

SOME ABIOTIC AND BIOTIC FACTORS OF THE SIX LAKES
OF ŁĘCZNA-WŁODAWA LAKELAND (LUBLIN POLESIE REGION)
IN SUMMER PERIOD

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A b s t r a c t. Studies were carried out in six lakes located within the Łęczna-Włodawa Lakeland (the Zagłębcze, the Czarne near Sosnowica, the Głębokie near Uścimów, the Rotcze, the Sumin and the Długie) during the summer season (from June to August) of 2001. They involved physico-chemical parameters (water transparency, conductivity, pH, oxygen saturation, total phosphorus and nitrogen) and also biological ones (chlorophyll-*a* concentration, phytoplankton abundance and structure, take into account dominant species and domination of higher taxa). Physical and chemical factors and the phytoplankton composition of lakes usually confirm their trophic character. The mesotrophic Zagłębcze lake was characterised by a high Secchi disc (SD), low abundance of phytoplankton and chlorophyll-*a* values typical of a low trophic status. Physical and chemical water characteristics and over 90% domination of blue-green algae showed high trophy of the Czarne lake near Sosnowica. In the shallow, eutrophic lakes: the Rotcze, the Sumin and in the dystrophic the Długie lake high abundance of phytoplankton and chlorophyll-*a* concentration was also high diversity of species, was recorded. Stability of character of these lakes was thus confirmed. The highest concentration of nutrients and chlorophyll-*a* and high abundance of phytoplankton with low SD was recorded in the Głębokie lake near Uścimów.

K e y w o r d s: lakes, summer physical and chemical factors, phytoplankton, biodiversity, the Łęczna-Włodawa Lakeland, the Polesie Lubelskie Region

INTRODUCTION

A hydrobiological characteristic of lakes includes physical, chemical and biological parameters. The basic, factors analysed were: water transparency as measured by a Secchi disc (SD), pH, conductivity and oxygen saturation in the water column. An important element in the lakes description is concentration of nutrients, necessary for the phytoplankton growth. Phosphorus and nitrogen are such elements. They usually limit the growth of algae and macrophytes. In the natural lakes ecosystems, algae are the producers in deep water. An assessment of the lake

trophic status takes into account an abundance of summer phytoplankton and especially the structure of dominant species and domination of higher taxa. Another biological factor is concentration of chlorophyll-*a* in the water. Chlorophyll-*a* is the most important photosynthetic pigment in the cells of all groups of algae and its concentration can indicate phytoplankton biomass.

The aim of the present work was to present a quantitative and qualitative structure of the planktonic algae in some chosen lakes situated in the Łęczna-Włodawa Lakeland against the background of physical and chemical factors.

STUDY AREA AND METHODS

Six lakes located within the Łęczna-Włodawa Lakeland (Lublin Polesie Region) were selected for the present study: deep lakes – the Zagłębobcze and the Czarne near Sosnowica (n/S), and shallow lakes – the Głębokie near Uścimów (n/U), the Rotcze, the Sumin and the Długie (Fig. 1). The area and depth of the lakes studied are given in Table 1, together with their trophic character [5].

The physico-chemical and biological factors were studied during the summer period from June to August in 2001, once a month. The results presented in this work are arithmetic averages of these three measurements. Sampling for analyses was carried out in the pelagic zone. A sampler of the Ruttner type with a capacity of 2 dm³ was used. Water from the stratified lakes was sampled as a collective sample from three depths in the epilimnion layer. Water of the shallow lakes was taken from a depth of about 1 m. Conductivity and pH were measured using a

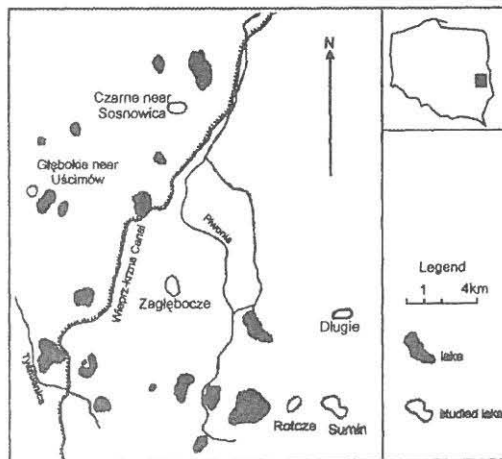


Fig. 1. Location of the lakes studied

Table 1. Morphological and trophic characteristics of the lakes according to Radwan and Kornijów [5]

