Qualitative and quantitative studies on phytoplankton and chlorophyll content in the pelagic water of Lake Żarnowieckie in 1974

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Abstract

Species composition of phytoplankton, its biomass, share of nannoplankton, and concentration of chlorophyll and pheophytin in phytoplankton and nannoplankton were assessed basing on the materials collected from two pelagic stations of Lake Żarnowieckie during the period 30 March — 6 December 1974. Average and maximal values of phytoplankton biomass (4—5 and 10—11 mg/l respectively), as well as the concentration of chlorophyll (1.7—10.0 µg/l together with pheophytin) point to slightly advanced eutrophication of the lake. Share of nannoplankton in total phytoplankton biomass was very low (as a rule below 3%) with an increase to 15% only in spring. Relatively slight taxonomic differentiation of phytoplankton (164 taxons), its qualitative composition with the predominance of *Cyanophyceae* in summer, and of *Bacillariophyceae* in spring and autumn, as also seasonal succession of algae, point to eutrophic character of the lake.

INTRODUCTION

Studies on phytoplankton in Lake Żarnowieckie were carried out within a collective limnological programme undertaken by the Inland Fisheries Institute, together with the Department of Hydrobiology of the Institute of Ecology of the Polish Academy of Sciences, and the Department of Hydrobiology of the Zoological Institute of the University of Warsaw, under the commission of the Institute of Water Constructions of the Polish Academy of Sciences. They were aimed at obtaining an overall picture of environmental elements of lake biocenosis in order to create basis for future assessment of changes induced in the lake by the construction of a pump-hydroelectric power station. Results

of these studies will also serve as a basis for forecasting changes in water bodies induced by similar constructions.

The present paper presents preliminary characteristics of the community of planktonic algae in Lake Żarnowieckie; the Inland Fisheries Institute will continue observations on this lake for the next few years.

DESCRIPTION OF THE AREA AND METHODS

Coastal Lake Żarnowieckie is situated in the northern Poland, in the Gdańsk Voivodeship. Direct surroundings of the lake are rather rich — they consist mainly of aerable lands, and to a smaller extent of forests and pasture areas. On the other hand catchment area of the main inflow — the Piaśnica River, is poor and covered with forrests. The lake is 7.6 km long and 2.6 km wide, with maximal depth of 19.4 m. It extends along the N-S direction (Management Programme of Lake Żarnowieckie, 1968). Shape of the lake, its size (14 km²), and location, favour intensive mixing of waters by wind action. The lake is characterized by poorly developed shore line — index of shore line development amounts to only 1.39. Bottom of the lake can be divided into the following zones: littoral, extending up to the depth of 5 m and covering about 45% of the total lake area, profundal (below the depth of 10 m) occupying 45% of the total area, and a narrow belt of sublittoral, constituting 10% of the lake area.

Characteristic of algal community in Lake Żarnowieckie was based on materials collected from two pelagic stations, located at the depth of about 16 m in the northern and southern part of the lake. Samples were collected from March on the first station, and from May on the second, to December 1974. Detail dates of sampling are presented in Table 1.

Three phytoplankton and chlorophyll samples were collected each time from the following water layers: 0—5 m, 6—10 m, 11—16 m. Volume of samples used for quantitative analysis of phytoplankton amounted to 0.5 l. They were prepared by mixing equal volumes of water collected every 1 m within the range of a given water layer. In order to obtain larger amounts of phytoplankton, necessary for taxonomical analysis, each time one additional sample was also collected by filtering 85 l of water through the net made of blotting-cloth No. 25. These samples were collected with the 5 l Bernatowicz sampler, every 1 m from the surface to the bottom, and served as the basic material for floristic composition of the algae. Quantitative relations were, on the other hand, analysed basing on non-strained samples which also served as additional material for taxonomical analysis.

