THE EFFECT OF PHYSICO-CHEMICAL PROPERTIES OF WATER ON THE DISTRIBUTION AND COMPOSITION OF CILIATES (CILIATA) IN THE PELAGIAL OF LAKES

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Summary. Results presented in this paper concern data from 2 lakes located in the area of Drawieński Nationality Park. The Płocionka River, which flows through them, supplies the lakes with large amount of nutrients. The abundance of ciliates in inflow zone were lower in both lakes than in pelagial. The outflow zone from both lakes were strongly influenced by the open lake water, and the abundance was similar in pelagial and outflow zones. In pelagial the highest ciliates abundance was determined by strongly wind.

Key words: ciliates, throughflow lakes

INTRODUCTION

Water bodies are regarded in modern limnology as integral elements of larger landscape units. Relations between water bodies and other elements of landscape are a subject of research in the field of landscape ecology, which takes into account factors of a wider regional importance (e.g. climate, precipitation, landscape characteristics at the regional level) and of local importance (e.g. morphometry and hydrology of the water body, land use in the catchment area) [Forman and Godron 1986, Richting and Solon 1996]. According to these assumptions, the basic mechanism that regulates the functioning of water ecosystems is run-off and supply of matter from the catchment – including nutrients responsible for the trophic level [Kajak 1979]. Nevertheless, there are still many examples of lakes with similar morphometric and catchment parameters and similar loading with nutrients, which are completely different in respect of the character and intensity of trophic relations. The major factors affecting environmental conditions within a shallow lake include weather conditions, e.g. direction and intensity of the wind.

Pelagic ciliates have been ignored for a long time by plankton ecologists, although studies from the sixties and eighties showed that they form an integral part of the planktonic food web and contribute significantly to the total zooplankton standing crop
[Foissner et al. 1999]. It was the concept of the microbial loop, developed by Azam et al. [1993], which stimulated more detailed and intensive research. Ciliates contribute considerably (sometimes more than 50%) to standing crop, grazing, nutrient regeneration and secondary productivity of pelagic organisms communities [Foissner et al. 1999]. Protists are important in the functioning of aquatic ecosystems because they are ubiquitous and abundant in all types of habitats. Ciliates are literally found from pole to pole, from lakes in dry valleys of Antarctica [Keiper et al. 1990] to water under the Arctic ice cap [Finley and Esteban 2001].

Ciliates play a pivotal role in the indication of pollution degree in running waters and lakes. Unfortunately, protists were often neglected in the studies on diverse ecosystems. Especially for planktonic ciliates, high standards in terms of methods, user-friendly literature and supplementary autoecological data have been sparse until nowadays [Sommer et al. 2002]. We studied the influence of the river on the lake in order to understand distribution of ciliates in throughflow lakes.

STUDY AREA, MATERIAL AND METHODS

Samples were taken at several points across two lakes in the area of the Drawiński National Park, from inflow to outlet, during the summer of 2002. Ciliates numbers in lakes were determined from the surface layer. Samples for study of ciliates were preserved with Lugol solution and analysed with inverted microscope after sedimentation. The volume of organisms was calculated on the basis of shape, size and numbers. The analysis of physical-chemical parameters was conducted in 2002, during the summer. Water temperature, concentration of soluble oxygen, saturation of water with oxygen were measured in the field with the use of the multiparameter sonde 600R and logger made by YSI Inc.

RESULTS AND DISCUSSION

Weather conditions, e.g. direction and strength of the wind, modify the matter circulation within the lake ecosystems through modifying thermal and oxygen parameters and indirectly affect the occurrence of other organisms by changing light conditions and water chemistry, creating refuges, etc. In some shallow water bodies these parameters may play a very important role.

These throughflow lakes are characterised by a large catchment area composed of farmland and woodland (Tab. 1) The Płocienno River, which flows through them, supplies the lakes with large amount of nutrients. The most quantities of nutrients flow into the three lakes: Sińsko, Płocienno and Ostrowiec. Płocienno Lake, which is additionally supplied by loads of nutrients through inflow from the Janno Lake, is the most loaded lake in the Drawiński National Park. Over 180 g N and 17 g P flow in to one-meter square of water table per year.

However, the water-flushing rate in this lake belongs to the highest, and occurs 46 times a year. It means the lake water residence time is very short and persists only a little longer than one week. The fast rate of water exchange is also associated with fast
removal of large amounts of nutrients from the lake. The nutrients are then transported to Lake Ostrowice. In Lake Płocicznko the highest concentrations of phosphorus and nitrogen were recorded. However, in relation to the area of the lake the amounts of both elements were not so striking because of its small mean depth.

