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DYNAMICS OF PHYTOPLANKTON BIOMASS IN TWO LAKES OF A DIFFERENT LIMNOLOGICAL CHARACTER*

ABSTRACT: The changes in total biomass of phytoplankton and nannoplankton are presented. The study was conducted in two lakes of the Lublin region: in a-mesotrophic, holomictic Lake Piaseczno and in eutrophic, polimictic Lake Bikcze. The biomasses were the highest in spring and in summer, and the lowest in winter. Nannoplankton contribution was the greatest from autumn till early spring. The changes in the percentage of systematic groups depended on the season of the year and on the lake.

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1. INTRODUCTION

In the hydrobiological literature there are several papers on the relations between the trophic character of lakes and the biomass of their phytoplankton. Many authors (Micheeva 1970, Hillbricht-Ilkowska, Pieczyńska and Pieczyński 1971, Winberg, Babickij and Gavrilov 1971, Willen 1972, Kyvask 1973,

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Lavrenteva 1973) say that the biomass (and numbers) of phytoplankton increases together with the degree of lake eutrophy. The relation between biomass and productivity of phytoplankton is also connected with the character of lake trophy. Findenegg (1965) has observed that the size of phytoplanktonic organisms is an important factor having an influence upon this correlation. Nannoplanktonic species dominated in the not very abundant but highly productive phytoplankton of oligotrophic lakes whereas microplanktonic species dominated in fertile lakes. High productivity of nannoplanktonic species at a simultaneously low biomass and a low microplankton productivity at high biomass, are confirmed also by the studies of Mac Arthur and Connell (1971), Kajak, Hillbricht-Ilkowska and Pieczyńska (1972). Also several authors (Hillbricht-Ilkowska, Pieczyńska and Pieczyński 1971, Pechlaner 1971, Kyvask 1973) confirm the fact of more abundant occurrence of nannoplanktonic forms in lakes having a lower degree of trophy.

Another important algological problem, frequently discussed, is the problem of seasonal dynamics of phytoplankton which is mentioned, amongst other things, in this paper. Many authors (Goldman et al. 1968, Winberg 1971, Nikolaev 1972, Hickman 1974) confirm the seasonal character of occurrence of particular systematic groups. According to Round (1971) in the so-called pure lakes characteristic are the spring and autumn maxima of phytoplankton growth which are mainly influenced by light, temperature and nutrients. In the winter, low temperature and unfavourable light conditions limit the phytoplankton growth, whereas in the summer the defficiency of mineral salts. Lecewicz, Sokołowska and Wojciechowski (1973) have observed that in the winter the increasing amount of light penetrating through the ice cover increases the abundance of phytoplankton even at typical winter temperatures.

The aim of this study was to present comprehensively the changes in phytoplankton and its components in an annual cycle during two consecutive years as depending on the season of the year and on the character of the lake. The biomass was used as an index of quantitative changes of phytoplankton.

2. CHARACTERISTIC OF LAKES

The study was conducted in two lakes of the Łęczyńsko-Włodawskie Lakeland (Pojezierze Łęczyńsko-Włodawskie) (Lublin province): lakes Piaseczno and Bikcze.

Lake Piaseczno has a surface area of 85 ha and a maximum depth of 38.8 m (Wilgat 1953). It is an a-mesotrophic, holomictic lake with distinct thermal stratification. At the beginning of April in 1971 and at the beginning of March in 1972 when the ice cover was thawing the lake began its spring circulation and the summer thermal stratification was already observed in May 1971 and in April 1972. Epilimnion was usually 7 m thick, whereas the metalimnion reached the depth of 12 m. The greatest difference in temperatures between the epi- and hypolimnion was recorded in August 1971 and in July 1972. The highest content of oxygen dissolved in water was usually found on the border of meta- and hypolimnion, and the saturation of water with oxygen in the hypolimnion did not decrease below 40% in the period investigated. The water in Lake Piaseczno had a green colour. Transparency and transmission of water were always high and the visibility measured by Secchi's disc fluctuated within a year from 5.2 to 8.7 m. The reaction of surface water layers changed within the pH limits of 6.2–7.8. The autumn circulation in Lake Piaseczno began in the first days of October in both years. As soon as the ice cover appeared at the turn of December the lake underwent the winter stagnation which lasted about 3 months.

Lake Bikcze is a shallow, strongly overgrown water body of a surface area 85 ha and of a maximum depth 3.3 m (Wilgat 1953). Fijałkowski (1959) has determined this lake as an eutrophic one. According to the criteria of Stangenberg (1936) this is a pond lake. Here, it has been assumed that Lake Bikcze is a pond lake of an eutrophic character. The water in Lake Bikcze had usually a yellow colour, sometimes yellow-green. The visibility in the winters of 1971 and 1972 reached the bottom, during the warm seasons of the year it decreased to 0.5 m. Lake Bikcze is a polimictic water body. The highest thermal gradient was observed in the winter e.g. in February 1972 the temperature of water directly under the ice was 1.0°C, and at the bottom 4.9°C. The oxygen content in water was always high at a small quantitative differentiation due to the depth. The reaction of water was always basic within the pH limits of 7.3–8.1. The dates at which Lake Bikcze became frozen were 5 days earlier than those for Lake Piaseczno.

The snow cover on both lakes was slight. It appeared only at the beginning and at the end of the winter in 1971, whereas it did not occur at all in 1972 thus allowing the light to penetrate the water in both lakes (Lecewicz, Sokołowska and Wojciechowski 1973).

