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THE EFFECTS OF ANTHROPOGENIC POLLUTION ON THE KANEV RESERVOIR (UKRAINE) PHYTOPLANKTON. 1. PHYTOPLANKTON DYNAMICS AT STATIONS WITH DIFFERENT LEVELS OF POLLUTION

The aim of the investigation was to compare the phytoplankton structure in two zones of the river part of Kanev Reservoir characterized by different levels of urban pollution. Two stations were selected for this purpose: 1, in a relatively pure area of the the river part of Kanev Reservoir; and 2, at the mouth of the Dneiper tributary, the Syrets River, which has been polluted by mineral and organic substances from urban sewage. The "vibrancy" of the phytoplankton was evaluated by determining their biomass, cell abundance, and cell surface area (denoted as B, N, and S, respectively), achieved on the basis of a routine monitoring dataset collected over 24 months at these stations. The investigated zones were characterized by divergent phytoplankton composition and considerably different annual dynamics. The profiles shown by the B, N and S dynamics of the phytoplankton at station 1 were characterized by regular and predictable peaks in summer, formed by the same complex of algal species. Similar-type graphs for station 2 exhibited 3-4 peaks per year formed by completely different groups of algae during different periods. Furthermore, the saprobic zone indicator species, as well as those characterized by highly specific cell-surface estimates, were often observed at station 2. Such species were absent or developed only to a minor extent in phytoplankton of station 1. These facts can be interpreted as symptoms of ecosystem destabilization at station 2, which could be due to the impact of polluted water from the Syrets River on the phytoplankton of the Kanev Reservoir.

Keywords: phytoplankton**,** taxonomic structure, anthropogenic pollution, spatial-temporal dynamics.

Introduction

Ecological self-regulation mechanisms, including the structural adaptation of natural aquatic communities to changes, are very complex. This makes it especially difficult fully to understand the important empirical problems of water quality management and surveillance within parts of the aquatic environment vulnerable to intensive anthropogenic impact. The Kanev Reservoir used for freshwater urban consumption, is influenced by many anthropogenic factors, including the numerous impacts from the waste produced by a huge industrial city (the Ukraine capital, Kiev), such as the negative influences of the Kiev hydroelectric station, water sports, fishing, etc. The plankton in the reservoir is one of the main natural agents of water-quality regulation and thus plankton monitoring is one of the central parts of the water-quality management activities. As a result, the phytoplankton of the riverine part of the Kanev Reservoir, influenced by all the above-mentioned factors, has been described in many publications (Zhdanova et al., 1986; Sirenko, 1989; Scherbak, Majstrova, 1996, 2000, 2001; Oksiyuk et al., 1999, 2000, 2005). The aim of this investigation was to compare the taxonomic structure with the quantitative variables of biomass (B), cell abundance (N), and cell surface area (S), which constitute the annual dynamics of the phytoplankton in the two neighbouring parts of the Kanev Reservoir characterized by different levels of water pollution. In this way, we shall determine the effect of the urban impact on the reservoir phytoplankton.

Materials and Methods

As part of a routine monitoring programme, freshwater phytoplankton was sampled monthly over two annual cycles (June 2004 – May 2006) at two stations of the river part of Kanev Reservoir within the Kiev City region. Station 1 is situated within the river part of Kanev Reservoir, below bay "Obolon", facing to the park "Natalka" and represented relatively pure area; station 2 is located at the mouth of the Syrets River (the inflow of the River to the bay of reservoir "Volkovatyi"), which is polluted by Kiev's drains (Fig. 1).

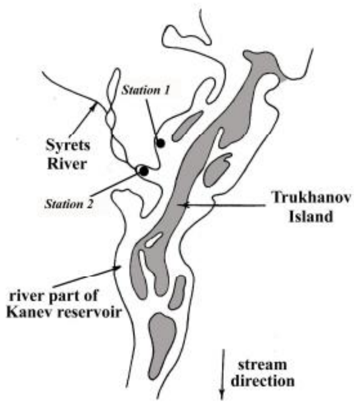


Fig. 1. Scheme of the Kanev Reservoir river part within the administrative limits of the city Kiev.

