4			
	Nitzschia palea (Kütz.) W.Sm.					4			
	Nitzschia paleacea Grun.					4			
	Petalomonas mira Awe. Zinzew.			4					
XI	*Petalomonas pusilla* Skuja		6	4		4			
1976	*Bodo caudatus* (Duj.) Stein			4					
	Bodo edax Klebs			4		4			
	Bodo minimus Klebs	4							
	Bodo putrinus Lemm.			4					
	Cercobodo bodo (Meyer) Lemm.					4			
	Cercobodo longicauda Stein					4			
	Monas dangeardi Lemm.					4			
	Monas vulgaris (Cienk.) Senn.			4		4			
	Rhynchomonas nassuta (Stokes) Klebs			4					
	Amoeba verrucosa Ehr.		5						
	Chilodonella uncinata Ehr.		4			4			
	Nassula gracilis (Bloch) Roux.		4			4			
	Paramecium caudatum Ehr.					4			
	Uronema griseolum Maupas				6				
I	*Bodo caudatus* (Duj.) Stein					4			
1977	*Monas socialis* Lemm.					4			
II	*Thiothrix nivea* (Rab.) Winogr.	4							
1977	*Dactylococcopsis rhaphidioides* Hansg.							4	
	Spirillum sp.		4		4		5		
	Sphaerotilus dichotomus (Cohn.) Migula						4		
III	*Thiothrix niveas* (Rab.) Winogr.						5		
1977	*Diatoma elongatum* (Lyngb.) Ag.								5
	Diatoma vulgare Bory.						4		6
	Melosira granulata (Ehr.) Ralfs.						4		

I	II	III	IV	V	VI	VII	VIII	IX	X
III 1977	*Melosira granulata* var. *angustissima* (Müll.) Hust.					4			
	Navicula cryptocephala Kütz.	4	4			4	4		
	Navicula radiosa Kütz.				4		5		
	Navicula viridula Kütz.				4	4	4		
	Nitzschia palea (Kütz.) W.Sm.		4			4	4		
	Nitzschia paleacea Grun.						4		
	Synedra ulna (Nitzsch) Ehr.								5
	Bodo minimus Klebs								4
	Monas vulgaris (Cienk.) Senn.	4					4		
	Chilodonella uncinata Ehr.						4		
IV 1977	*Meridion cilculare* Ag.						4		
	Navicula cryptocephala Kütz.	5	5	5	4	5	6		
	Navicula radiosa Kütz.						6		
	Navicula rhynchocephala Kütz.						5		
	Navicula mutica Kütz.						6		
	Navicula viridula Ehr.		4	4	4		6		
	Navicula gracilis Ehr.						5		
	Nitzschia acicularis W.Sm.						5		
	Nitzschia palea (Kütz.) W.Sm.		5	6	4	5	6		
	Nitzschia paleacea Grun.			4			6		
	Synedra ulna (Nitzsch.) Ehr.			4	4	4	4		
V 1977	*Nitzschia palea* (Kütz.) W.Sm.					4			4
	Euglena viridis Ehr.	4							
	Helkesimastix faecicola Woodcock-Lapabe	6	4						
VI 1977	*Beggiatoa alba* (Vauch.) Trevisan			4					
	Pelomena subtilissima Skuja			5					
	Spirillum sp.			5			6		
	Oscillatoria brevis (Kütz.) Gom.		5						
	Rhabdoderma lineare Schmidle et Lauterborn					6			
	Synedra ulna (Nitzsch) Ehr.	4	4	4			4		
	Anthophysa vegetans (O.F.M.) Stein.	4							
	Amoeba proteus Pallas	4							
	Amphileptus claparedei Stein.						5		
	Euplotes muscicola Khal.			4					
	Paramecium caudatum Ehr.			4					
	Paramecium trichium Stokes			4			4		
	Oxytricha fallax Stein.			5					
	Tachysoma pelionella (O.F.M.) Stein.	4							
	Uronema marinum Dujardin				4				
	Nemathodes sp.						4		
	Diplogaster rivalis Bütschli		4						
VII 1977	*Spirillum* sp.	4							

I	II	III	IV	V	VI	VII	VIII	IX	X
	Navicula cryptocephala Kütz.				4				
	Nitzschia palea (Kütz.) W.Sm.	4			4				
VII	*Bodo globosus* Stein.		4						
1977	*Bodo putrinus* Lemm.	4	4						
	Uronema marinum Dujardin	4	4						
	Pelonema subtilissima Scuja.	5	4						
	Menoidium minutum Matv.							4	
VIII	*Helkesimastix faecicola* Woodcock-Lapage			4				4	
1977	*Uronema marinum* Dujardin			4					

toria brevis occurring in strongly polluted waters (tab. 2). Benthos (tab. 3) in autumn was represented by the mentioned above sulphur bacteria and additionally by *Beggiatoa minima*. In spring numerous diatoms occurred in May to decrease distinctly in June.