The changes of physical and chemical factors in 1971 for both lakes are described in a paper by Brzęk et al. (1975), and for Lake Bikcze in both years of investigations in a paper by Wojciechowski (1976).

3. METHODS

The study was conducted in two consecutive years, in 1971 and 1972. Field work was carried out in all seasons of the year, once a week usually in three successive weeks with intervals of 3–6 weeks (exceptionally 12 weeks) between the 3-week series of investigations, according to the season of the year. On the whole, at 29 dates in Lake Piaseczno and at 32 dates in Lake Bikcze, during the 2 years of investigations. At each date, study of abiotic environmental factors was made simultaneously with plankton sampling.

In both lakes, the study was conducted in the pelagial, on sites close to the maximum depth points. In Lake Piaseczno Bernatowicz's(1953) sampler, 0.5 m in height and of 5 l capacity, was used for sampling from successive water layers every one metre down to the depth of 20 m, whereas at greater depths every 5 metres. The samples were poured together. In Lake Bikcze, Patalas (1954) sampler, 30 cm in height and of 2 l capacity, was used for sampling from three evenly distributed water layers, which were afterwards constituting one sample. For each joint sample a representative sample of a capacity 250 ml was taken, then fixed in Lugol liquid and preserved in 3% formalin with glycerin.

Microscopic analyses of samples allowed to determine the species composition of phytoplankton. The numbers of phytoplankton were determined using Utermöhl's "inverted" microscope (after Vollenweider 1969) in chambers of a capacity from 5 to 100 ml depending on plankton concentration.

In order to calculate the biomass 10 specimens of each species were measured separately for each lake and for each season of the year, in samples from Lake Piaseczno specimens from each thermal layer were measured. In one season of the year about 80 species were recorded on average. Then for each species the mean dimensions of cells or colonies (depending on the form in which they occurred and on the counted forms) were calculated separately for a given season of the year and a given lake. The algal volume was calculated by comparing each species to an appropriate geometrical figure.

In the calculations of algal volume into mass it was assumed after several authors (Pavoni 1963, Goldman et al. 1968) that the weight density of planktonic algae is 1.0. The numbers and biomass were calculated per water volume unit (litre) and per surface area unit of the lake (m^2). The concentration of phytoplankton biomass unit in a water volume unit was expressed in $\mu g/l$, and the biomass values in the entire water column in mg/m^2.

4. RESULTS

4.1. Comparison of phytoplankton biomass in different seasons of the year, in different years and lakes

In both lakes the lowest values of phytoplankton biomass were recorded in winter and the highest in summer (Fig. 1). In Lake Piaseczno in each season of 1971 the biomass was lower than at analogous periods in 1972, the extreme values, indicated by horizontal lines in the

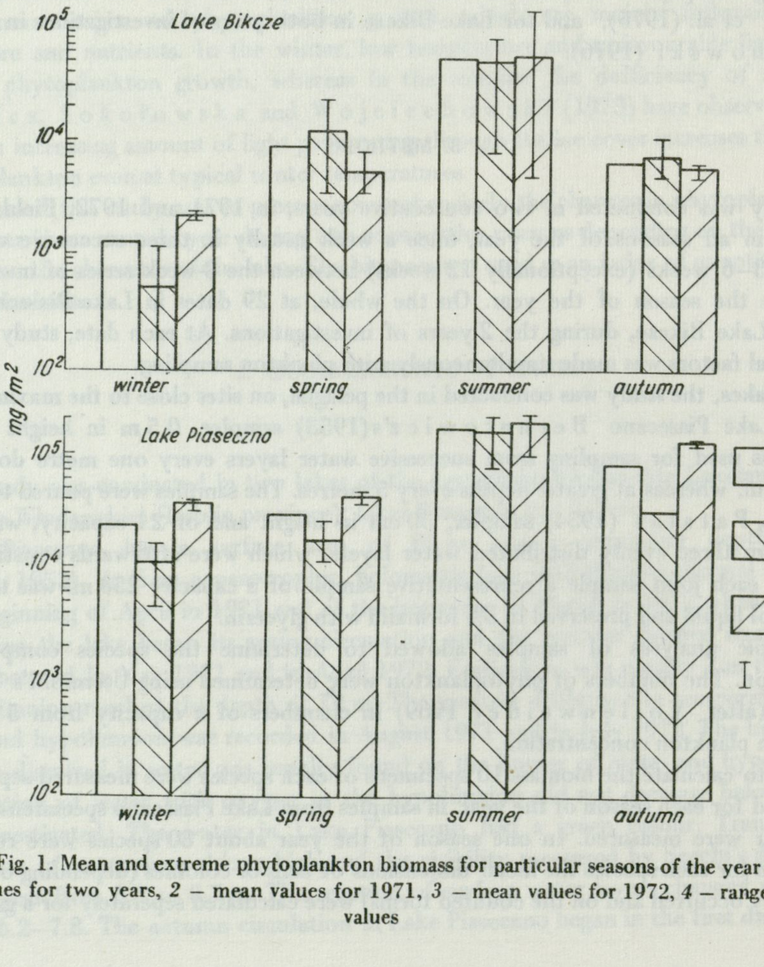

Fig. 1. Mean and extreme phytoplankton biomass for particular seasons of the year
1 – mean values for two years, 2 – mean values for 1971, 3 – mean values for 1972, 4 – range of extreme values

