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PELAGIC PHYTOPLANKTON IN FOUR BASINS OF THE ROSNOWSKIE DUŻE LAKE IN THE WIELKOPOLSKA NATIONAL PARK

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ABSTRACT. The qualitative and quantitative structure of phytoplankton was studied in the pelagic zone of four basins of the shallow, eutrophic Rosnowskie Duże Lake in 2002-2003. The basins differ in morphometry and taxonomic composition of vegetation. Green algae were the predominant group. Great differences in phytoplankton diversity, abundance and biomass between the four basins of the lake were observed. The greatest diversity was recorded in basin II, where maximum depth was only 3.5 m. The smallest number of taxa was observed in basin I, which was the most eutrophic. The highest phytoplankton abundance and biomass were found in basins I and II, while the lowest in basin III, probably as a result of grazing by zooplankton. Total phytoplankton abundance and biomass considerably increased in 2003 in all basins, which was associated with an increase in electrolytic conductivity.

Key words: phytoplankton, pelagic zone, eutrophic lake, shallow lake, green algae

Introduction

The Rosnowskie Duże Lake is an interesting object of research because of the presence of four morphologically different basins. Under the influence of the progressing human disturbance and gradual colonization of the lake by emergent vegetation, phytoplankton structure in this water body is changing continuously (**Juskowiak** 1978, **Organiściak** 1978, **Dąmbska** et **al.** 1981, **Koczorowska** and **Wetula** 1984, **Abulgasem** 1999, **Alsambany** 1999, **Celewicz-Gołdyn** 2005).

The aim of the study was to analyse the qualitative and quantitative structure of phytoplankton communities in four basins of the lake and to assess their trophic state.

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Study area

The Rosnowskie Duże Lake is located in the Wielkopolska National Park (near the city of Poznań in western Poland). It is an elongated non-throughflow lake of glacial origin (area 34.2 ha, max. depth 10.2, mean depth 3.9 m). The village of Rosnówko extends along its south-eastern and south-western shores. The lake is markedly affected by domestic sewage and agricultural pollution because of excessive nutrient loads from the catchment (**Dąmbska** et **al.** 1981, **Labijak** 1990, **Pańczakowa** 1990). As a result of the progressing sediment deposition and colonization of the lake by emergent vegetation, the lake was naturally separated into four basins that differ in depth and surface area (Fig. 1, Table 1). The southern basin (further called basin I), situated beside a road, is the most strongly affected by human activity and has the poorest vegetation. Only aggregations of *Phragmites communis* Trin. and *Typha angustifolia* L. were found there, while submerged vegetation was absent. The next southern basin (further called basin II) was distinguished by patches of elodeids (*Ceratophyllum demersum* L.). Northern basins (further called basins III and IV), located closer to Lake Chomęcickie, were characterized by the presence of nymphaeids (*Nymphaea alba* L.) covering a large part of its surface area. The basins are separated by narrower sections densely overgrown with aquatic vegetation, but water exchange between them is still possible.

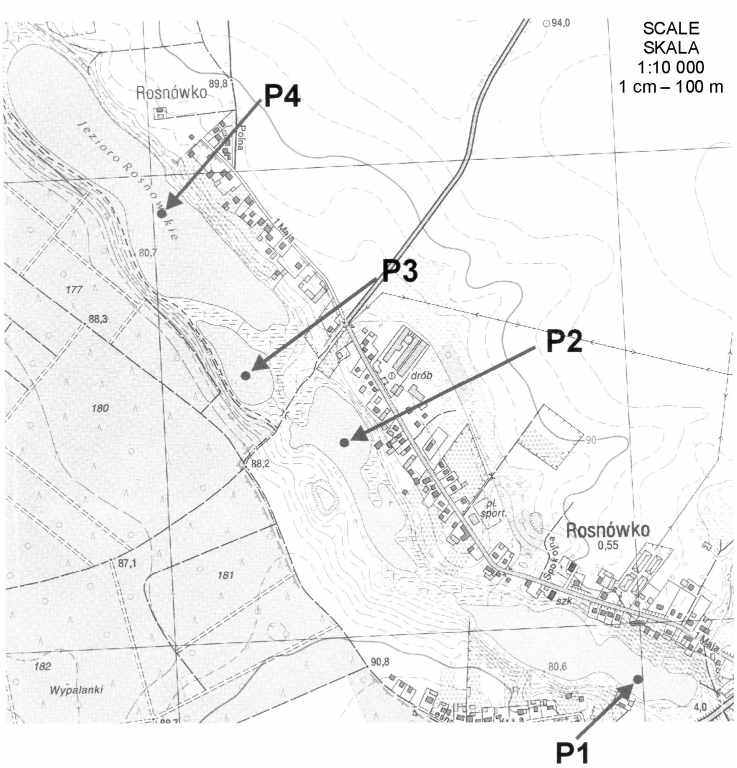

Fig. 1. Location of sampling stations
Ryc. 1. Rozmieszczenie stanowisk badawczych