The presence of the mentioned above organisms in biocenosis of the river Nysa Łużycka water gives the evidence to its strong pollution and to the intense transformations of sulphur occurring in this river. This fact was confirmed by the studies on the occurrence of physiological groups of sulphur bacteria [6].

Table 3

Significant populations of benthos in the river Nysa Łużycka waters during one-year cycle (4 — mean, 5 — much, 6 — very much)

Organizmy bentosu występujące w wodzie Nysy Łużyckiej w znaczących ilościach w cyklu rocznym (4 — średnio, 5 — dużo, 6 — bardzo dużo)

Month	Genus and species	Station							
		3	4	5	6	8	20	21	26
I	II	III	IV	V	VI	VII	VIII	IX	X
	Beggiatoa sp.	5				5			
	Navicula oblonga Kütz.		5						
	Nitzschia palea (Kütz.) W.Sm.		5						
	Nitzschia paleacea Grun.	5							
	Synedra Vaucheriae Kütz.	4		5					
	Synedra ulna var *impressa* Hust.	5							
	Petalomonas mediocanellata Stein.			4	4				
IX	*Euglena oxyuris* Schmarda	4							
1976	*Chlamydomonas ehrenbergii* Goros.	6				5			
	Chilomonas bacillaris Ehr.							4	
	Amoeba radiosa Dujardin			4					
	Loxocephalus ellipticus Khal.		6	5					
	Paramecium caudatum Ehr.		4		5				
	Diplogaster rivalis Bütschli	4		4	6				
	Cyclops strenuus S. Fisch.				5				

I	II	III	IV	V	VI	VII	VIII	IX	X
IX 1976	*Tanypus monilis* L.								
	Gordius aquaticus Dujardin					6		4	
X 1976	*Aphanothece clatrata* W. et G.S. West	6							
	Oscillatoria putida Schmidle	5							
	Oscillatoria subtilissima Kütz.					5			
	Navicula exiqua (Greg) O. Müll.					4			
	Petalomonas mediocanellata Stein		6						
	Bodo edax Klebs					4			
	Cercobodo crassicauda (Alex.) Lemm.		4						
	Monas arhabdomonas Meyer		6						
	Oicomonas termo (Ehr.) Kent.				6				
	Pelomyxa villosa Greeff.		4						
	Euplotes charon					4			
	Euplotes patella Ehr.					4			
	Loxocephalus ellipticus Khal.		4						
XI 1976	*Beggiatoa alba* (Vaucher) Trevisan							4	
	Sphaerotilus dichotomus (Cohn.) Migula							4	
	Oscillatoria subtilissima Kütz.	4	4			6			
	Nitzschia palea (Kütz.) W.Sm.					4			
	Synedra ulna var. *impressa* Hust.					4			
	Anisonema acinus Dujardin						5		
	Bodo edax Klebs		6		4	6			
	Cercobodo crassicauda (Alex.) Lemm.					5			
	Monas elongata (Stokes) Lemm.				5				
	Loxocephalus ellipticus Khal.						4		
I 1977	*Beggiatoa alba* (Vaucher) Trevisan	6					4		
	Beggiatoa minima Winogr.	6							
	Sphaerotilus dichotomus (Cohn.) Migula	5			5				
	Sphaerotilus natans Kütz.					6			
	Spirillum kolkwitzii Wislouch.	4							
	Diatoma vulgare Bory.					4			
	Navicula lanceolata Kütz.	4			5				
	Navicula cuspidata Kütz.	4							
	Nitzschia linearis W.Sm.				4				
	Nitzschia hungarica Grun.					4			
	Pinnularia maior (Kütz.) Cl.					4			
	Stauroneis anceps Ehr.				4	4			
	Surirella ovata Kütz.					4			
	Bodo angustus Dujardin							4	
	Bodo edax Klebs							4	
	Bodo globosus Stein.						4	4	
	Polytoma obtusum Pascher	4			4		6		
	Amoeba guttula Dujardin	4			4	4			
	Amoeba limax Dujardin				4				