The two investigated stations were characterized by different levels of anthropogenic pollution. It is known that bay "Obolon" and nearest territories of reservoir (where station 1 is situated) are represented conditionally pure area where negative anthropogenic influence are minimal and direct sources of pollution are absent (Scherbak, Majstrova, 2001). Syrets River runs on the territory of Kiev city and gets urban drains of industrial and household origin (Pligin et al., 1998; Khilchevsky, Boiko, 2000; Kolesnik, 2000). These drains increase quantity of mineral and organic substances in water, therefore lead to trophic load on ecosystem. As well as there are cases of presence in water of Syrets River high concentration of oil products, phenols, heavy metals, surfactants (Pligin et al., 1998; Khilchevsky, Boiko, 2000). The data of hydrochemical analyses, investigations of phytoplankton, bacterial population and zoobenthic organisms testify about bad water quality of Syrets River. It is characterized as "polluted" and corresponds to the α-mesosaprobic zone, according to the ecological sanitary classification of surface waters (Khilchevsky, Boiko, 2000). It is noted in this and other papers (Scherbak, Majstrova, 2001) that bay of reservoir "Volkovatyi" (in which Syrets River is flowed – station 2) is area with considerable anthropogenic impact; water and benthic deposits of the bay accumulate all spectra of pollutants of industrial and household origin. As a result, typical average summer-autumn (July-September 2005) concentrations of $PO4^{3-}$ were 50 times higher in water of station 2 than in station 1, i.e., 0.129 and 0.0025 mg/dm^3, respectively1. Less pronounced but also very large differences were evidenced for $NH4^{+}$, NO^{3-}, SiO_3^{2-}, and other hydrochemical components[1].

These stations differ also by some peculiarities of hydrological regime. Station 1, situated within the reservoir river part, is characterized by a fast stream, about 0.4 m/s. Station 2, situated near the mouth of the Syrets, which is a small river, is characterized by a slower stream (0.2 m/s) and, therefore, this part of the reservoir is characterized by slightly stagnant conditions.

A total of 48 algal samples were collected and examined in 2 years. The samples were collected from both stations at the same time of day, about 12 a.m. The depth of investigated stations was to 2 m. The 1.8 L samples were collected from subsurface water layer (to 0.5m) by a bathometer, fixed by formalin, and concentrated by the sedimentation method (Scherbak et al., 2002). Then, the samples were investigated under the light microscope (Mikmed-2, "LOMO" Russia).

The meanings of numbers, biomass and cell surface area were used for description of phytoplankton of investigated stations as well as for determination of peculiarities of its dynamics and role of some algal species. These indicators are widely used in hydrobiological practice (Sirenko et al., 1989; Scherbak, Majstrova, 1996; Oksiyuk et al., 2000, 2005; Nesterova, 2003 and others). The numbers (N) of algal cells (or filaments for cyanoprokaryotes) were determined in triplicate using a Goryaev camera with 9 mm³ volume. The algal biomass (B) and cell surface area (S) were evaluated by a volumetric method (Scherbak et al., 2002; Bryantseva et al., 2005). The index of taxonomic (species) composition similarity for samples at each of the two stations under investigation was determined using the Sørensen index (Shmidt, 1980) and the "measure of inclusion" method (Syomkin, Komarova, 1977). The latter can be applied to compare lists of species distinguished by great differences in their number. The estimates of similarity between two lists are calculated for each pair of them using the formula 2c/(a+b), where a is the number of species on the first list, b – the number of species on the second list, and c – the number of species on both lists (Syomkin, Komarova, 1977). Saprobiological analysis was provided on the basis of Pantle-Buck scale using the modification by Sladeček (Barinova et al., 2000). The systematic determination of algae was done on the basis of the known guides "Diversity … 2000" and "Algae … 2006".

Results

As seen in Table, a total of 202 species of algae (213 varieties) were found at the two stations. They belonged to the following divisions: *Cyanoprokaryota* – 18 species (20 varieties), *Euglenophyta* – 7(9), *Chlorophyta* – 91(96), *Bacillariophyta* – 52(53), *Dinophyta* – 8, *Cryptophyta* – 10, *Chrysophyta* – 15, *Xanthophyta* – 1(2). At the level of the divisions in

[1] We are deeply grateful to A.C. Romanov (Hydrophysical Institute of NAS of Ukraine, Sevastopol) for providing chemical analysis of the water.

the phytoplankton, the taxonomic spectra of both investigated stations were rather similar (Fig. 2), but the phytoplankton at station 1 was characterized by a greater diversity of diatom algae, which is typical for water bodies with fast streams (Barinova et al., 2000). At the same time, the phytoplankton collected at station 2 had a greater number of green and euglenophytic species. Such type of spectra, on the one hand, is characteristic for the water bodies with slow stream (Barinova et al., 2000) that usual for the Syrets River mouth; on the other hand, development of green and euglenophytic algae may be caused by high concentration of biogenic elements in water. Taken as a whole, the phytoplankton of the two locations was characterized as the diatom-green with an enhanced presence of cyanoprokaryotes during the summer-autumn period and of diatoms and chrysophytes during the later autumn-winter-spring period. On the other hand, the phytoplankton of both stations was differentiated by different spatial-temporal structures.

