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Characteristics of the winter phytoplankton in Rogóźno Lake

Charakterystyka zimowego fitoplanktonu jeziora Rogóźno

SUMMARY

We studied phytoplankton number and composition during winter months (from January to March in 2003) in Rogóźno lake. The samples were taken from the surface water layer covered by ice and overlain by snow (thickness of the snow layer was from 5 cm in January to 30 cm at the beginning of March). At the same time measures of light intensity, temperature and water oxygenation were made. It was considered that water saturation of oxygen was high through all winter period and the amount of light under the ice-snow cover was low (0.5–270 klx). The total phytoplankton number was low (30–50$\times 10^3$ indiv./dm^3), among algae *Planktothrix aghardii* from *Cyanoprokaryota* class and euglenid *Trachelomonas volvocina* were dominants. The occurrence of diatoms was observed during all winter period, and in February abundant number of flagellates from *Cryptomonas* genus appeared. Results were compared with similar investigations conducted in 1996 and nowadays the greater share of flagellates was noted.

STRESZCZENIE

Zimą roku 2003 (styczeń-marzec) przeprowadzono badania liczebności i składu gatunkowego fitoplanktonu głębokiego Jeziora Rogóźno. Próby pobierano spod lodu przykrytego warstwą śniegu jako łączną próbę z głębokości 1 i 3 m. Jednocześnie wykonano pomiary: ilości światła, temperatury i ilości tlenu rozpuszczonego w wodzie. Stwierdzono, że w czasie całej zimy jezioro było natlenione do samego dna (24 m), a przez lód przechodziła niewielka ilość światła (0,5–270 klx). Ogólna liczebność fitoplanktonu była niewielka (30–50 tys. os./dm^3), wśród glonów dominowały: należąca

do *Cyanoprokaryota — Planktothrix aghardii* i euglenina *Trachelomonas volvocina.* Przez całą zimę występowały też okrzemki, a w lutym licznie pojawiły się wiciowce z rodzaju *Cryptomonas*. Wyniki porównano z podobnymi badaniami z roku 1996, w składzie gatunkowym stwierdzono wyższy niż wtedy udział form wiciowych.

K e y w o r d s: lakes, winter phytoplankton, Łęczna-Włodawa Lakeland.

INTRODUCTION

It is accepted that mechanisms of phytoplankton changes are connected with many physical, chemical and biological parameters and a lot of possible interactions exist between these parameters and the number of the algae increases or decreases (8). In temperate or arctic zones the main factor is seasonal variability of solar radiance intensity and following it the variances of water temperature (3). In our climatic zone, lakes are covered by ice in the winter period. Typical features of the ice--covered water are low temperature (0–4°C) and a small quantity of light (caused by short length of day, acute angle of sun rays incidence and a great reflection from the ice-cover, especially covered with snow) (8). The layer of ice is also an isolator from the influence of the wind; there is no possibility for a creation of tides and the gaseous exchange with the atmosphere. These conditions bring out that aquatic biocenosis are less replete with plankton individuals than in warmer year seasons and small, planktic species with short life-cycles, adapted to poor irradiation and low temperature are dominants (12).

The aim of our paper was presentations of abundance and species phytoplankton structure during the winter period and comparison of our current results with dates of similar investigations carried out in 1996 (11).

STUDY AREA AND METHODS

Rogóźno Lake is situated in the west part of Łęczna-Włodawa Lakeland. It is a deep — max. depth 25.4 m lake, one of the deepest water bodies of Lakeland. Its area covers 57.1 ha. This is the dimictic lake, with stable thermal stratification in summer and reversed thermal stratification in winter (5). In respect of trophy state, Rogóźno was classified as mesotrophic lake since the 1970s (6, 7).