Table 1

Morphometric parameters of basins of the Rosnowskie Duże Lake
Charakterystyka morfometryczna basenów Jeziora Rosnowskiego Dużego

Basin Basen	Maximum depth (m) Głębokość maksymalna (m)	Area (ha) Powierzchnia (ha)
I	7.8	4.4
II	3.5	3.0
III	5.5	1.8
IV	10.2	10.8

Material and methods

Phytoplankton research was conducted in 2002 and 2003 during the growing season of hydromacrophytes (April−September). Samples were collected bi-weekly in spring, and monthly in summer. One sampling station was established in the pelagic zone of each basin (Fig. 1). Water samples were collected from the surface layer of water (at a depth of c. 0.5 m) and preserved with Lugol's solution and formalin. In the laboratory, they were sedimented to a volume of 10 ml, and next analysed qualitatively and quantitatively. Numbers of cells of cyanoprokaryotes and eukaryotic algae were counted in Fuchs-Rosenthal chambers. Biomass was assessed by estimating cell volume (**Kawecka** and **Eloranta** 1994). A species was regarded as a dominant if its contribution to total phytoplankton abundance or biomass exceeded 10% in a sample.

To calculate chlorophyll *a* concentration, **Strickland** and **Parsons'** (1972) formulas were used, as modified by **Lorenzen** (1967).

Values of trophic state index (TSI) were estimated according to **Carlson's** (1977) logarithmic transformation, basing on chlorophyll *a* concentration and Secchi depth.

Taxonomic similarity for individual sampling stations was calculated from the formula suggested by Jaccard (**Kawecka** and **Eloranta** 1994).

Results

Values of the analysed trophic parameters in 2002 and 2003 indicate that Rosnowskie Duże Lake, is eutrophic. TSI reached up to 63 units for Secchi depth and up to 68 units for chlorophyll *a*. The highest values were usually recorded in basins I and II, while basin III was often classified as meso-eutrophic.

Mean values of electrolytic conductivity during this study varied considerably in time and space (Table 2). In 2002, values of this parameter at all sampling stations were much lower than in the following year. The lowest mean value was noted in the pelagic zone of basin IV. In 2003 the highest value was recorded in basin I, but there was a decreasing trend from basin I to basin IV.

Table 2

Mean values of electrolytic conductivity at sampling stations in the Rosnowskie Duże Lake in 2002-2003 (μS/cm)

Średnie wartości przewodnictwa elektrolitycznego na poszczególnych stanowiskach Jeziora Rosnowskiego Dużego w latach 2002-2003 (μS/cm)

Basin Basen	Station Stanowisko	2002	2003
I	P1	537	807
II	P2	527	710
III	P3	552	682
IV	P4	434	677

The detailed phytoplankton analysis showed that during the study period, 127 taxa of prokaryotic and eukaryotic algae were observed in the lake. They represented seven systematic groups (Table 3).

Table 3

Numbers of taxa in systematic groups of phytoplankton in the Rosnowskie Duże Lake in 2002-2003

Liczba taksonów fitoplanktonu w poszczególnych grupach systematycznych w Jeziorze Rosnowskim Dużym w latach 2002-2003

Taxonomic group Grupa systematyczna	Number of taxa Liczba taksonów	(%)
Chlorophyta (Green algae – Zielenice)	56	44
Bacillariophyceae (Diatoms – Okrzemki)	34	27
Cyanoprokaryota (Blue-green algae – Sinice)	17	13
Euglenophyta (Euglenophytes – Eugleniny)	7	5
Cryptophyceae (Cryptomonads – Kryptofiny)	6	5
Dinophyceae (Dinoflagellates – Bruzdnice)	5	4
Chrysophyceae (Chrysomonads – Złotowiciowce)	2	2
Total – Suma	127	100

The dominant group of phytoplankton were green algae (mainly members of Chlorococcales), which accounted for 44% of the total number of taxa (Table 3). Also diatoms and cyanoprokaryotes were important contributors to phytoplankton diversity.

Other groups, such as euglenophytes, cryptomonads, dinoflagellates and chrysophytes, were infrequent and represented by few species.