Table 1. **The seasonal distributions of phytoplankton species taxonomic diversity, described at the divisional level, for the two investigated stations**

Division	Number of species (varieties)								
	Station 1				Station 2				Total
	winter	spring	summer	autumn	winter	spring	summer	autumn	
Cyanoprokaryota	–	–	9	10	6	–	8	14	18(20)
Euglenophyta	–	–	1	–	1	1	1	7	7(9)
Chlorophyta	10	16	55(57)	16(17)	24(27)	29(30)	53(56)	46(48)	91(96)
Bacillariophyta	22	27(28)	35	27	34(35)	29	42(43)	30	52(53)
Dinophyta	–	2	3	1	1	2	3	4	8
Cryptophyta	1	6	7	5	6	6	7	5	10
Chrysophyta	7	10	7	3	6	9	4	8	15
Xanthophyta	–	–	1(1)	–	–	1	–	–	1(2)
Total	40	61(62)	118(121)	62(63)	78(82)	77(78)	118(121)	114(116)	202 (213)
	141(149)				172 (180)				

The station 1 phytoplankton was marked by high taxonomic richness and diversity: 141 species (149 varieties) were found, including *Cyanoprokaryota* – 10 species (12 varieties), *Euglenophyta* – 1, *Chlorophyta* – 62(65), *Bacillariophyta* – 41(43), *Dinophyta* – 4, *Cryptophyta* – 9, *Chrysophyta* – 13, and *Xanthophyta* – 1(2). The peaks of biomass (Fig. 3), cell number (Fig. 4), as well as cell surface area (Fig. 5) and species diversity (Table) of plankton of station 1 observed in the summer periods were due to the intensive development of a diatom complex of algae (*Aulacoseira granulata* (Ehr.) Sim. var. *angustissima* (O. Müll.) Hust. – 0.1-0.16 mg/dm^3, *A. italica* (Ehr.) Sim. – 0.02-0.04 mg/dm^3, *Stephanodiscus hantzschii* Grun. in Cl. et Grun. – 0.17-1.57 mg/dm^3, and *S. minutulus* (Kütz.) Cl. et Möll. – 0.01-0.06 mg/dm^3), as well as planktonic cyanoprokaryotes (*Microcystis aeruginosa* (Kütz.) Kütz. – 0.08-0.37 mg/dm^3, *M. wesenbergii* (Komárek)

Komárek – 0.05-0.11 mg/dm^3, and *Anabaena flos-aque* Bréb. – 0.06-1.4 mg/dm^3). So great were their presence that they caused a water "bloom" in the Kanev Reservoir during this period. While these taxa dominated the biomass, abundance, and cell surface of the phytoplankton, the green planktonic coenobial and unicellular algae (especially representatives of *Desmodesmus* (Chod.) An et al., *Micractinium* Fres., *Lagerheimia* Chod., *Monoraphidium* Kom.-Legn., *Dictyosphaerium* Näg., and *Tetrastrum* Chod.) were the most diverse (Table), while not being so important for the phytoplankton biomass and abundance. The "bloom" was observed in the reservoir in July 2004 (1st annual cycle) and in August-September 2005 (2nd annual cycle). It in both cases continued to the middle of autumn and then the quantitative characteristics of the phytoplankton as well as species diversity began to decrease and remained insignificant during the winter, when diatom and chrysophytic algae became the most numerous. As can be seen in Figs. 3 to 5, all three variables described here (B, N, and S) for the station 1 phytoplankton, as well as the species diversity (Fig. 6), increased smoothly from the beginning of spring and reached their maxima in the summer months.