Lake	Surface area (ha)	Maximum depth (m)	Trophic status
the Zagłębcze	84.7	25.0	mesotrophic
the Czarne near Sosnowica	38.8	15.6	eutrophic
the Głębokie near Uścimów	20.5	7.1	eutrophic
the Roteze	42.7	4.3	eutrophic
the Sumin	91.5	6.5	eutrophic
the Długie	28.4	1.3	dystrophic

conductivity meter and pH-meter, respectively. At the same time, visibility was measured in water using a Secchi disc. Measurements of oxygenation were made at depth intervals of one meter with an aid of a WTW OXI 96 oxymeter. Chemical water analyses was carried out according to standard methods described by Hermanowicz [1].

Analyses of chlorophyll-*a* always began on the day of sample collection, 1-2 dm³ of water was filtered through a Whatman GF/C glass-fibre filter and the residue was then homogenized and extracted with boiling 90% ethanol [4]. Measurements of light absorption at the wavelengths of 665 and 750 nm were carried out with a Beckman DU 640B spectrophotometer. The final concentration of chlorophyll-*a* per dm³ of water was calculated using a Lorenz formula [8]. The number of phytoplankton was determined with an inverted microscope by Utermöhl method. Species diversity was calculated on the basis of a number of "individuals" according to an equations by Shannon and Weaver [7] with logarithm of the 2 (H') base and a Lloyd and Ghelardi [3] – index of evenness (e).

RESULTS

The lakes studied varied in respect of the parameters analysed. The thermal-oxygen stratification was formed during the summer season in the deep, dimictic the Zagłębcze lake and the Czarne lake near Sosnowica and also in the shallow the Głębokie lake. The waters of these lakes showed oxygen depletion in the hypolimnion. Other lakes were well oxygenized in the whole water column (Table 2). Physical parameters showed similarities in terms of pH and conductivity, pH was alkaline (from 8.4 to 9.2) and the level of mineralization was low (conductivity values varied from 154 to 469 $\mu\text{S cm}^{-1}$). The Secchi disk visibility was varied in the individual lakes, in direct relation to biological factors, mainly phytoplankton abundance. The highest (over 3 m) water transparency was observed in the

Table 2. Physico-chemical factors in the water of the lakes studied

Physico-chemical factors	Lakes					
	the Zagłę- bocze	the Czarne n/S	the Głę- bokie n/U	the Roteze	the Sumin	the Długie
SD (m)	3.2	0.7	0.6	1.9	0.9	0.9
pH	8.4	9.2	9.0	9.0	8.7	9.2
Conductivity ($\mu\text{S cm}^{-1}$)	282	470	348	188	413	154
O ₂ (%) surface	102	132	108	120	114	127
O ₂ (%) hypolimnion	3.3	0.7	0.7	112	95	127
N _{tot} ($\mu\text{g dm}^{-3}$)	460	997	1443	1175	809	123
P _{tot} ($\mu\text{g dm}^{-3}$)	107	197	202	65	67	76

Zagłębocze lake, at the same time, a low number of algae plankton occurred (below $400 \text{ indiv.} \cdot 10^3 \text{ dm}^{-3}$) and the lowest chlorophyll-*a* concentration (in the epilimnion water $8.5 \mu\text{g dm}^{-3}$) on average. The remaining chlorophyll-*a* concentration below $10 \mu\text{g dm}^{-3}$ is characteristic of deep, dimictic lakes in other regions of Poland [2]. In spite of the low phytoplankton abundance great species diversity (as expressed by a Shannon-Weaver index) and its evenness was found (Table 3).