The highest number of taxa (107) during the study period was recorded in the pelagic zone of basin II, where also the highest diversity of green algae, diatoms and cyanoprokaryotes was recorded (Fig. 2). At that station, the highest number of exclusive species (14) was noted: eight of green algae, four of diatoms, and two of cyanoprokaryotes (Table 4). The lowest species diversity (87 taxa) was observed in the pelagic zone of basin I. Also the number of taxa of green algae was the smallest there.

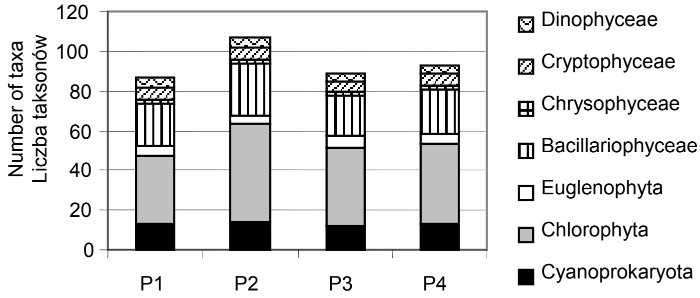

Fig. 2. Number of phytoplankton taxa at sampling stations in the Rosnowskie Duże Lake in 2002–2003
Ryc. 2. Liczba taksonów fitoplanktonu na poszczególnych stanowiskach w Jeziorze Rosnowskim Dużym

Table 4

Taxonomic composition of phytoplankton in the Rosnowskie Duże Lake at sampling stations in 2002-2003

Fitoplankton Jeziora Rosnowskiego Dużego na poszczególnych stanowiskach w latach 2002-2003

	Station – Stanowisko			
	P1	P2	P3	P4
1	2	3	4	5
CYANOPROKARYOTA				
Anabaena affinis Lemm.	+	+		+
Anabaena flos-aquae Bréb. ex Bornet et Flahault		+		
Anabaena spiroides Klebahn		+		
Aphanizomenon flos-aquae (L.) Ralfs	+	+	+	+
Chamaesiphon curvatus Nordstedt.	+	+	+	+
Gloeocapsa minuta (Kütz.) Hollerbach	+	+	+	+
Jaaginema pseudogeminatum Schmid	+	+		+
Leptolyngbya thermalis Anagn.	+		+	+
Limnothrix redekei (Van Goor) Meffert	+	+	+	+

Table 4 – cont.

1	2	3	4	5
Lyngbya contorta Lemm.	+	+	+	+
Lyngbya hieronymusii Lemm.	+	+	+	+
Microcystis aeruginosa Kütz.	+	+	+	+
Microcystis incerta (Lemm.) Starmach			+	+
Microcystis wesenbergii Komárek	+	+	+	+
Oscillatoria limnetica Lemm.			+	
Planktothrix agardhii (Gom.) Anagn. et Kom.	+	+	+	+
Woronichinia rosea (Snow) Lemm.	+	+		
CHLOROPHYTA				
Actinastrum raphidioides (Reinsch) Brunthaler		+		+
Ankistrodesmus bibraianus (Reinsch) Koršikov				+
Ankistrodesmus falcatus (Corda) Ralfs	+	+	+	+
Ankistrodesmus gracilis (Reinsch) Koršikov		+		
Ankistrodesmus stipitatus (Chod.) Kom.-Legn.	+	+	+	+
Characium angustum A. Braun		+		
Chlamydomonas globosa Snow	+	+	+	+
Chlorotetraedron bitridens (Beck-Mann.) Kovač.		+	+	
Closterium aciculare T. West		+	+	
Closterium acutum Bréb. in Ralfs	+	+	+	+
Closterium ceratium Perty		+		
Closterium ehrenbergii Meneghini ex Ralfs	+	+		
Closterium strigosum Bréb.		+	+	+
Coelastrum astroideum De Notaris	+	+	+	+
Coelastrum microporum Nägeli in A. Braun	+	+	+	+
Coelastrum reticulatum (Dang.) Senn	+	+	+	+
Cosmarium granatum Bréb. ex Ralfs	+			
Cosmarium laeve Rabenhorst	+	+	+	+
Cosmarium margaritatum (Turp.) Ralfs			+	+
Cosmarium punctulatum Bréb.	+	+	+	+
Cosmarium rectangulare Grunow in Rabenhorst	+			
Crucigenia tetrapedia (Kirchner) W. et G.S. West	+	+	+	+

Table 4 – cont.