Table I. Phytoplankton biomass (μg/l) in limnetic layers of lakes Piaseczno and Bikcze in successive seasons in 1971 and 1972

Lake	Limnetic zones	Values	1971				1972			
			winter	spring	summer	autumn	winter	spring	summer	autumn
Piaseczno	epilimnion	mean	599	721	9,179	858	983	1,633	10,475	3,589
		extreme	244–1,350	416–1,027	3,238–16,310	858	650–1,600	1,000–2,200	5,332–14,604	3,478–3,700
	metalimnion	mean	206	839	12,141	909	2,050	1,600	7,923	3,547
		extreme	151–269	285–1,826	6,839–19,542	909	1,150–3,200	1,300–1,800	4,577–12,923	3,545–3,683
	hypolimnion	mean	250	360	1,679	978	773	1,016	3,478	3,990
		extreme	80–417	200–509	901–2,585	978	650–900	950–1,100	2,006–4,706	3,800–4,180
Bikcze		mean	260	6,256	25,118	3,914	1,100	2,799	28,721	3,053
		extreme	38–515	1,862–11,956	4,260–40,609	2,748–5,081	1,053–1,148	1,752–4,353	2,698–77,797	2,500–3,360

figure, were also lower in 1971. In Lake Bikcze the biomass of winter phytoplankton was higher in 1972, of spring phytoplankton in 1971, and in summer and autumn of both years the biomass was similar. The range of biomass changes within a year, calculated as a ratio of the lowest biomass value to the highest one, was for both lakes higher in the first year than in the second one. In Lake Piaseczno it was 1:59 in 1971 and 1:7 in 1972, and in Lake Bikcze 1: 1,057 and 1:74, respectively.

The above comparison points to a greater variability of phytoplankton biomass in Lake Bikcze than in Lake Piaseczno, at higher absolute values of biomass in Lake Piaseczno (Fig. 1). The biomass for Lake Piaseczno was higher only when comparing the values from the entire water column (under 1 m^2) of both lakes. This is due to the greater depth of Lake Piaseczno and the considerable transparency of water there, because the phytoplankton concentration in a water volume unit was usually greater than in Lake Bikcze (Table I). In the deep Lake Piaseczno the biomass concentration in one litre varied in particular thermal layers. In the first year of investigations, from January to May, the biomass concentration was the highest in the epilimnion, and later on (from May to November) in the metalimnion. And it remained thus in the latter during the whole winter of 1972 (no snow on the ice cover) and in early spring (up to May 3, 1972). Afterwards up to October 17 the maximum biomass was observed in the epilimnion contrariwise to analogous seasons of the previous year. During the periods of water circulation the vertical distribution of total phytoplankton biomass was more or less even, e.g. on November 10, 1971 at complete homothermy there were 858 μg/l in the epilimnion, 909 μg/l in the metalimnion and 978 μg/l in the hypolimnion.

4.2. Nannoplankton contribution to total phytoplankton biomass

When dividing the phytoplankton into micro- and nannoplankton the size limit of body length was assumed as 60 μm after Starmach (1955). Because of the small size of nannoplanktonic species in comparison to microplankton their contribution to numbers (Wojciechowska 1976) was much greater than to the biomass. For example, on June 9, 1971 *Chlorella vulgaris* Beijer. was 15% of the total phytoplankton number in Lake Bikcze, but only 0.3% of its biomass. The changes in total biomass of phytoplankton and in the contribution of micro- and nannoplankton during the period examined are presented for both lakes in Figures 2 and 3.

In Lake Piaseczno, in all seasons of the year, the main species of the nannoplanktonic fraction (Fig. 2) was *Cryptomonas pusilla* Bachm., and apart from it there were smaller numbers of *Monoraphidium minutum* (Näg) Kom.-Legn., *Chlorella vulgaris*, *Mallomonas caudata* Iwanoff and less numerous species of the genera *Ankistrodesmus*, *Oocystis* and others. The nannoplankton biomass was the greatest in Lake Piaseczno in the winter-autumn periods and in late autumn. Only at the beginning of the winter (January 18) of 1971 in the epilimnion the nannoplankton did not contribute much to the total phytoplankton biomass. This was caused by microplanktonic colonies of blue-green algae of the genera *Microcystis* and *Aphanothece* which probably survived since autumn. At the same year, on March 1, in the hypolimnion large colonies of *Aphanothece clathrata* W. et G. S. West appeared decreasing in this water layer the contribution of nannoplankton. In summer periods nannoplankton contribution decreased below 20% due to the development of microplanktonic forms, mainly of the groups

