ANNALES
UNIVERSITATIS MARIAE CURIE-SKŁODOWSKA
LUBLIN – POLONIA
VOL. LXII, 5 SECTIO C 2007

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An attempt to establish relationships between the management of catchments of lakes and their trophy and rotifers assemblies in selected lakes of Łęczyńsko-Włodawskie Lake District

Próba ustalenia zależności pomiędzy sposobem zagospodarowania zlewni jezior i ich trofią a zespołami wrotków w wybranych jeziorach Pojezierza Łęczyńsko-Włodawskiego

SUMMARY

Study was performed in June, July and August 2005 in shallow littoral of 9 lakes at Pojezierze Łęczyńsko-Włodawskie. Lakes were divided into three groups referring to the basin management manner. The research focused on rotifer plankton and selected physicochemical properties of water from these lakes. The main purpose of the research was to evaluate the influence of catchment area type on qualitative and quantitative structure of identified rotifer taxons. Differences between physicochemical parameters of water originating from different basins were found. Some divergence also referred to the quality and quantity of rotifers observed in studied reservoirs. Furthermore, the presence of species characteristic of water with high trophy level (species of *Brachionus*, *Trichocerca*, *Keratella cochlearis f. tecta, Pompholyx sulcata etc.* genera) along with the decrease of bio-diversity index, was observed in basins of strongly degraded lakes. It could be concluded that, regardless the lake basin management manner, the qualitative and quantitative structure of rotifers did not show significant differences between studied reservoirs.

STRESZCZENIE

Badania przeprowadzono w miesiącach letnich 2005 roku w płytkim litoralu 9 jezior Pojezierza Łęczyńsko-Włodawskiego. Jeziora podzielono na trzy grupy ze względu na sposób

zagospodarowania zlewni. Studia badawcze były skoncentrowane na planktonie wrotkowym i wybranych właściwościach fizycznochemicznych wód z powyższych jezior. Głównym celem pracy była ocena wpływu rodzaju zlewni na strukturę jakościową i ilościową zidentyfikowanych taksonów wrotków. Wykazano różnice pomiędzy fizykochemicznymi parametrami wód pochodzących z różnych zlewni. Pewna odmienność dotyczyła także jakości i ilości zaobserwowanych w powyższych wodach wrotków. W zlewniach jezior silnie zdegradowanych (duży udział gruntów ornych) wykazano obecność gatunków charakterystycznych dla wód o wysokim stopniu trofii, tj. gatunki z rodzaju *Brachionus*, *Trichocerca*, oraz taksony *Keratella cochlearis f. tecta*, *Pompholyx sulcata etc.*, przy jednoczesnym spadku wskaźnika bioróżnorodności.

Keywords: lake catchment area, lake trophy, planktonic rotifers, bioindicators of trophy.

INTRODUCTION

Catchment basin is the area from which water flows to a fixed water reservoir. The physical-geographical structure of a water tank basin serves as an important "supplier" of the biogenic substances to lakes. The catchments differ in relation to the scale and a structure of land use. Rainfall and atmospheric inputs cause runoff with substantial quantity of fertilizers and pesticides from arable land that in turn, induces increased content of nitrogen and phosphorus compounds in the top water, lakes in particular. This process affects significantly a fertility level of water reservoirs. Degradation of catchment areas manifested by the water trophy growth may also result from the intensive tourist pressure (4). Some taxons of water invertebrates constitute quite useful indicators of water tank trophy, in that rotifers. Numerous species of planktonic rotifers respond strongly to the changes of the abiotic environmental factors which is conditioned by their fast growth, great reproductive potential and metabolism level integrated with the cycles of matter circulation in the water ecosystem. That is why rotifers tend to be a sensitive bioindicator of surface waters (10).

The objective of the present investigations was to evaluate the effect of a type of the Łęczyńsko-Włodawskie Lake District catchment on the qualitative and quantitative structure of planktonic rotifers and lake fertility linked with it.

MATERIAL AND METHODS

The studies were conducted in June, July and August 2005 at four-week intervals. The summer months were chosen deliberately as at this season the greatest economic and tourist anthropopression is recorded in the lake basins as well as within their waters. The investigations covered nine lakes of the Łęczyńsko-Włodawskie Lake District they were divided into three groups due to their collecting area management. The first group of lakes had the basins most resistant to the degradation owing to high forestation and abundant shrubs that impede the biogenic matter fluxes to the lakes. The collecting areas of the second group of lakes were contiguous to large woodland area as well as farmed agricultural land. It was shown that in these areas nutrients were likely to be transported to the lake waters (4). Finally, the catchment basins of the third lake group were covered mainly by farmed agricultural land (4) and the biogene delivery to the lakes was most probable to have been realized from these areas (4). In the lake littoral the measurements of water temperature, pH, electrolyte conductance and oxygen content were made. Transparency was determined by Secchi's disk; the results are plotted in the Tables. The following equipment was employed in the studies: oxymeter HANNA instruments HI 9142, thermometer SLANDI TC

204,conductometer SLANDI CM 204, pH-meter SLANDI pH 204. Besides, water was sampled for the laboratory examinations and the content of total phosphorus, nitrate and ammonia nitrogen was fixed after the Hermanowicz method (5).