Studies of the lake were made in winter of 2003, from January till March once a month. The lake was covered with ice during all investigations period. The samples were collected always at the same position in the lake located near the point of maximal depth and at the same time measurements of light intensity under the ice-cover by LX204 Slandi luxometer were made. Measurements of temperature and oxygenation were made at depth intervals of one meter, from the water surface up to the depth of 20 m, with the aid of a WTW OXI96 oxymeter. Water for phytoplankton analysis was taken using Ruttner-type water sampler of 2 dm^3 capacity from surface water layer (from the depth of 1 and 3 meters, then poured into collective sample) where light conditions allow phytoplankton growing. The abundance of phytoplankton was determined by way of the Utermöhll, using an inverted microscope (10). Measurement of the concentration of chlorophyll-a involved the filtering of water through Whatman GF/C filter papers in the day of samples collecting, later resting sediment was homogenized and chlorophyll extracted in boiling 90% ethanol. Absorption of extract was made with Beckman DU 640B spectrophotometer at wavelengths of 665 and 750 nm. The concentration of chlorophyll-a in dm^3 was calculated based on Lorenz's formula (10).

RESULTS

During the time of studies the lake was covered with 40 cm layer of ice, additional overlain with snow. It had the great influence on the amounts of light penetrating the water in the lake. Snow efficient reflects and absorbs solar radiation, only just 5.7% of the sun light penetrates through the 7 cm-thick snow layer, through 17 and 25 cm — 1.8% and 0.16% respectively (12). In the winter period of 2003 the thickness of the snow layer was 5 cm in January, 15 cm in February and 30 cm in March. It was reflected in an amount of light transmission, whose values as well as values of water temperature and oxygenation measured next under the ice are presented in Table 1. During investigations the rapid worsening of light conditions was observed, the light amount decreased from 270 klx in January to 0.5 klx in February. The water temperature under the ice cover was stable and ranged between 0.5–1°C. Rogóźno Lake had reversed thermal stratification and the water oxygen saturated to the bottom.

Table 1. Water parameters under the ice cover

Month	Temp. [°C]	% O_2	Values of light [klx]
January	0.5	93	270
February	0.2	90	0.5
March	1	73	0.6

Temperature and the decreasing amount of light have reduced number and species diversity of phytoplankton in Rogóźno lake. The algae abundance, in comparison with spring-summer season was low and it was noted respectively: 27.2×10^3 indiv./dm^3 in January, 56×10^3 indiv./dm^3 in February and 39×10^3 indiv./dm^3 in March. All phytoplankton assemblage was composed of 13 species belonging to a few taxonomic groups (Fig. 1). Only four algal species determined the total number of phytoplankton (Tab. 2). Throughout these three winter months permanent components of phytoplankton were cyanoprokaryotic species *Planktothrix agardii*, *Trachelomonas volvocina* belonging to *Euglenophyta* phylum and two species of diatoms: *Cyclotella ocellata* and *Asterionella formosa.* The number of these species in each month was variable. The number of *Planktothrix agardii* was 9 and 16×10^3 indiv./dm^3 in January and February respectively and rapid decrease to less than 2×10^3 indiv./dm^3 in March. The number of *Trachelomonas volvocina* was similar in January and February and ranged from 10 to 17×10^3 indiv./dm^3, whereas showed al-

most two-fold increase in abundance in March. The genus *Cryptomonas* (1.4–17×10^3 indiv./dm^3) and diatoms (0.1–6 indiv.$\times10^3$/dm^3) had less share in phytoplankton number.

The decreasing amount of light during winter period did not bring out the total rebuilding of qualitative structure of phytoplankton but influenced the number of particular species (Fig. 1, Tab. 1). The number of *Trachelomonas volvocina* has increased and the number of *Planktothrix agardii* has considerably decreased, which has caused decreasing of total phytoplankton abundance from 56×10^3 indiv./dm^3 in February to 39 indiv./dm^3 in March. In February *Cryptomonas* sp. was absent and the decrease of *Cyclotella ocellata* was observed — in January this species accounted 6×10^3 indiv./dm^3 while in March less than 1×10^3 individuals per dm^3.