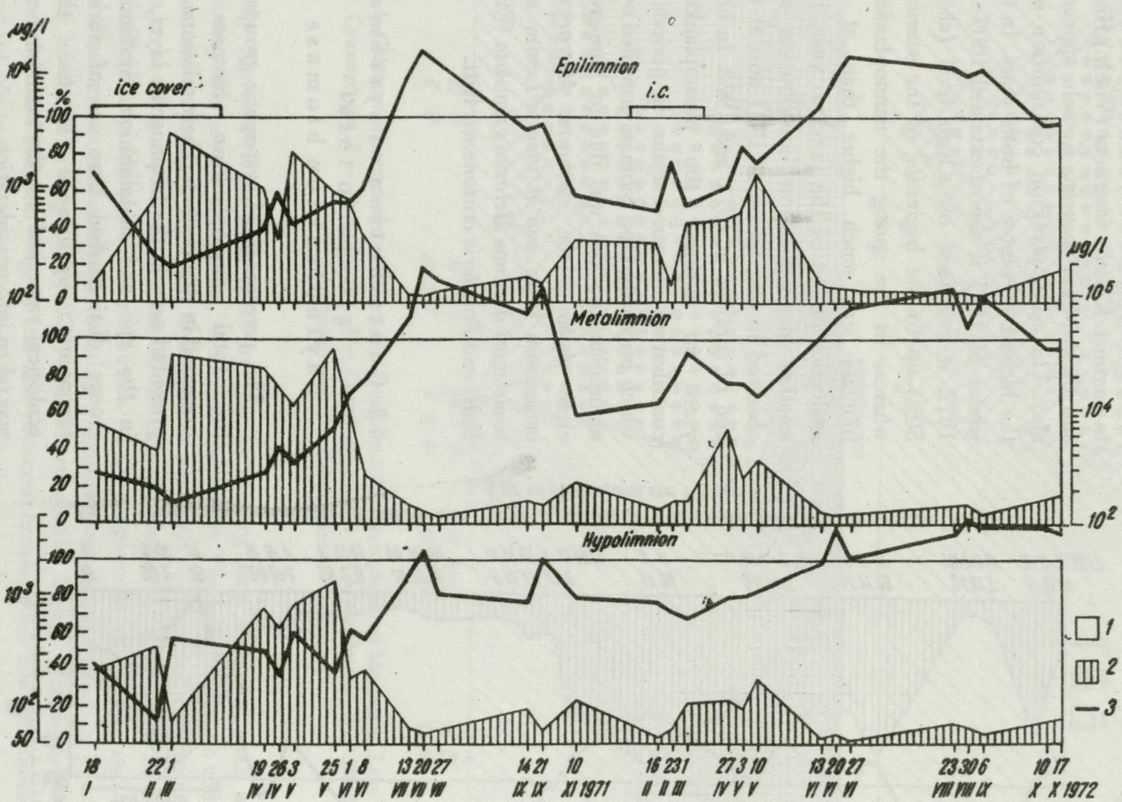

Fig. 2. Changes in percentage of micro- and nannoplankton in total phytoplankton biomass and changes in total phytoplankton biomass in Lake Piaseczno

1 — microplankton, *2* — nannoplankton, *3* — total phytoplankton biomass

Cyanophyta and *Chlorococcales.* Simultaneously the absolute values of biomass of *Cryptomonas pusilla* and nannoplanktonic species of the order *Chlorococcales* decreased. In autumn of both years the biomass of all species forming the nannoplankton increased again.

The main nannoplankton components (Fig. 3) in Lake Bikcze were *Cryptomonas pusilla* and other species of the genus *Cryptomonas,* and less numerously represented species of the genera *Trachelomonas, Chlorella* and *Scenedesmus.* In summer *Koliella longiseta* (Visch.) Hind, and *Elakatothrix lacustris* Korsch. appeared also. The nannoplankton contribution was the highest in winter of both years. In the winter of 1971 it almost attained 100%. In 1972 it remained on a high level (above 50%) up to the beginning of the summer, whereas in the spring the nannoplankton biomass was much higher than at an analogous period of the previous year. The smallest nannoplankton contribution was observed in late spring of 1971 and at the end of summer in 1971 and 1972. In both years, in autumn, the nannoplankton contribution increased again. In periods in which microplankton biomass prevailed over nannoplankton this was due to blue-green algae *Aphanothece clathrata*, *Microcystis aeruginosa* Kütz. and *M. incerta* Lemm. and sometimes diatoms *Melosira granulata* (Ehr.) Ralfs and *Fragilaria crotonensis* Kitt.

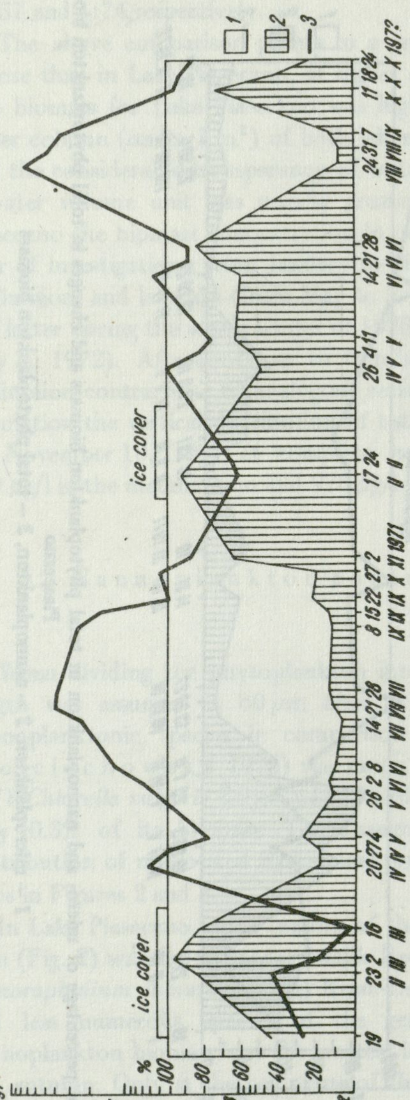

Fig. 3. Changes in percentage of micro- and nannoplankton in total phytoplankton biomass in Lake Bikcze
For explanations see Figure 2

4.3. Contribution of systematic groups to total phytoplankton biomass

The percentage of systematic groups in the total phytoplankton biomass is presented in Figures 4–6. These relations are presented only in the trophogenic layer, i.e. in the epi- and metalimnion. Systematic groups distinguished here are of various taxonomic significance because their ecological value and not the taxonomic one was taken into consideration.

