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Original Research

Studies on Sustainability of Planktonic Rotifer Assemblages in Select National Park Ponds and Wetland Reservoirs

Andrzej Demetraki-Paleolog*

Department of Hydrobiology, University of Life Sciences,
Dobrzańskiego 37, 20-262 Lublin, Poland

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Abstract

One of the most interesting though little-known water ecosystems of Łęczyńsko-Włodawskie Lakeland is its small water bodies – ponds and wetland reservoirs. Three ponds and three wetland reservoirs were studied in 2008 and then again in 2012 and 2013 to examine their rotifer assemblages. While watching the changes occurring in the plankton during periods of 4 and 5 years, we were trying to find out which of the reservoirs were inhabited by more sustainable rotifer assemblages and which ecological qualities were more closely related to such sustainability. The results of the studies revealed different, though insignificant, variability in the ecological properties of planktonic rotifer assemblages, particularly in the ponds, as well as they suggested some relationship between the sustainability of planktonic assemblages and their species diversity.

Keywords: ponds, wetland reservoirs, planktonic rotifers, Polesie National Park, sustainability

Introduction

Polesie National Park, characterized by a network of water bodies and peat-bogs, is rich in valuable small water habitats such as old re-naturalized ponds and wetland reservoirs. They are inhabited by rotifers that provide good research material since they constitute the basic component, of small zooplankton [1]. Consuming bacteria, algae, protozoa, and dead organic matter, they play an important role in the trophodynamics of water reservoirs and they inhabit them relatively early [1-4]. Some of them may also become good indicators of water fertility and purity [5-7].

The studies were initiated in order to determine the ecological profile of these little-known water bodies, as well as to find the dynamics of changes in planktonic rotifer assemblages in the course of 4 and 5 years. Our work aimed to determine the degree of sustainability among planktonic rotifer assemblages inhabiting the ponds and wetland reservoirs of Polesie NP to see if sustainability was similar in all the examined ecosystems and if it referred to all or only some ecological features of rotifer assemblages.

*e-mail: andrzej.paleolog@up.lublin.pl

Study Area

Our studies were carried out in the area of the poorly diversified topography of Polesie National Park, which covers the most precious areas of Łęczyńsko-Włodawskie Lakeland regarding its flora, including swamps, peat-bogs, and wetland reservoirs [8].

This particular area embraces two complexes of ponds, Burskie Ponds and Pieszowolskie Ponds, as well as wetland reservoirs (Fig. 1).

Perkoz Pond (representing Burskie Ponds) and Głęboki and Dziki Ponds (representing Pieszowolskie Ponds) were selected for the studies. They were created in the 1930s on meadows dominated by transitional bogs. Since the 1970s they have all been supplied by the Mietiułka River [9]. For many years these reservoirs were excluded from fisheries.

Tabele 1. Physical and chemical parameters of the waters in the ponds and wetland reservoirs of Polesie National Park – mean values in 2008.

Parameter of water	Ponds			Wetland reservoir		
	Głęboki	Perkoz	Dziki	Mietiułka	Radwania	Bubnów
Temperature ºC	22.1±0.28	22.5±0.07	21.8±1.41	19.4±0.56	19.45±0.49	26.4±2.97
pH	7.66±0.26	7.51±0.76	7.24±0.03	7.20±0.26	5.95±0.13	8.97±0.15
Conductivity $\mu S \cdot cm^{-2}$	488.0±111.7	390.5±38.9	306.0±15.5	183.5±30.4	161.3±67.5	417.0±21.4
O_2 $mg \cdot dm^{-3}$	9.2±3.3	10.5±1.3	10.3±3.1	6.0±2.7	5.1±2.2	10.9±5.4
$P\text{-}PO_4$ $mg \cdot dm^{-3}$	0.014±0.004	0.013±0.013	0.020±0.016	0.006±0.006	0.180±0.212	0.011±0.013
Total P $mg \cdot dm^{-3}$	0.015±0.006	0.054±0.066	0.038±0.022	0.081±0.026	0.442±0.253	0.179±0.068
$N\text{-}NO_3$ $mg \cdot dm^{-3}$	0.528±0.318	0.300±0.098	0.465±0.117	0.476±0.254	1.000±0.442	0.443±0.192
$N\text{-}NH_4$ $mg \cdot dm^{-3}$	0.594±0.086	0.780±0.206	0.684±0.240	0.611±0.183	2.390±1.286	0.655±0.213
Total-N $mg \cdot dm^{-3}$	1.376±0.616	1.332±0.525	1.982±1.411	1.443±0.347	4.718±3.171	2.147±1.648