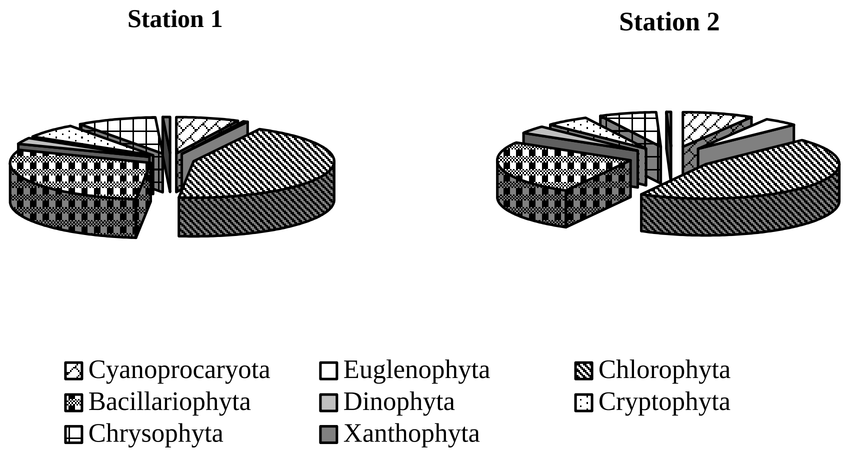


Fig. 2. The phytoplankton taxonomic spectra, described at the divisional level, for the two stations.

In the parallel series of data gained over the 2-year period for the phytoplankton at station 2 (Figs. 3 to 5), the biomass, numbers of cells, and area of the cell surface variables were marked by their temporal instability in terms of their peaks, i.e. there was less repeatability than with station 1 organisms. On the other hand, the phytoplankton at station 2 displayed an even greater taxonomic richness than that at station 1 (Table): 172 species of algae (180 varieties): *Cyanoprokaryota* – 15 species, *Euglenophyta* – 7 (9 varieties), *Chlorophyta* – 78(81), *Bacillariophyta* – 44(47), *Dinophyta* – 6, *Cryptophyta* – 9, *Chrysophyta* – 12, and *Xanthophyta* – 1. The green planktonic coenobial (namely *Coelastrum reticulatum* (Dang.) Senn – 0.01-0.07 mg/dm^3, *C. microporum* Näg. in A. Br. – 0.12-0.26 mg/dm^3, *C. astroideum* De-Not. – 0.01-0.03 mg/dm^3, *Desmodesmus armatus* (Chodat) Hegew. – 0.01-0.02 mg/dm^3, *D. grahneisii* (Heynig) Hegew. – 0.01-0.05 mg/dm^3, *D. brasiliensis* (Bohl.) Hegew. – 0.01-0.02 mg/dm^3, and *Acutodesmus dimorphus* (Turp.) Tsar. – 0.02-0.03 mg/dm^3), as well as diatom algae (typically *Diatoma tenue* Ag. – 0.06-0.38 mg/dm^3, *Cyclotella radiosa* (Grun.) Lem. – 0.09-0.27 mg/dm^3, *Stephanodiscus minutulus* – 0.02-0.03 mg/dm^3, and *Cyclostephanos dubius* (Fricke) Round – 0.03-0.16 mg/dm^3), developed in the water at this site very intensively during the summer period.

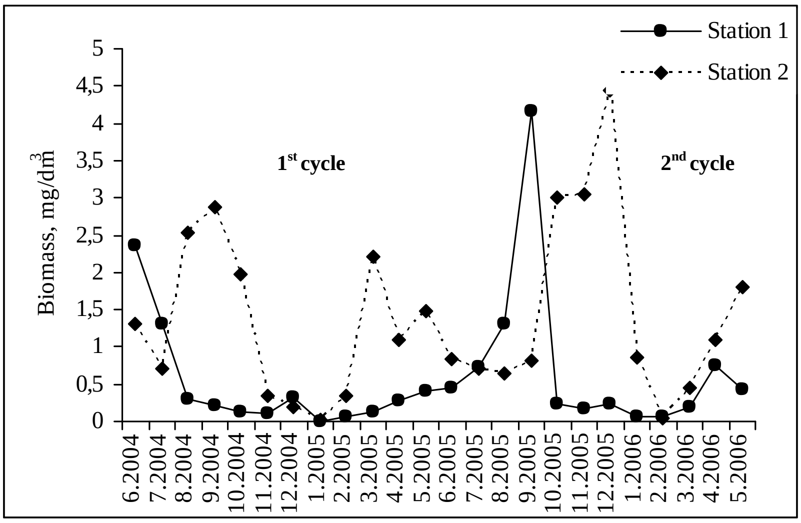


Fig. 3. Dynamics of the algal biomass for the two stations during two consecutive annual cycles.