Abundance of phytoplankton was determined by assessing the bio-

mass. Biomass of the algae was calculated on the basis of their number, estimated with the method used in previous works (Sosnowska, 1974, pg. 1), and volume. Volume of individual species was calculated taking advantage of measurements of several parameters, depending on the shape of a given taxonomical unit; these were used to obtain the volume of similar geometric figure. Each time 10 individuals belonging to dominant species were measured; number of measurements for other components of phytoplankton varied depending on their frequency. It was assumed (following Fetzmann, 1956; Nauwerck, 1963; Pavoni, 1963; Januszko, 1972; Spodniewska, 1972; Grandberg, 1973; and others) that specific weight of algae equals one, hence volume of 1 mm^3 or $10^9 \mu^3$ represents 1 mg of wet weight.

Studies on the chlorophyll content of the plankton were carried out together with dr. M. Gliwicz from the Department of Hydrobiology of the Institute of Zoology of the University of Warsaw. Method described by Golterman (1969) was applied. Concentration of the pigment was assessed separately for organisms bigger and smaller than 50μ . Chlorophyll samples for organisms bigger than 50μ consisted of materials obtained from straining the water through net made of proper blotting-cloth. Several tens liters of water strained; samples were collected with a 5 l Bernatowicz sampler, every 1 m within the range of distinguished water layers. A few liters of the filtrate, mixed in equal amounts for each water depth, constituted samples for the assessment of chlorophyll content in nanoplankton.

RESULTS

Qualitative composition of phytoplankton

164 taxons of algae (Table 1) were distinguished in 44 phytoplankton samples in which 33 constituted non-strained materials. Most of them, i.e. over 89.6% were identified on the basis of qualitative analysis of strained samples. Non-strained samples added only 17 taxons (about 10%) to the floristic composition of phytoplankton. In most cases they consisted of small organisms. Similar relations were noted in every microscopic analysis. Net taxons usually constituted over 80—93% of the components of phytoplankton floristic list.

The richest group of phytoplankton (80 taxons) consisted of *Bacillariophyceae* (Table 2). Second position with respect to the number of taxonomical units was occupied by *Chlorophyceae* (53 taxons), third — by *Cyanophyceae* (27 taxons). Other groups added only slightly to the floristic list of the lake under study. Similar relations were noted upon both stations, although Southern Station was characterized by a slightly

richer (by 19 taxons) composition of phytoplankton. Number of taxons distinguished in different periods of sampling was similar and varied from 44 in December to 83 in mid-summer.

High share of *Bacillariophyceae* (about 50%) in the pelagial of Lake Żarnowieckie resulted from the presence of accidental forms which did not play any more important role in the biomass. They were mechanically transported by winds from shore areas into the open water area. There are no grounds for the assumption that these accidental components could have been more abundant during circulation periods since their share was similar both, during circulation, and in stagnation periods. From among 80 taxons of *Bacillariophyceae* only a few belonged to typical euplankton forms (for instance *Melosira islandica* ssp. *helvetica*, *Stephanodiscus Hantzschii*), and these constituted higher share in the biomass. Contrary to *Bacillariophyceae* most taxons of *Cyanophyceae* were typical plankton forms. Some of them represented species known to produce water blooms (*Microcystis aeruginosa*, *M. Wessenbergii*, *Anabaena flos-aquae* f. *Lemmermanni*, *Aphanizomenon flos-aquae*, *Gomphosphaeria Naegeliana*).

Total number of algal taxons (164) found in Lake Żarnowieckie is extremely low compared to rich phytoplankton from other lakes of similar limnological type. For instance, in mesotrophic Lake Harsz 251 taxons of algae were found (Sósnowska, 1974), the most rich group consisting — contrary to Lake Żarnowieckie — of *Chlorophyceae* (47.8%), mainly of the *Chlorococcales* order (27.9%), with numerous small, nannoplankton forms. Less frequent sampling of Lake Żarnowieckie compared to Lake Harsz does not seem to be the only reason of the lower number of taxons in this lake, the more so that particular samples always contained less differentiated phytoplankton than in case of Lake Harsz. Most probably more intensive wave action on Lake Żarnowieckie, observed throughout the whole season, is responsible for the high share of non-plankton *Bacillariophyceae* in the pelagic phytoplankton of this lake. However, the lake does not seem to be of a special type; phytoplankton species found in this lake occur commonly both, in mesotrophic, and eutrophic water bodies. Also dominating forms presented in fig. 1 are commonly noted in both types of lakes, and abundant occurrence of *Melosira islandica* ssp. *helvetica* in March should be connected with intensive mixing of Lake Żarnowieckie (Póltoracka, 1960) rather than with its trophic type.

