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SPECIES RICHNESS AND SPATIAL HETEROGENEITY OF SPRING PLANKTON IN A LAKE WITH VARYING MORPHOMETRY*

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A b s t r a c t. Species richness and spatial heterogeneity of spring phyto- and zooplankton were studied in a slightly eutrophic lake. Plankton of one meter below the water surface was compared in the main basin of the lake, a shallow, small basin, and a bay of intermediate depth. The results suggest that the two shallower sampling stations lifted up the lake phytoplankton species richness considerably, whereas no such effect was noted for the zooplankton. There were differences between the three sampling stations in dominant taxa, as well as in the abundance and biomass of both phyto- and zooplankton.

K e y w o r d s: species richness, spatial heterogeneity, phytoplankton, zooplankton

INTRODUCTION

Typical plankton analysis covers organisms present in samples taken from the deepest point of a lake. In comparison, there are very few works concerning plankton, in which also other parts with varying morphometry are included. However, in the works available, many differences were described between compared sampling stations in taxonomical composition, and the abundance and biomass of both phyto- and zooplankton [2,3,10,11]. That is why, examining the plankton of Strzeszyńskie Lake, we focused not only on the deepest part of the lake, but also on two other stations varying in depth.

The aim of our study was to analyse species richness of the pelagic zone of Strzeszyńskie Lake, and to compare plankton abundance, biomass and dominant taxa at the same depth (1 meter) at three different sampling stations within the

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lake. We assumed that the stations differ from each other in the characteristics of plankton listed above.

STUDY SITE

The water body analysed was Strzeszyńskie Lake, situated in the north-western part of the city of Poznań. The lake is of glacial origin, located 76.8 m above sea level. Its area is 34.9 ha, volume 2.8×10^6 m^3, the maximum depth 17.8 m, and the mean depth 8.2 m. Strzeszyńskie Lake is dimictic, with well-developed thermal stratification in summer [6]. Earlier investigation showed that the lake is moderately degradation persistent and the negative influence of human activity on the lake is limited to the one of intensive recreation and fishing [7]. According to Szeląg-Wasielewska [9] the lake is slightly eutrophic.

METHODS

Water samples were taken three times in May, 2003 (19.05, 26.05 and 30.05), from three stations:

- station 1, situated in a small basin of the lake (maximum depth 3.1 m), with the bottom covered with charophytes, isolated from the main basin by a strip of emerged macrophytes
- station 2, situated in the main basin (max. depth 17.8 m)
- station 3, situated in a south-west bay (max. depth 7.5 m), wide open to the main basin.

The samples were taken without concentration from 1 meter depth and preserved with the Lugol solution. All taxonomical groups were counted with an inverted microscope after sedimentation in cylindrical chambers of 14 ml volume. Within phytoplankton all organisms larger than 2 µm were taken into account. Phytoplankton wet weight was estimated from the cells' volume which was calculated on the basis of geometric models. Dry weight was assumed to constitute 10% of the wet weight. Within zooplankton communities, the abundance of crustaceans (cladocerans and copepods) and rotifers was estimated. One-litre water samples were taken without concentration and preserved with the Lugol solution. All organisms present in the samples were counted with an inverted microscope after sedimentation. The crustaceans' dry weight was estimated using length/weight regression described by Botrell *et al.* [1] and that of the rotifers was calculated on the basis of geometric models by the same authors. In some cases the abundance or biomass of plankton was expressed as the arithmetic mean value from the three sampling dates.

RESULTS AND DISCUSSION

Within phytoplankton, 98 taxa belonging to 9 groups were found, and within zooplankton – 36 taxa (21 taxa of rotifers and 15 taxa of crustaceans). For the species richness of the phytoplankton in the lake the two shallower sampling stations were of crucial importance. In the small basin and in the bay we found 73% and 70% of all the taxa noted, respectively, whereas in the main basin only 40%. On all the sampling dates there were at least twice as many taxa in the samples from each of the shallower stations than in the sample from the main basin. There was no such difference in the number of zooplankton taxa noted (Tab. 1). The reason behind higher phytoplankton taxa number on the shallower stations was the enrichment of the phytoplankton in periphyton taxa, resulting from relative closeness to macrophytes. Vegetation influence on zooplankton richness is more indirect, as it provides a shelter for the zooplankton against predators. That is why the zooplankton species richness is usually much lower in the pelagic zone than in the littoral zone and among macrophytes [2,3]. As all the samples in our study were taken in the pelagic zone, the zooplankton species richness was similarly low on each station.