I	II	III	IV	V	VI	VII	VIII	IX	X
I 1977	*Amoeba striata* Penard	4							
	Chilodonella fluviatilis Stokes					4			
	Loxocephalus ellipticus Khal.					4			
	Loxodes rostrum Müller				4				
	Paramecium putrinum (Clap.) et Lachman					4			
	Spirostomum ambiquum Müll.-Ehr.						5		
	Stylonychia putrina Stokes						5		
	Cyclops strenuus S. Fisch						4		
II 1977	*Beggiatoa alba* (Vaucher) Trevisan						4		
	Beggiatoa minima Winogr.	4							
	Crenothrix polyspora Cohn.							4	
	Sphaerotilus dichotomus (Cohn.) Migula	4					6		
	Mycetes sp.						4		
	~~*Thiothrix nivea* (Rab.) Winogr.~~	~~4~~							
	Cymbella cistula (Hemp.) Grun.				4				
	Gomphonema olivaceum (Lyngb.) Kutz.	4							
	Meridion circulare Ag.		4						
	Navicula dicephala (Ehr.) W.Sm.			4					
	Navicula viridula Kütz.			4					
	Nitzschia hungarica Grun.			4				4	
	Nitzschia palea (Kütz) W.Sm.			4					
	Nitzschia vermicularis Grun.	5					4		
	Stauroneis anceps Ehr.		4						
	Synedra ulna (Nitzsch.) Ehr.				4				
	Euglena viridis Ehr.			4					
	Petalomonas pusilla Skuja.				6				
	Cercobodo crassicauda (Alex.) Lemm.			4					
	Monas arhabdomonas Meyer				6				
	Amoeba botrylis Penard						6		
	Chilodonella uncinatus Ehr.	4							
	Prorodon minutus Khal.	4							
	Tubifex tubifex Müller				4				
III 1977	*Beggiatoa alba* (Vaucher) Trevisan		4	4					
	Sphaerotilus natans Kütz.	5	4						
	Spirillum sp.				6				
	Thiothrix nivea (Rab.) Winogr.	5							
	Oscillatoria subtilissima Kütz.					4			
	Cymbella cistula (Hemp.) Grun.			4					
	Diatoma vulgare Bory.						4		
	Navicula cuspidata Kütz.			4			4		
	Nitzschia hungarica Grun.	4		4			4		
	Stauroneis anceps Ehr.	4		4					
	Synegra ulna (Nitzsch) Ehr.	4							

I	II	III	IV	V	VI	VII	VIII	IX	X
III 1977	*Distigma proteus* Ehr. em. Pringsheim			4					
	Bodo minimus Klebs.								4
	Amoeba limax Dujardin					4			
	Loxocephalus ellipticus Khal.	4							
	Stylonychia mytilus Ehr.						4		
IV 1977	*Spirillum* sp.	6							
	Oscillatoria brevis (Kütz.) Gom.			4					
	Oscillatoria tenuis Agardh.		6						
	Stauroneis anceps Ehr.			4					
	Stauroneis phaenicentron Ehr.			4					
	Synedra ulna (Nitzsch) Ehr.						4		
	Distigma curvatum Pringshein			4					
	Bodo edax Klebs		4						
	Monas arhabdomonas Meyer		4						
	Monas elongata (Stokes) Lemm.			4					
	Monas minima Meyer		4						
	Monas obliquus Schewiakoff		4						
V 1977	*Sphaerotilus dichotomus* (Cohn.) Migula					4			
	Meridion circulare Ag.				4				
	Navicula rhynchocephala Kütz.			4					
	Nitzschia hungarica Grun.				4				
	Nitzschia palea (Kütz.) Smith			4	4				
	Stauroneis anceps Ehr.			4					
	Anisonema acinus		4						
	Euglena pisciformis Klebs						4		
	Petalomonas pusilla Skuja		5						
	Bodo edax Klebs				4				
	Monas arhabdomonas Meyer					5			
	Monas vulgaris (Cienk.) Senn.		5						
	Euplotes charon Ehr.	4							
	Loxocephalus ellipticus Khal.	4							
	Paramecium putrinum (Clap.) Lachman		5						
	Spirostomum ambiquum Müll.-Ehr.	4							
	Vorticella microstoma Ehr.		5						
	Branchius sp.	4							
	Asellus aquaticus (L.) Racov.					4			
	Tubifex tubifex Müller				5				
VI 1977	*Beggiatoa alba* (Vaucher) Trevisan					5			
	Sphaerotilus natans Kütz.	4				5			
	Spirillum kolkwitzii Wislouch.				5				
	Spirillum sp.							6	
	Oscillatoria limnetica Lemm.	4							
	Phormidium foveolarum (Mont.) Gom.				4				

