

## PRELIMINARY STUDIES ON PLANKTONIC ROTIFERS OF HYPERTROPHIC LAKE MIEJSKIE

Andrzej Demetraki-Paleolog

Department of Hydrobiology, University of Life Sciences in Lublin  
Dobrzańskiego str. 37, 20–262 Lublin, daga@pro.onet.pl

**Summary.** Lake Miejskie is situated on the area of the Łęczyńsko-Włodawskie Lakeland, near Ostrów Lubelski. The surface area of the lake is 154.7 ha and the maximum depth is 2.2 m. The lake is not stratified, it is polymictic and hypertrophic. Preliminary studies on planktonic rotifers communities were conducted in May, June and July 2006. A total of 28 rotifers species were noted in the lake, among them 9 indicator species of eutrophic waters and 1 indicator of oligotrophic environments. Obtained results showed little influence of sparsely vegetated littoral zone on the planktonic rotifer communities. High densities, low species richness, non-sustainable domination structure, domination of euplanktonic and detritivorous species in rotifers community confirm very low resistance of the lake to degradation processes and a high degree of eutrophication.

**Key words:** hypertrophic lake, shallow lake, polymictic lake, planktonic rotifers, Lake Miejskie

### INTRODUCTION

Lake Miejskie is situated on the area of the Łęczyńsko-Włodawskie Lakeland – one of the areas of Poland of high ecological value [Chmielewski (ed.) 2006]. The whole region has the status of a UNESCO Biosphere Reserve, due to the high naturalness of ecosystems and presence of protected areas, such as Poleski National Park, 3 landscape parks, 7 areas of NATURA 2000 and 12 nature reserves. The catchment area of Lake Miejskie is relatively small, which suggests high resistance of the lake to degradation process. Unfortunately, the catchment area is intensively used for agriculture purposes (long term use of manure as a fertiliser for surrounding fields), which causes high constant loadings of nutrients to the lake and deterioration of water quality due to eutrophication process. The lake is situated near Ostrów Lubelski, and the close vicinity of

the town accelerates the negative impact of recreation on the lake ecosystem. The commune authorities of Ostrów Lubelski have undertaken the task of working out and implementing a programme of improvement of the ecological state of the catchment of Lake Miejskie and optimisation of recreational activity in the area [Chmielewski (ed.) 2006]. Under such conditions, before the implementation of the restoration programme, studies of the structure of planktonic rotifers have appeared to be valuable. Rotifers belong to the small zooplankton. They are consumers of small organisms such as bacteria, algae and protozoans, some species are detritivorous. So, they constitute an important link in the trophic structure in lake ecosystems [Radwan 1973]. Some species are good indicators of eutrophic waters [Radwan 1973, Karabin 1985, Paleolog *et al.* 1997, Radwan *et al.* 2003].

#### STUDY AREA

Lake Miejskie is situated in the area of the Łęczyńsko-Włodawskie Lakeland, near Ostrów Lubelski. Its surface area is 154.7 ha and the maximum depth is 2.2 m [Harasimiuk *et al.* (eds) 1998]. The lake is not stratified, and it is polymictic and hypertrophic [Chmielewski (ed.) 2006]. In the summer of 2006 the concentration of N-NO<sub>3</sub> in water ranged from 0.5 to 1.0 mg dm<sup>-3</sup>, P-PO<sub>4</sub> from 0.1 to 0.7 mg dm<sup>-3</sup>, and water transparency usually did not exceed 0.5 m [Chmielewski (ed.) 2006]. Lake shore of the length 2943 m is differentiated, on particular sections it is bordered with peatbogs, forest, fields and sandy beach [Chmielewski (ed.) 2006].

#### MATERIAL AND METHODS

Planktonic rotifers were collected in May, June and July 2006, from three sites situated in the littoral and pelagic zones. At each site samples were collected at the depth of 0.5 m by taking 10 dm<sup>3</sup> of water using the planktonic sampler Toń II. Water samples were sieved through a screen with mesh size of 25 µm and condensed to the constant volume of 100 cm<sup>3</sup>. Samples were preserved with Lugol liquid and, after some hours, with 4% formaldehyde with glycerine. Rotifers were counted and identified under inverted microscope. The number of individuals in the sample was calculated per 1 dm<sup>3</sup> of water. Collected data were analysed statistically. The test of Shapiro-Wilk was used to verify the normal distribution of the data. The significance of differences in rotifer densities between particular zones and months were verified using non-parametric rang test of Kruskal-Wallis.