The water samples for planktonic rotifers were collected from the littoral zone with a 5-liter bathometer Bernatowicz type (11). Plankton was analyzed using inverted microscope Utermöhl type. Rotifer number was expressed as rotifer count in 1 l of water (11), while taxons with the keys for rotifer identification (7). The results were analyzed on the grounds of a formula for rotifer domination level calculation (3). Besides, a coefficient of species richness was computed after Shannon-Wiener (8) and a reservoirs trophy degree was determined by means of Carlson index (6). Percentage of *Keratella cochlearis f. tecta* biomass against all the forms of *Keratella cochlearis* was also established (1,6).

Table 1. Percentage structure of lake basin land management (4)

No.	Lake	Ploughs	Buildings	Forests	Shrubbiness	Recreational area
1	Białe Sosnowickie	3.71%	0.24%	61.52%	1.64%	0.00%
2	Czarne Sosnowickie	1.11%	0.00%	76.31%	11.34%	0.00%
3	Uściwierzek	0.93%	0.00%	0.00%	87.72%	0.00%
4	Bikcze	9.89%	0.09%	0.14%	0.07%	0.00%
5	Piaseczno	28.84%	0.43%	23.69%	2.91%	4.22%
6	Zagłębocze	12.39%	0.80%	33.52%	2.71%	2.11%
7	Głębokie-Uścimowskie	73.48%	4.17%	0.57%	0.39%	0.00%
8	Maśluchowskie	62.61%	3.07%	1.93%	0.18%	0.00%

Explanations: (1–3) – basins of the first category of degradation susceptibility, (4–6) – basins of the second category of degradation susceptibility, (7–9) – basins of the third category of degradation susceptibility.

RESULTS AND DISCUSSION

The assessment of the chemical parameters reflects the actual rational units that determine water fertility, thus some physicochemical parameters of water may be employed to set the trophy (9). The influence of a catchment character on the rotifer fauna was proven by Widuto (12). He claimed that the application of liquid manure and fertilization in the Bęskie lake basin used for farming purposes induced the strong development of the rotifer species, being the indicators of the eutrophic lakes. This lake was a shallow and fertile tank. Other authors (2) found that the other four lakes exhibited a high fertility level eutrophy of these reservoirs occurred owing to their fertilization with nitrogen, phosphorus and potassium compounds.

The lakes assigned to the catchment area of the greatest percentage of arable land were characterized by the highest nutrient quantity (Tab. 2). Our own studies prove that some strictly defined species of rotifers serve as the bioindicators of high fertility of water. It is confirmed by the fact that in the basins of lakes from group I the following eudominants were present: *Brachionus forficula*, *Keratella cochlearis f. typica and Polyarthra vulgaris*. The dominants included *Brachionus diversicornis*, *Keratella cochlearis f. tecta* and *Trichocerca similis* (Table 3). The eudominants in the lake group II appeared to be *Conochilus unicornis*, *Keratella cochlearis f. typica*, *Keratella cochlearis f. tecta* and *Polyarthra vulgaris*, whereas the dominants included *Asplanchna priodonta, Brachionus angularis* and *Trichocerca capucina*. The domination structure, however, is slightly different in the lake group III, where *Brachionus angularis*, *Keratella cochlearis f. tecta, Keratella cochlearis f. typica* and *Polyarthra vulgaris* were the eudominants. The dominants comprised *Keratella quadrata*. *Pompholyx sulcata* and *Trichocerca capucina* (Table 3). Generally, total 30 rotifer taxons were determined. These zooplankters quantity was differentiated subject to a lake (Table 4).

The values of species biodiversity index (8) in the lake group I were found to be the lowest, slightly higher in group III, while the highest in the lake group II (Table 4). These high values of the richness index (8) give evidence of the environmental conditions being conducive to the development of numerous rotifer taxons.