They turned into reeds, bushes, and forested areas (birch, alder). In 1990 they were included in the Polesie National Park, and four years later they started to be re-naturalized [9]. The area of Perkoz Pond is 44.01 ha and its catchment area includes 0.76 ha of rushes, 0.76 ha of shrubs and 36.38 ha of forests. Głęboki and Dziki Ponds are smaller, 18.18 ha and 28.30 ha, respectively. Their catchment areas include 11.75 ha of dikes and rushes, 10.53 ha of arable lands, and 3.0 ha of shrubs, and bushes. The wetland reservoirs of Mietiułka, Radwania, and Bubnów are very shallow water bodies of different sizes. Their waters, from slightly acidic to slightly alkaline, are usually oxygenated to a low degree and have diversified content of biogenes (Table 1).

Materials and Methods

Biological material was sampled in spring and autumn of 2008 and, additionally, in spring and autumn of 2012 from the wetland reservoirs and in 2013 from the ponds. Three ponds (two Pieszowloskie Ponds, Głębokie and Dzikie, and one Burskie Pond) and three wetland reservoirs (Mietiułka, Radwania, and Bubnów) provided material for the study. At each time the plankton from each water body was sieved in three replications. Samples were collected by taking 10 dm^3 of water with the use of a “Toń II” sampler at 0 to 0.5 m below the surface. The water collected in this way was sieved through a planktonic net No. 25 and condensed to a constant volume of 100 cm^3. The samples were pre-

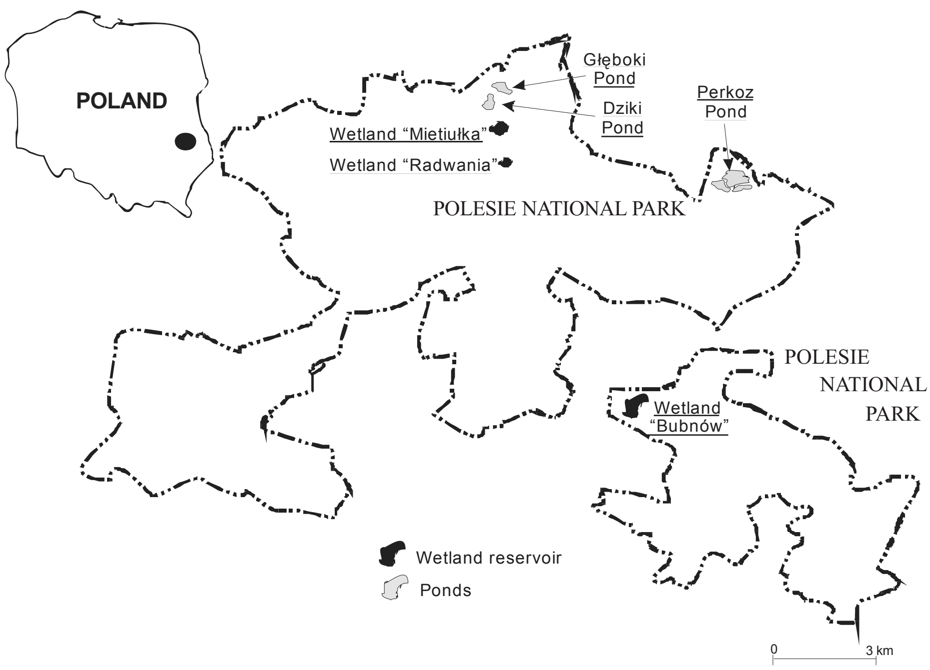

Fig. 1. Map of the study area.