The varying contribution of systematic groups to total biomass was to some extent due to the varying numbers of organisms belonging to particular groups, but mainly depended on the size of organisms. Therefore, systematic groups, mainly consisting of large species, highly contributed to total phytoplankton biomass. This observation can be illustrated by the contribution of *Cyanophyta* to phytoplankton

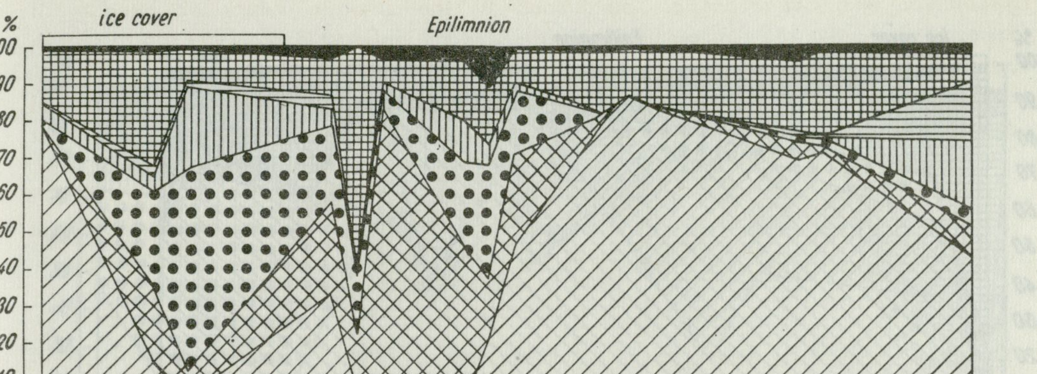

Fig. 4. Changes in percentage of systematic groups in total phytoplankton biomass in Lake Piaseczno in 1971
1 — Cyanophyta, 2 — Dinophyceae, 3 — Cryptophyceae, 4 — Chrysophyceae, 5 — Bacillariophyceae, 6 — Chlorococcales, 7 — Conjugatae + Volvocales

mainly represented in both lakes by species forming large colonies, such as *Aphanothece clathrata*, *Microcystis aeruginosa*, *M. incerta* and others. For instance, in the epilimnion of Lake Piaseczno, on January 18, 1971, *Cyanophyta* were only 7.4% of total phytoplankton numbers (Wojciechowska 1976), but 77.6% of total biomass (Fig. 4). Later on in the winter of 1971 (February, March) the contribution of *Cryptophyceae* in the epi- and metalimnion of Lake Piaseczno considerably increased at a simultaneous disappearance of *Cyanophyta*. In the winter of the following year (1972) the *Chlorococcales* highly contributed to both thermal layers of Lake Piaseczno (Fig. 5) and *Botryococcus braunii* Kütz was the dominant species. An important phytoplankton component in shallower water layers in the winter of 1972 was the group *Dinophyceae* and species *Ceratium hirundinella* (O. F. Müll.)Bergh and *Peridinium bipes* Stein contributed mainly to its biomass. In the spring of the first year the contribution of *Cryptophyceae* was high. Rapidly, but for a short time, increased the contribution of *Chlorococcales* in the epilimnion (April 26) due to the "explosive" development of

