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DIFFERENTIATION OF THE STRUCTURE OF ZOOPLANKTON COMMUNITIES IN STANDS OF WATER AND RUSH VEGETATION OF POST-EXPLOITATION SMALL WATER BODIES IN POZNAŃ

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Summary. Differentiation of the structure of the rotifera and crustacea communities in the phytocoenosis of the rush and submerged vegetation and comparably in the open water zone of 10 small water bodies, differing in size, shape and depth, was examined. There were 60 species of Rotifera, 23 of Cladocera and 4 of Copepoda identified. The number of taxa differed depending on the pond and habitat. The differentiation of the zooplankton numbers between particular habitats of examined water bodies was statistically significant. When analysing the rotifera densities in a particular habitat differences of Rotifera were received for open water zone, while in the case of Crustacea for the *Ceratophyllum* bed and also the open water. The mean biodiversity index values were low – between 0.8 and 2.2; however, the lowest were in ponds H and J, which were overshaded and lacking in rush and water vegetation. Differentiation of the zooplankton communities within the rush and water vegetation of the Junikowski Stream might have been caused by the spatial and morphological structure of particular phytocoenosis, especially their biomass and density, the physical-chemical parameters of a habitat, overshading, differentiated morphometry of particular water bodies and biotic factors such as predation.

Key words: zooplankton, Rotifera, Crustacea, species biodiversity

INTRODUCTION

The area of the river-basin of the Junikowski Stream within the borders of Poznań city has undergone a strong anthropogenic transformation caused by the ceramic mining industry since the 19th century. The characteristic feature of this area is a large amount of small water bodies – clay-pits – situated along both banks of the stream. The main source of contamination here is rainfall together with illegal municipal and industrial waste disposal as well as unregulated rubbish dumping [Goldyn *et al.* 1996].

The main aim of this study was to find out whether there was any differentiation in the structure of zooplankton (rotifers and crustaceans) between particular ponds as well as within phytocoenosis of rush and submerged vegetation and open water.

STUDY AREA

The research was carried out on 10 water bodies located in the south-west part of Poznań, in the river-basin of the Junikowski Stream, of differentiated size, shape and depth (from 1.5 to 3.5 m), characterised by unequal beds and also by differentiated rush and water vegetation and different levels of macrophyte coverage. Some of the ponds had been systematically stocked with fry.

Only two of the examined water bodies (H and J) had no macrophytes. In the next two reservoirs (G2, I) the number of communities reached between 1 and 2 phytocoenosis (from *Lemnetea* and *Potametea* class) and in the remaining clay-pits between 7 and 10 (from *Lemnetea, Potametea* and *Phragmitetea* class). Altogether, 18 communities of rush and water vegetation were distinguished in the studied area. The highest differentiation was found among helophytes – 9 associations, 6 among elodeids and 3 among pleustophytes. No phytocoenosis of nymphaeids were recorded. All the phytocoenosis indicate the eutrophic character of water of the examined water bodies [Rosenzweig 1991].

MATERIAL AND METHODS

The studied reservoirs, in close proximity to each other, were numberd by letters from A to J. The B and G ponds had both two basins. The water and rush vegetation was examined using the Braun-Blanquet method and then in the chosen stands of *Phragmitetum communis* and *Ceratophylletum demersi* the water samples for zooplankton, chemical analysis and chlorophyll „a" were collected. Additionally, the plant material was cut off to measure the density and biomass of plants in particular phytocoenosis. The field study was conducted in August 2002. Zooplankton samples were collected once, in triplicate, from 3 stations of each pond: open water, *Ceratophyllum* bed and *Phragmites* stand. The material was collected using a plexiglass core sampler (∅ 50 mm), it was concentrated using 45-µm plankton net and was fixed immediately with 4% formalin.

The Kruskal-Wallis test was used in order to evaluate the differences in zooplankton densities between particular ponds and habitats (N = 93).