served with Lugol's liquid and 4% formaldehyde and glycerine solution. Planktonic rotifers were identified and counted in the preserved samples. The number of individuals was counted per 1 dm^3 of water in the reservoir. Samples for physical and chemical analyses were collected in spring and autumn 2008. In order to verify the regularity of all the variables the Shapiro-Wilk test was used. The significance of differences in the density and biomass of rotifers among individual reservoirs and study periods was tested with the use of Kruskal-Wallis non-parametric range ANOVA test in SAS. The similarity of rotifer communities studied in the particular ecosystems and periods was determined by means of the Jaccard index with the cluster method using a Multi Variate Statistical Package (MVSP-3.1). The analysis of similarities was performed with the help of unweighted pair-group method using arithmetic averages (UPGMA). The work included calculating the index of rotifer domination and evaluating the sustainability of domination structure [10]. Wet biomass of planktonic rotifers was calculated in WW $\mu g \cdot dm^{-3}$ [11] and the Shannon index was determined.

Results and Discussion

The six studied ponds revealed the presence of 57 taxa of rotifers. Wetland reservoirs were inhabited by 5 to 12 species, while in the ponds there were 10 to 17 species. For the sake of comparison, other ponds in Europe and other parts of the world reveal most frequently similar species richness [12-16], or lower values [3, 17-19]. Few available studies examining rotifer communities in other reservoirs also suggest low numbers of these organisms, and their biomass was the lowest among all the groups of zooplankton, including protozoa [20]. Species richness was not a stable value in the ponds because it was different in 2008 than five years later. On the other hand, in wetland reservoirs maximum and minimum numbers of species in 2012 occurred in the same ecosystems as four years earlier. Species diversity expressed with the Shannon index was similar in both the ponds and wetland reservoirs, both in the earlier period and 4-5 years later (Fig. 2). The literature does not offer any data regarding long-term stability of the Shannon index calculated for rotifers in the ponds and wetland reservoirs of other European regions.

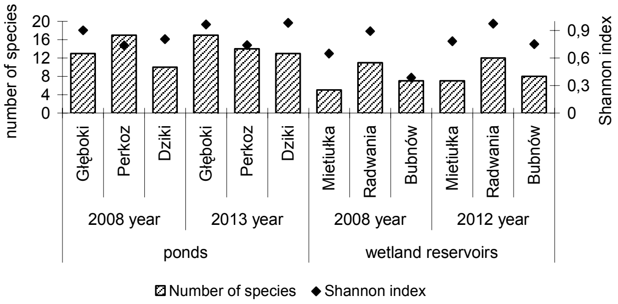

Fig. 2. Number of species and Shannon index for planktonic rotifers in the ponds and wetland reservoirs of Polesie NP in 1998 and 2012/13.

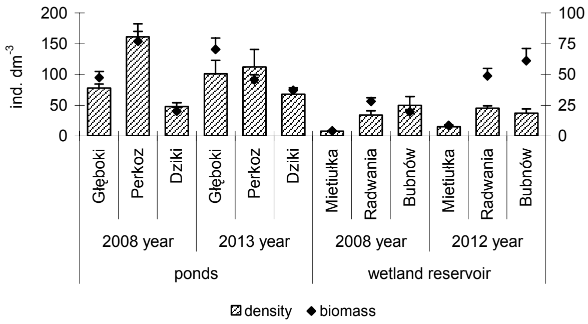

Fig. 3. Planktonic rotifer density and wet biomass (+SD) in the ponds and wetland reservoirs of Polesie NP in 1998 and 2012/2013.

The density of rotifer plankton was rather low and characteristic of poor and medium-fertile waters. Higher values of density, from 48 ind.$\cdot dm^{-3}$ to 161 ind.$\cdot dm^{-3}$ were observed in the ponds, whereas significantly lower values, from 8 ind.$\cdot dm^{-3}$ to 50 ind.$\cdot dm^{-3}$, were recorded in the wetland reservoirs (Fig. 3). Such low densities of rotifer plankton are also noted in other reservoirs of this type [21, 22]. The differences between the density of rotifers in particular ponds and wetland reservoirs, as well as between particular dates of analyses in each individual water body, are statistically significant, except for Mietiułka Wetland in 2008 and Mietiułka Wetland in 2012. The majority of the remaining ponds revealed higher or significantly higher densities of rotifers [15, 19, 22]. The biomass of planktonic rotifers in the studied small water reservoirs of Polesie were insignificant and its value was higher in the ponds as compared with the wetland reservoirs (Fig. 3).