1	2	3	4	5
Crucigeniella rectangularis (Näg.) Komárek	+	+	+	+
Desmodesmus communis (Hegew.) Hegew.	+	+	+	+
Dictyosphaerium ehrenbergianum Nägeli		+		
Dictyosphaerium pulchellum Wood		+	+	+
Euastrum gemmatum Bréb. in Ralfs				+
Kirchneriella contorta (Schmidle) Bohlin	+	+	+	+
Lagerheimia ciliata (Lagerheim) Chodat		+	+	+
Lagerheimia citriformis (Snow) Collins	+	+	+	+
Monoraphidium circinale (Nyg.) Nygaard		+		
Monoraphidium griffithii (Berk.) Kom.-Legn.	+	+		
Mougeotia sp.	+	+		+
Oedogonium sp.		+	+	
Oocystis parva W. et G.S. West	+	+	+	+
Pediastrum boryanum (Turp.) Menegh.	+	+	+	+
Pediastrum duplex Meyen		+	+	+
Pediastrum tetras (Ehrenb.) Ralfs	+	+	+	+
Scenedesmus dimorphus (Turp.) Kütz.	+	+	+	+
Scenedesmus ecornis (Ehrenb.) Chodat	+	+	+	+
Scenedesmus obtusus Meyen	+	+	+	+
Schroederia planctonica (Skuja) Philipose		+		
Sorastrum spinulosum Nägeli		+		
Sphaerocystis planctonica (Korš.) Bourrelly	+	+	+	+
Spirogyra sp.		+	+	+
Staurastrum paradoxum Meyen				+
Staurastrum polymorphum Bréb.	+	+	+	
Staurastrum pseudotetracerum (Nord.) W. et G.S. West	+	+	+	+
Staurastrum tetracerum Ralfs	+	+	+	+
Staurodesmus apiculatus (Bréb.) Teiling	+	+	+	+
Staurodesmus cuspidatus (Bréb.) Teiling	+	+	+	+
Tetraedron caudatum (Corda) Hansgirg	+	+	+	+
Tetraedron minimum (A. Braun) Hansgirg	+	+	+	+

Table 4 – cont.

1	2	3	4	5
Tetraedron triangulare Koršikov	+	+	+	+
Treubaria setigera (Archer) G.M. Smith		+	+	+
Ulothrix zonata (Weber et Moor) Kütz.		+		
EUGLENOPHYTA				
Euglena acus var. *acus* Ehr.	+	+	+	+
Phacus acuminatus Stokes	+			+
Phacus mirabilis Pochmann	+	+	+	+
Phacus onyx Pochmann		+	+	
Phacus orbicularis Hübner	+	+	+	+
Phacus strongylus Pochmann	+		+	+
Phacus sp.			+	
BACILLARIOPHYCEAE				
Achnanthes flexella (Kütz.) Grun.	+		+	+
Asterionella formosa Hassal	+	+	+	+
Cocconeis placentula Ehr.	+	+	+	+
Cyclotella distinguenda Hustedt	+	+	+	+
Cyclotella radiosa (Grun.) Lemm.	+	+		+
Cymbella lanceolata (Ehr.) Kirchner	+	+	+	+
Cymbella ventricosa Kütz.	+	+		+
Diatoma elongatum (Lyngb.) Ag.		+		
Epithemia turgida (Ehr.) Kütz.	+	+	+	+
Epithemia zebra (Ehr.) Kütz.				+
Fragilaria capucina Desm.	+	+		+
Fragilaria capucina var. *capucina* Desm.	+	+	+	+
Fragilaria construens (Ehr.) Grun.	+	+	+	+
Fragilaria dilatata (Bréb.) Lange-Bertalot		+	+	
Fragilaria fasiculata (Ag.) Lange-Bertalot sensu lato	+			
Fragilaria ulna (Nitzsch) Lange-Bertalot	+	+	+	+
Fragilaria ulna var. *acus* (Kütz.) Lange-Bertalot	+	+	+	+
Gomphonema acuminatum Ehr.		+	+	+
Gomphonema augur Ehr.			+	

Table 4 – cont.