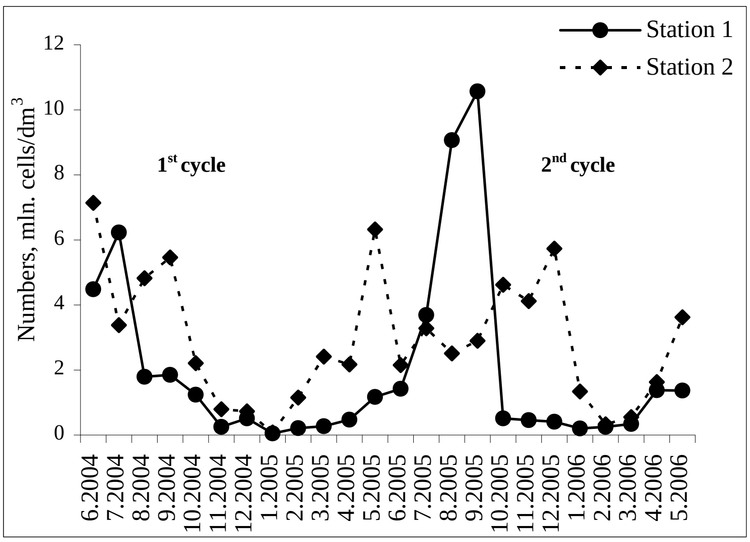


Fig. 4. Dynamics of algal cell abundance at the two stations during two consecutive annual cycles.

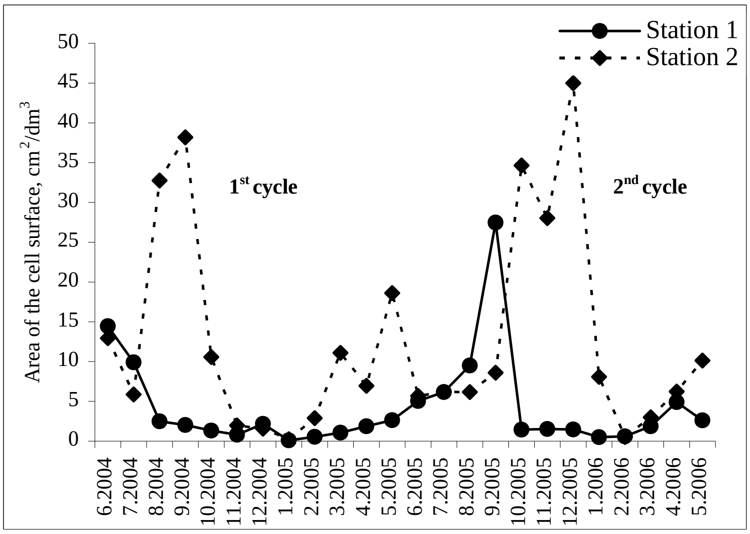


Fig. 5. Dynamics of the algal cell surface area at the two stations during two consecutive annual cycles.

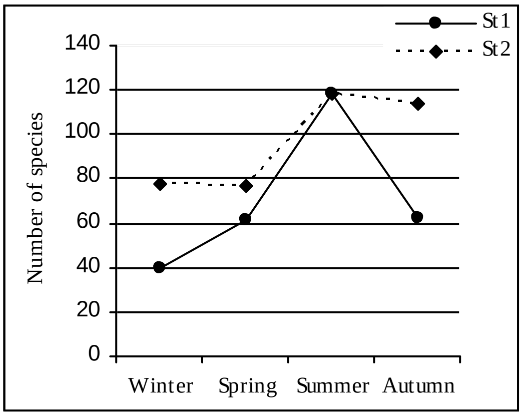


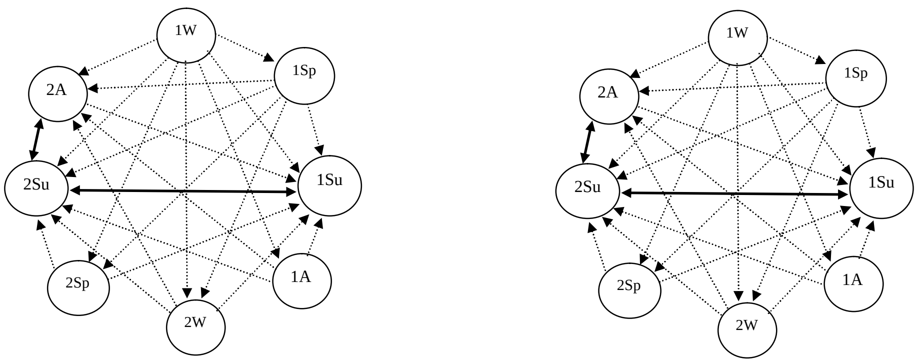
Fig. 6. Seasonal dynamics of phytoplankton species number for the two stations.