The second lake in size – the Czarne near Sosnowica, was characterized by different values of the parameters studied. Visibility of 0.7 m only, very high abundance of algae in the pelagial layer ($23.95 \text{ indiv.} \cdot 10^6 \text{ dm}^{-3}$) and high values of chlorophyll-*a* ($50 \mu\text{g dm}^{-3}$) were observed. The total amount of phosphorus in the surface water was $197 \mu\text{g dm}^{-3}$. According to Zdanowski [10], such high values of phosphorus are typical of high trophy in lakes. High fertility was confirmed by the phytoplankton structure dominated by filamentous blue-green

Table 3. Mean numbers (N) of phytoplankton and chlorophyll-*a* concentration (Chl), mean values of Diversity Index (H') and Evenness (e) of phytoplankton and dominated species in the lakes studied

Lakes	N 10^3 dm^{-3}	Chl ($\mu\text{g dm}^{-3}$)	e	H'	Dominated species	Percentage of domination
the Zagłębocze	379.1	8.5	0.7	2.6	<i>Gomphosphaeria pusilla</i>	58
the Czarne n/S.	23952.8	50.2	0.3	0.8	<i>Limnothrix planctonica</i>	85
the Głębokie n/U.	1583.2	91.7	0.7	3.3	<i>Ceratium hirundinella</i>	39
					<i>Closterium diana</i>	14
the Roteze	677.6	17.2	0.5	4.6	<i>Cryptomonas sp.</i>	19
the Sumin	1009.5	55.0	0.8	3.4	<i>Tetraëdron minimum</i>	
the Długie	1147.1	25.1	0.7	2.9	<i>Scenedesmus quadricauda</i>	18
					<i>Cryptomonas sp.</i>	18

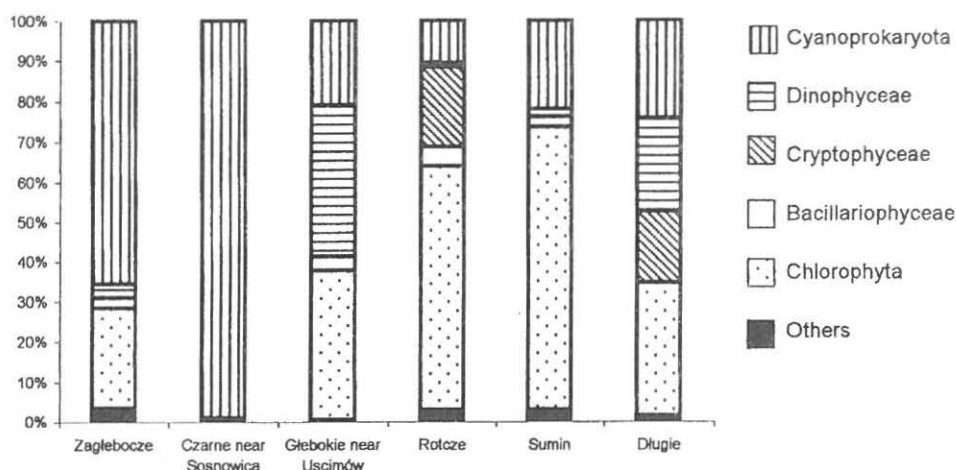


Fig. 2. Percentage shares of taxonomic groups in the total numbers of phytoplankton in studied lakes

algae (Fig. 2): *Limnothrix planctonica*, *L. redekei* and *Planktothrix aghardii* (with the predominance of *L. planctonica*), species typical of advanced eutrophy [6]. Studies on the Czarne Lake near Sosnowica were conducted in the sixties by Wojciechowski [9]. Great diversity of the phytoplankton species and twice greater water transparency nowadays was then noted.

The Głębokie Lake near Uścimów was characterized by the highest physico-chemical values among all studied reservoirs, i.e., a high level of total nitrogen, and phosphorus as well as by a very low Secchi disk visibility (Table 1). The chlorophyll-*a* concentration reached as much as $90 \mu\text{g dm}^{-3}$ (Table 3) and exceeded the values characteristic of advanced eutrophy in lakes [2]. An abundance of phytoplankton was dominated by one *Dinophyceae* species *Ceratium hirundinella* (Table 3).