1	2	3	4	5
Gomphonema constrictum Ehr.	+	+	+	
Gomphonema lateripunctatum Reich. & Lange-Bertalot		+	+	+
Gomphonema parvulum (Kütz.) Grun.	+			
Gyrosigma attenuatum (Kütz.) Rabenhorst		+		
Navicula cryptocephala Kütz.	+		+	+
Navicula cuspidata Kütz.		+		
Navicula radiosa Kütz.	+	+	+	+
Nitzschia sigma (Kütz.) W. Smith	+	+		+
Nitzschia sigmoidea (Ehr.) W. Smith		+		
Pinnularia maior (Kütz.) Rabenhorst	+	+	+	
Rhopalodia gibba (Ehr.) O. Müll		+	+	+
Rhopalodia gibba var. *ventricosa* (Ehr.) Grun.		+	+	+
Stephanodiscus parvus Stoermer et Hakansson	+	+	+	+
Tabellaria fenestrata (Lyngb.) Kützing				+
Tabellaria flocullosa (Roth) Kützing	+			
CHRYSOPHYCEAE				
Dinobryon bavaricum Imhoff	+	+	+	+
Dinobryon divergens Imhoff	+	+	+	+
CRYPTOPHYCEAE				
Chroomonas acuta Utermöhl	+	+	+	+
Cryptomonas erosa Ehr.	+	+	+	+
Cryptomonas marssonii Skuja	+	+	+	+
Cryptomonas ovata Ehr.	+	+	+	+
Cryptomonas rostrata Troitzkaja em. I. Kiselev	+	+	+	+
Rhodomonas minuta Skuja	+	+		+
DINOPHYCEAE				
Ceratium hirundinella (O.F. Müll.) Bergh	+	+	+	+
Gymnodinium albulum Lindemann	+	+	+	+
Peridiniopsis elpatiewskyi (Ostenfeld) Bourrelly	+	+	+	+
Peridinium cinctum (O.F. Müll.) Ehr.	+	+	+	+
Peridinium incospicuum Lemm.	+	+		

The floristic list of all recorded taxa is presented in Table 4. The greatest taxonomic similarity (75%) was observed between pelagic zones of basins III and IV (Table 5).

Table 5

Taxonomic similarity of phytoplankton between sampling stations in the Rosnowskie Duże Lake in 2002-2003 (%)

Wartości podobieństwa taksonomicznego dla poszczególnych stanowisk badawczych Jeziora Rosnowskiego Dużego w latach 2002-2003 (%)

Station Stanowisko	P1	P2	P3
P2	66		
P3	64	69	
P4	68	65	75

Quantitative analysis of planktonic algae showed that total phytoplankton abundance at individual stations in 2002 was much lower than in 2003 (Fig. 3). In 2002, the highest mean total abundance (5380 cells/ml) was recorded in the pelagic zone of basin II, where also the highest mean abundance of green algae was observed (4384 cells/ml), as compared with other stations. The highest mean abundance of cyanoprokaryotes (2291 cells/ml), chrysophytes (622 cells/ml), and dinoflagellates (80 cells/ml) was noted in the pelagic zone of basin I, whereas the highest mean abundance of diatoms (2256 cells/ml) was found in basin IV. The lowest mean total abundance was detected in the pelagic zone of basin III (2472 cells/ml). At all stations in 2002, constant dominants in respect of abundance were: *Kirchneriella contorta* (Schmidle) Bohlin, *Tetraedron minimum* (A. Braun) Hansgirg, *Tetraedron triangulare* Koršikov, *Cyclotella radiosa* (Grun.) Lemm., and *C. distinguenda* Hustedt. Basin I was additionally characterized by the dominance of the cyanoprokaryotes *Planktothrix agardhii* (Gom.) Anagn. et Kom. and *Limnothrix redekei* (Van Goor) Meffert, and the chrysophyte *Dinobryon divergens* Imhoff.

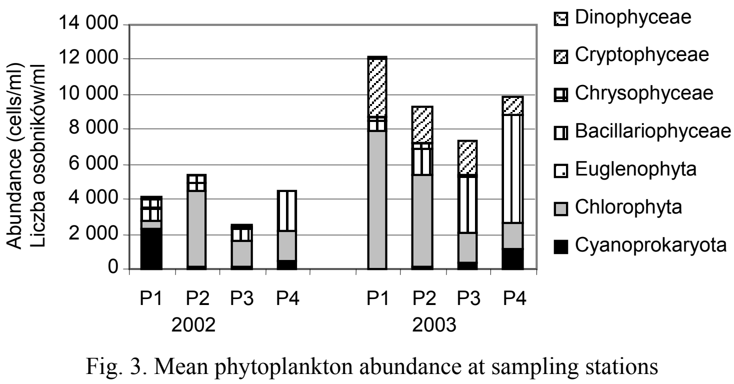

Fig. 3. Mean phytoplankton abundance at sampling stations in the Rosnowskie Duże Lake in 2002 and 2003
Ryc. 3. Średnia liczba osobników fitoplanktonu na poszczególnych stanowiskach w Jeziorze Rosnowskim Dużym w latach 2002 i 2003