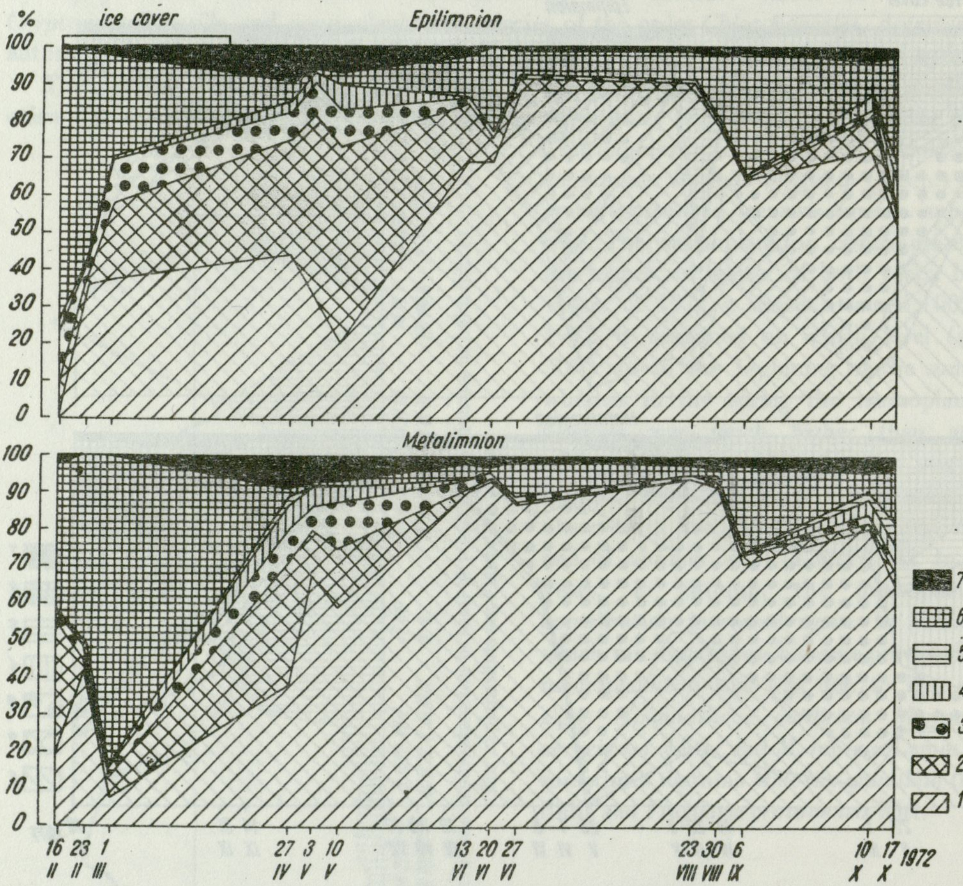

Fig. 5. Changes in percentage of systematic groups in total phytoplankton biomass in Lake Piaseczno in 1972
For explanations see Figure 4

Botryococcus braunii. But in 1972, at the first dates of spring investigations in Lake Piaseczno, the contribution of *Cyanophyta* increased rapidly. Only the contribution of *Dinophyceae* increased similarly as in the previous year which was especially visible in the epilimnion.

In summer periods the phytoplankton biomass in Lake Piaseczno had a similar structure in both years. *Cyanophyta* dominated in all thermal layers of the lake and attained this domination much quicker in 1972 than in 1971. A relatively high contribution in summer periods was also shown by *Chlorococcales* (with the main species *Botryococcus braunii*).

In both years, in autumn, in Lake Piaseczno the biomass of *Cyanophyta* decreased. While it decreased the contribution of other systematic groups increased. In 1971 the contribution of *Bacillariophyceae* and *Chrysophycae* increased most and in 1972 that of *Chlorococcales*.

The dynamics of superior systematic groups in the phytoplankton of Lake Bikcze also varied in both years of investigations.

In winter periods of 1971 the *Cryptophyceae* with dominant species *Cryptomonas pusilla*

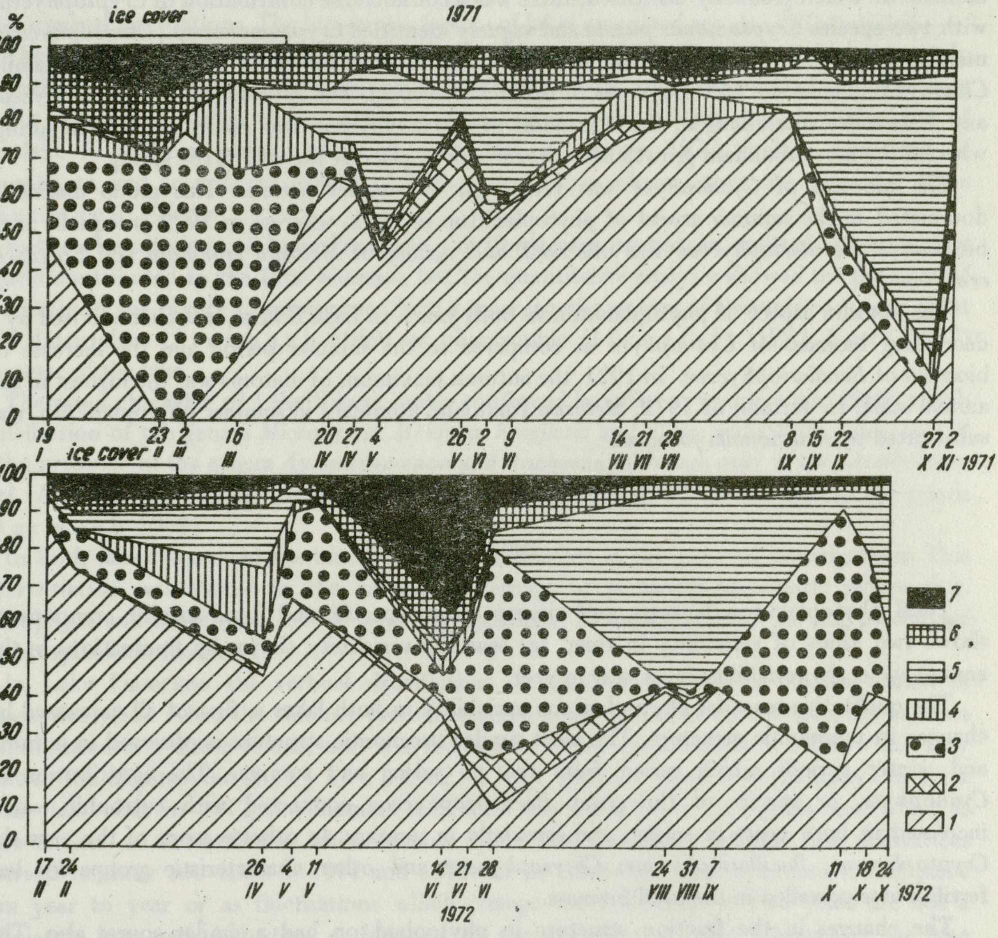

Fig. 6. Changes in percentage of systematic groups in total phytoplankton biomass in Lake Bikcze
For explanations see Figure 4

dominated in total phytoplankton biomass of Lake Bikcze (Fig. 6). Whereas in winter of 1972 (Fig. 6) the *Cyanophyta* distinctly dominated in total phytoplankton biomass and the contribution of other systematic groups was very small. In both years, in spring, the *Cyanophyta* also considerably contributed to total phytoplankton biomass. Species *Microcystis aeruginosa* and *Aphanothece clathrata* decided mainly about this biomass.