The only characteristic distinguishing phytoplankton in Lake Żarnowieckie from other lakes is the lack of *Chrysophyceae* most numerously represented by the genus *Dinobryon*. It is possible that this genus does not occur in Lake Żarnowieckie due to low content of mineral nitrogen and high content of phosphates (Korycka, 1975) — according to Pearsall (1932) *Dinobryon* requires high ratio of nitrogen to phosphorus.

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—Wesenbergii Komár.

Oscillatoria Agardhii Gom.

— limnetica Lemm.

— planctonica Wołosz.

—Redeckeri Van Goor

SD.

Phormidium musicola Huber-Pestalozzi et Naumann

EUGLENOPHYTA

Euglenophyceae

Trachelomonas sp.

PYRROPHYTA

Dinophyceae

Ceratium hirundinella (O.F.M.) Bergh

Glenodinium sp.

Peridinium cinctum (O.F.M.) Ehr.

CHRYSTOPHYTA

Bacillariophyceae

Amphora ovalis Kütz.

— — var. *pediculus* Kütz.

Asterionella formosa Hass.

Caloneis amphisbaena (Borv) Cl.

—bacillum (Grun.) Mer.

—silicula (Ehr.) Cl. var. truncatura Grun.

Camphylodiscus noricus Ehr. var. *hibernica* (Ehr.) Grun.

Cocconeis disculus (Schum.) Cl.

— *pediculus* Ehr.

—placentula Ehr.

— — var. *euglypta* (Ehr.) Cl.

Cyclotella comta (Ehr.) Kütz.

— *Meneghiniana* Kütz.

Cymatopleura elliptica (Bréb.) W. Sm.

—solea (Bréb.) W. Sm.

— var. *apiculata* (W. Sm.) Ralfs

— duplex Meyen	+ + +
— Tetras (Ehr.) Ralfs	+ . + + + + + + × + × × ×
Quadrigula lacustris (Chod.) Smith	+ + + + + + + + × + × × ×
Scandesmus armatus Chod. var. bogláriensis Hortob.	. + . + . + . + . + . + . +
f. semicostatus Hortob.	+ + + + + + + + +
— bicaudatus (Hansg.) Chod.	+ . + + . + + + × + × + . .
— bijugatus (Turp.) Lag.	+ . . + . . × × . . + × . .
— circumfusus Hortob. var. bicaudatus Hortob.	. . × . . × × . . + × . .
— dispar Bréb.	. . +
— eornis (Ralfs) Chod. var. disciformis Chod.	+ + + + + + + + × + × . .
— quadricauda (Turp.) Bréb.	+ + + . + + + + + + + +
— ——— var. quadrispina (Chod.) G. M. Smith	+ + . . . + . . + + . .
Schroederya Judayi G. M. Smith	+ . . + . . × + + . .
Sphaeroecystis Schroeteri Chod.	+ . . + . . + + + + + +
Tetraëdron minimum (A.Br.) Hansg.	+ . . + . . + + + + + +
Tettrastrum staurogeniaeforme (Schroed.) Lemm.	+ . . + . . + + + + + +
Westella botryoides (W. West) Wild	+ . + + . + × + + + + +
×	x x x
Conjugales	.
Closterium acutum (Lyngb.) Bréb. var. variabile Krieg.	+ + + + + × + + + +
— aciculare T. West	+ + + + + × + + + +
— gracile Bréb.	. + . + . + +
— moniliferum (Bory) Ehr.	+ + . . + + + + + +
— Venus Kütz.	+ . . + + + + + + +
Cosmarium sp.	+ . . + + + + + + +
Mougeotia sp.	+ . . + + + + + + +
Spirogira sp.	+ . . + + + + + + +
Stauroastrum gracile Ralfs	+ . . + + + + + + +

