

THE ROTIFERA AND CRUSTACEAN PLANKTON IN DIFFERENTIATED PHYTOCOENOSIS OF THE AQUATIC VEGETATION OF PIASECZNO LAKE

Grzegorz Grzegorz, Natalia Kuczyńska-Kippen

Zakład Ochrony Wód
Uniwersytet im. A. Mickiewicza, ul. Drzymały 24, 61-613 Poznań

Summary. The results of the chemical analysis, water transparency, the concentration of chlorophyll and the dominance structure of zooplankton revealed a low trophic state of the examined lake. There were 145 zooplankton species. The species diversity as well as the zooplankton numbers were the highest in September and the lowest in March. *Phragmites australis* was the taxonomically richest zone in the lake. The biodiversity index showed generally low values, reaching a maximum of 3.27 in Cladonietum stand.

Key words: zooplankton, Piaseczno Lake, species diversity, littoral

INTRODUCTION

The littoral zone reveals a significant mosaic in its structure, owing to the differentiated architecture and variation of ecological niches, which contribute to the increase of the species diversity of both rotifers and crustaceans. Macrophytes are also of great importance since they protect animals from the stress of predators and also indirectly influence the development of the food base for zooplankton [Kajak 1998]. It is known that the spatial and morphological structure of a vegetated habitat may modify zooplankton communities [Timms and Moss 1984, Downing and Cyr 1986]. However, the developmental stage of the macrophyte stand may also have a great impact, influencing the seasonal changes of plankton [Lampert and Sommer 1996]. This is why the aim of the study was to examine the spatial distribution of zooplankton and its seasonal changes within the littoral zone and open water of Piaseczno Lake.

STUDY AREA

The youngest nature reserve of the Wdecki Landscape Park in Tucholskie Forest – Piaseczno Lake – was established in 2001. It is supplied by underground water and atmospheric fall. It fills the post-glacial valley to a length of 1575 m and width of be-

tween 130 to 300 m. This lake, covering an area of 38 ha and with a maximum depth of 10.7 m, is a dimictic water body, surrounded by a pine forest [Goszczyński 2001].

MATERIAL AND METHODS

Zooplankton was sampled in 2-month intervals (May 2003 – March 2004) from 10 stations, including 5 in the rush zone (*Phragmites australis*, *Cladium mariscum*), 4 among nymphaeids (*Nymphaea alba*, *Potamogeton natans*) and 1 comparably in the pelagic zone. Samples were collected using a calibrated vessel from the surface layer, thickened using a planktonic net (45 µm) and preserved with 4% formaldehyde. At the same time the water transparency was measured. The chemical analysis and the concentration of chlorophyll was carried out in the laboratory. The evaluation of the trophic conditions was done based on the physical-chemical analysis and zooplankton species indicators [Karabin 1985], while the analysis of the species diversity was measured according to the Shannon-Weaver biodiversity index.

RESULTS

The concentrations of NO₃ in Piaseczno Lake were significantly lower than the liminal values for the I cleanness class of water, with the exception in September – 1.8 mg/l. P content was found to be below the lowest border of detection. The water transparency ranged between 5 and 6.6 m and the chlorophyll concentrations were between 1.07 do 2.78 µg/l.

Table 1. The number of zooplankton species in Piaseczno Lake
Tabela 1. Liczba gatunków zooplanktonu jeziora Piaseczno

	Month Miesiąc	Nym1	Nym2	Nym3	Pelag	Phr1	Phr2	Phr3	Phr4	Potam	Clado
Rotifera	March	2	7	14	9	6	10	11	10	6	7
	May	9	17	14	15	16	20	9	17	8	11
	July	11	10	4	11	14	26	16	22	17	16
	September	25	20	31	18	17	25	19	28	35	26
	November	11	13	11	10	14	25	15	13	9	6
Crustacea	March	0	4	1	3	12	7	7	4	2	1
	May	3	5	4	4	5	6	0	5	4	4
	July	5	8	6	5	7	11	8	6	8	1
	September	12	13	13	11	21	21	15	20	15	7
	November	12	24	13	2	19	7	9	15	6	5

Nym – Nymphaetum; Pelag – open water; Phr – Phragmitetum; Potam – Potametum; Clado – Cladonietum

Table 2. The densities of zooplankton communities in Piaseczno Lake
Tabela 2. Liczebność ugrupowań zooplanktonowych w jeziorze Piaseczno