In spring periods of both years a considerable percentage of total phytoplankton biomass of Lake Bikcze were the *Bacillariophyceae*. In both years, their contribution was much higher than in the plankton of Lake Piaseczno, but each year different species decided about the biomass of this group. In 1971, there was a considerable contribution of *Cyclotella comta* Ehr. (maximum on May 4), and in the next year *Fragilaria crotonensis* and *Asterionella formosa* Haas were the main components of diatom biomass. In the spring of 1972, apart from blue-green algae the biomass of which gradually decreased, there was a considerable contribution of *Cryptophyceae* with two species *Cryptomonas pusilla* and vaguely identified *Cryptomonas* sp., *Chrysophyceae*, mainly *Dinobryon divergens* Imh. and *Volvocales* (primarily small species of the family *Chlamydomonadaceae* and zoospores of other *Volvocales*). The appearances of *Chrysophyceae* and *Volvocales* interchanged; the maximum of *Chrysophyceae* was recorded early in spring, whereas the most abundant growth of *Volvocales* took place at the end of the spring.

The biomass of *Cyanophyta* was very high in summer periods. This group distinctly dominated in the summer aspect of phytoplankton in 1971, whereas in 1972 an equally high biomass of *Bacillariophyceae* was observed, and mainly of *Melosira granulata* and *Fragilaria crotonensis.*

The autumn aspect of phytoplankton in both years, in Lake Bikcze, was characterised by a decreasing biomass of *Cyanophyta* as compared to the summer period and the increase of biomass of *Bacillariophyceae.* In 1971, the autumn maximum of diatoms was the highest in the annual scale. In autumn of 1972, *Melosira granulata,* dominant in summer phytoplankton, was substituted by *Asterionella formosa.*

5. DISCUSSION

Total phytoplankton biomass and biomass of its specific and supra-specific components shows two kinds of variability in time: (a) seasonal variability shown by fluctuations in the annual cycle, (b) variability from year to year.

The qualitative seasonal phytoplankton variability in both lakes is first of all expressed by changes in taxonomic structure. The most similar taxonomic structure is observed in autumn and winter periods which varied from that in spring and summer. The contribution of *Cyanophyta*, or species of the group *Bacillariophyceae* connected with eutrophic water, increased in both years in spring, and especially in summer. In other seasons of the year the *Cryptophyceae*, *Bacillariophyceae*, *Chrysophyceae* and other characteristic groups for less fertile water prevailed in the total biomass.

The changes in the fraction structure in phytoplankton had a similar course also. The highest nannoplankton biomass in both lakes was observed in periods from late autumn till early spring. Similar seasonal changes in nannoplankton were observed in the eutrophic Mikołajskie Lake by Spodniewska, Hillbricht-Ilkowska and Węgleńska (1973). According to Hillbricht-Ilkowska, Pieczyńska and Pieczyński (1971) the contribution of nannoplankton to total phytoplankton biomass increases as the extent of water body eutrophication decreases. Similar conclusions may be drawn from the observations of Findenegg (1965): (a) nannoplankton has a much higher photosynthetic activity than microplankton, (b) phytoplankton of oligotrophic lakes, largely formed of nannoplankton, is more productive than the phytoplankton of eutrophic lakes which consists mainly of microplankton.

As regards the annual cycles of changes in total phytoplankton biomass of both lakes the highest values were recorded in summer periods, and the lowest in winter periods. Spodniewska, Hillbricht-Ilkowska and Węgleńska (1973) have observed a similar seasonal variability of total phytoplankton biomass in Mikołajskie Lake in consecutive years and came to the conclusion that the increase of phytoplankton biomass in summer is a symptom of eutrophication.

The above biocenotic criteria for estimating the trophic character of both lakes point to their seasonal fluctuations. The biocenotic factors of lakes examined are also differentiated.

The general taxonomic structure of phytoplankton of Lake Piaseczno which is mainly consisting of *Dinophyceae*, *Chrysophyceae*, *Bacillariophyceae* and *Chlorococcales* is according to Starmach (1969) characteristic of oligotrophic lakes. Whereas the phytoplankton of this lake in summer periods of both years and of autumn 1972, mainly composed of *Cyanophyta* and to a lesser extent of *Chlorococcales*, is characteristic of eutrophic lakes (Starmach 1969).

In the characteristic of Lake Piaseczno the *Conjugatae* cannot be omitted although they slightly contributed to the total biomass, but the quantitative analyses showed the presence of 26 species of the family *Desmidiaceae*. Such a great specific variety of *Desmidiaceae* may point to a dystrophic (Starmach 1969) or oligotrophic (Järnefelt 1952, Fott 1967) character of the lake.

The pond character of Lake Bikcze is also confirmed by (after Starmach 1969) a high contribution of the genera *Microcystis*, *Melosira*, *Fragilaria* and of the order *Volvocales*, as well as the presence of the genera *Aphanizomenon* and *Anabaena*, although only at the adomination level. Also, the succession of systematic groups, especially in 1971, was typical for ponds (Starmach 1969).

In both lakes examined the biocenotic factors differed in the years of investigations. This differentiation was visible in the varying percentage of particular systematic groups (e.g. *Cyanophyta* and *Cryptophyceae*) in total phytoplankton biomass and in the varying percentage of phytoplankton fractions.