RESULTS AND DISSCUSSION

The water transparency measured with the Secchi disc varied between reservoirs from 0.5 to 1.5 m and the concentration of chlorophyll „a" from 4.81 to 63.99 mg L^{-1}. The content of NO_3 and NO_2 was highest in the ponds located up-stream (pond A1, A2, B), while the values of NH_4 and PO_4 were lower in this group of water bodies (Tab. 1). According to the new classification of surface water cleaness, pond F belonged to the 5th and the remaining ones to the 3rd class.

The analysis of the zooplankton of the clay-pits of the Junikowski Stream river basin revealed the presence of 87 taxa (60 of Rotifera, 23 of Cladocera and 4 of Copepoda). The number of species differentiated depending on the examined pond or sam-

pling station. Furthermore, the taxonomical dominance of rotifers was noticed in the open water zone as well as among macrophytes in all the ponds.

When analysing the taxonomical structure of zooplankton no significant changes were found. Many papers [Irvine *et al.* 1990, Havens 1991, Vuille 1991] indicate that crustaceans, as well as rotifers, which are organisms evolutionarly prefering littoral habitats [Pejler 1995], create rich communities in the macrophyte zones of water reservoirs. In the case of the Junikowski Stream ponds there were no such distinct differences noted, which might have been due to the very small area of those water bodies, as reflected in the large participation of littoral species, considerably enriching the quality stucture of the open water station. Moreover, the pelagic zone was examined more thoroughly, because ponds H and J were lacking in any aquatic vegetation. Chengalath and Koste [1983] stated that the frequency of collecting and examining zooplankton material influences the degree of taxonomical recognition.

Table 1. The content of N and P in the examined water bodies (mg L^{-1})
Tabela 1. Zawartość N i P w wodzie badanych zbiorników (mg L^{-1})

Water body – Zbiornik	NO_3	NH_4	NO_2	PO_4
A1	1.34	1.385	0.041	0.120
A2	1.02	1.385	0.027	0.236
B	0.99	1.305	0.028	0.530
C	0.88	1.325	0.020	0.256
D	0.89	1.404	0.015	0.166
E	0.89	1.642	0.015	0.420
F	0.89	1.385	0.023	1.280
G1	0.89	1.602	0.014	0.110
G2	0.88	1.642	0.014	0.090
H	0.88	1.286	0.015	0.236
I	0.92	1.662	0.016	0.100
J	0.88	1.602	0.015	0.550

Additionally, the analysis of zooplankton abundance revealed a dominance of rotifers over crustaceans in all, exept one, reservoir. Only in clay-pit B, situated the highest up-stream were the densities of Crustacea higher than those of Rotifera in the stands of *Ceratophyllum* and *Phragmites*. The number of zooplankton specimens per 1 litre ranged in particular ponds from 57 up to 1158 for rotifers and from 1 to 669 for crustaceans.

Comparing the rotifer ($H(2.93) = 12.97$, $p = 0.002$) and crustacean numbers ($H(2.93) = 19.08$, $p = 0.000$) in all the ponds there were statistically significant differences found between particular habitats (Fig. 1). However, on analysing the differences between habitats for a certain reservoir significant results were obtained for ponds A2 (Rotifera – $H(2.9) = 6.49$, $p = 0.039$; Crustacea – $H(2.9) = 6.99$, $p = 0.037$) and D (Crustacea – $H(2.9) = 7.20$, $p = 0.027$). The densities of macrophytes in the examined stands expressed by the dry mass reached medium values for *Phragmites* in ponds A2 and D and for *Ceratophyllum* in pond D. However, *Ceratophyllum* in clay-pit A2 had the highest values of dry mass.