— taxons found in net and non-strained samples; × — taxons found only in non-strained samples

Table 2

Number of taxons in particular taxonomical groups of phytoplankton
in Żarnowieckie Lake in 1974

		Stations														Stat. North. and South.
		Northern						Southern								
Taxonomical groups	Date	22. 05	25. 06	7. 08	24. 09	6. 12	05- 12	30. 03	22. 05	25. 06	7. 08	24. 09	6. 12	03- 12		
<i>Cyanophyceae</i>		9	15	9	13	6	23	4	10	13	10	12	5	23	27	
<i>Euglenophyceae</i>		.	.	.	.	.	.	.	.	1	.	.	.	1	1	
<i>Dinophyceae</i>		2	2	2	2	.	2	2	2	2	2	2	1	3	3	
<i>Bacillariophyceae</i>		22	28	35	26	27	55	33	26	35	39	31	23	72	80	
<i>Chlorophyceae</i>		21	32	29	17	14	47	8	22	31	32	17	15	47	53	
Total		54	77	75	57	47	127	47	60	82	83	62	44	146	164	

tes. There are also data suggesting that high concentrations of phosphates, of the order frequently met in Lake Żarnowieckie, can limit the development of some popular *Chrysophyceae*, for instance *Dinobryon divergens* (Hutchinson, 1967).

Quantitative relations

Low species differentiation of algae in the pelagial of Lake Żarnowieckie coincides, as a rule, with low values of phytoplankton biomass and primary production (Zdanowski, 1975) upon both stations. Average biomass of phytoplankton in the water column from the surface to the bottom was similar in both stations, reaching for the period May — December very low values of 3.1 mg of wet weight/l on Northern Station, and 3.4 mg/l on Southern Station. Taking into account only the surface water layers (0—5 m) phytoplankton biomass was slightly higher, amounting to 4.1 and 4.7 mg/l respectively. Average daily gross production in the trophogenic layer of Lake Żarnowieckie amounted to 0.4 mg O₂/l/24 h. It should be, however, pointed out that low frequency of sampling did not allow for the estimation of phytoplankton biomass; some peaks of phytoplankton development were omitted and hence the values may be slightly underestimated. Vertical distribution of phytoplankton (Fig. 2), with highest biomass values at the depth of 11—17 m on 30 March upon Southern Stations (no samples were taken on the Northern one), points to the fact that spring maximum of algae broke down rather early. By including this maximum into the calculations average values of the biomass are almost doubled: from 3.4 mg/l to 6.4 mg/l, while values for the surface layers (0—5 m) increase from 4.7 mg/l to 7.0 mg of wet weight/l. Vertical stratification of phytoplankton in December, with lowest density in the layer 0—5 m, also suggests that

Fig. 2. Vertical distribution of phytoplankton in Żarnowieckie Lake

autumn maximum occurred earlier. Consequently, values of the biomass of phytoplankton in Lake Żarnowieckie may be slightly underestimated. Both stations under study were not only similar with respect to the average abundance of phytoplankton, but also as regards particular periods in the surface layer 0—5 m (Fig. 3): phytoplankton biomass during the period May — December varied from 0.3 in May to 10.5 mg/l in September upon Northern Station, and from 0.5 in May to 11.5 mg/l in August on Southern Station. Taking into account sample from 30 March from the latter station these values vary between 0.5 in May and 19.2 mg of wet weight/l in March.

