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PLANKTONIC ROTIFER COMMUNITY BEFORE AND AFTER RESTORATION OF LAKE PAPROCANY

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Summary. The rotifer community in Lake Paprocany, which is a dam reservoir in Upper Silesia (SW Poland), was observed before and after restoration measures: dredging and removal of macrophytes from the lake. The restoration measures changed the community structure of rotifers in the lake. Before restoration, the community was dominated by species typical of eutrophic waters, and afterwards the number of species typical for clear water increased. However, after restoration the total number of rotifer species decreased, probably due to the removal of macrophytes.

Key words: eutrophication, dredging, restoration, rotifer community

INTRODUCTION

Although many papers on lake restoration have been published, they concern mainly the influence of restoration measures on physicochemical parameters and quality of lake water [Marsden 1989, Imbogen 1992, Liere and Janse 1992, Stenson and Svensson 1995, Annadotter *et al*. 1999]. Many papers also deal with restoration based on food-web biomanipulation and its impact on zooplankton, especially on crustaceans [Duncan 1990, Gliwicz 1992, Seda and Kubecka 1997, Lammens 1999, Perrow *et al*. 1999]. In contrast, little is known about the influence of lake restoration on rotifer plankton [Gulati 1990a, b].

There is no data on the impact of dredging on planktonic rotifers, so this study on changes in the rotifer plankton community in response to lake restoration was initiated. Our aim was to analyse the influence of restoration measures, including dredging and removal of macrophytes, on the rotifer community in Lake Paprocany (Upper Silesia, Poland).

MATERIALS AND METHODS

The dam reservoir called Lake Paprocany was built in the 18th century by damming up the river Gostynka by a ground dam in an area where iron ore used to be excavated. Paprocany is a shallow through-flow lake. It has a mean depth of 1.5 m, maximum depth of 3.5 m, and surface area of 110 ha. Its catchment is covered mostly by coniferous and broadleaved forests.

Because of intensive silting up, the reservoir was emptied and the sediments were dredged from 1986 to 1990. The restoration measures included lowering of the bottom of the lake by 0.5 m in the area of 110 ha, and consolidation of lakeshores by using crushed stone. In January 1991, flooding of the reservoir was started. Due to little rainfall during winter and spring, the rate of flooding was so slow that nearly 70% of the lake bottom was covered by the common reed *Phragmites australis* Trin. ex Stendel. The plants were partly removed mechanically, and to reduce the area covered by plants a population of grass carp, *Ctenopharyngodon idella* (Val.), was introduced.

Table 1. Selected parameters of water chemistry in Lake Paprocany in 1996–1997

Station	Parameter	Autumn	Winter	Spring	Summer	Autumn
A	Temperature (°C)	8–14.5	1–7	4–17	17–20	11–18
	O_2 (mg · $dm^{-3)}$	7.3–10.4	10.9–12.4	10.3–12.3	6.3–15.25	7.4–9.27
	pH	6–6.8	6.8–7.1	6.6–7.6	7.2–8.0	8.1–8.5
	Visibility (m)	0.4–0.4	0.4–0.45	0.35–0.4	0.19–0.25	0.3–0.45
B	Temperature (°C)	8.2–14.2	1–7	4–20,5	18.8–24	11–18.1
	O_2 (mg · dm^{-3})	9.5–10.8	10.5–11.1	8.2–11.2	2,1–9,48	7,4–9,2
	pH	6.1–6.7	6.7–6.9	7–7.6	6.8–7.5	7.7–7.8
	Visibility (m)	0.45–0.5	0.5	0.4–0.45	0.2–0.3	0.45–0.5
C	Temperature (°C)	8.1–11.2	1–6.7	4.2–19	18.6–23.1	11.2–18
	O_2 (mg · dm^{-3})	10–10.9	11.3–11.95	9.7–12.26	6.4–9.7	7.8–10.1
	pH	5.9–6.9	5.8–6.5	7.2–7.4	6.9–7.3	7.3–7.9
	Visibility (m)	0.7–0.75	0.75–0.8	0.23–0.4	0.4–0.55	0.4–0.55

The first study of the rotifer community was conducted before the restoration, from March to November 1980 [Bielańska-Grajner 1983/84]. The material was collected then at five sampling stations: stations 1–4 in the littoral zone, among vegetation dominated by *Typha latifolia* L., *P. australis* Trin. ex Stendel, or *Potamogeton natans* L., and station 5 in the pelagic zone.

