STRUCTURE OF SUMMER PHYTOPLANKTON COMMUNITIES OF LAKE PŁOTYCZE URSZULIŃSKIE (ŁĘCZNA-WŁODAWA LAKELAND) IN THE ESTIMATION OF THE STATE OF ITS TROPHY

Krzysztof Czernaś, Agnieszka Szczurowska, Barbara Banach

Department of General Ecology, University of Life Sciences Akademicka str. 15, 20-950 Lublin krzysztof.czernas@up.lublin.pl, agnieszka.szczurowska@up.lublin.pl, barbara.banach@up.lublin.pl

Summary. The lake under study is situated in the buffer zone of the Polesie National Park. It is a degradation-prone, shallow eutrophic lake. The quality of the waters in the lake is determined by the character of its catchment basin, the area structure of which is dominated by meadows and forests. In the summer seasons of 2007 and 2008 analysis was made of the qualitative and quantitative structure of the phytoplankton communities, of the productivity on the basis of concentration of chlorophyll a, and determination of the basic physicochemical properties of the water was performed. During the period of the study a change occurred in the qualitative and quantitative structure of phytoplankton communities. In 2007 the highest share in the total number of taxa was that of taxa from the classes Chlorophyta and Cyanoprokaryota, while in 2008 the qualitative structure was dominated by the Cyanoprokaryota. At the same time there was a notable increase in the quantitative share of taxa from the classes Dinophyta (primarily Peridinium gatunense) and Cryptophyta, and from the class Chrysophyceae. The changes in the quantitative and qualitative structure of phytoplankton were accompanied by a decrease in the concentration of chlorophyll a. The high presence of Peridinium gatunense and increased level of mixotrophic algae from other systematic groups may be related with a notable share of macrophytes and a considerable level of dead organic matter. The structure of phytoplankton communities and the concentration of chlorophyll *a* indicate good ecological status of the lake despite its susceptibility to degradation.

Key words: lakes, phytoplankton, lake trophy

INTRODUCTION

Lake Płotycze Urszulińskie is one of eight lakes situated within the buffer zone of the Polesie National Park. Like other aquatic ecosystems in the area, also lake Płotycze Urszulińskie has been subjected to unfavourable changes in the environmental factors. As a result of lowering of the ground water table and the melioration treatments performed, the lake surface area shrank by 22% during the period of 1949–1976 [Furtak and Sobolewski 1998].

Phytoplankton is an important element in the estimation of the ecological status of aquatic ecosystems. The qualitative, and primarily the quantitative changes in the structure of phytoplankton communities reflect the rapid adaptation of organisms to changing habitat conditions, and at the same time the algae themselves can affect the changes in those conditions.

The objective of the study was to determine the qualitative and quantitative structure of phytoplankton communities and the productivity on the basis of chlorophyll *a* concentration as biological indicators for the estimation of the ecological status of waters.

MATERIAL AND METHOD

The lake under study is situated in the Łęczna-Włodawa Lakeland, in the buffer zone of the Polesie National Park. It is a degradation-prone, shallow eutrophic lake with maximum depth of 2.2 m and an area of 10.9 ha [Furtak *et al.* 1998, Krupa and Czernaś 2003]. The quality of the waters in the lake is determined by the area of its catchment basin (565.3 ha) and its character, where meadows and arable lands occupy a total of 69.7% while forests account for 25.7% [Furtak *et al.* 1998].

Phycological studies and physicochemical analyses of the water of the lake were conducted in July 2007 and 2008. Due to the small area and depth of the lake, water samples for the analyses were taken from only one mid-lake station.

For the qualitative determinations non-strained samples were taken as well as those taken with a planktonic net, and microscopic analysis was performed both on live and preserved material.

Samples for quantitative determinations were taken at a specific volume, and the alfae were counted in sedimentation chambers under an inverted microscope [Utermöhl 1958]. Measurements of the concentration of chlorophyll *a* were made with the use of the method proposed by Nusch [1980].

Simultaneously, basic analyses of the physicochemical properties of the water were performed *in situ* – the measurements included water temperature, electrolytic conductivity, reaction, and the range of visibility (transparency).

RESULTS

The range of visibility in the lake, both in 2007 and in 2008, was through to the bottom. The reaction of the water and the electrolytic conductivity remained at a similar level throughout the period of the study. The water reaction in 2007 and 2008 was 7.8 and 8.0 pH, and the conductivity 205 and 298 μ S·cm⁻¹, respectively (Tab. 1).