According to the data by Pavoni (1963), Vollenweider (1968), and Micheeva (1969, after Spodniewska 1972) maximal values of phytoplankton biomass in the pelagial of Lake Żarnowieckie fall within the range of values characteristic for eutrophic lakes (usually over 7—10 mg of wet weight/l) but, on the other hand, they lie closely to the lower limit. Moreover, higher values are reached rarely, only during maximal development (especially during spring maximum), while in the remaining periods they remain on lower levels, approaching values noted in mesotrophic lakes.

Extremely low values of chlorophyll content, from 0.48 to 8.52 $\mu\text{g/l}$, or — with pheophytin — from 1.69 to 9.73 $\mu\text{g/l}$, were noted upon both stations in the layer 0—5 m. Such values are characteristic for meso-

Fig. 3. Seasonal changes of phytoplankton biomass and chlorophyll content in Żarnowieckie Lake in the layer 0—5 m

trophic lakes (Czeczuga, 1958, 1964, 1965; Sol'ski, 1962; Sosnowska, 1974) and point to low eutrophy of Lake Żarnowieckie.

Three taxonomical units of algae determined the qualitative character of phytoplankton (Fig. 4): *Bacillariophyceae* in spring and autumn (mainly *Melosira islandica* ssp. *helvetica* in both periods, and *Stephanodiscus Hantzschii* in the first one), *Cyanophyceae* (mainly *Microcystis aeruginosa*,

Fig. 4. Seasonal changes in qualitative composition of phytoplankton in Żarnowieckie Lake
(diagrams based upon data for the layer 0–5 m)

M. Wesenbergii, *Aphanothece clathrata*, and *Aph. nidulans*) and to a lower extent *Chlorophyceae* (mainly *Pandorina morum*) in summer. Visibly low number of nanoplankton species, restricted only to several taxons, did not play any more significant role with the only exception on 30 March when small diatom *Stephanodiscus Hantzschii* reached about 15% of the total phytoplankton biomass. Share of nanoplankton in the phytoplankton biomass during the period May — December ranged between 0.1 and 2.5% on the Northern Station, and up to 3.3% on the Southern Station (Fig. 3). Values of nanoplankton biomass in summer period (August, September) were determined rather by single cells of disintegrating colonial taxons of some green (*Dicysphaerium pulchellum*) or blue-green algae (*Microcystis* sp. div., *Gomphosphaeria* sp. div.) present in the water column, and to a much lower extent by real nanno-

plankton species. Significant divergence of the results obtained from the assessment of nannoplankton biomass and chlorophyll content in nannoplankton (the latter values frequently exceed those obtained for net plankton) suggests that nannoplankton organisms do not undergo sedimentation process. On the other hand these divergences seem to point that small organisms are more intensively filled with chromatophores than net species, or at least this is true of some species.

Results obtained in course of the present studies support previous results from a single sampling performed in August 1968, namely that phytoplankton in Lake Żarnowieckie is poor both qualitatively, and quantitatively. Its character approaches typical picture of summer plankton of eutrophic lakes (Management Programme of Lake Żarnowieckie, 1968).

CONCLUSIONS AND PREDICTED CHANGES

Qualitative relations of phytoplankton in Lake Żarnowieckie point to the mesotrophy of this lake. On the other hand species composition, and especially character of seasonal succession of algae, do not differ from those noted frequently in eutrophic lakes (Półtoracka, 1963, 1966; Sosnowska, 1974, unpubl. data). So far Lake Żarnowieckie has been classified as eutrophic (Management Programme of Lake Żarnowieckie, 1968)

Basing on the experience gained during studies on heated Konin lakes (Półtoracka, 1968; Sosnowska, unpubl. data) it can be expected that although each factor resulting from the utilization of lake waters by the power plant will result in direct changes in the lake, and consequently, will affect the phytoplankton, their detail effect and significance will differ. These factors will consist of: strong water currents and variations in the water level, and in the later period (after the plant will be turned into a nuclear power station) — slight increase of water temperature, most probably by a few degrees. Expected increase of lake fertility, induced by the decomposition of bottom sediments as a result of daily exposure of large littoral areas to the atmosphere on one hand, and deepening of the epilimnion with simultaneous increase of temperature on the other, will undoubtedly result in an increase of the average annual phytoplankton biomass (Devyatkin, 1971; Sosnowska, unpubl. data), lengthening of the period of abundant occurrence of phytoplankton, and a decrease in the seasonal differentiation of its biomass. Summer domination of blue-green algae, favoured by an increase of water temperature, and especially domination of species responsible for water blooms, in proper oxygen conditions should guarantee rapid rotation of nutrients and, consequently, should favour abundant occurrence of such phytoplankton species.