In 2003, the highest mean total phytoplankton abundance was found in the pelagic zone of basin I (12 127 cells/ml), where also the highest mean abundance of green algae (7943 cells/ml), cryptomonads (3342 cells/ml) and dinoflagellates (54 cells/ml) was observed. In basin II, the highest mean abundance of chrysophytes (351 cells/ml), was noted, whereas in basin IV, of cyanoprokaryotes (1120 cells/ml) and diatoms (6112 cells/ml). In basin III, as in the year 2002, the mean total phytoplankton abundance was the lowest (7375 cells/ml). Constant dominants in respect of abundance at all studied stations in 2003 were: *Chroomonas acuta* Utermöhl and *Cryptomonas erosa* Ehr. Characteristic dominants for basin I included: *Chlamydomonas globosa* Snow, *Scenedesmus ecornis* (Ehrenb.) Chodat, and *S. dimorphus* (Turp.) Kütz.; for basins I and II: *Ankistrodesmus falcatus* (Corda) Ralfs; for basins II and III: *Crucigenia tetrapedia* (Kirchner) W. et G.S. West; for basins II, III and IV: *Cyclotella distinguenda* Hustedt; and for basin IV: *Planktothrix agardhii* (Gom.) Anagn. et Kom.

Quantitative structure of euglenophytes did not show any differences between the four studied stations.

As in the case of abundance, also values of total phytoplankton biomass at individual stations were much higher in 2003 than in 2002 (Fig. 4). In 2002 the highest mean total biomass was observed in basin I (4.94 mg/l). Cyanoprokaryotes, diatoms, chrysophytes, and dinoflagellates reached their highest mean biomass in basin I (1.7 mg/l, 0.73 mg/l, 1.13 mg/l and 1.08 mg/l, respectively). The highest mean biomass of green algae was recorded in basin II (2.91 mg/l), while of euglenophytes in basin III (0.07 mg/l). The pelagic zone of basin III was distinguished by the lowest mean total phytoplankton biomass (1.55 mg/l) among the studied stations. No considerable differences in biomass of cryptomonads were observed between individual stations. For each sampling station, the taxa that dominated most frequently were distinguished:

– pelagic zone of basin I: *Planktothrix agardhii* (Gom.) Anagn. et Kom., *Limnothrix redekei* (Van Goor) Meffert, *Ankistrodesmus stipitatus* (Chod.) Kom.-Legn., *Cyclotella distinguenda* Hustedt, *C. radiosa* (Grun.) Lemm., *Dinobryon divergens* Imhoff., *Peridiniopsis elpatiewskyi* (Ostenfeld) Bourrelly, *Peridinium cinctum* (O.F. Müll.) Ehr., *Stephanodiscus parvus* Stoermer et Hakansson;

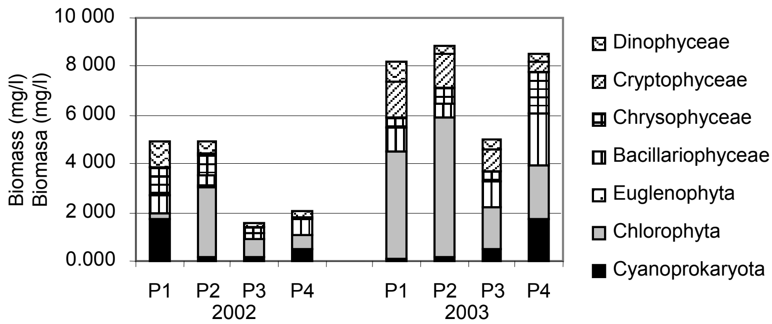

Fig. 4. Mean phytoplankton biomass at sampling stations in the Rosnowskie Duże Lake in 2002 and 2003

Ryc. 4. Średnia biomasa fitoplanktonu na poszczególnych stanowiskach w Jeziorze Rosnowskim Dużym w latach 2002 i 2003

– pelagic zone of basin II: *Fragilaria ulna* var. *acus* (Kütz.) Lange-Bertalot, *C. radiosa* (Grun.) Lemm., *Kirchneriella contorta* (Schmidle) Bohlin, *Coelastrum astroideum* De Notaris, *Pediastrum boryanum* (Turp.) Menegh., *Crucigenia tetrapedia* (Kirchner) W. et G.S. West;

– pelagic zone of basin III: *Dinobryon divergens* Imhoff., *Tetraedron minimum* (A. Braun) Hansgirg, *C. distinguenda* Hustedt, *Staurastrum pseudotetracerum* (Nord.) W. et G.S. West, *Peridinium cinctum* (O.F. Müll.) Ehr., *Ceratium hirundinella* (O.F. Müll.) Bergh;