	Month Miesiąc	Nym1	Nym2	Nym3	Pelag	Phr1	Phr2	Phr3	Phr4	Potam	Clado
Rotifera	March	8	19	25	69	11	27	68	59	12	22
	May	42	92	70	189	141	170	103	187	65	70
	July	59	89	6	59	47	83	58	130	43	132
	September	124	40	142	69	38	761	48	162	103	105
	November	65	88	40	52	94	149	39	89	50	36
Crustacea	March	0	4	1	3	12	7	7	4	2	1
	May	4	27	6	49	29	36	0	16	7	5
	July	22	18	8	22	27	85	24	17	62	1
	September	61	111	62	86	95	300	162	90	78	30
	November	44	120	42	2	62	52	82	43	26	8

Nym – Nymphaetum; Pelag – open water; Phr – Phragmitetum; Potam – Potametum; Clado – Cladonietum

The presence of 145 zooplankton species was noted (59% Rotifera, 27% Cladocera, 14% Copepoda). Species diversity was highest in September (114 species) and the lowest in March (41). *Phragmites australis* was the taxonomically richest zone in the lake with 30 species per sample on average and the poorest was open water with 18 species (Tab. 1). In the rush zone of Piaseczno Lake the presence of a postglacial relict – cladoceran *Rynchotalona falcata* (Sars) was recorded.

The lowest zooplankton numbers were noticed in March, while the highest in September. Comparing all the examined stations in the whole season it was found that the Phragmitetum2 stand was characterized by the highest mean densities (383 ind. · dm⁻³) and Nymphaetum1 by lowest (98 ind. · dm⁻³, Table 2). The quantity dominance of Rotifera (72% of total zooplankton abundance) over Crustaceans was recorded. The highest participation of rotifers was found in May – 90% on average – and in March, when at some stations they reached 100%, while the lowest in September – 57%. On the other hand, the highest participation of cladocerans was noted in September – 38% on average (in Nymphaetum3 – 76%) – and the lowest in May – 9%.

The group of dominants consisted of 26 species altogether (14 Rotifera and 12 Crustacea). In the spring season species such as: *Gastropus stylifer* (Imhof), *Keratella cochlearis* (Gosse), *Kellicottia longispina* (Kellicott), *Bdelloidea* sp., *Polyarthra dolichoptera* (Idelson), in summer: *Polyphemus pediculus* (Linnaeus), *Synchaeta* sp., *Ascomorpha ovalis* (Bergendahl), in autumn: *Conochilus hippocrepis* (Schränk) and *Gastropus stylifer* dominated.

Filinia terminalis (Plate), *Daphnia longispina* (O.F. Müller) and *Eudiaptomus graciloides* (Lilljeborg) were the species present only in the pelagic zone, while *Ascomorpha ovalis*, *Asplanchna priodonta* (Gosse) and *Filinia longiseta* (Ehrenberg) occurred both in the open water and the Nymphaetum zone. Species characteristic for the Phragmitetum were *Philodina* sp., *Conochilus hippocrepis* (Schränk), *Lecane aculeata*

aculeata (Jakubski), *Alona rustica* (Scott), *Microcyclops varicans* (Sars), *Ceriodaphnia reticulata* (Jurine) and for the Cladonietum: *Euchlanis hyra hyra* (Hudson) and *Pleuroxus trigonellus* (O.F. Müller).

The analysis of the species biodiversity revealed that the values were mostly quite low, reaching 3.27 in the zone of Cladonietum (Tab. 3).

Table 3. The value of the Shannon-Weaver biodiversity index of zooplankton communities in Piaseczno Lake

Tabela 3. Wartości współczynnika różnorodności gatunkowej Shannon-Weaver zooplanktonu jeziora Piaseczno

	Month Miesiąc	Nym1	Nym2	Nym3	Pelag	Phr1	Phr2	Phr3	Phr4	Clado	Potam
Rotifera	March	0.38	1.5	2.02	1.5	1.64	1.45	1.32	1.9	1.63	1.78
	May	1.07	2.06	1.45	1.59	1.79	1.92	1.64	1.69	1.39	1.81
	July	1.8	1.18	1.24	1.8	2.45	2.83	2.22	2.23	2.47	1.97
	September	2.32	2.7	2.92	2.34	2.67	0.63	2.78	1.92	3.27	2.85
	November	1.35	1.77	1.82	1.34	1.89	2.4	2.5	1.83	1.07	1.49
Crustacea	March	0	1.04	0	0	1.81	1.68	1.6	1.16	0.69	0.69
	May	1.04	0.72	1.24	1.19	1.29	1.42	0	1.33	1.28	1.33
	July	2.17	1.86	2.24	1.5	2.44	2.46	2.45	2.52	1.95	0
	September	2.17	1.86	2.24	1.5	2.44	2.46	2.45	2.52	1.95	1.69
	November	1.89	2.56	2.18	0.69	2.63	1.49	1.84	2.25	0.8	1.39