The density of planktonic rotifers was a value which was hardly changing in time, since both in the earlier period and 4-5 years later it was similar. It was always the highest in Perkoz Pond and the lowest in Dziki Pond, while its highest values for wetland reservoirs were noted in Radwania or Bubnów, and the lowest in Mietiułka. Changes of rotifer biomass in time were different than those affecting rotifer density. It is hard to discuss sustainability here as the maximum and minimum values of the biomass in 2008 occurred in different ponds or wetland reservoirs than 4-5 years later (Fig. 3).

Numerous authors claim that the composition of species in plankton may be varied, yet the biomass remains stable. It should be emphasized, however, that the majority of such statements is based on studying phytoplankton, rather than zooplankton [23, 24].

The dominants in those small water reservoirs included as many as 22 species of rotifers (38% of all the species recorded). Most of them are common species (Table 2). Despite the presence of so many dominating species, the sustainable domination structure was observed only in Głębokie Pond in 2013 and in Radwania wetland reservoir in 2012.

The criterion of the degree of domination sustainability among rotifers was adopted after Bielańska-Grajner [10]. The author treats an assemblage as sustainable when it includes all three classes of domination (dominants, sub-

Table 2. Domination structure of planktonic rotifers (%) in the ponds and wetland reservoirs of Polesie National Park in 2008 and 2012/2013.

		Ponds						Wetland reservoir					
	Year	2008			2013			2008			2012		
Lp.	Reservoir	Głęboki	Perkoz	Dziki	Głęboki	Perkoz	Dziki	Mietiułka	Radwania	Bubnów	Mietiułka	Radwania	Bubnów
	Dominants												
1	*Anuraeopsis fissa* Gosse										13.3		
2	*Brachionus quadridentatus* Herm.								8.8				
3	*Colurella adriatica* Ehrb.						8.8						
4	*Elosa spinifera* Wiszn.		13.7			26.8							
5	*Euchlanis dilatata* Ehrb.						7.4			8.0		11.1	16.2
6	*Keratella cochlearis* (Gosse)		55.9	43.8		45.5	26.5			78.0			29.7
7	*Keratella cochlearis* f. *tecta* (Gosse)								20.6			22.2	8.1
8	*Keratella quadrata* (Müll.)	24.4		12.5	30.7		7.4						
9	*Lecane acus* (Harr.)							12.5			13.3		
10	*Lecane bulla* (Gosse)	25.6			18.8								
11	*Lecane closterocerca* (Schm.)	7.7											
12	*Lecane crenata* Harr.							12.5					
13	*Lecane furcata* (Murray)										13.3		
14	*Lepadella ovalis* (Müll.)	12.8			9.9			37.5	20.6		33.3		
15	*Lepadella patella* (Müll.)											17.8	
16	*Lepadella rhomboides* (Gosse)												
17	*Lepadella triptera* Ehrb.						10.3						
18	*Macrochaetus subqudratus* Perty							25.0					
19	*Mytilina crassipes* (Lucks)							12.5			13.3		
20	*Mytilina mucronata* (Müll.)	12.8			9.9				23.5			8.9	
21	*Polyarthra euryptera* Wierz.			10.4			16.2						
22	*Polyarthra vulgaris* Carl.												29.7
	Subdominants	16.7	27.9	33.3	26.7	24.1	23.5	0.0	26.5	14.0	13.3	38.6	16.2
	Recedents	0.0	2.5	0.0	4.0	3.6	0.0	0.0	0.0	0.0	0.0	1.4	0.0

dominants, and recedents), at least three of the species belong to dominants and none of them exceeds the 45% share of their total abundance.

In order to analyze the degree of changes occurring in time for species composition and domination structure in the individual water reservoirs, the Sorensen index was calculated to show the degree of faunistic similarity of different rotifer communities (Fig. 4).