Table 2. Physicochemical parameters of waters originating from chosen lakes

Lake	pH	Conduction (μS/cm)	Temp. (°C)	Oxygen saturation (%)	Oxygen (mgO_2/l)	P_{tot} (mgP/l)	NO_3 (mgN/l)	NH_4 (mgN/l)	Visibility (m)
Białe Sosnowickie	8.1	263	26.8	95	7.2	n.w.	0.085	0.153	0.9
Czarne Sosnowickie	7.9	304	25.6	64	5.8	0.196	0.100	0.277	0.7
Uściwierzek	6.2	482	18.5	13	1.1	0.164	n.w.	1.925	0.3
Bikcze	7.6	250	27.0	98	8.6	n.w.	0.06	0.400	1.5
Piaseczno	7.4	81	27.0	95	7.5	0.012	0.030	0.180	3.8
Zagłębocze	7.2	180	27.2	98	7.9	0.110	0.150	0.200	3.2
Głębokie Uścimowskie	7.6	212	27.3	100	8.7	0.280	0.116	0.277	0.6
Maśluchowskie	7.0	115	25.4	56	4.3	0.200	0.210	0.310	0.5
Uścimowskie	7.5	321	27.6	72	5.6	0.220	0.216	0.271	0.5

Table 3. Percentage structure of dominant species of rotifers originating from chosen lakes

Species	Name of the lake								
	Białe	Czarne	Uściwierzek	Bikcze	Piaseczno	Zagłębocze	Głębokie	Mzśluchowskie	Uścimowskie
Anuraeposis fissa (Gosse)			26.67						
Asplanchna priodonta (Gosse)				5.26	6.25	6.84			2.73
Brachionus angularis (Gosse)	11.04			7.89	8.04	11.11	9.91	14.49	10.38
Brachionus diversicornis (Daday)	6.34	19.18							
Brachionus forficula (Wierzejski)	29.45	15.07							
Conochilus unicornis (Rousselet)		6.85		7.89	10.71	15.38	2.24	2.91	2.19
Keratella cochlearis f. typica (Gosse)	10.43	12.33	40	10.53	16.96	10.26	15.32	20.29	14.21
Keratella cochlearis f. tecta (Gosse)	5.25	8.22		12.63	8.93	14.53	22.52	22.22	18.58
Keratella quadrata (Müller)				4.74			8.56	3.86	9.29
Lepadella borealis (Harring)			33.33						
Polyarthra vulgaris (Carlin)	14.72	13.01		9.47	14.29	12.82	18.02	14.49	18.58
Pompholyx sulcata (Hudson)				12.63			10.81	8.21	
Trichocerca capucina (Wierzejski)				6.32	5.36	4.27	6.76		7.11
Trichocerca cylindrica (Imhof)	9.23	2.05		3.16					
Trichocerca similes (Wierzejski)	6.75	6.16			6.25	2.56	5.86		
Other	6.79	17.13		19.48	23.2	22.23		13.53	16.93

A significant characteristic indicating high trophy proved to be total rotifers count that ranged from 560 up to 1,035 ind./l. water and, according to Carlson (6), this interval shows the eutrophic character of waters. Uściwierzek Lake was the only exception with the total count 150 ind./l. water. This index values in the studied group of lakes indicated the eutrophic or even polytrophic character of waters, whereas the group of lakes of a medium level of basin degradation had mesotrophic or mesoeutrophic waters according to the above index. Waters studied in the lake group III showed an absolutely polytrophic character.

Table 4. Trophic and rotifer's indices of fecundity of waters

Indices	Name of the lake								
	Białe	Czarne	Uściwierzek	Bikcze	Piaseczno	Zagłębocze	Głębokie	Maśluchowskie	Uścimowskie
% *tecta* in the total population	21	32	0	38	27	50	43	36	48
TSI index	61.52	65.14	7736	54.15	40.74	43.21	67.36	70	70
Rotifer numbers of species	10	12	3	15	13	12	9	9	12
Shannon's diversity index	3.2	3.25	1.57	3.63	3.54	3.65	3.38	3.19	3.18
Density of rotifers	815	730	150	950	560	585	1000	1035	915

The values of biomass index of *Keratella cochlearis f. tecta* as against all the forms of *Keratella cochlearis* were found within 21–50% (Table 4). They confirm the eutrophic character of the investigated lakes.

CONCLUSIONS

1. Regardless the way of catchment area management, there was recorded a process of fertility growth in all the studied lakes.

2. The lake analysis proved that lake trophic identity has been on the decline as those commonly defined as dystrophic or mesotrophic exhibited the characteristics of lakes of different eutrophy level (increased fertility).

The above conclusions were confirmed with the presence of specific assemblies rotifers as bioindicators of high fertility of water.

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