The great diversity and biomass of green planktonic algae at station 2 were probably associated with the slightly stagnant conditions in this part of the reservoir as well as may be caused by high concentrations of biogenic elements in the water. The intensive development of filamentous cyanoprokaryotes (*Oscillatoria splendida* Grev. ex Gomont – 0.31-1.33 mg/dm^3, *O. agardhii* Gomont – 0.32-1.11 mg/dm^3, *O. acutissima* Kuff. – 0.1-0.18 mg/dm^3, and *Pseudanabaena catenata* Lauterborn – 0.07-0.13 mg/dm^3), which did not occur at station 1, began at the end of summer and continued during early autumn. The intensive development of these algae is normally indicative of water enrichment by mineral substances. According to Pantle-Buck scale in modification of Sladeček, these algae were meso- and polysaprobic organisms (Barinova et al., 2000). Their development was observed in August-October 2004 (1st annual cycle) and in October-November 2005 (2nd annual cycle). During the 1st cycle, the quantitative characteristics (B, N, and S) and species diversity of station 2 phytoplankton began to decrease and remained insignificant during the winter. However, during the 2nd cycle, the intensive development of diatom algae (*Diatoma tenue* – 1.69-3.01 mg/dm^3, *Synedra acus* Kütz. – 0.1-0.18 mg/dm^3, and *Asterionella formosa* Hass. – 0.11-0.17 mg/dm^3) began in November at station 2 and continued until the middle of winter. The spring periods were characterized by a steep increase in taxonomic diversity and in the B, N, and S variables for the phytoplankton. The most important role was played by macrocellular flagellated green (*Chlamydomonas* sp. – 0.07-0.37 mg/dm^3), chrysophytic (*Mallomonopsis* sp. – 0.63-0.77 mg/dm^3), and cryptophytic (*Cryptomonas borealis* Skuja – 0.62-0.71 mg/dm^3) algae, as well as by the microcellular diatom algae (*Stephanodiscus minutulus* – 0.05-0.64 mg/dm^3). In the spring, 2006 (2nd annual cycle), the microcellular coccoid green algae (*Choricystis minor* (Skuja) Fott – 0.01-0.04 mg/dm^3, *Chlorella vulgaris* Beijer. – 0.02-0.06 mg/dm^3, and *Monoraphidium contortum* (Thur.) Kom.-Legn. – 0.001-0.003 mg/dm^3) also developed at station 2.

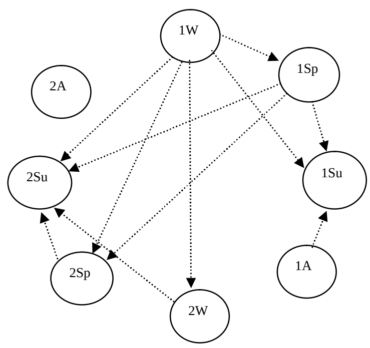
Discussion

Taken as a whole, the phytoplankton at the two stations in the river part of Kanev Reservoir can be characterized as diatom-green. The values for the variables of the phytoplankton, as well as its species diversity, taxonomic composition, and the list of dominant species for different seasons, correspond to previous data on the phytoplankton in the river part of the reservoir (Sirenko, 1989; Oksiyuk et al., 2000, 2005; Scherbak, Maistrova, 2001). Station 1 was the more representative one in this respect and, appears to be typical reflection of the situation for phytoplankton in the river part of the reservoir, subjected to the permanent influence of the Kiev hydroelectric power station, which causes very pronounced daily fluctuations in the water level. The species composition of the plankton at this station was dominated by the diatom complex, including typical planktonic species of the genera *Aulacoseira* Thw., *Stephanodiscus* Ehr., *Cyclostephanos* Round. in Ther. et al., and *Cyclotella* Kütz. Cyanoprokaryotes – also including the widely known causative organisms of the water “bloom” (*Microcystis* (Kütz.) Elenk. and *Anabaena* Bory ex Born. et Flah.) – enhanced this complex in the summer. The green planktonic algae were characterized by high species diversity but were not very abundant and did not play an important role in the formation of the total biomass. The seasonal fluctuations of the phytoplankton species diversity at this station were characterized by one clearly expressed peak during the summer months and by a gradual, smooth decrease in autumn, winter, and spring (Table, Fig. 6).