## RESULTS AND DISCUSSION

Totally in Lake Miejskie only 28 planktonic rotifers species were noted; 9 species were classified as indicators of eutrophic waters and 1 species – *Kellicotia longispina* – as an indicator of oligotrophic waters. The total number of species did not differ visibly between zones and months. In the pelagic zone it ranged from 5 (in May) to 13 (in July). In the littoral zone the number of species showed higher values and ranged from 7 (in May) up to 17 (in July) (Fig. 1A). The higher number of species observed in the littoral zone compared to the open water was probably a consequence of the presence of sparse macrophyte stands in the littoral zone. A similar influence of submerged macrophytes on the rotifers structure was observed by other authors [Pawłowski 1980, Bielańska-Grajner 1987, Radwan *et al.* 2005].

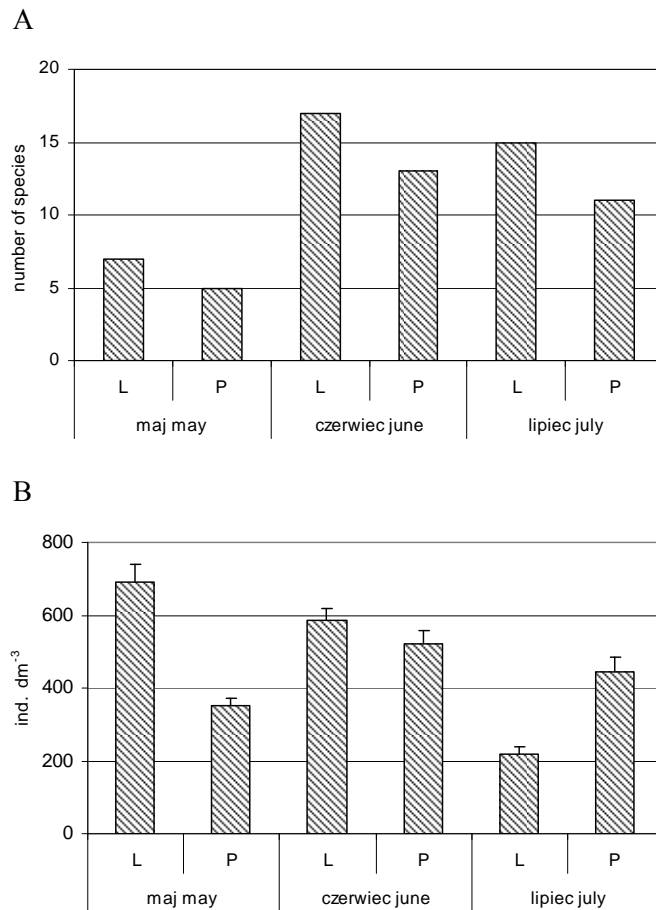


Fig. 1. Quality and quantity structure of planktonic rotifers in Lake Miejskie in 2006: A – species richness, B – density, L – littoral, P – pelagic zone

Densities of planktonic rotifers differed between zones and months. In the littoral zone the highest density (690 ind. dm<sup>-3</sup>) was noted in May and its value decreased in particular months down to 220 ind. m<sup>-3</sup> in July (Fig. 1B). In the open water zone the rotifer densities showed lower values and ranged from 355 ind. dm<sup>-3</sup> in May to 520 ind. dm<sup>-3</sup> in June (Fig. 1B). Except for June, all differences between zones and months were significant. Usually, in the eutrophic lakes of the Łęczyńsko-Włodawskie Lakeland densities of planktonic rotifers were higher in the pelagic than in the littoral zone [Radwan *et al.* 1998, 2003], while in the studied Lake Miejskie an opposite pattern was observed. Such a situation is often noted in highly fertile-hypertrophic lakes which are shallow and sparsely vegetated [Demetraki-Paleolog 2005]. Karabin [1985] stated that rotifer densities oscillating between 400 and 2000 ind. dm<sup>-3</sup> are typical for eutrophic waters.