Nym – Nymphaeetum; Pelag – open water; Phr – Phragmitetum; Potam – Potametum; Clado – Cladonietum

Among the dominating species of Piaseczno Lake the presence of five species of a status of indicator forms for water of low trophy – *Ascomorpha ovalis*, *Conochilus hippocrepis*, *Gastropus stylifer*, *Kellicottia longispina* and *Daphnia hyalina* (Leyding) – were recorded. However, the participation of the „tecta” form in the population of *Keratella cochlearis* was lower than 1%.

DISCUSSION AND CONCLUSIONS

The littoral zone of Piaseczno Lake is characterized by much higher taxonomical and quantity richness of zooplankton communities compared with the open water zone, especially considering the rush vegetation with *Phragmites australis*. Such great variation and richness is due to the distinct mosaic of the littoral, which is reflected in differentiated architecture of particular macrophyte bed and provides a high variety of ecological niches, supplying the inhabiting organisms with optimal conditions for their growth and development [Gliwicz and Rybak 1976, Kuczyńska-Kippen and Nagengast 2003a, 2003b]. Periphytic algae, which intensively overgrow macrophyte stems also

contribute to increasing the spatial differentiation of a vegetated stand, providing the animal plankton with numerous places of concealment (refugium) and with nutritional food source (7th), as they are rich in detritus, bacteria and protozoans [Gons 1979, Moore *et al.* 1994]. Furthermore, the phenomenon of the niche overlap of some species, which is connected with the shared exploitation of the food resources or in the common occurrence in time and space [Lampert and Sommer 1996] as well as horizontal migrations of zooplankton between particular macrophyte stands and open water [Walsh 1995, Moss *et al.* 1998, Węgleńska and Rybak 1998], may also influence the profusion of the zooplankton littoral fauna [Kajak 1998]. In the pelagic zone of Lake Piaseczno the zooplankton communities, both rotifers and crustaceans, were significantly poorer in comparison with the littoral zone, which can confirm that conditions of the open water area of a lake are less favourable. However, the Shannon-Weaver biodiversity index indicated low diversity among zooplankton communities, irrespective of the sampling station. In Piaseczno Lake the presence of one only postglacial relict – *Rynchotalona falcata* – was recorded. It confirms a decrease of the quantity of the rarest species since 1990 in mesotrophy lakes in Polish [Radwan *et al.* 1994].

The habitat selectivity of particular species was found when analysing zooplankton communities of Piaseczno Lake. There was a group of species with preferences towards the pelagic zone; another group was present in the open water and Nymphaetum zone. The third group of species was characteristic of the Phragmitetum area and the last one occurred only within the Cladonietum stand.

Rotifera dominated over Cladocera and Copepoda in the macrophyte-dominants as well as in the pelagic zone. Such a pattern is often characteristic of lake ecosystems and gives a clear picture of the relations between planktonic organisms. Rotifers as organisms are much smaller and so compose a supreme food source for numerous predatory cladocerans and copepods, which can actively follow their preys. Therefore, few densities of representatives of Copepoda relate to their high position in the trophic pyramid compared to other groups of zooplankton organisms [Lampert and Sommer 1996].

Analysing the seasonality of zooplankton communities in Piaseczno Lake it was noticed that there is distinct Rotifera domination in spring, then a slight increase of Cladocera populations in the summer and distinct Cladocera dominance in the autumn. Similar schemes of seasonal distribution of zooplankton characterize most water bodies of the temperate climate. This is connected with the presence of 'small' and 'large' algae, where 'small' ones, available for rotifers, occur in the spring. After the clear-water phase the 'large' species appear, restricting the development of rotifers, as they are too big for them, so their participation declines in the summer and the densities of crustaceans, for which large algae forms are suitable, increase in the summer and autumn seasons [Lampert and Sommer 1996]. However, Radwan *et al.* [1998], analysing lakes of Polesie Lubelskie, found that rotifer communities reached the highest numbers in the autumn season.

The results of chemical analysis, high water transparency and low concentrations of chlorophyll *a* confirm the results obtained in 2000, when Lake Piaseczno waters were classified as I cleanness class [Goszczyński 2001].