The cluster method revealed a very high similarity between different rotifer communities inhabiting Głęboki Pond in 2008 and the same pond in 2013 (Sorensen index of 0.88), and Dziki Pond in 2008 and 2013 (Sorensen index of 0.70). The third of the analyzed ponds, Perkoz, situated in a differently managed catchment area, was characterized by a significantly lower sustainability of planktonic rotifer communities. Rotifer assemblages inhabiting this particular pond in 2008 and 2013 were similar to each other in only 20% (Sorensen index of 0.20, Fig. 4). Many authors believe that sustainability of assemblages may be related to their low species diversity [25]. The present studies on planctonic rotifers may confirm this opinion, as the Shannon index noted in 2008 in Perkoz Pond was the lowest among all the examined ponds. The reason for a significantly higher sustainability of rotifer assemblages in Dziki and Głębokie

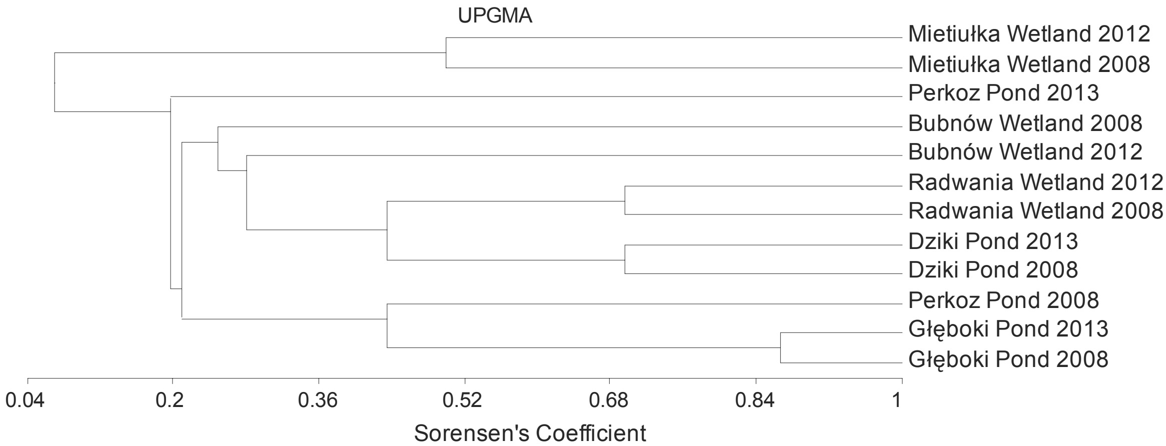

Fig. 4. Similarity structure of planktonic rotifer assemblages, based on their quantity composition in the ponds and wetland reservoirs of Polesie NP in 1998 and 2012/2013.

ponds may be their situation in a complex of a number of ponds. Howeth [23] claims that the relationship between diversity and sustainability may be determined by the rate of the spread of a particular species among the local community. The author quotes an example of a complex of closely situated ponds as a habitat for more sustainable meta-populations. The relationship between rotifer sustainability and their species diversity was even more clear in wetland reservoirs. The higher the Shannon index in 2008 was, the higher was rotifer assemblage sustainability. The highest faunistic similarity in wetland reservoirs regarding the periods of 2008 and 2013 was recorded in Radwania wetland reservoir. The value was slightly lower for Mietiułka, and the lowest for Bubnów, with the Sorensen index amounting to, respectively, 0.70, 0.50, and 0.26 (Fig. 4). The Shannon index in those ecosystems was, respectively, 0.89, 0.64, and 0.38. It is worth noting that more sustainable rotifer assemblages inhabited the closely situated wetlands of Radwania and Mietiułka. This suggests that higher sustainability of rotifer communities (and thus maintaining their species diversity and preserving rare species) is fostered by biocenoses consisting of numerous meta-populations. Such a regularity among other hydrobionts is also suggested in other studies [23, 26].

Conclusions

1. Sustainability of planktonic rotifer assemblages is higher in those water bodies in which higher species diversity was observed at the beginning of the studies.
2. Planktonic rotifer communities were more sustainable in the water reservoirs situated in complexes of a few separate water bodies, rather than those occurring as single, "isolated" aquatic ecosystems.
3. Species richness in the majority of water bodies revealed significant variability in time and higher sustainability in species diversity.
4. Density of planktonic rotifers in wetland reservoirs was a property more variable in time, whereas higher sustainability of this feature was observed in ponds.
5. Changes regarding the biomass of planktonic rotifers in time were diversified and this particular property of rotifer assemblages cannot be regarded as sustainable.

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