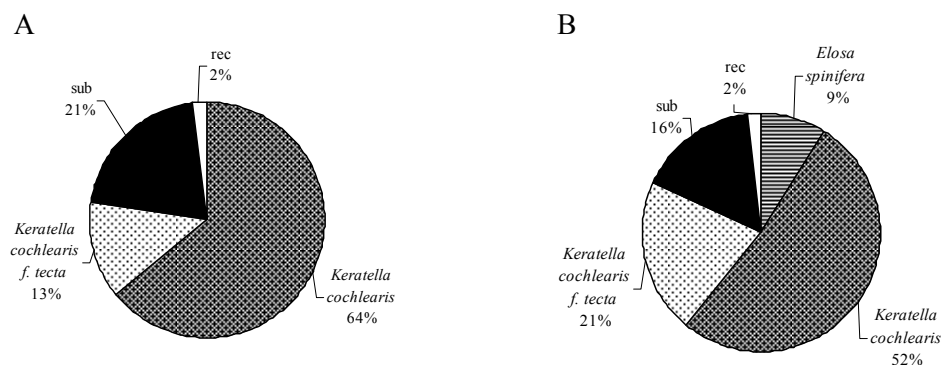


Fig. 2. Domination structure of planktonic rotifers in Lake Miejskie in 2006: A – littoral, B – pelagic zone, sub – subdominants, rec – recedents

The structure of domination showed a high percentage of scarce species: *Keratella cochlearis*, *Keratella cochlearis f. tecta*, *Elosa spinifera*. These species are typical for eutrophic waters. Very low percentage of recedents, only 2%, confirmed the high fertility of Lake Miejskie [Fig. 2A, B]. The rotifer communities were classified in the sustainable and non-sustainable domination structure according to Łuczak and Wierzbowska [1981], Müller [1984] and Bielańska-Grajner [2005]. Those authors assumed a community to be sustainable when there occurred 3 domination classes (dominants, subdominants and recedents), at least 3 species represented dominants and none of them exceeded 45% of total density. According to such criteria, the studied communities of planktonic rotifers, in both the littoral and open water zones, were non-sustainable (Fig. 2A, B). The domination structure of rotifers evidenced low ecological stability and high susceptibility of this eutrophic lake to degradation.

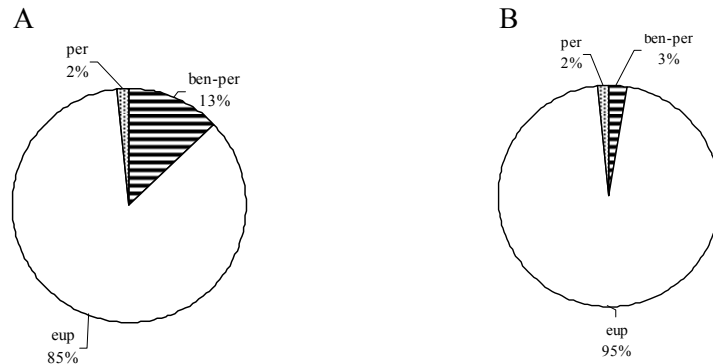


Fig. 3. Ecological structure of planktonic rotifers in Lake Miejskie in 2006: A – littoral, B – pelagic zone, per – periphytic species, ben-per – benthic-periphytic species

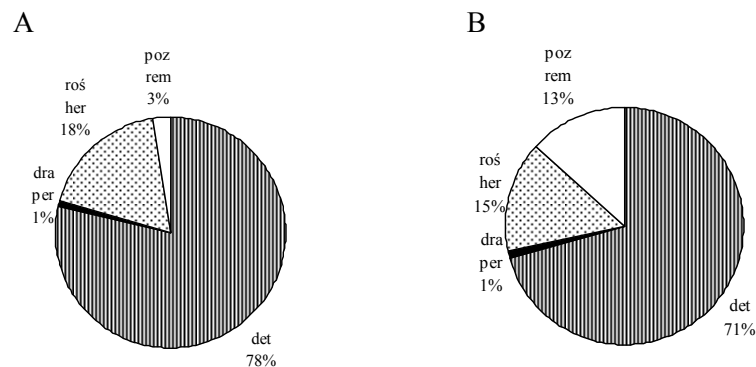


Fig. 4. Relative abundances of trophic groups of rotifers in total density in Lake Miejskie in 2006: A – littoral, B – pelagic zone, det – detritivorous species; her – herbivorous species, pre – predators, rem – remaining species