REFERENCES

- Downing J.A., Cyr H., 1986: Quantitative estimation of epiphytic invertebrate populations. *Can. J. Fish. Aquat. Sci.* 42, 1570-1579.
- Gliwicz Z.M., Rybak J.I., 1976: Zooplankton. [In:] E. Picczyńska (ed.): Selected problems of lake littoral ecology. Wyd. Uniwersytetu Warszawskiego, Warszawa, pp. 69-96.
- Gons H.J., 1979: Periphyton in Lake Vechten, with emphasis on biomass and production of epiphytic algae. *Hydrobiol. Bull.* 13 (2-3), 116.
- Goszczyński J., 2001: Water quality of Piaseczno Lake in 2000. WIOŚ, Bydgoszcz, pp. 88 (in Polish).
- Kajak Z., 1998: Ecosystem of freshwaters. PWN, Warszawa, pp. 355 (in Polish).
- Karabin A., 1985: Pelagic zooplankton (Rotatoria + Crustacea). Variations in the process of lake eutrophication. I Structural and quantitative features. *Ekol. Pol.* 33(4), 567-616.
- Kuczyńska-Kippen N., Nagengast B., 2003: The role of the architecture of macrophytes on the spatial structure of zooplankton of Wielkowiejskie lake. *Rocz. Akademii Rolniczej w Poznaniu CCCLIV, Bot.* 6, 121-129.
- Kuczyńska-Kippen N., Nagengast B., 2003: The impact of the spatial structure of hydromacrophytes on the similarity of rotifera communities (Budzyńskie Lake, Poland). *Hydrobiologia* 506(1), 333-338.
- Lampert W., Sommer H., 1996: Ecology of freshwaters. PWN, Warszawa, pp. 399 (in Polish).
- Moore B.C., Funk W.H., Anderson E., 1994: Water quality, fishery and biologic characteristics in a shallow, eutrophic lake with dense macrophyte populations. *Lake Reservoir Managem.* 8(2), 175-188.
- Moss B., Beklioglu M., Kornijów R., 1998: Differential effectiveness of nymphs and submerged macrophytes as refuges against fish predation for herbivorous *Cladocera*. *Verh. Internat. Verein. Limnol.* 26, 1863-1869.
- Radwan S., Jarzynowa B., Kowalczyk Cz., Kowalik W., Popiołek B., Wojciechowska W., Zwolski W., 1994: Bio-cenotic relations in the lakes of the Łęczyńsko-Włodawskie Lakeland. [In:] Lobel lakes. Characteristics, functioning and protection. Cz. II. M. Kraska (ed): *Idee Ekologiczne*, 7, Ser. Szkice, 5, 9-16 (in Polish).
- Radwan S., Bielańska-Grajner I., Popiołek B., 1998: Groups of the rotifers (*Rotatoria*) in different types of littoral and pelagial habitats of the lakes of Polesie Lubelskie. Materials from a Polish Conference: Sweet water eco-tones. Structure – kinds – functioning. S. Radwan (ed), Lublin. UMCS, pp. 63-74 (in Polish).
- Timms R.M., Moss B., 1984: Prevention of growth of potentially dense phytoplankton populations by zooplankton grazing, in the presence of zooplanktivorous fish, in a shallow wetland ecosystem. *Limnol. Oceanogr.* 29(3), 472-486.
- Walsh E.J., 1995: Habitat – specific predation susceptibilities of a littoral rotifer to two invertebrate predators. *Hydrobiologia* 313-314, 205-211.
- Węgleńska T., Rybak J.I., 1998: Diurnal horizontal migrations of the plankton crustacean between groups of littoral plants and the zone of free water. Materials from a Polish Conference: Sweet water eco-tones. Structure – kinds – functioning. S. Radwan (ed), Lublin. UMCS, pp. 117-129 (in Polish).

PLANKTON WROTKOWY I SKORUPIAKOWY W ZRÓŻNICOWANYCH
FITOCENOZACH ROŚLINNOŚCI WODNEJ JEZIORA PIASECZNO

Streszczenie. Wyniki analizy chemicznej, widzialności wód, koncentracji chlorofilu oraz struktura dominacji zooplanktonu wskazywały na niską trofę badanego jeziora. Ogółem stwierdzono obecność 145 gatunków. Różnorodność gatunkowa zooplanktonu, podobnie jak liczebność osobników była najwyższa we wrześniu, najniższa natomiast w marcu. Strefą najbogatszą taksonomicznie był *Phragmites australis*. Wskaźnik różnorodności biologicznej wykazywał niskie wartości, osiągając maksymalnie 3,27 w Cladonietum.

Słowa kluczowe: zooplankton, jezioro Piaseczno, wskaźnik różnorodności gatunkowej, litoral