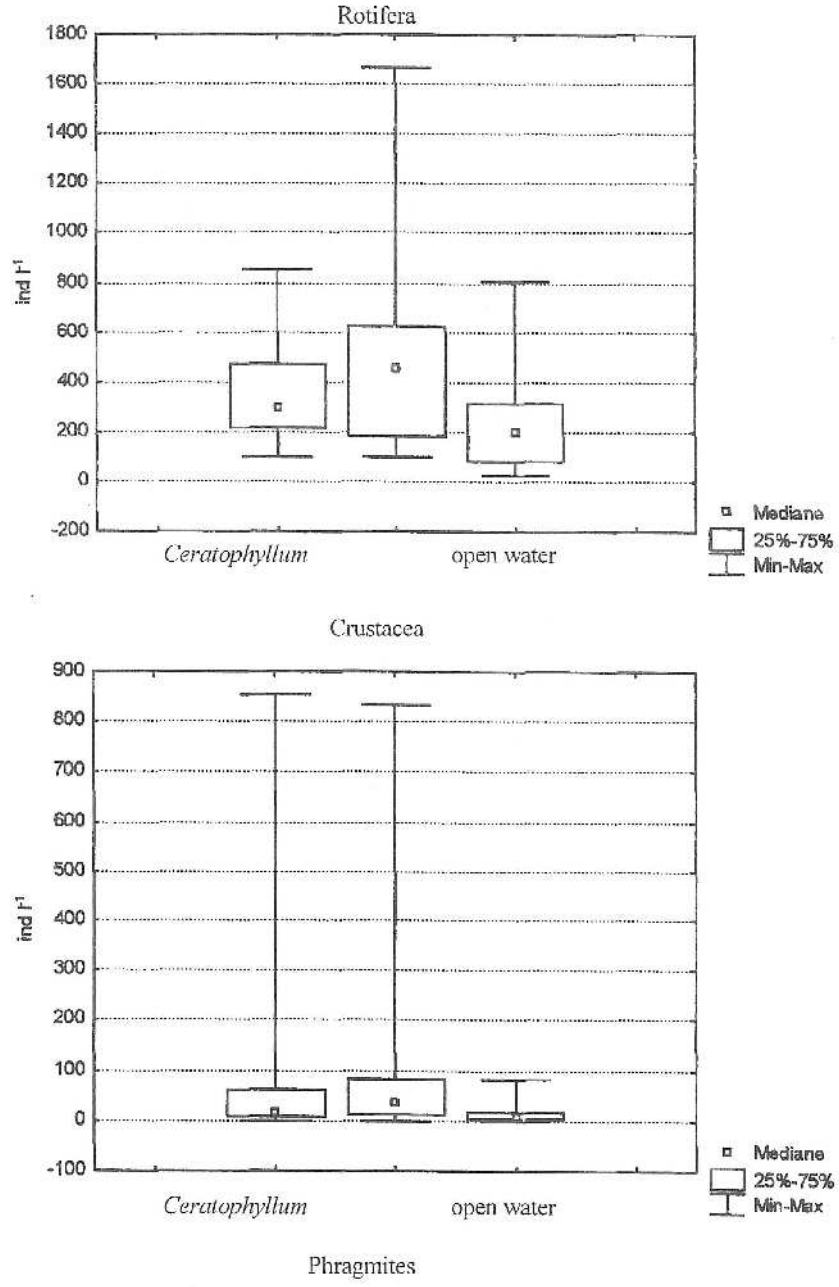

Fig. 1. The numbers of Rotifera and Cladocera in particular zones of the examined water bodies
Rys. 1. Liczebność Rotifera i Cladocera w poszczególnych strefach badanych stawów