Station 2 phytoplankton was characterized by higher B, N, and S variables and species diversity of algae than that at station 1. The species composition of algae in the water at both stations was the most similar in the summer and spring months (the Sørensen index was 63.9 % and 63.3 %, respectively) and different in autumn and winter (48.8 % and 44.2 %, respectively). As a whole, station 2 phytoplankton mirrored the main succession patterns of station 1 phytoplankton, but exhibited some peculiarities. On the one hand, the river mouth phytoplankton was the richest and combined the peculiarities of the phytoplankton in both the Dneiper and its tributaries, producing ecotone conditions (Scherbak, Bondarenko, 2004). Increase of species diversity of algae was observed in the mouths of rivers flowed into Kanev Reservoir – Desna, Lybid (Scherbak, Majstrova, 2001). On the other hand, the higher species diversity and biomass of algae may be caused by the impact on the local biota of organic and mineral substances of industrial and household origin produced by such a large city as Kiev. It is known fact that increasing of species diversity and biomass of algae is observed in water bodies with moderate trophic pollution, which characteristic for mesotrophic waters (Barinova et al., 2000).



a *b*



c

Fig. 7. Species diversity comparison of phytoplankton collected at the two stations in the Kanev Reservoir calculated for the different seasons using the “measure of the inclusion” method. Annotation: 1 – station 1; 2 – station 2; W – winter; Sp – spring; Su – summer; A – autumn; *a* – the similarity index (σ) level ≥ 55 %; *b* – σ ≥ 60 %; *c* – σ ≥ 70 %.

⟷ similarity of 2 species compositions;
⋯▶ inclusion of one species composition to others.

The most distinctive characteristic of station 2 phytoplankton was its high species diversity and the intensive development of filamentous cyanoprokaryotes in the autumn period. Some of these are known as indicators of highly saprobic zones. These representative species were not registered at station 1 but intensively developed in the phytoplankton at station 2. The comparison of phytoplankton species diversity, calculated for the two stations for the different seasons using the “measure of the inclusion” method (Fig. 7), showed a rather close similarity of species composition, especially for the summer months (Fig. 7, *a*, *b*). After an increase of the similarity index (σ) level to 70 %, the composition of autumnal phytoplankton collected at station 2 lost all similarity to its composition during all the other seasons (Fig. 7, *c*). This fact testifies to its significant specificity.

Another distinctive property of station 2 phytoplankton was its low abundance of cyanoprokaryotes, which are the apparent causative agents of the water “bloom” at station 1. It appears that small numbers of these algae, registered at station 2, are brought by the water mass from the upper zone of the Kanev Reservoir to the Syrets River entrance. Finally, one more distinctive feature of station 2 phytoplankton is the sudden and intensive development of various groups of algae in the spring and the winter-autumn seasons, which differed for the two annual cycles. Thus, a massive development of flagellated chrysophytic, green, cryptophytic and diatom algae with small cells was observed in the spring of the 1st annual cycle. In contrast, the spring of the 2nd cycle saw the mass development of unicellular small coccoid green algae. The intensive development of diatom algae (*Diatoma* Bory emend. Heiberg., *Asterionella* Hass., and *Synedra* Ehr.) was observed only during the winter period of the 2nd annual cycle. On the whole, the seasonal fluctuations of species diversity at station 2 had smoother characteristics than those of station 1 (Fig. 6). Thus, phytoplankton of station 2 was more diverse during all seasons. Thus, phytoplankton of station 2 was more diverse during all seasons. Several peaks on the graphs described quantitative parameters of phytoplankton of station 2 reflect influence on ecosystem unnatural (perhaps anthropogenic) factors which caused mass development of algae during such seasons as early spring, autumn or winter. The same graphs described phytoplankton of station 1 have one predictable summer peak per year which caused by mainly influence of natural factors on ecosystem for example temperature. Similar mass development of algae during cold seasons was registered for mouth of Lybid River polluted by industrial and household drains (Scherbak, Majstrova, 2001).

Saprobiological analysis performed on the basis of the Pantle-Buck scale in the modification of Sladeček (Barinova et al., 2000), shows that the saprobic index for station 1 phytoplankton varied from 1.63 to 1.92, indicating that the water was in the β-mesosaprobic zone, class III quality, i.e., it was in the “clean enough” category. However, the same index for station 2 phytoplankton was 2.08-2.57, corresponding to the α-β-mesosaprobic zone, III-IV class quality, i.e., the water was “slightly to moderately polluted”. The lack of a clear difference between the index for the two stations can, perhaps, be explained by the comparatively low number of species-indicators found in phytoplankton (about 50-60 %) and unimportant cenotical role played by most of these species. Unfortunately, many of the 'mass species' of station 2 phytoplankton algae have unclear ecological characteristics, and therefore, cannot be used as indicators. Plausibly, these waters (especially at station 2) should be attributed to the highly saprobic zones.