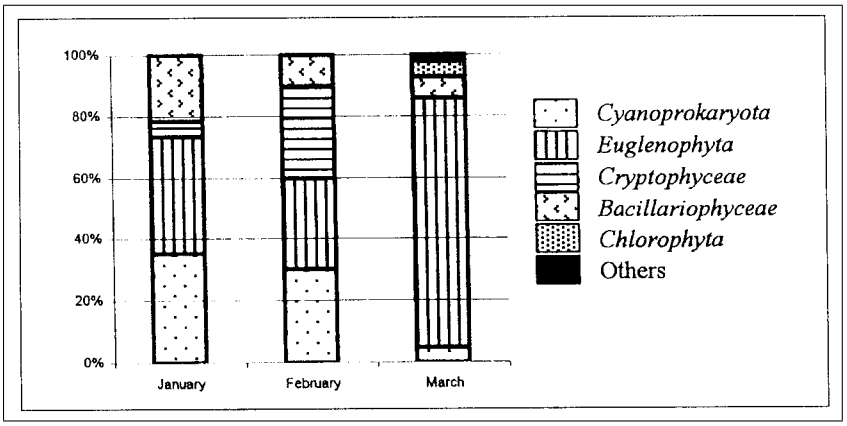

Fig. 1. Percentage shares of taxonomic groups in the total phytoplankton number

Apart from the number of algal cells, the quantity of phytoplankton was measured as concentration of chlorophyll-a in water. The amounts of chlorophyll were in January — 7 μg/dm^3, in February — 11 μg/dm^3 and in March — 4 μg/dm^3 and were proportional to the phytoplankton abundance.

DISCUSSION

The low water temperature and small amount of light considerably limits plant development in the studied lake. The winter period is more often associated with the lowest in year abundance and biodiversity of phytoplankton (2, 8, 12).

The frequent occurrence of blue-green algae *Plaktothrix aghardii* in winter was also found in the other water bodies (9). This species rarely shows peak of

Table 2. Abundance of dominant algal species and the total phytoplankton number ($N \times 10^3$ indiv./dm^3)

Species	Months		
	January	February	March
Planktothrix aghardii	9.5	16.7	1.8
CYANOPROKARYOTA	9.5	16.7	1.8
Trachelomonas volvocina	10.4	16.7	31.6
EUGLENOPHYTA	10.4	16.7	31.6
Cryptomonas sp.	1.4	16.7	0
CRYPTOPHYCEAE	1.4	16.7	0
Cyclotella ocellata	5.7	1.9	0.9
Asterionella formosa	0.1	1.9	1.8
Synedra acus	0	1.9	0
BACILLARIOPHYCEAE	5.8	5.7	2.7
Total number of individuals	27.2	56.0	39.0

its number in summer (unlike others of *Cyanoprokaryota* species) but it often develops in a great abundance during winter when there is a low increase of light (1). The occurrence of flagellate euglenids from genus *Trachelomonas* was noted in ice-covered lakes (13) and in cold waters of Finnish lakes in late autumn (2). The genus *Trachelomonas* was observed in phytoplankton of frozen over Bikcze Lake in Łęczna-Włodawa Lakeland (4). The species from *Bacillariophyceae* class, which were present in Rogóźno Lake through all winter as well as the species from *Cryptomonas* genus are common in phytoplankton of the ice-covered lakes (1, 2, 4, 13). The presence of diatoms is the result of their good adaptation to low temperature and poor light conditions (8), whereas *Cryptophyceae* is a class resistant to low temperatures and able to hetero- and mixotrophy (1).

Similar investigations were carried out in Rogóźno Lake during winter of 1996 and showed the little higher total number of phytoplankton ($12–200 \times 10^3$ indiv./dm^3) and the clear domination of *Bacillariophyceae* class (with dominant *Asterionella formosa* species) in January and February (11). The dissimilarities of phytoplankton abundance and qualitative structure between 1996 and 2003 are resulting from much lesser amount of light transmitted by the ice cover in the year 2003. In 1996 the thickness of snow overlain the ice layer did not reach more than 5 cm, while in 2003 it reached of 30 cm. In such conditions when the light is the main factor limiting algae appearance, high abundance can be maintained only by heterotrophic species (13).

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