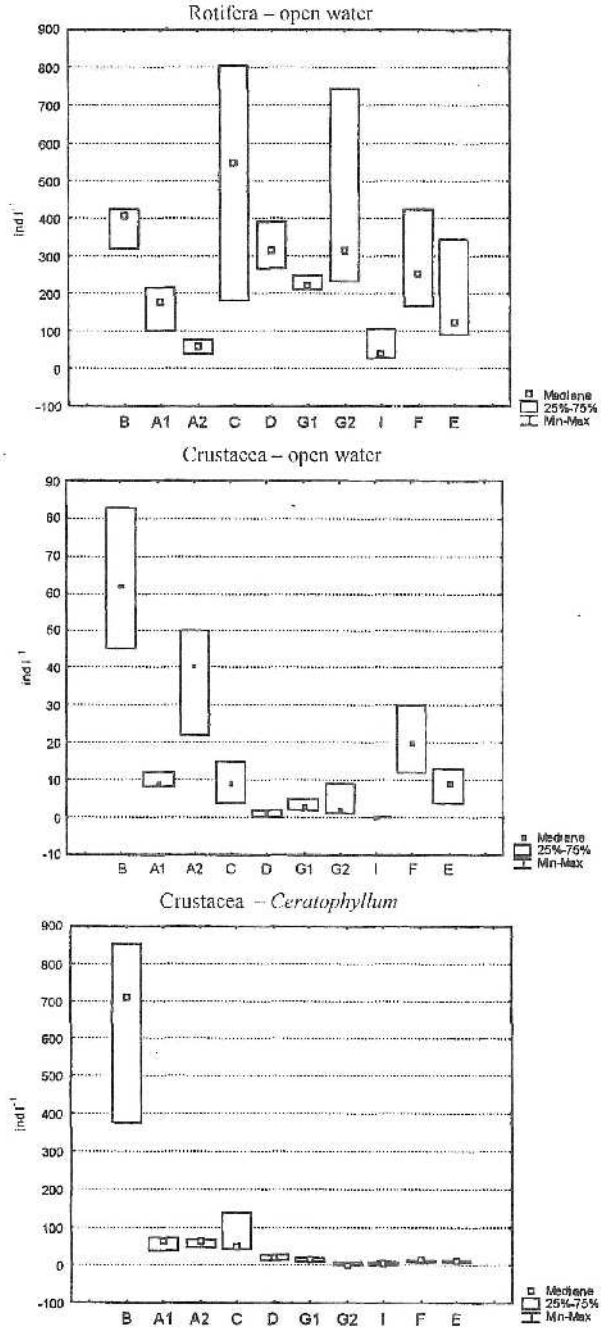

Fig. 2. The numbers of Rotifera and Cladocera in the open water zone and Crustacea in *Ceratophyllum* of the examined water bodies

Rys. 2. Liczebność Rotifera i Cladocera w strefie toni wodnej oraz Crustacea w *Ceratophyllum* badanych stawów

On analysing the numbers of Rotifera within a particular habitat only in the case of open water were differences between particular ponds significant ($H(9.30) = 20.44$, $p = 0.015$), when analysing Crustacea, differences concerned *Ceratophyllum* ($H(9.30) = 26.80$, $p = 0.002$) as well as open water zone ($H(2.30) = 25.91$, $p = 0.002$ – Fig. 2).

The mean Shannon-Weaver biodiversity index [Margalef 1957] values were quite low – between 0,8 and 2,2; however, the lowest was in ponds H and J, which were considerably overshaded and lacking in rush and water vegetation (Tab. 2).

Tabela 2. Wartość współczynnika różnorodności gatunkowej dla badanych zbiorników
Table 2. The value of biodiversity index in the examined water bodies

Station	Group Grupa	A1	A2	B	C	D	E	F	G1	G2	H	I	J
Cerato-phyllum	Rotifera	1,39	2,39	2,3	2,31	1,85	2,54	2,45	1,62	2,47	x	2,84	x
	Crustacea	1,8	1,27	1,83	1,93	1,09	0,93	1,31	0,75	0,92	x	0,97	x
Phragmites	Rotifera	1,32	2,47	2,5	3,01	3,05	2,34	2,6	1,56	2,3	x	x	x
	Crustacea	1,81	1,37	1,56	2	1,84	0,86	1,7	1,46	0,69	x	x	x
Open water	Rotifera	1,56	2,38	2,39	2,21	1,45	2,72	2,52	1,18	2,24	0,8	2,06	1,2
	Crustacea	1,57	0,97	1,36	1,74	0,64	1,46	2,02	0,9	0,84	0	x	0,85

Of all the zooplankton species of all the examined reservoirs only *Keratella cochlearis* Gosse and *K. quadrata* (O.F. Müller) were present in each sample.

