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PERIPHYTON COMMUNITY COMPOSITION AND WATER QUALITY IN RUSAŁKA LAKE INFLOWS AND OUTFLOW

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Summary. The aim of the studies was to determine water quality and the peryphiton community composition in the inlets and the outlet of Rusałka Lake (Poznań). In autumn high values of conductivity (> 1000 μS cm^{-1}) and low nutrient concentrations (TP < 0,02 mg P l^{-1} and N-NO_3 < 0,9 mg N l^{-1}) were observed, while in spring – an increase in nitrate nitrogen (up to 21 mg N l^{-1}) and seston concentration (up to 16 mg l^{-1}). *Navicula cryptocephala* and *Cyclotella meneghiniana* were the most numerous in the peryphiton community in autumn, whilst *Achnanthes lanceolata* in spring. Saprobic index indicated β-mesosaprobic zone in both analysed periods.

Key words: man-made lake, nutrients, periphyton, streams

INTRODUCTION

Urban areas exert an important impact on ecological state of water ecosystems. Small rivers and watercourses, crucial for biological diversity maintenance, are particularly endangered and even a marginal negative influence can disturb its functioning. The aim of this study was to determine water quality in one river and 5 streams flowing into and one river flowing out from Rusałka Lake, situated in urban area in Poznań (West Poland). The greatest transformations (communication infrastructure and sewage system development) are observed at present in the Bogdanka River and Golęcinka stream catchments.

MATERIAL AND METHODS

Rusałka Lake is a man-made reservoir situated in north-west part of the city of Poznań. It was constructed in 1943 by damming the waters of River Bogdanka [Farat 1996]. The area of the reservoir is 36.7 ha with mean depth of 1.9 m and maximum depth of 9.0 m. The forest covers almost 90% of its direct catchment area. Bogdanka River is 9.3 km long and almost all its course is regulated [Grabia 1988]. Five more inflows are feeding the lake: Golęcinka (1.3 km long) and four nameless, mainly temporary streams [Karnowski and Kozikowski 2006] (Fig. 1).

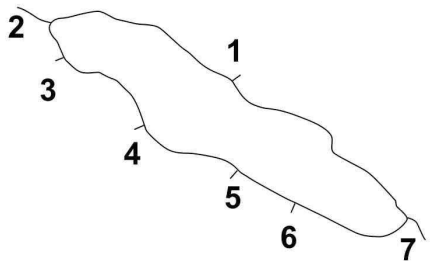

Fig. 1. Location of the research stations (1 – Golęcinka, 2 – Bogdanka inflow, 3–6 – nameless streams, 7 – Bogdanka outflow)

Water samples were collected in November 2006 and March 2007. Temperature, pH, conductivity and dissolved oxygen concentration were measured *in situ*. Nutrients concentrations (ammonium, nitrite and nitrate nitrogen, soluble reactive phosphorus – SRP and total phosphorus – TP), dry mass of seston and BOD_5 were analysed according to Polish Standards [Hermanowicz and Dojlido 1999]. Periphyton taxonomic composition was determined with light microscope Olympus CH-2 at magnification x100–1000. Samples for diatoms analyses were digested with hydrogen peroxide. On the basis of frequency of periphyton species in the samples, Pantle and Buck saprobic index (SI) was calculated [Atlas of saprobic organisms 1977)].

RESULTS

In November 2006 water and peryphiton were sampled from five stations only, as streams 3 and 6 were dry. Very high values of conductivity (> 1000 μS cm^{-1}), high oxygen concentrations (> 8 mg O_2 l^{-1}) and low amounts of organic matter analysed as BOD_5 (2.1–4.28 mg O_2 l^{-1}) were noted. Dry mass of seston in all the waters flowing into the lake was below 2 mg $l^{-1,}$, and only in Bogdanka River flowing out of Rusałka Lake it reached 9.3 mg l^{-1}. Nutrient concentrations were low (TP < 0.02 mg P l^{-1}, $N\text{-}NO_3$ < 0.9 mg N l^{-1}) (Tab. 1). Among periphyton species Bacillariophyceae dominated. *Cyclotella meneghiniana* Kutz. and *Navicula crypto-*

cephala Kutz. had the greatest share in quantitative composition (up to 37 and 40%, respectively). Only in the outflow 50% of specimens constituted *Cymbella ventricosa* Kutz. SI indicated β-mesosaprobic zone in all the streams and the river (Fig. 2).