Most probably the effect of heating on quantitative development of algae will be different in particular seasons. Its stimulating action will probably be most visible in cold seasons (Devyatkin, l.c.; Vinogradskaya, 1971; Sosnowska, unpubl. data).

It may be expected that simultaneously with quantitative changes of phytoplankton community changes in its structure will also occur, mainly as a result of increased trophic and increased temperature of pelagic waters. These changes should be reflected by increased share of nanoplankton in phytoplankton biomass, not only as a result of increased number of currently occurring species, but also through the appearance of new taxons, belonging mostly to *Chlorophyceae*, which prefer higher water temperatures (especially from the order *Chlorococcales*, embracing many minute species). Hence, it may be said that the expected increase of the share of nanoplankton in the phytoplankton of Lake Żarnowieckie will not only result from increased trophic of the lake (Spodniewska, 1972), but also from more favourable thermal conditions for many warm-water species.

From the opposite factors represented by strong water currents and variations in the water level on the one hand, and increase of water temperature on the other, the latter factor will certainly most decisively affect the biomass of algae. On the other hand undoubted enrichment of the species composition will result not only from the effect of temperature, but also from strong water currents transporting accidental, tychoplankton species to the central part of the lake. However, it does not seem that such species could more significantly contribute to the increase of phytoplankton biomass in Lake Żarnowieckie (Sosnowska, unpubl. data). Strong water currents together with heating of waters will constitute main reasons of the expected species differentiation, by creating more favourable conditions for the occurrence and development of several warm-water species, and by prolonging vegetation season over the whole year. This should result in a relatively constant number of algae species throughout the whole year, without seasonal variations usually noted in normal lakes (Półtoracka, 1968).

On the basis of observations carried out on the Konin lakes complex it may be supposed that the strongest reaction of the phytoplankton community, induced by changes occurring in lake environment, will be noted in the first year of heating. Process of environment adaptation to new conditions will proceed in successive years, until a state of balance, but on a level higher than previously, will be established.

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Jakościowe i ilościowe badania planktonu roślinnego i zawartego w nim chlorofilu w pelagialu Jeziora Żarnowieckiego w 1974 roku

Streszczenie

Prowadzone w 1974 roku badania planktonu roślinnego Jeziora Żarnowieckiego, usytuowanego w strefie przymorskiej, wchodzące w skład zespołowych prac Instytutu Rybactwa Śródlądowego stanowią jeden z elementów charakterystyki limnologicznej ekosystemu jeziora przed uruchomieniem projektowanych nad nim elektrowni: szczytowo-pompowej, a w późniejszym okresie — atomowej. Uzyskany na ich podstawie obraz obecnego stanu środowiska stanowi wyjściowy materiał do porównania stosunków, jakie zaistnieją w biotopie jeziornym po rozruchu obu elektrowni.

W oparciu o materiały zebrane z dwóch stanowisk pelagialu Jeziora Żarnowieckiego w okresie od 30 III do 6 XII 1974 r. określono skład gatunkowy fitoplanktonu, jego biomasę z wyszczególnieniem nannoplanktonu oraz koncentrację chlorofilu i feofityny z wyodrębnieniem również frakcji nannoplanktonowej.