I	II	III	IV	V	VI	VII	VIII	IX	X
	Navicula gracilis Ehr.	4							
	Nitzschia hungarica Grun.					4			
	Nitzschia linearis W.Sm.	4							
	Nitzschia palea (Kütz.) Smith	4							
	Stauroneis anceps Ehr.	4							
	Astasia quartana (Moroff.) Pringsheim						6		
	Bodo minimus Klebs.					5			
	Cercobodo crassicauda (Alex.) Lemm.				5	5			
VI	*Monas vulgaris* (Cienk.) Senn.				5				
1977	*Lionotus varsoviensis* Wrześn.					4			
	Vorticella microstoma Ehr.				4				
	Navicula cuspidata Kütz.					4			
	Nitzschia linearis W. Smith					4			
	Distigma curvata Klebs					5			
	Petalomonas pusilla Skuja.	4							
	Philodina roseola Ehr.					4			
	Tubifex tubifex Müller	4						6	
	Cyclops strenuus Fischer			4					
	Encyclops sp.			5					
	Chironomus plumosus L.					4			
	Achroonema spiroideum Skuja.	4							
	Beggiatoa alba (Vaucher) Trevisan	5							
	Oscillatoria formosa Bory.				4				
	Oscillatoria fragilis Böcher.				5				
	Cymbella amphicephala Nag.		4						
	Nitzschia linearis W. Smith				4				
	Pinnularia microstauron (Ehr.) Cl.	4							
	Stauroneis phaenicentron Ehr.		4						
	Synedra ulna (Nitzsch) Ehr.				4				
VIII	*Distigma curvata* Pringshein	5							
1977	*Chlorella vulgaris* Beyerinck		4						
	Bodo globosus Stein.				4				
	Monas vulgaris (Cienk.) Senn.	4	4						
	Amoeba verrucosa Ehr.		4						
	Diflugia limnetica LeVander		4						
	Colpidium colpoda (Ehr.) Stein.	6							
	Loxocephalus ellipticus Khal.				4				
	Nassula gracilis Bloch-Roux	6							
	Paramecium caudatum Ehr.	4							

4. CONCLUSIONS

Results of hydrobiological investigations have confirmed a high degree of the river Nysa Łużycka water pollution. This fact is manifested by the characteristic indices of saprobial state, such as the presence of filamentous bacteria of the genera *Sphaerotilus*, *Thiothrix* and *Beggiatoa* and of *Cyanophyta*, chiefly the species *Oscillatoria subtilissima* as well as the presence of zoomastigina. The presence of such organisms as *Beggiatoa alba*, *Beggiatoa minima*, and *Oscillatoria subtilissima* gives and additional evidence to intense transformation of sulphur compounds. In the Turoszów region the main sources of sulphur compounds are power plants in which enormous amounts of brown coal are burnt with a simultaneous emission of SO_2 to the atmosphere. Diffusion of the latter into water enables the development of numerous species of sulphur-oxidizing organisms. This fact is confirmed by the presence of sulphur bacteria, such as *Beggiatoa minima* and *Thiothrix* found in the biocenosis of the river Witka, classified — according to the physicochemical, bacteriological and hydrobiological investigations — among α- mesosaprobial zone [6].

The substantial development of diatoma observed during late spring and summer does not correlate with their seasonal characteristics. This could be due to non-typical variations in temperature and to disturbances in nitrogen and phosphorus cycles [4].

The decreasing population of plankton organisms along the river course resulted from the changes occurring in water due to industrial pollution and also from secondary pollution caused by the decay of *Bacteria* and *Cyanophyta* developed in mass.

The saprobial state index calculated from hydrobiological analyses showed (except for the initial period of investigations — September, October, November) high variations.