In Lake Piaseczno the vertical distribution of total phytoplankton biomass varied in consecutive years. After the summer period, assumed as characteristic for the lake, the biomass concentration in a water volume unit was the highest in the metalimnion in 1971, which may point to the oligotrophic (Lityński 1952, Fott 1967) or close to oligotrophy character of the lake. But in 1972 the biomass maximum was recorded in the epilimnion, which is characteristic of more fertile lakes. It is a matter for discussion whether the differences observed in these two lakes in 1971 and 1972 can be considered as fluctuations taking place from year to year or as fluctuations which change the lake trophy. Two years are not a sufficiently long period to draw conclusions on the evolution of lakes. Changes in the lake trophy have been shown by: Spodniewska, Hillbricht-Ilkowska and Węgleńska (1973), Spodniewska (1974), Edmondson (1961, 1966, 1968) on the basis of several years of investigations.

6. SUMMARY

The aim of this paper was to present the changes in phytoplankton biomass in relation to the seasons of the year and the limnological character of lakes. The study was carried out in the pelagial of two lakes: a-mesotrophic, holomictic Lake Piaseczno of a maximum depth 38.8 m; eutrophic, polimictic Lake Bikcze of a depth of 3 m. Firstly the phytoplankton numbers were determined using Utermöhl's method (after Vollenweider 1969), then the specimens of each species were measured and their volume was calculated by comparing them to appropriate geometrical figures. In calculations of the volume of species into mass it was assumed that the specific density of planktonic algae is 1.0.

In both lakes the values of phytoplankton biomass were the lowest in winter and the highest in summer (Fig. 1). The qualitative seasonal phytoplankton variability in both lakes was primarily expressed by changes in the taxonomic structure of this community (Figs. 4, 5, 6). In both lakes, in spring and summer, the *Cyanophyta* and species of the group *Bacillariophyceae* connected with eutrophic water contributed highly

to total phytoplankton biomass. In other seasons of the year *Cryptophyceae*, *Bacillariophyceae*, *Chrysophyceae* and other groups characteristic for less fertile water prevailed.

The changes in the structure of dimension fractions in phytoplankton were also similar. In both lakes, the nannoplankton biomass and its contribution to total biomass were the highest from late autumn till early spring (Figs. 2, 3). The differentiated trophic character of lakes was reflected in the differentiated phytoplankton biomass. Biomass concentration in a water volume unit was usually higher in Lake Bikcze (Table I). The frequently observed biomass concentration in the metalimnion of Lake Piaseczno is characteristic for oligotrophic lakes or those close to oligotrophy. The species diversity and nannoplankton contribution were higher in Lake Piaseczno thus pointing to its lower fertility as compared to Lake Bikcze.

The biocenotic factors were also different in these lakes in 1971 and 1972. As these differences are only for two consecutive years it is quite possible that these are fluctuations taking place from year to year.

7. POLISH SUMMARY (STRESZCZENIE)

Celem pracy było przedstawienie zmian biomasy fitoplanktonu w zależności od pory roku i charakteru limnologicznego jezior. Badania prowadzono w pelagialu dwóch jezior: a-mezotroficznego, holomiktycznego jeziora Piaseczno o głębokości maksymalnej 38,8 m i jeziora Bikcze – eutroficznego, polimiktycznego, o głębokości 3 m. Najpierw określono liczebność fitoplanktonu metodą Utermöhla (wg Vollenweidera 1969), następnie mierzono okazy każdego gatunku, a ich objętości obliczano przyrównując je do odpowiednich brył geometrycznych. Przy przeliczaniu objętości gatunków na masę przyjmowano, że ciężar właściwy (względny) planktonowych glonów = 1,0.

W obydwu jeziorach najniższe wartości biomasy fitoplanktonu stwierdzono w zimie, a najwyższe latem (fig. 1). Jakościowa zmienność sezonowa fitoplanktonu w obydwu jeziorach wyrażała się przede wszystkim zmianami taksonomicznej struktury tego zbiorowiska (fig. 4, 5, 6). W obydwu jeziorach wiosną i latem duży udział w ogólnej biomasię fitoplanktonu miały *Cyanophyta* i gatunki z gromady *Bacillariophyceae*, związane z wodami eutroficznymi. W pozostałych porach roku przeważały *Cryptophyceae*, *Bacillariophyceae*, *Chrysophyceae* i inne grupy charakterystyczne dla wód mniej żyznych.

Również zmiany struktury frakcji wielkościowych w fitoplanktonie przebiegały podobnie. W obydwu jeziorach największą biomasę nannoplanktonu i największy jego udział w ogólnej biomasie stwierdzono w okresach od późnej jesieni do wczesnej wiosny (fig. 2, 3). Zróżnicowanie charakteru troficznego jezior miało odbicie w zróżnicowaniu biomasy ich fitoplanktonu. Koncentracja biomasy w jednostce objętości wody była zwykle większa w jeziorze Bikcze (tab. I). Skupienie biomasy w metalimnionie, często obserwowane w jeziorze Piaseczno, było charakterystyczne dla jezior oligotroficznych lub zbliżonych do tego typu. Różnorodność gatunkowa i udział nannoplanktonu – większe w jeziorze Piaseczno – też wskazywały na mniej żyzny charakter tego zbiornika w porównaniu z jeziorem Bikcze.

W obydwu jeziorach stwierdzono też zróżnicowanie czynników biocenotycznych pomiędzy latami badań. Ponieważ różnice dotyczyły dwóch kolejnych lat, być może, że są to tylko często opisywane fluktuacje zachodzące z roku na rok.

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