 Table 1. Values of physicochemical parameters and concentration of chlorophyll a in lake Płotycze Urszulińskie in the years 2007–2008

Parameter	2007	2008
Reaction, pH	7.8	8
Electrolytic conductivity, $\mu S \cdot cm^{-1}$	205	298
Temperature, °C	26.5	23
Transparency, m	1.5	1.7
Concentration of chlorophyll a, µg/l	16.9	10.6

Overall, in 2007, 28 taxa of pro- and eucaryotic algae were determined, belonging to 7 systematic groups. Most numerously represented were algae from the classes *Chlorophyta* – 10 taxons (which constituted 35% of the total number of taxa) and *Cyanoprokaryota* – 7 taxons (25% of the total). Among *Bacillariophyceae* and *Chrysophyceae* 3 and 4 taxons were determined, respectively, which constituted 14 and 11%. Other groups were represented by smaller numbers of taxa (Fig. 1). A similar number of taxa (27) were identified in 2008. The qualitative structure of summer phytoplankton was different in 2008. The most numerous group were *Cyanoprokaryota* – 8 taxons, which constituted 30% of the total number of taxa. Among the green algae (*Chlorophyta*) only 6 taxons were identified – 22%, while the qualitative share of *Dinophyta* increased to 15% (Fig. 1).



Fig. 1. Shares of particular algal groups in the phytoplankton of the studied lake in 2007 and 2008



Fig. 2. Abundance of phytoplankton in the water of the studied lake in 2007 and 2008

The total populations of algae in the two years of study were comparable, at 526.6 thoun. ind. \cdot dm⁻³ in 2007 and 237.7 thoun. ind. \cdot dm⁻³ in 2008 (Fig. 2). The highest share in the total numbers of phytoplankton in 2007 was that of *Chlorophyta* (over 50%) and *Chrysophyceae* (26%). Among the green algae, the dominant species in terms of numbers was *Scenedesmus arcuatus* (Lemmermann) Lemmermann, while among the golden algae the most abundant species was *Dinobryon divergens* Imhof. In 2008 the greatest numbers were noted in the case of *Dinophyta*. The large total phytoplankton populations in 2008 were due primarily to the great abundance of *Perydinium gatunense* Nygaard, a species that accounted for 31% of the total number, and again *Dinobryon divergens* (17% share in the total population).

The concentration of chlorophyll *a* in both periods of analyses was relatively low, at 16.9 μ g dm⁻³ chl. *a* in 2007 with a further reduction to 10.6 μ g dm⁻³ chl. *a* in 2008 (Tab. 1).

DISCUSSION

In 2007, taxa from the classes *Chlorophyta* and *Cyanoprokaryota* represented the largest share in the qualitative structure. A similar qualitative structure was noted in lake Płotycze Urszulińskie in 2003 [Krupa and Czernaś 2003]. Whereas, in 2008 the highest qualitative participation was recorded among *Cyanoprokaryota*, the green algae accounting for only 22% of all taxa. The relatively small number of identified taxa may result from the fact that samples were taken at only one mid-lake sampling station. Greater diversity in the structure of phytoplankton communities in the summer season can be found in the macrophyte zone [Kuczyńska-Kippen and Messyasz 1998, Celewicz *et al.* 2001]. Green algae were the dominant group in terms of numbers – in 2007 they represented an over 50% share. In that year of the study also a notable quantitative

presence of the golden alga *Dinobryon divergens* was observed. In 2008 there was a significant increase in the quantitative share of taxa from the class *Dinophyta* (primarily *Peridinium gatunense*), *Cryptophyta*, and from the class *Chrysophyceae* (*Dinobyon divergens* was a co-dominant in both years of the study). The notable quantitative share of *Peridinium gatunense* and increased presence of mixotrophic taxa from other systematic groups may be related with the considerable levels of dead organic matter. Mixotrophic flagellates, *inter alia* from the genus *Perydinium*, *Dinobryon* or *Cryptomonas*, can use dissolved organic matter [Kawecka and Eloranta 1994]. The increased numbers of flagellate forms of phytoplankton may also be related with the abundance of macrophytes which occupied 88.7% of the lake surface area [Sender 2009]. In the summer season the macrophyte vegetation may have a limiting effect on phytoplankton, but this does not apply to flagellate forms, among others, that have a preference for the macrophyte zone [Kowalczewski and Pieczyńska 1976, Schrivera *et al.* 1995, in Celewicz *et al.* 2001].

It is difficult to determine the trophy of the lake under study on the basis of the qualitative and quantitative structure of phytoplankton. Both the co-dominant in both years *Dinobryon divergens* and *Peridinium gatunense* can appear in various habitats. With the change in the quantitative and qualitative structure of phytoplankton a decrease was noted in the concentration of chlorophyll *a*, but in both years that concentration fell within a range characteristic for mesotrophy. In none of the study periods algal blooms, frequently characteristic of eutrophic lakes, were observed in the water, and the water transparency (range of visibility) extended right to the bottom.