The studies included an analysis of domination structure of particular ecological groups of planktonic rotifers. The euplanktonic species showed very high percentage ranging from 85% in the littoral up to 95% in the open water zone. The share of benthic-periphytic and periphytic species amounted only to 5% in the pelagic zone and 15% in the littoral, while epibiont species were not noted (Fig. 3A, B). Very low differentiation of ecological forms and high percentage of euplanktonic species, especially in small reservoirs, can be a consequence of high fertility of water, low degree of naturalness, sparse vegetation and other effects of lake degradation [Radwan 1973, Demetraki-Paleolog 2007]. During the years 1966–1996 Radwan [1973] surveyed 57 lakes of the Łęczyńsko-Włodawskie Lakeland and only in some ecosystems the shares of euplanktonic

rotifers were as high as those observed in Lake Miejskie. It is worth noting that studies of those 57 lakes were performed 38 years ago, and that at that time the degree of lake degradation in Poland was much lower than at present.

The analysis of different trophic groups of rotifers showed high percentage of detritivorous species. Their share ranged from 71% in the pelagic zone to 78% in the littoral. At the time the share of predatory species amounted only to 1% of total density (Fig. 4A, B). Studies performed in other lakes and seasons showed that increasing domination of detritivorous species over other groups is common in strongly eutrophicated ecosystems [Gliwicz 1974, Karabin 1985].

### CONCLUSIONS

1. In Lake Miejskie only 28 species of planktonic rotifers were noted: 9 species classified as indicators of eutrophic waters and 1 species – an indicator of oligotrophic waters. Total density of rotifers ranged from 220 to 690 ind. dm<sup>-3</sup>.

2. The number of species observed in the littoral zone was higher than in open water, which can indicate a positive influence of sparse vegetation on species richness of planktonic rotifers.

3. The group of dominants included common rotifers species: *Keratella cochlearis*, *Keratella cochlearis tecta* and *Elosa spinifera*.

4. High domination of euplanktonic species over other ecological forms, as well as domination of detritivorous species over algae-eating and predatory species, confirm low degree of naturalness of the lake, its low resistance to degradation and high degree of eutrophication.

### REFERENCES

- Białańska-Grajner I., 1987. Comparison of rotifer (Rotatoria) assemblages in various types of reservoirs in Upper Silesia (in Polish). *Przeg. Zool.*, 31, 37–47.
- Białańska-Grajner I., 2005. Psammon rotifers (Rotifera) of selected reservoirs of Poland (in Polish). *Wyd. Uniw. Śląski*, pp. 114.
- Chmielewski T. (ed.), 2006. The improvement of ecological status and optimisation of recreational use of catchment of lakes Miejskie – Kleszczów as a pilot study for implementation on the post-lake areas of Euroregion Bug (in Polish). Programme of ecological cooperation PHARE – Fund of Small Projects. *Wyd. Gmina Ostrów – Tow. Ziemi Ostrowa Lub.*, Akapit S.C., 16–17.
- Demetraki-Paleolog A., 2005. Qualitative and quantitative composition of planktonic rotifers in Zemborzycki Reservoir. *Teka Kom. Ochr. Kszt. Środ. Przyr.*, 2, 115–121.
- Demetraki-Paleolog A., 2007. Planktonic rotifers (*Rotifera*) of the rivers of west Lubelszczyzna (in Polish). *WAR Lublin, Rozprawy Naukowe*, 317, pp. 124.
- Gliwicz M., 1974. Trophic status of freshwater zooplankton species (in Polish). *Wiad. Ekol.*, XX, 3, 197–203.