Table 1. Number of phyto- and zooplankton taxa on each sampling station

Station	Smaller basin (st. 1)				Main basin (st. 2)				Bay (st. 3)				
Group	19.05	26.05	30.05	Total	19.05	26.05	30.05	Total	19.05	26.05	30.05	Total	**Total**
Phytoplankton													
Cyanobacteria	4	2	2	6	0	2	1	2	3	6	7	7	10
Cryptophyceae	4	4	4	5	3	4	4	6	3	2	4	4	6
Dinophyceae	5	5	5	5	2	2	2	4	3	4	3	6	6
Bacillariophyceae	8	18	15	21	3	3	5	10	16	17	11	22	36
Chlorophyceae	10	14	17	22	6	8	8	10	9	11	14	15	24
Conjugatophyceae	5	8	7	9	2	5	2	5	8	8	9	10	11
Other	1	1	3	4	1	2	1	2	1	4	1	4	5
Total	37	52	53	72	17	26	23	39	43	52	49	68	98
Zooplankton													
Copepoda	0	2	2	4	2	1	2	4	0	2	1	18	6
Cladocera	5	7	7	8	4	7	4	8	2	5	4	6	9
Rotatoria	11	12	14	16	8	10	8	16	9	11	10	5	21
Total	16	21	23	28	14	18	14	28	11	18	15	29	36

The abundance of phytoplankton in the samples ranged from 0.5 to 15×10^6 cells l^{-1}, and the dry weight varied from 11 to 1127 µg l^{-1}. The phytoplankton abundance and biomass rose successively in the sampling dates on each station (Fig. 1). It was caused by changes in development conditions for the phytoplankton, i.e. lengthening of the day and rising temperature (unpublished data).

Both abundance and biomass of phytoplankton differed between the sampling stations. The mean phytoplankton cell number in the small basin was nearly three times as high as on the other sampling stations, and the mean biomass was eleven times as high. In the small basin (station 1) a mass development of the chrysophyte *Dinobryon divergens* was observed, so the dominant group in both abundance and biomass was *Chrysophyceae*. On the two deeper sampling stations the dominant groups changed from *Cryptophyceae* (mainly *Rhodomonas lacustris*) to *Chlorophyceae* and *Dinophyceae* (Fig. 1).

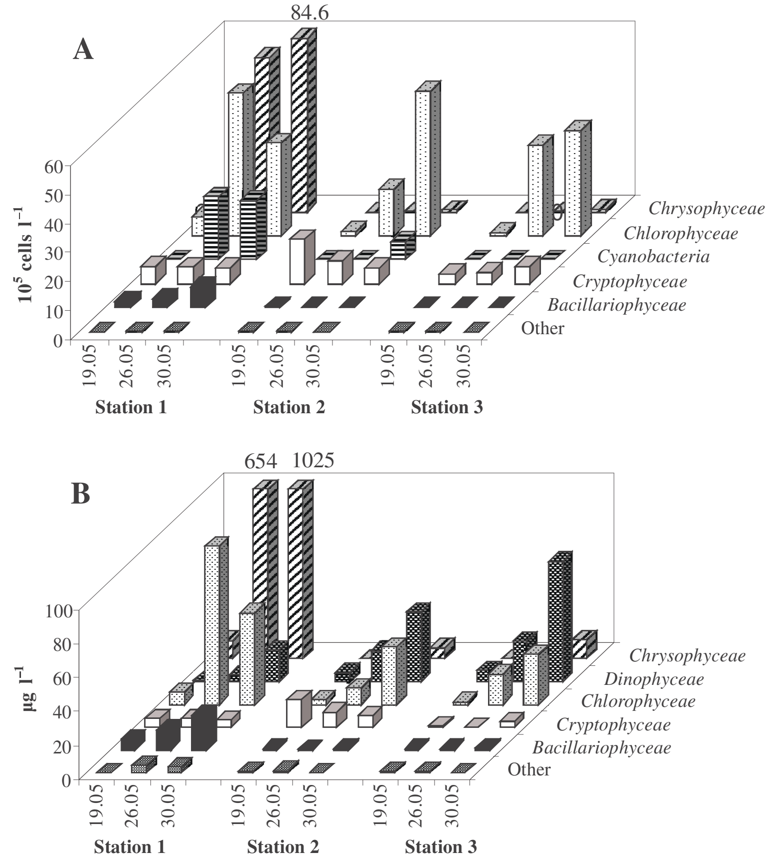

Fig. 1. Abundance (A) and dry weight (B) of phytoplankton of Strzeszyńskie Lake on each sampling station

The abundance of zooplankton in the samples varied between 226 and 685 individuals l^{-1} and the dry weight ranged from 2 to 352 µg l^{-1}. In the small basin the highest mean zooplankton abundance and the lowest dry weight was noted, which was caused by a greater share of young copepods and small species among the cladocerans (*Bosmina coregoni*, *B. longirostris* and *Ceriodaphnia quadrangula*). The zooplankton dry weight in the main part of the lake was more than twice as high as in the two other sampling stations (Fig. 2). The rotifers, with the dominant *Keratella cochlearis*, were the most numerous group in the main basin and in the bay, whereas in the small basin the copepods were a bit more abundant. Much sharper differences were found in biomass, which was dominated by the copepods in the small basin, by the cladocerans in the bay, and divided between the two groups in the main basin (Fig. 2). The dominant in biomass among cladocerans on the two deeper stations was *Daphnia cucullata*, and among copepods on all the stations – *Eudiaptomus gracilis*.