After restoration, lasting from November 1996 to November 1997, a similar study was conducted at three sampling stations. Station A was situated among aquatic plants, mostly the common bulrush *Typha latifolia* L., and characterised with a slimy bottom covered by decaying plant remains. Station B was located among *P. australis* Trin. ex Stendel, where the bottom was covered by a

layer of sediment and detritus. Station C was situated in the pelagic zone.

The materials were collected by using standard methods. Each water sample (10 dm^{-3}) was filtered through a nylon sieve (50 μm mesh size). Two qualitative and one quantitative sample were taken at each station twice a month. Before the restoration, water was well oxygenated (3.0–13.2 mg O_2 dm^{-3}), while pH ranged from 5.1 to 9.5 [Bielańska-Grajner 1983/84]. After restoration, water oxygenation ranged from 6.3 to 12.2 mg O_2 dm^{-3} (except for the flooding in 1997, when it was 2.06 mg O_2 dm^{-3}), while pH ranged from 5.9 to 8.5 (Tab. 1).

RESULTS AND DISCUSSION

Before the restoration, the rotifer community was studied in the early 1980s [Bielańska-Grajner 1983/84]. At that time, 74 taxa of rotifers were found. The highest number of species was observed among *Phragmites* (50 taxa), and among *Typha* (49 taxa). The dominant rotifer species were then *Keratella cochlearis*, *Conochilus unicornis* and *Polyarthra luminosa*, whereas subdominants included *Keratella cochlearis* f. *tecta*, *Keratella quadrata*, *Anuraeopsis fissa*, *Kellicottia longispina*, and *Pompolyx sulcata* (Tab. 2, 3).

Table 2. Constancy (C) in %, dominance (D) in % and index of ecological significance ($Q = \sqrt{CD}$) of some species in Paprocany Lake before and after restoration

Taxon	Before restoration			After restoration		
	C	D	Q	C	D	Q
Keratella cochlearis (Gosse)	97.56	27.77	52.05	82.45	29.3	49.13
Keratella quadrata (Müll.)	75.61	6.98	22.97	78.95	2,13	12.97
Keratella cochlearis f. tecta (Laut.)	63.4	9.47	24.5	38.6	3.97	12.38
Keratella irregularis Laut.	–	–	–	56.14	13.9	27.96
Asplanchna priodonta Gosse	63.5	0.86	7.36	52.63	5.31	16.72
Kellicottia longispina (Kell.)	56.1	2.22	11.16	63.15	32.9	45.62
Anuraeopsis fissa (Gosse)	46.3	4.68	14.73	–	–	–
Pompholyx sulcata Hudson	43.9	2.18	9.78	–	–	–
Brachionus angularis Gosse	39.02	0.32	3.53	31.58	1.37	6.57
Polyarthra luminosa Kut.	26.83	11.47	17.54			
Polyarthra dolichoptera Idel.	–	–	–	33.33	366	11.04
Conochilus unicornis Rouss.	24.39	15.56	19.48	–	–	–
Synchaeta pectinata Ehrb.	–	–	–	28.07	1.33	6.11

Table 3. Rotifers community in the Paprocany dam reservoirs before and after restoration