The indexes of the total and specific areas of the phytoplankton cell surface were recently used for identification of the water quality and the direction of the succession in the water ecosystem (Minicheva, 1990, 1998; Nesterova, 2003). It was assumed that species with high specific cell surface area (i.e., the ratio of cell surface to cell volume, S/V) are characterized by higher photosynthetic activity, metabolic exchange level, and, as a rule, belong to the inhabitants of waters with high trophic levels. S/V levels depend on algal cell size and shape. Algae with small cell size, as well as those with thin and long cells (trichomes), have high S/V values. It is interesting that the dominant species in the mass development of station 2 phytoplankton in spring, autumn, and winter were species with notably high S/V levels, such as *Oscillatoria splendida*, *O. acutissima, Pseudanabaena catenata*, *Diatoma tenue*, *Synedra acus*, *Asterionella formosa* and *Monoraphidium contortum.* The S/V values for these species were in the range 1.82-5.47, i.e., much higher than the average S/V of phytoplankton at the station 1, which was 1.2-1.4. This fact can also be interpreted as evidence of more marked pollution of station 2 water (or eutrophication by organic and mineral substances) in comparison to that at station 1. These our findings were confirmed by earlier investigation of Kanev Reservoir phytoplankton. So, many of green and diatom algae with small cell size (and with high meaning of S/V respectively) appeared in phytoplankton of the reservoir recently as answer on increase of anthropogenic load on the ecosystem and impairment of water quality (Scherbak, Majstrova, 2000, 2001).

Conclusions

The two investigated stations in the river part of the Kanev Reservoir, despite their adjacent location and close hydrological regime, had different spatial-temporal structures of phytoplankton. The annual dynamics of phytoplankton biomass, abundance, and cell surface area for the water taken at station 1 are characterized by two regular and predictable peaks taking place in summer and produced by the same complex of algae. Data for the same variables at station 2 showed 3-4 peaks per annum, formed by explicitly different groups of algae being dominant at the various seasons; these are the flagellated, diatom and sometimes coccoid green algae in spring, filamentous cyanoprokaryotes in autumn and diatoms in winter. The algal species-indicators of the high saprobic level zones, as well as species with high levels for the specific cell surface variable, exhibited massive development in the phytoplankton fraction in water at station 2, while they were absent or developed only to a minor extent at station 1. We interpret this distinction as a sign of ecological destabilization at station 2. These facts can be explained by the influence of a water mass polluted with mineral and organic substances, flowing from the Syrets River.

This conclusion is confirmed by the results of earlier investigation of these areas of the reservoir as well as by chemical analysis of water from both stations.

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ВЛИЯНИЕ АНТРОПОГЕННОГО ЗАГРЯЗНЕНИЯ НА ФИТОПЛАНКТОН КАНЕВСКОГО ВОДОХРАНИЛИЩА (УКРАИНА). 1. ДИНАМИКА ФИТОПЛАНКТОНА НА СТАНЦИЯХ С РАЗНЫМ УРОВНЕМ ЗАГРЯЗНЕНИЯ

Исследованы структуры фитопланктона двух точек речной части Каневского водохранилища с разным уровнем загрязнения: ст. 1 – в сравнительно чистом районе его русловой части, ст. 2 – в устье притока Днепра, р. Сырец, загрязненной минеральными и органическими веществами с городских стоков. Динамика фитопланктона была оценена посредством определения его биомассы, численности и площади клеточной поверхности (B, N и S соответственно) на основе мониторинга данных, собранных на протяжении 24 мес. с обеих станций. Исследованные точки характеризовались разным видовым составом фитопланктона и существенно различной годовой динамикой. Кривые динамики B, N и S фитопланктона на ст. 1 характеризовались регулярными и предсказуемыми пиками в летний период, сформированными одинаковым комплексом видов водорослей. Такой же тип графиков для ст. 2 демонстрировал 3-4 пика в год, сформированных совершенно разными группами водорослей в течение разных периодов. Кроме того, водоросли-индикаторы высоких зон сапробности, а также характеризующиеся высокой удельной площадью поверхности клеток, часто наблюдались на ст. 2. Эти виды отсутствовали или развивались только в небольших количествах в фитопланктоне ст. 1, что свидетельствует о дестабилизации экосистемы на ст. 2 из-за влияния загрязненной воды из р. Сырец на фитопланктон Каневского водохранилища.

Ключевые слова: фитопланктон, таксономическая структура, антропогенное загрязнение, пространственно-временная динамика.

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