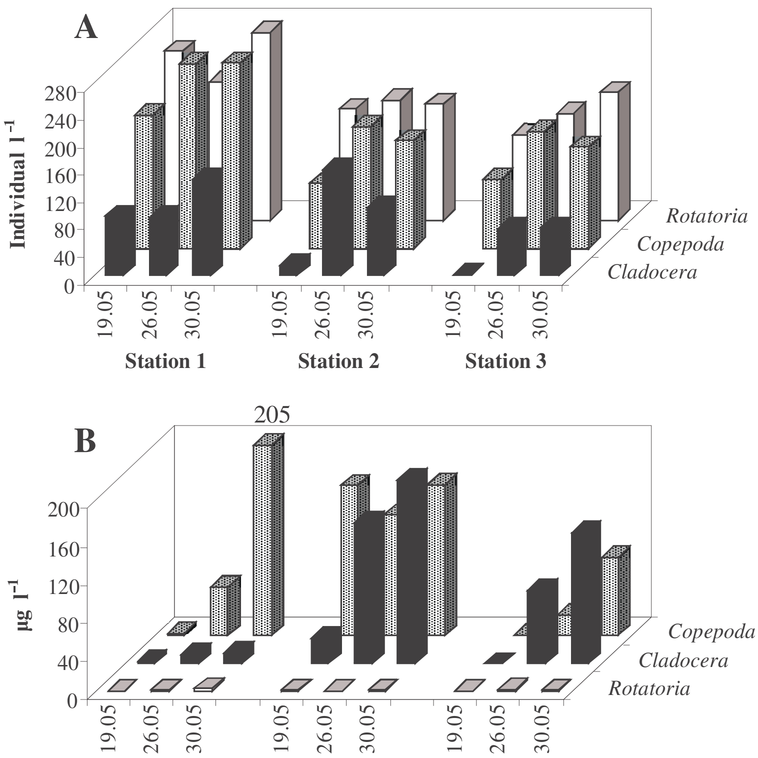

Fig. 2. Abundance (A) and dry weight (B) of phytoplankton of Strzeszyńskie Lake on each sampling station

The most distinctive was the phyto- and zooplankton of the small basin of the lake, which was caused by the different character of that part of the lake. The vegetation of the small basin (wide strip of *Cladium mariscus* in the littoral zone, dense *Chara*-beds on the bottom) and surrounding wetlands probably supplies the water with many organic substances, which results in a darker colour and a change in physiochemical characteristics of water, ex. higher water temperature (unpublished data). In that specific environment *Dinobryon divergens* found optimal conditions to develop in great numbers, which was the reason behind the much higher abundance and biomass of the phytoplankton on this station. The chrysophyte aggregates in bush-like colonies, so it is almost inedible for the zooplankton. This must have allowed such an intensive growth of *Dinobryon divergens* population and caused the relatively low biomass of zooplankton on this station. Also the low abundance of Daphnia-species on this station might have been caused by the filtration interference of the net-algal species to which big cladocerans are particularly vulnerable [5].

On the two deeper stations we observed a shift from the dominance of small, 'edible' algae (mainly *Rhodomonas lacustris*) to bigger, 'inedible' forms (*Ceratium hirundinella* and colonial green-algae), which is typical for the late spring period [8]. According to Dawidowicz [4], small Daphnia-species, such as *D. cucullata* (dominant on the two stations), can control the densities of algae smaller than 50 μm, but promote the growth of larger, net algae. That is because the net algae are too big for the cladoceran to be grazed upon, but use the high loads of nutrients excreted by zooplankton. It is interesting that, despite the sharp decrease of nanoplankton, the biomass of the zooplankton increased successively on the sampling dates. It suggests that the zooplankton might relay on a food-source different than the phytoplankton larger than 2 μm, such as autotrophic picoplankton, bacteria and/or suspended organic matter.

CONCLUSIONS

1. In research aimed at learning the phytoplankton species richness of a lake it is necessary to include not only the main basin, but also isolated bays, as well as those wide open.

2. Phytoplankton is especially vulnerable to changes in the taxonomical composition between differing stations within one lake.

3. Zooplankton is less vulnerable to changes in the species richness between differing stations within one lake. Nevertheless, the zooplankton community structure may as well differ significantly at various points in the pelagic zone of a lake, as may the trophic interactions between phyto- and zooplankton.

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BOGACTWO GATUNKOWE I ZRÓŻNICOWANIE PRZESTRZENNE PLANKTONU WIOSENNEGO W JEZIORZE O NIEJEDNORODNEJ MORFOMETRII

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Streszczenie. Zbadano bogactwo gatunkowe i zróżnicowanie przestrzenne planktonu wiosennego w jeziorze słabo eutroficznym. Porównywano plankton na głębokości 1 metra w głównej misie jeziora, w małym, płytkim plosie i w zatoce o pośredniej głębokości. Z przeprowadzonych analiz wynika, że dwa płytsze stanowiska znacznie podwyższały bogactwo gatunkowe fitoplanktonu jeziora, nie wpływając istotnie na bogactwo gatunkowe zooplanktonu. Odnotowano znaczne różnice pomiędzy badanymi stanowiskami w liczebności, biomasie oraz taksonach dominujących zarówno w fito-, jak i zooplanktonie.

Słowa kluczowe: bogactwo gatunkowe, zróżnicowanie przestrzenne, fitoplankton, zooplankton