Three of the lakes studied, the Rotcze, the Sumin and the Długie, are shallow and polymictic with different character of the catchment areas: agricultural and recreational in the case of the Rotcze and the Sumin; forest and peat-bog in the case of the Długie. Concentration of total phosphorus (TP) in all above-mentioned lakes was not very high and reached about $70 \mu\text{g dm}^{-3}$. Concentrations of chlorophyll-*a* values ranged from 17 to $55 \mu\text{g dm}^{-3}$. At the same time, a high percentage share of phytoplankton had green algae and blue-green algae. Biodiversity indices, i.e.: Shannon-Weaver and evenness were high in all lakes of this group (Table 3).

Among the lakes studied, a relatively high water transparency was in the Rotcze lake ($SD=1.9 \text{ m}$) and in the Długie lake where light always reached the

bottom (SD=0.9 m). In this latter lake, macrophytes were a frequent occurrence. They could absorb and accumulate biogenics elements and limit the growth of algae. Values of the parameters studied indicated a similar, temperate eutrophic character of these lakes.

CONCLUSION

Physical and chemical factors and the phytoplankton composition of lakes studied usually confirmed their trophic character. The mesotrophic lake Zagłębcze was characterised by a high SD, low abundance of phytoplankton and chlorophyll-*a* values typical of a low trophic status. Another deep lake the Czarne near Sosnowica showed a high trophy of its water confirmed by a great predominance of filamentous blue-green algae. In the shallow, eutrophic lakes: Rotcze, Sumin and in the dystrophic the Długie lake a high abundance of phytoplankton and a high chlorophyll-*a* concentration was recorded. However, rather high biodiversity can indicate stability of these lakes. The highest concentration of nutrients and chlorophyll-*a* and a high abundance of phytoplankton with low SD was recorded in the Głębokie lake near Uścimów.

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WYBRANE CZYNNIKI ABIOTYCZNE I BIOTYCZNE SZEŚCIU JEZIOR
POJEZIERZA ŁĘCZYŃSKO-WŁODAWSKIEGO (POLESIE LUBELSKIE)
W OKRESIE LETNIM

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S t r e s z c z e n i e. Badania sześciu jezior Pojezierza Łęczyńsko-Włodawskiego (Zagłęboce, Czarne Sosnowickie, Głębokie Uścimowskie, Rotcze, Sumin i Długie) przeprowadzono w okresie letnim (czerwiec-sierpień) roku 2001. Wybrane jeziora cechowała odmienna morfometria i status troficzny. Oznaczono parametry fizyczno-chemiczne (SD, pH, kondukcja, natlenienie, koncentracja pierwiastków biogennych) i biologiczne (stężenie chlorofilu-*a* oraz liczebność i struktura jakościowa fitoplanktonu z uwzględnieniem gatunków i grup dominujących).

Czynniki fizyczno-chemiczne i struktura fitoplanktonu na ogół potwierdzały typ troficzny badanych jezior. Mezotroficzne jezioro Zagłęboce charakteryzowało się wysokim SD, niską liczebnością glonów i wartościami chlorofilu-*a* typowymi dla jezior o niskiej trofii. Fizyczno-chemiczne właściwości wody oraz ponad 90-cio procentowa dominacja sinic wskazują na wysoką żywność jeziora Czarne Sosnowickie. W płytkich jeziorach eutroficznych Rotcze, Sumin i w dystroficznym jeziorze Długie stwierdzono wysokie liczebności fitoplanktonu i stężenia chlorofilu-*a*, przy czym duża różnorodność gatunkowa może świadczyć o stabilności tych zbiorników. Najwyższe stężenia biogenów i chlorofilu-*a*, a także dużą liczebność glonów planktonowych i niskie SD stwierdzono w jeziorze Głębokie.

S ł o w a k l u c z o w e: jeziora, letni fitoplankton, czynniki fizyko-chemiczne, bioróżnorodność