The dominant community of all the water bodies was formed by 35 species (16 of Rotifera and 19 of Crustacea). *Keratella cochlearis, K. cochlearis* f. *tecta* (Lauterborn), *K. quadrata*, *Lecane closterocerca* (Schmarda), *Polyarthra remata* (Skorikov), *Bosmina coregoni* Baird, *B. longirostris* (O.F. Müller), *Chydorus sphaericus* (O.F. Müller) and *Diaphanosoma brachyurum* (Lievin) belonged to the group that dominated irrespective of the habitat. Within the macrophytes *Bdelloidea* and *Ceriodaphnia quadrangula* (O.F. Müller) dominated, while in the open water zone – *Brachionus angularis* Gosse and *Daphnia longispina* (O.F. Müller).

Based on the obtained results a differentiation of the zooplankton communities within rush and water vegetation and also within particular ponds of the Junikowski Stream was found. A series of factors many have been involved, including the spatial and morphological structure of particular phytocoenosis, especially their biomass and density, which are often described as factors modifying the behaviour of freshwater organisms [Crowder and Cooper 1982, Downing and Cyr 1986, van den Berg *et al.* 1997]. Moreover, the physical-chemical parameters of a habitat, overshading caused by the surrounding canopy of tree-tops, morphometry of particular water bodies may have an impact [Leibold 1991, Rosenzweig 1991, Sarma *et al.* 1996]. On analysing the distribution of zooplankton communities within differentiated habitats the role of biotic factors, including fish or invertebrate predation [Pejler and Bērziņš 1989, Schriver *et al.* 1995, Kairesalo *et al.* 1998] should also be taken into consideration.

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ZRÓŻNICOWANIE STRUKTURY UGRUPOWAŃ ZOOPLANKTONU W PŁATACH ROŚLINNOŚCI WODNEJ I SZUWAROWEJ DROBNYCH ZBIORNIKÓW POEKSPLOATACYJNYCH MIASTA POZNANIA

Streszczenie. Badano zróżnicowanie struktury ugrupowań wrotków i skorupiaków w fitocenozach roślinności szuwarowej i zanurzonej oraz porównawczo w strefie toni wodnej 10 stawów o zróżnicowanej wielkości, kształcie i głębokości. Analiza zooplanktonu wykazała ogółem obecność 60 taksonów Rotifera, 23 Cladocera i 4 Copepoda. Liczba taksonów była różna w zależności od badanego stawu i stanowiska. Zróżnicowanie liczebności zooplanktonu pomiędzy poszczególnymi siedliskami badanych stawów było istotne statystycznie.

Analizując liczebność organizmów w obrębie konkretnego siedliska różnice wykazano dla Rotifera w toni wodnej, natomiast dla Crustacea w toni oraz w *Ceratophyllum*. Średnia wartość różnorodności gatunkowej Shannona-Weavera była stosunkowo niska (od 0,8 do 2,2), najniższa dla stawu H i J, które były zacienione i pozbawione roślinności.

Na podstawie uzyskanych wyników stwierdzono zróżnicowanie struktury ugrupowań wrotków i skorupiaków w płatach roślinności wodnej i szuwarowej badanych zbiorników, na które miały wpływ takie czynniki, jak struktura przestrzenna i morfologiczna poszczególnych fitocenoz, ich biomasa i zagęszczenie, parametry fizyczno-chemiczne siedliska, zacienienie, morfometria oraz czynniki biotyczne, m.in. drapieżnictwo.

Słowa kluczowe: zooplankton, Rotifera, Crustacea, różnorodność gatunkowa