CONCLUSIONS

1. In the period under analysis there was a change in the qualitative and quantitative structure of phytoplankton communities in the lake studied.

2. The notable share of flagellate forms in the quantitative structure of phytoplankton may be related with the large area of the phytolittoral in the lake under study.

3. The quantitative share of *Peridinium gatunense* and other mixotrophic taxa may be related with the considerable amount of dead organic matter in the waters of the lake.

4. The structure of phytoplankton communities and the concentration of chlorophyll *a* indicate good ecological status of the waters of the lake under study, in spite of its considerable susceptibility to degradation.

REFERENCES

Celewicz S., Messyasz B., Burchardt L., 2001. Roczniki AR Pozn. 334, Bot. 4, 3-11.

- Furtak T., Sobolewski W., Turczyński M., 1998. Characterisation of lake catchment basis (in Polish), in: The Łęczna-Włodawa lakes. A Nature Monograph (eds) M. Harasimiuk, Z. Michalczyk, M. Turczyński, Bibl. Monit. Środ. Lublin, 73–90.
- Furtak T., Turczyński M., 1998. Changes in lake surface areas (in Polish), in: The Łęczna-Włodawa lakes. A Nature Monograph (eds) M. Harasimiuk, Z. Michalczyk, M. Turczyński, Bibl. Monit. Środ. Lublin, 91–92.
- Kawecka B., Eloranta P.V., 1994. Outline of algal ecology of fresh waters and land ecosystems (in Polish). Wyd. Nauk. Warszawa, 147.
- Krupa D., Czernaś K., 2003. Phytoplankton and its productivity in lakes Płotycze n. Urszulin and Wereszczyńskie in the buffer zone of the Polesie National Park (in Polish), Acta Agrophysica 1 (1), 131–138.
- Kuczyńska-Kippen N., Messyasz B., 1998. The estimation of phytoplankton and zooplankton in the zones of rushes and submerged vegetation of Lake Lubaskie Duże. Oceanol. Stud. 27, 2, 23–29.
- Nusch A.E., 1980. Comparison of methods for Chlorophyll and phaeopigment determination. Arch. Hydrobiol. Beih. Limnol. 14, 14–36.
- Utermöhl H., 1958. Zur Vervollkommung der quantitativen Phytoplankton Methodik. Mitt. Internat. Verein. Limnol. 9, 1–38.
- Sender J., 2009. Analysis of succession changes taking place in the aquatic phytocenoses and in the macrophyte flora of the studied lakes in the years 1960–2009 (in Polish), in: Ecology of hydrogenic landscapes of the "West Polesie" Biosphere Reserve (ed.) T.J. Chmielewski, Wyd. PZN Sp. z o. o., 161–190.

STRUKTURA ZBIOROWISK LETNIEGO FITOPLANKTONU JEZIORA PŁOTYCZE URSZULIŃSKIE (POJEZIERZE ŁĘCZYŃSKO-WŁODAWSKIE) W OCENIE STANU JEGO TROFII

Streszczenie. Badane jezioro położone jest w otulinie Poleskiego Parku Narodowego. Jest to eutroficzne, podatne na degradację płytkie jezioro. Decydujący wpływ na jakość wód jeziora ma charakter zlewni, gdzie łąki i lasy zajmują największą powierzchnię.

Latem 2007 i 2008 r. poddano analizie strukturę jakościową i ilościową zbiorowisk fitoplanktonu, produktywność na podstawie koncentracji chlorofilu *a* oraz określono podstawowe parametry fizyczno-chemiczne wody. W okresie badań nastąpiła zmiana w strukturze jakościowej i ilościowej zbiorowisk fitoplanktonu. W 2007 r. największy udział w ogólnej liczbie taksonów miały taksony z gromady *Chlorophyta* oraz *Cyanoprokaryota*. W 2008 r. największy udział w strukturze jakościowej stwierdzono natomiast wśród *Cyanoprokaryota*. Jednocześnie znacznie wzrósł udział ilościowy taksonów z gromad *Dinophyta* (głównie *Peridinium gatunense*) i *Cryptophyta* oraz z klasy *Chrysophyceae*. Przy zmianie struktury ilościowej i jakościowej fitoplanktonu stwierdzono spadek koncentracji chlorofilu *a*. Znaczny udział ilościowy *Peridinium gatunense* oraz większy udział glonów miksotroficznych z innych grup systematycznych może być związany z dużym udziałem makrofitów oraz znacznym udziałem martwej materii organicznej.

Struktura zbiorowisk fitoplanktonu oraz koncentracja chlorofilu *a* wskazują na dobry stan ekologiczny badanego jeziora, mimo znacznej jego podatności na degradację.

Słowa kluczowe: jeziora, fitoplankton, trofia jezior