– pelagic zone of basin IV: *Fragilaria ulna* var. *acus* (Kütz.) Lange-Bertalot, *C. tetrapedia* (Kirchner) W. et G.S. West, *Coelastrum microporum* Nägeli in A. Braun, *Cyclotella distinguenda* Hustedt, *Pediastrum boryanum* (Turp.) Menegh., *Tetraedron minimum* (A. Braun) Hansgirg, *Ceratium hirundinella* (O.F. Müll.) Bergh, *Planktothrix agardhii* (Gom.) Anagn. et Kom.

In 2003, the highest phytoplankton biomass was reached in basin II (8.86 mg/l), where also green algae reached their highest biomass (5.79 mg/l), as compared with other stations. Cryptomonads and dinoflagellates reached their highest biomass in basin I (1.48 mg/l and 0.86 mg/l, respectively), euglenophytes in basin III (0.04 mg/l), while cyanoprokaryotes, diatoms and chrysophytes in basin IV (1.75 mg/l, 2.1 mg/l and 1.78 mg/l, respectively). The lowest total phytoplankton biomass was recorded in basin III (5.02 mg/l). At individual stations, the dominant taxa were:

– pelagic zone of basin I: *Dinobryon divergens* Imhoff., *Chlamydomonas globosa* Snow, *Fragilaria ulna* var. *acus* (Kütz.) Lange-Bertalot, *Chroomonas acuta* Utermöhl, *Scenedesmus ecornis* (Ehrenb.) Chodat, *Pediastrum boryanum* (Turp.) Menegh., *Peridinium cinctum* (O.F. Müll.) Ehr.;

– pelagic zone of basin II: *Crucigenia tetrapedia* (Kirchner) W. et G.S. West, *Ankistrodesmus falcatus* (Corda) Ralfs, *Chroomonas acuta* Utermöhl, *Coelastrum astroideum* De Notaris, *Peridinium cinctum* (O. F. Müll.) Ehr., *Dinobryon divergens* Imhoff.;

– pelagic zone of basin III: *Crucigenia tetrapedia* (Kirchner) W. et G.S. West, *Fragilaria ulna* var. *acus* (Kütz.) Lange-Bertalot, *Chroomonas acuta* Utermöhl, *Cyclotella distinguenda* Hustedt, *Dinobryon divergens* Imhoff., *Peridinium cinctum* (O.F. Müll.) Ehr., *Peridiniopsis elpatiewskyi* (Ostenfeld) Bourrelly, *Planktothrix agardhii* (Gom.) Anagn. et Kom.;

– pelagic zone of basin IV: *Fragilaria ulna* var. *acus* (Kütz.) Lange-Bertalot, *Crucigenia tetrapedia* (Kirchner) W. et G.S. West, *Pediastrum boryanum* (Turp.) Menegh., *Cyclotella distinguenda* Hustedt, *Planktothrix agardhii* (Gom.) Anagn. et Kom.

Additionally, *Cryptomonas erosa* Ehr. and *Staurastrum pseudotetracerum* (Nord.) W. et G.S. West. dominated in respect of biomass at all stations in 2003.

Discussion

Results of this study show that in the Rosnowskie Duże Lake, phytoplankton diversity in the pelagic zone decreased considerably, as compared with earlier research in this zone of the lake (**Juskowiak** 1978, **Organiściak** 1978, **Dąmbska** et **al.** 1981, **Koczorowska** and **Wetula** 1984, **Abulgasem** 1999, **Alsambany** 1999). The analysis of qualitative structure of phytoplankton indicated that basin I was characterized by the lowest number of taxa in comparison with the other basins of the lake. The decrease in species diversity in the lake probably attests to its eutrophication. Many researchers (**Reynolds** 1984, **Philips** 1992, **Sayer** and **Roberts** 2001) reported that in waters with higher concentrations of nutrients (eutrophic and polluted), species diversity is lower than in meso-eutrophic and oligotrophic lakes. The high contribution of green algae (44%) to the total number of phytoplankton taxa during the growing season also suggests that the lake is very fertile (**Kawecka** and **Eloranta** 1994, **Gajdus** 1998). In fact, TSI values based on Secchi depth and chlorophyll *a* concentrations, as a rule indicated that the lake is eutrophic. The highest values of trophic parameters were recorded in basins I and II, which was probably due to the large supply of nutrients from the catchment. Similarly, the highest values of total phytoplankton biomass and abundance were observed in basins I and II. In basins III and IV, around which buildings are less numerous, TSI values based on Secchi depth often showed that lake water is meso-eutrophic.