Taxon	Before restoration	After restoration	Eutrophic indicator
1	2	3	4
Anuraeopsis fissa Gosse	+	+	eu
Ascomorpha ecaudis Perty	+	+	
Asplanchna priodonta Gosse	+	+	
Bipalpus hudsoni (Imh.)	+		
Brachionus angularis Gosse	+	+	eu
Brachionus quadridentatus Herm.	+		eu
Brachionus rubens Ehrb.	+		eu
Cephalodella sp.	+		
Cephalodella gibba (Ehrb.)	+	+	
Cephalodella sterea (Gosse)	+	+	
Colurella adriatica (Ehrb.)	+	+	
Colurella colurus (Ehrb.)	+		
Colurella uncinata (Müll.)	+	+	
Conochilus unicornis Rouss.	+	+	eu
Euchlanis deflexa Gosse	+	+	
Euchlanis dilatata (Ehrb.)	+	+	
Euchlanis triquetra Ehrb.	+		
Filinia longiseta (Ehrb.)		+	eu
Filinia terminalis (Plate)	+		
Gastropus stylifer Imh.		+	
Kellicottia longispina (Kell.)	+	+	
Keratella cochlearis (Gosse)	+	+	
Keratella cochlearis f. *tecta* (Gosse)	+	+	eu
Keratella irregularis (Laut.)	+	+	
Keratella irregularis f. *wartmanni* (Asp.)	+	+	
Keratella ticinensis (Call.)	+		
Keratella hiemalis Carl.	+		
Keratella quadrata (Müll.)	+	+	eu
Lecane bulla (Gosse)	+	+	
Lecane closterocerca (Schm.)	+	+	
Lecane flexilis (Gosse)	+	+	
Lecane ludwigii (Ecks.)	+		
Lecane luna (Müll.)	+	+	
Lecane lunaris (Ehrb.)	+	+	
Lecane scutata (Harr. et Myers)	+	+	
Lecane ungulata (Gosse)	+		
Lepadella acuminata (Ehrb.)	+		
Lepadella ovalis (Müll.)	+	+	
Lepadella patella (Müll.)	+	+	
Lepadella quadricarinata (Sten.)	+		
Lophocharis oxysternon (Gosse)	+		
Mytilina mucronata (Müll.)	+		
Mytilina mucronata f. *spinigera* (Ehrb.)	+		
Mytilina vantralis (Ehrb.)	+	+	
Mytilina unquipes (Lucks)	+		
Notholca acuminata (Ehrb.)	+		
Notholca labis Gosse	+		
Notholca squamula (Müll.)	+	+	
1	2	3	4

Platyias patulus (Müll.)	+		
Platyias quadricornis (Ehrb.)	+	+	
Polyarthra dolichoptera Idel.	+	+	
Polyartra luminosa Kut.	+		
Polyarthra major Burckh.	+	+	
Polyarthra remata Skor.		+	
Polyarthra vulgaris Carl.	+	+	eu
Pompholyx sulcata Huds.	+	+	eu
Ptygura sp.	+	+	
Rotaria rotatoria Ehrb.	+	+	
Scaridium longicaudum (Müll.)	+	+	
Squatinella rostrum (Schm.)	+		
Stephanoceros fimbriaticus (Cold.)	+		
Synchaeta pectinata Ehrb.	+	+	
Testudinella bidentata (Tern.)	+		
Testudinella carlini Bartoš	+	+	
Testudinella emarginula (Sten.)	+		
Testudinella patina (Herm.)	+	+	
Testudinella patina f. *trilobata* (And. et Sheph.)	+		
Testudinella mucronata (Gosse)	+		
Testudinella sphagnicola Rud.	+	+	
Testudinella truncata (Gosse)	+	+	
Trichocerca capucina (Wierz. et Zach.)	+		eu
Trichocerca elongata (Gosse)	+	+	
Trichocerca longiseta (Schr.)	+		
Trichocerca pusilla Laut.	+		eu
Trichocerca rattus (Müll.)	+	+	
Trichocerca similis Wierz.		+	
Trichotria pocillum (Müll.)	+	+	
Trichotria truncata (Whit.)	+	+	