W słabo zróżnicowanym pod względem taksonomicznym zbiorowisku glonów planktonowych (164 taksony) największy udział wykazywały okrzemki (około 50%), mniejszy zielenice (32%) i sinice (16%). Duże znaczenie okrzemek wynikało z obecności w planktonie form przypadkowych, wpływających w nieznacznym tylko stopniu na biomasę glonów, a które do strefy wolnej wody dostały się w wyniku bardzo silnego falowania jeziora, trwającego przez większą część roku. Znalezione gatunki należą do powszechnie spotykanych zarówno w jeziorach mezotroficznych, jak i eutroficznych. Jedyną właściwością odróżniającą plankton roślinny Jeziora Żarnowieckiego od innych jezior o zbliżonym charakterze troficznym jest brak w nim złotowiciowców.

Stosunki ilościowe fitoplanktonu wskazują na słabo zaawansowany proces eutrofizacji jeziora. Wprawdzie maksymalne wartości świeżej masy glonów (10—11 mg/l) mieszczą się w dolnych granicach wielkości charakterystycznych dla jezior eutroficznych, ale średnie pomiary biomasy fitoplanktonu, jak również wybitnie niskie wartości chlorofilu (łącznie z feofityną 1,7—10,0 $\mu\text{g/l}$) są znamienne dla jezior mezotroficznych.

Trzy gromady glonów decydowały o jakościowym charakterze fitoplanktonu: wiosną i jesienią okrzemki, głównie *Melosira islandica* ssp. *helvetica* w obu okresach i *Stephanodiscus Hantzschii* w pierwszym z nich; latem przede wszystkim sinice, a zwłaszcza gatunki *Microcystis aeruginosa* i *M. Wessenbergii*, *Aphanothece clathrata* i *Aph. nidulans*, w mniejszym stopniu zielenice, wśród których największe wartości biomasy osiągnęła *Pandorina morum*.

Udział nannoplanktonu w całkowitej biomase fitoplanktonu kształtował się na bardzo niskim poziomie (na ogół poniżej 3%), jedynie wiosną wzrastał do 15% na skutek intensywnego rozwoju drobnej okrzemki — *Stephanodiscus Hantzschii*.

W wyniku wykorzystania wód Jeziora Żarnowieckiego przez elektrownię

szczytowo-pompową, a później atomową przewiduje się w zakresie stosunków ilościowych: 1) zwiększenie średniej rocznej wartości biomasy fitoplanktonu jako efektu spodziewanego wzrostu żyzności zbiornika; 2) wydłużenie okresu jego obfitego występowania oraz zmniejszenie sezonowych wahań biomasy glonów planktonowych; 3) obfite występowanie przez dłuższe okresy czasu sinic w sprzyjających ich rozwojowi warunkach podwyższonej temperatury wody, a zwłaszcza gatunków wywołujących zakwity.

Przypuszczalnie wpływ podgrzania na ilościowy rozwój glonów przejawiać się będzie w różnych sezonach w niejednakowym stopniu. Jego stymulujące działanie najwyraźniej uwidaczniać się będzie zapewne w zimnym okresie roku.

Równocześnie należy oczekiwać zmian w strukturze zbiorowiska glonów planktonowych w kierunku zwiększania się udziału nannoplanktonu w całkowitej biomasy fitoplanktonu, zachodzących poprzez wzrost liczebności obecnie występujących gatunków, a także pojaw nowych, bardziej ciepłolubnych taksonów, głównie spośród *Chlorophyceae* preferowanych przez wyższe temperatury wody.

Podgrzanie wody stwarzające bardziej sprzyjające warunki dla wystąpienia i rozwoju szeregu ciepłolubnych gatunków i przedłużające okres wegetacji do całego roku oraz silne przepływy wody to główne przyczyny spodziewanego wzrostu zróżnicowania taksonomicznego glonów, w efekcie którego przypuszczalnie liczba taksonów fitoplanktonu pozostanie względnie stała w ciągu całego roku, nie ulegając większym wahanom sezonowym, jak dzieje się to zwykle w jeziorach w warunkach braku ingerencji człowieka w naturalne środowisko wodne.