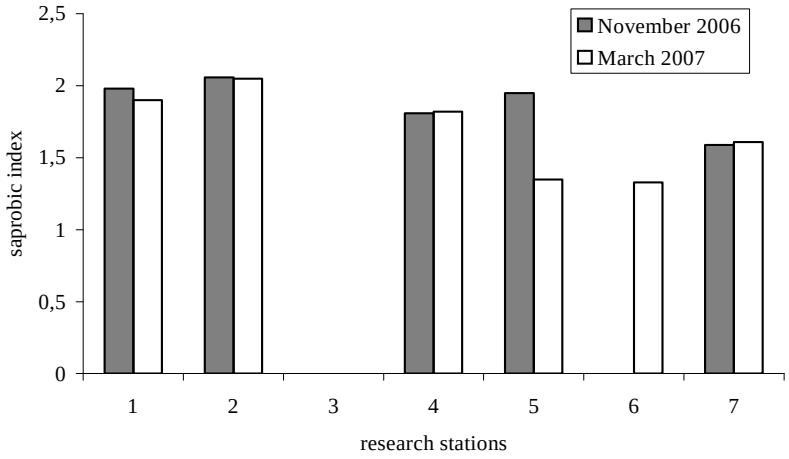

Fig. 2. Comparison of SI values between analysed stations

Tabele. 1. Nutrients concentrations in analysed streams

2006					
Station	NH_4	NO_2	NO_3	SRP	TP
	mg N l^{-1}			mg PO_4 l^{-1}	mg P l^{-1}
1	0.51	0.01	0.64	0.03	0.01
2	0.55	0.01	0.61	0.02	0.01
3	–	–	–	–	–
4	0.40	0.01	0.64	0.02	0.01
5	0.30	0.01	0.88	0.01	0.02
6	–	–	–	–	–
7	0.83	0.02	0.12	0.04	0.02
2007					
Station	NH_4	NO_2	NO_3	SRP	TP
	mg N l^{-1}			mg PO_4 l^{-1}	mg P l^{-1}
1	0.72	0.02	3.64	0.18	0.11
2	0.50	0.01	0.47	0.09	0.11
3	–	–	–	–	–
4	0.57	0.01	7.49	0.10	0.06
5	0.10	0.01	20.01	0.05	0.07
6	0.37	0.01	19.62	0.06	0.09
7	0.44	0.01	0.58	0.09	0.07

The amount of dry mass of seston increased significantly in March, 2007 (up to 16 mg l^{-1}), while BOD_5 values were rather low, especially at station 4 (1 mg O_2 l^{-1}). Dissolved oxygen concentrations were higher than in autumn 2006 in most watercourses (8.5–11.1 mg O_2 l^{-1}), as well as nutrient concentrations (Tab. 1). Nitrate nitrogen reached 20.01 mg N l^{-1} at station 5. Similarly as in autumn, *Navicula cryptocephala* Kutz. was the dominant species among Bacillariophyceae in periphyton (up to 59% at station 2). However, at station 6 the most numerous (61%) was *Achnanthes lanceolata* (Breb.) Grun. which was not noted in November. SI indicated oligomesosaprobic zone in streams 5 and 6, while in the rest of them – β-mesosaprobic zone (Fig. 2). Stream 3 was dry in spring, just as in November 2006.