<table>
<thead>
<tr>
<th>Basic statistics</th>
<th>Płocicznko Lake</th>
<th>Sitno Lake</th>
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</thead>
<tbody>
<tr>
<td>Water surface area</td>
<td>Obszar powierzchni wody</td>
<td>ha</td>
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<tr>
<td>Maximum depth</td>
<td>Max. głębokość</td>
<td>m</td>
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<tr>
<td>Mean depth</td>
<td>Środnia głębokość</td>
<td>m</td>
</tr>
<tr>
<td>Length of shoreline</td>
<td>Długość linii brzegowej</td>
<td>m</td>
</tr>
<tr>
<td>Volume</td>
<td>Volumen</td>
<td>m³</td>
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<tr>
<td>Catchment area</td>
<td>Obszar zlewiska</td>
<td>m²</td>
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Overall, surface ciliate communities were similar both lakes. In Lake Sitno lower abundance of ciliates was observed than in Lake Płocicznko. The abundance of ciliates ranged from 11 000 cells·dm⁻³ to 22 130 cells·dm⁻³ in Płocicznko Lake and from 4500 cells·dm⁻³ to 19 800 cells·dm⁻³ in Sitno Lake. Surface communities of ciliates in both lakes were dominated by *Oligotrichs*.

The river-lake system may be perceived as a spatial system of two kinds of ecosystems or patches: a river and a lake connected with each other by surface water flow. Ecotonal zones of these patches would be formed by water/land interface as well as by the zones of mixing the lake water with the river water [Hillbricht-Ikowska and Węglewska 2003]. The river flowing through the lakes represents a diversified landscape system composed of lotic patches (river sections) and lentic patches (lake fragments). The presence of lakes in a river system basically eliminates the continuity of nutrient transport, especially of phosphorus; lakes and river sections connecting them function in this system as "inserts" cumulating or exporting this nutrient. However, lakes in summer more often export this nutrient than retain it [Hillbricht-Ikowska 1999, Hillbricht-Ikowska and Węglewska 2003]. Taking the Płocicznko river flowing through the shallow non-stratified lakes of Drawiński National Park, we noticed that this mechanism could be driven by wind (Fig. 1). Despite the small depth, oxygen stratification appears in hidden part of lake. By anoxia conditions big loads of phosphorus release from sediments to the water [Kajak 1979]. With every change of direction and speed of the wind the location and thickness of anoxic layer is transformed. In addition, waves transport the matter, including planktonic organisms, to the open part of the lake.

In the zone of the river inflow to a lake, lake waters may be totally exchanged into river waters, or only partially mixed (vertically or horizontally) [Hillbricht-Ikowska and Węglewska 2003]. In Sitno Lake, in the zone of the river inflow, the "open" littoral, without macrophytes, was presented. The abundance of ciliates was lower in this section than in pelagial (Fig. 1). This low abundance was probably the effect of hydraulic stress (speed current and increased turbulence). In Lake Płocicznko (Fig. 1) the contact zone was covered by vegetation with floating leaves and submerged vegetation, but the situation was similar to Lake Sitno. Generally, the abundance in contact zone was lower than in pelagial.
Fig. 1. Distribution of ciliates in pelagial of Lake Płockie and Lake Stino and vertical profiles of selected physico-chemical factors.

Rys. 1. Rozmieszczenie orzysków w tylu wodnej jeziora Płockie i jeziora Stino oraz proilo pionowe wybranych fizyko-chemicznych parametrów wody.
The zone of the river outflow from the lake is strongly and directly influenced by the open lake water. As a result, the abundance and structure of plankton communities are often similar between the pelagial and the zone of outflow (Hillbricht-Iklovskowa and Weglewskia 2003). In both lakes Sitno i Plociacze, the abundance of ciliates in pelagial and outflow zone was similar (Fig. 1).

The highest ciliates abundance was detected on sampling point XI in Lake Sitno (19 800 cells dm⁻³), and on VII sampling point in Lake Plociacze (22 130 cells dm⁻³). Both sampling points were in pelagial. This highest abundance was determined by strong wind.

CONCLUSIONS

Research can explain the great differences in lakes and between the years. The explanation of the mechanisms underlying these differences may be very interesting and should help to deepen our knowledge of river-lake system functioning. Creation of functional models for shallow lake ecosystems, including the role of the wind, will give us a possibility to protect these lakes and their biodiversity. It will be possible to use these results for the protection of other shallow lakes.

REFERENCES


THE EFFECT OF PHYSICO-CHEMICAL PROPERTIES...


Wpływ fizyczno-chemicznych właściwości wody na rozmieszczenie i skład orzęsków (Ciliata) w toni wodnej jezior przepływowych

Streszczenie. Wyniki prezentowane w tej pracy dotyczą badań prowadzonych na dwóch jeziorach zlokalizowanych w Drawieńskim Parku Narodowym. Przepływająca przez nie rzeka Płocka dostarcza bardzo duże ładunki biogenów. Zbiorniska orzęsków w obu jeziorach dominowane były przez gatunki należące do Oligocheilida. W strefie dopływu w obu jeziorach liczebność orzęsków była niższa niż w pelagiata. Strefa odpływu była pod silnym wpływem otwartych wód jeziora i liczebność orzęsków była podobna do ich liczebności w toni jezior. W pelagiata obu jezior rozmieszczenie i liczebność orzęsków były zależne od siły i kierunku wiatru.

Słowa kluczowe: orzęski, Ciliata, jeziora przepływowe