So high pollution degree of the river Nysa Łużycka and its estuaries creates exceptional difficulties in water intakes and wastewater disposal. The waters of the river Nysa Łużycka, being affected by wastewaters, surface runoffs and diffusing from the atmosphere, belong to the mesosaprobial zone and are the source of water taken by power plants for cooling purposes. Despite high costs the effects of purification and treatment are very often inadequate and, consequently, the walls of cooling towers are overgrown by filamentous forms of *Bacteria* and *Cyanophyta*.

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STAN ZANIECZYSZCZENIA NYSY ŁUŻYCKIEJ W REGIONIE TUROSZOWSKIM CZĘŚĆ III. ZMIANY EKOLOGICZNE W BIOCENOZIE I SAPROBOWOŚĆ NYSY ŁUŻYCKIEJ

Celem pracy było określenie stopnia zanieczyszczenia wody Nysy Łużyckiej i jego wpływu na kształtowanie się biocenozy badanej rzeki. Duża wartość wskaźnika saprobowości, charakterystyczna dla strefy α-saprobowej, potwierdziła znaczne zanieczyszczenie rzeki. W biocenozie wykazano obecność dużych ilości przedstawicieli organizmów typowych dla wód silnie zanieczyszczonych tj. *Sphaerotilus* sp., *Thiothrix* sp., *Beggiatoa alba*, *Beggiatoa minima*, *Oscillatoria subtilissima* i wiciowców bezzieleniowych. Okresowo występujące duże ilości bakterii i sinic siarkolubnych świadczą o intensywnych biologicznych przemianach związków siarki. Uchodzące do Nysy Łużyckiej rzeki miały dwojakiego rodzaju wpływ na stan jej zanieczyszczenia: Miedzianka — ujemny, Witka — dodatni.

DIE VERSCHMUTZUNG DER LAUSITZER NEISSE IM REGION VON TUROSZÓW TEIL. III. ÖKOLOGISCHE VERÄNDERUNGEN DER BIOZÖNOSE UND DES SAPROBIENSTANDES DES FLUßWASSERS

Ziel der Arbeit war die Bestimmung des Verschmutzungsgrades der Lausitzer Neiße und dessen Einfluß auf die Gestaltung der Biozönose des untersuchten Flußabschnittes. Ein hoher Saprobienbeiwert welcher für die α-mesosaprobe Zone charakteristisch ist, bestätigt die stark ausgeprägte Verunreinigung des Flußes. In der Biozönose sind für starke Verunrenigungen typische Organismen vertreten: *Sphaerotilus* sp., *Thiothrix* sp., *Beggiatoa alba*, *Beggiatoa minima*, *Oscillatoria subtilissima* und grünlose Geißeltierchen. Die von Zeit zu Zeit auftretende, starke Entwicklung von Bakterien und schwefelphilen Blaualgen, deutet auf einen intensiven Metabolismus der Schwefelverbindungen. Die in die Lausitzer Neiße mündenden Nebenflüße wirken auf die Wasserqualität grundaus verschieden: die verödete Miedzianka (Kupferbach) negativ, die relativ saubere Witka dagegen positiv.

СОСТОЯНИЕ ЗАГРЯЗНЕНИЯ НЫСЫ ЛУЖИЦКОЙ В ТУРОШОВСКОМ РАЙОНЕ ЧАСТЬ III. ЭКОЛОГИЧЕСКИЕ ИЗМЕНЕНИЯ В БИОЦЕНОЗЕ И САПРОБОВОСТЬ НЫСЫ ЛУЖИЦКОЙ

Цель работы состояла в определении степени загрязнения воды Нысы Лужицкой и влияния этой степени на биоценозу исследуемой реки. Большое значение коэффициента сапробовости, характерное для α-сапробовой зоны, подтвердило значительное загрязнение реки. Отмечено, что в биоценозе выступает большое количество представителей организмов, типичных для очень загрязненных вод, т. е. *Sphaerotilus* sp., *Thiothrix* sp., *Beggiatoa alba*, *Beggiatoa minima*, *Oscillatoria subtilissima* и жгутиковых. Выступающее периодически большое количество бактерий и серолюбых синюх свидетельствует об интенсивных биологических превращениях соединений серы. Реки, втекающие в Нысу Лужицку по-разному влияют на степень её загрязнения: Медзянка — отрицательно, Витка — положительно.