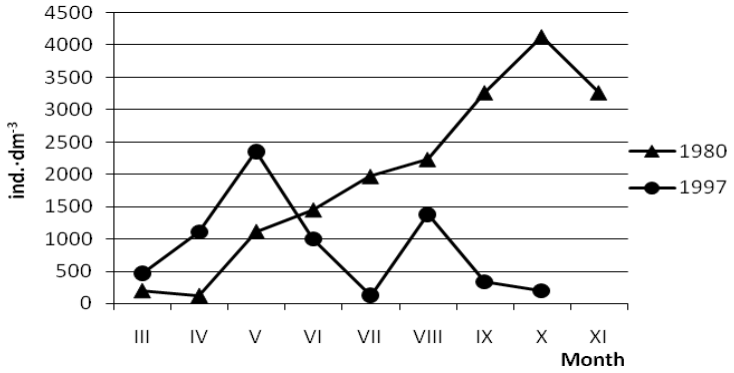

Fig. 1. Mean density of rotifers in Paprocany dam reservoir before and after restoration

After restoration, only 48 taxa of rotifers were found in Lake Paprocany. The highest number of taxa (40) was at the site dominated by *Typha*, and the lowest number (27) in the pelagic zone. Among *Typha latifolia*, littoral rotifer species dominated, and they constituted 51.3% of all rotifers. Among *Phragmites communis*, rotifer spe-

cies typical for the littoral zone accounted for only 40% of all rotifers found there. The pelagic zone was dominated by euplanktonic forms which constituted 69.2% of all rotifers.

At the three sampling stations after restoration, dominant species were *Kellicottia longispina*, *Keratella cochlearis*, and *K. irregularis*. Subdominants included *Asplancha priodonta*, *Keratella cochlearis* f. *tecta*, *Polyartha dolichoptera*, *Keratella quadrata*, *Brachionus angularis* and *Synchaeta pectinata* (Tab. 2).

Total abundance of rotifers during the study was variable. The highest densities of rotifers were observed in October and November 1996, when *Kellicottia longispina* and *Keratella irregularis* occurred in great quantities. The lowest densities were observed during the flood in July 1997 (Fig. 1).

Before restoration, a maximum number of rotifers was found in autumn, too, but their numbers were large also during summer. The structure of the rotifer community changed after restoration. Among dominant and subdominant species, the contribution of forms thought to be indicators of eutrophic waters significantly decreased (Tab. 3). Percentage contribution of f. *tecta* in the total number of *Keratella cochlearis* individuals decreased from 39.4% before restoration to 31% after restoration.

Three species of rotifers found after the restoration did not occur during the first study in this lake. These were *Filinia longiseta* (Ehrb.), *Gastropus stylifer* Imhof and *Trichocera similis* (Wierz.). Anyway, the number of recorded rotifer species was much lower after the restoration (Tab. 3). The impoverishment of the rotifer fauna in Lake Paprocany may be explained by partial removal of littoral plants during the restoration measures. The diversity of plants increases the number of ecological niches for rotifers [Klimowicz 1970]. Moreover, Donner [1964] suggested that species richness of rotifers is directly related to plant density, regardless of the number of plant species.

CONCLUSIONS

After restoration, the total number of rotifer species and the number of species that are indicators of eutrophication decreased in the dam reservoir. Densities of the rotifer community decreased, too. These changes were probably due mostly to the partial removal of aquatic vegetation during the restoration.

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ZGRUPOWANIA WROTKÓW PLANKTONOWYCH W ZBIORNIKU ZAPOROWYM PAPROCANY PRZED I PO REKULTYWACJI

Streszczenie. Badano zgrupowania wrotków planktonowych po rekultywacji w jeziorze Paprocany (Górny Śląsk). Rekultywacja polegała na bagrowaniu i usunięciu makrofitów z jeziora. Stwierdzono, że rekultywacja spowodowała zmianę struktury zgrupowań wrotków w badanym zbiorniku. Przed rekultywacją dominowały gatunki typowe dla wód eutroficznych, po zabiegach rekultywacyjnych wzrosła liczba gatunków charakterystycznych dla wód czystych. Po rekultywacji spadło zagęszczenie oraz liczba gatunków wrotków w zbiorniku, prawdopodobnie na skutek usunięcia makrofitów.

Słowa kluczowe: eutrofizacja, bagrowanie, rekultywacja, zgrupowania wrotków