- Harasimiuk M., Michalczyk Z., Turczyńska M. (eds), 1998. Lakes of Łęczna-Włodawa District – ecological monograph (in Polish). Wyd. UMCS, pp. 176.
- Karabin A., 1985. Pelagic zooplankton (Rotatoria + Crustacea) variation in the process of lake eutrophication. I. Structural and quantitative features. Ecol. Pol. 33, 567–616.
- Łuczak J., Wierzbowska T., 1981. Methods of zoocenological analysis (in Polish) [in:] M. Górny, L. Grüm (eds). Methods in Soil Zoology. PWN, Warsaw, 417–436.
- Müller H.J., 1984. Ökologie. Gustav Fischer Verlag. Jena, pp. 195.
- Paleolog A., Radwan S., Kowalik W., Kowalczyk C., Stryjecki R., Zwolski W., 1997. Water invertebrates of „Łasy Janowskie” Landscape Park (in Polish) [in:] Natural environment of „Łasy Janowskie” Landscape Park. Wyd. UMCS Lublin, 83–227, 1064–X, 117–133.
- Pawłowski L.K., 1980. The rotifer fauna in the pleuston of the association of *Wolffietum arrihizae* Miyaw et J.Tx. 1960. Acta Univ. Łódz. Ser. II, 33, 7–103.
- Radwan S., 1973. Pelagic rotifers of lakes of Łęczyńsko-Włodawskie Lakeland. Faunistic and ecological study (in Polish). Skróty rozprawy habilitacyjnej. AR, Ser. Rozpr. Hab., 8, pp. 57.
- Radwan S., Jarzynowa B., Zwolski W., Girsztowt K., Kowalczyk C., Kowalik W., Paleolog A., 1988. Ecological characteristic of upper and middle courses of Bystrzyca Lubelska River, its tributaries and Zemborzycki Reservoir (in Polish). Roczn. Nauk. PZW, t. 1, 123–156.
- Radwan S., Bielańska-Grajner I., Ejsmont-Karabin J., 2004. Rotifers (Rotifera). Fauna of freshwaters in Poland (in Polish). 32. Polish Hydrobiological Society, University of Łódź. Oficyna Wydawnicza Tercja, Łódź, pp. 146.
- Radwan S., Paleolog A., Popiołek B., 1998. Rotifer communities in nine lakes of different trophic in the Polesie National Park and its protection zone (Eastern Poland). Acta Hydrobiol., 40, 93–104.
- Radwan S., Bielańska-Grajner I., Popiołek B., Demetraki-Paleolog A., 2003. Rotifer communities of ecotones in six trophically different lakes of Polesie Lubelskie Region (Eastern Poland). Pol. J. Ecol., 51, 225–236.

#### WSTĘPNE BADANIA WROTKÓW PLANKTONOWYCH W HIPERTROFICZNYM JEZIORZE MIEJSKIM

**Streszczenie.** Jezioro Miejskie leży na Pojezierzu Łęczyńsko-Włodawskim w pobliżu Ostrowa Lubelskiego. Jego powierzchnia wynosi 154,7 ha, a maksymalna głębokość 2,2 m. Zbiornik nie wykazuje stratyfikacji termicznej, jest jeziorem polimiktycznym i hipertroficznym. W maju, czerwcu i lipcu 2006 r. w jeziorze przeprowadzono wstępne badania zgrupowań wrotków planktonowych. Łącznie stwierdzono 28 gatunków wrotków planktonowych, w tym 9 gatunków wskaźnikowych eutrofii i tylko jeden gatunek wskaźnikowy oligotrofii. Wyniki badań wskazują na nieznaczne oddziaływanie ubogiej w makrolity strefy litoralu na zgrupowania wrotków. Znaczne zagęszczenia wrotków, małe bogactwo gatunkowe, niezrównoważona struktura dominacji, duża przewaga gatunków euplanktonowych w strukturze ekologicznej i gatunków detrytosożernych w strukturze troficznej świadczą o niskiej odporności na degradację i wysoki stopień eutrofizacji zbiornika.

**Słowa kluczowe:** jeziora hipertroficzne, jeziora płytkie, jeziora polimiktyczne, wrotki planktonowe, Jezioro Miejskie