DISCUSSION

Well oxygenated waters in the streams were connected with low temperatures during sampling, determined by the season (autumn and early spring) as well as by shading the streams by trees, which made the warming of water difficult. The oxygen sources were diffusion from the atmosphere and photosynthesis provided by peryphiton algae. In the analysed period, production processes prevailed over mineralisation. The pool of organic matter in watercourses is a sum of primary production and allochtonic matter [Allen 1998]. Important sources of the second in the analysed area were leaves falling from the trees as well as parts of other plants. However, the amount of organic matter in water measured as BOD_5 was low. The SI calculated on the basis of taxonomic composition and occurrence frequency of periphyton species was not great, either (mainly β-mesosaprobic zone).

The process of organic matter mineralisation was limited in rate by low temperature, and that caused the low nutrients concentrations in water. However, in all the samples high conductivity was observed. Such increased values may indicate water pollution [Chełmicki 2001]. In Bogdanka River it was probably caused by inflow of waters rich in mineral substances from the storm sewer system and a great share of urban areas in the river catchment, while in Golęcinka Stream – by inflow of drainage system from the Agricultural Schools area. In the remaining streams conductivity was elevated probably by run-offs from railway embankment, situated near the reservoir, as no sewage outfalls were noted.

Afforested areas which covered the streams catchments were very effective in nutrients retention, therefore their concentrations were low, mainly in autumn 2006. In March of the following year a crucial increase was observed, especially in nitrate nitrogen values. It was a result of spring run-offs, snow melting, intense rainfalls as well as limited assimilation by plants. Those factors influenced also greater amounts of dry mass of seston in the waters.

Bacillariophyceae domination in periphyton taxonomic composition due to some adaptations to stream conditions has been frequently noted in the literature [e.g. Rakowska 2004, Szczepocka 2005, Caramujo *et al*. 2008]. Many diatom species are invulnerable to seasonal changes in light intensity due to specific pigment composition (i.e. fucoxanthin) and moving the chloroplasts in cells, therefore water shading by trees was a rather limiting factor for other groups of algae. Keithan and Lowe [1985] indicated a relation between diatoms growth and flow rate. When the flow rate was low, the genera forming colonies and gelatinous masses (*Gomphonema*, *Cymbella*) dominated, while at greater water flow rate – forms strictly adjacent to the substratum were popular, present as a brown, slippery coating (*Navicula*, *Cocconeis*). Although in the Rusałka inflows water flow was rather low, adjacent diatoms were the most numerous, especially *Navicula cryptocephala* which constituted over 50% of all the taxa found in the few streams.

CONCLUSION

The analysed inflows and the outflow from Rusałka Lake are slightly polluted – nutrient concentrations as well as BOD_5 were low and SI indicated β-mesosaprobic zone. Undoubtedly, covering the catchment by forest was the main factor that provided good water quality. However, development of urban areas, impact of storm water systems and garbage left by people on the recreational areas may create a threat to water quality as well as to ecosystems functioning in the future.

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ZBIOROWISKO PERYFITONU ORAZ JAKOŚĆ WÓD DOPŁYWAJĄCYCH I WYPŁYWAJĄCYCH Z JEZIORA RUSAŁKA

Streszczenie. Celem badań było określenie jakości wody oraz składu peryfitonu w wodach dopływających i wypływających z jeziora Rusałka (Poznań). Jesienią zanotowano wysokie wartości przewodnictwa elektrolitycznego (> 1000 μS cm^{-1}) oraz niskie stężenia związków biogennych (TP < 0,02 mg P l^{-1} i $N\text{-}NO_3$ < 0,9 mg N l^{-1}), zaś wiosną – zwiększenie stężeń azotu azotanowego (do 21 mg N l^{-1}) i suchej masy sestonu (do 16 mg l^{-1}). W peryfitonie jesienią dominowały *Navicula cryptocephala* i *Cyclotella meneghiniana*, zaś wiosną – *Achnanthes lanceolata*. W obu porach wartości indeksu saprobowego wskazywały na strefę β-mezosaprobową.

Słowa kluczowe: dopływy, peryfiton, zbiornik zaporowy, związki biogenne