In the pelagic zone of basin II, the greatest diversity of phytoplankton (particularly of cyanoprokaryotes, green algae and diatoms) and the highest number of exclusive species were recorded. This is probably due to the small depth of the basin. Because of the frequent mixing of water in shallow water bodies, benthic species are sometimes found in their pelagic zones (**Burchardt** and **Messyasz** 2004). An example is the diatom *Gyrosigma attenuatum* (Kütz.) Rabenhorst, which occurred only in the pelagic zone of basin II. The large number of taxa at that station can also be explained by the occurrence of patches of *Ceratophyllum demersum* L. in basin II, which additionally enriched the pelagic waters with periphyton taxa.

The greatest taxonomic similarity was found between basins III and IV, probably due to their similar trophic state and floristic composition (presence of patches with *Nymphaea alba* L.).

Basin III, both in 2002 and 2003, was characterized by the smallest total phytoplankton abundance and biomass. This could be caused by a strong grazing pressure on phytoplankton, exerted by zooplankton. **Kuczyńska-Kippen** and **Cerbin** (1998), on the basis of investigations conducted in basin III, demonstrated that among all lakes of the Wielkopolska National Park, the Rosnowskie Duże Lake ranks second in respect of the highest zooplankton abundance in summer (5092 cells/l).

The large increase in total phytoplankton biomass and abundance in 2003 (as compared with the preceding year) at all sampling stations might result from a rise in concentrations of soluble mineral compounds in waters in all basins of the lake. We also observed an interesting correlation between increased electrolytic conductivity and trophic level in successive basins of the lake and the quantitative structure of phytoplankton. In basin I (where human disturbance was the strongest and conductivity was the highest), green algae and cyanoprokaryotes dominated quantitatively throughout the study period. Basin II was dominated by green algae, basin III by green algae and diatoms, while basin IV by diatoms.

Continuation of phytoplankton research during the growing season in the Rosnowskie Duże Lake would enable an assessment of the rate of eutrophication and further modifications of the qualitative and quantitative structure of phytoplankton communities.

Conclusions

Results of this study show that the structure of pelagic phytoplankton communities in the Rosnowskie Duże Lake is characterized by a great variation in time and space. Its phytoplankton is dominated by green algae, diatoms and cyanoprokaryotes, like in many other eutrophic lakes.

Differences in qualitative and quantitative structure of phytoplankton between individual basins of the lake result from differences in morphometry, location, trophic state, and taxonomic composition of vegetation in those basins.

The analysis of phytoplankton and physicochemical properties of water over time showed that the increase in phytoplankton biomass and abundance is associated with the increasing eutrophication of the lake (particularly of basin I). Thus it is necessary to limit the nutrient loading from the catchment in order to protect the lake against the expansion of macrophytes and further decrease in lake depth.

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CHARAKTERYSTYKA FITOPLANKTONU PELAGICZNEGO CZTERECH BASENÓW JEZIORA ROSNOWSKIEGO DUŻEGO W WIELKOPOLSKIM PARKU NARODOWYM

S t r e s z c z e n i e

Badania fykologiczne prowadzono w czterech basenach Jeziora Rosnowskiego Dużego (w Wielkopolskim Parku Narodowym), zróżnicowanych pod względem morfometrii i składu gatunkowego hydromakrofitów. Próby pobierano z powierzchni wody w strefie pelagialu w czasie sezonu wegetacyjnego, w latach 2002 i 2003.

Celem niniejszej pracy była analiza jakościowa i ilościowa struktury fitoplanktonu pelagicznego oraz ocena stanu troficznego czterech basenów Jeziora Rosnowskiego Dużego.

Dominującą grupą fitoplanktonu były zielenice (głównie z rzędu Chlorococcales), okrzemki i sinice. Największe bogactwo taksonów glonów planktonowych stwierdzono w basenie II, o maksymalnej głębokości wynoszącej zaledwie 3,5 m. Najmniejszą liczbę taksonów odnotowano w basenie I (najbardziej eutroficznym).

Największą liczebność oraz biomasę fitoplanktonu wykazano w basenach I i II. Najmniejszą liczebność i biomasę glonów obserwowano w basenie III, prawdopodobnie wskutek ich wyjadania przez zooplankton.

W 2003 roku liczebność i biomasa fitoplanktonu w czterech basenach jeziora znacznie wzrosły, wraz ze wzrostem wartości przewodnictwa elektrolitycznego.

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