INTERNATIONAL ASSOCIATION FOR DANUBE RESEARCH
OF THE INTERNATIONAL ASSOCIATION OF THEORETICAL
AND APPLIED LIMNOLOGY

IAD

LIMNOLOGICAL REPORTS

Volume 33

Proceedings

33rd Conference, Osijek, Croatia 2000

Published for IAD by
Faculty of Education, Josip Juraj Strossmayer University of Osijek
and Croatian Ecological Society

Editor-in-Chief: Janja Horvatić

Printed by Grafika, Osijek 2000

Internat. Assoc. Danube Res.	33	103-110	Osijek, September 2000

Comparison of Phytoplankton of 80s and Late 90s in a Large Side Arm of the Danube River (Soroksár-Danube - Hungary)

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Summary: The chlorophyll-a content, abundance and taxonomic composition of phytoplankton were studied in the Soroksár-Danube between 1984-87 and 1999. Samples were taken biweekly in the 80's, monthly in 1999 at Dunaharaszti (the upper part of the side arm) and at Ráckeve (the lower part of the side arm) and from the main arm of the Danube River to compare the qualitative and quantitative composition of phytoplankton. The potential trophic state of Soroksár-Danube is hypertrophic, the actual trophic level is meso-, eutrophic in winter and eu- hypertrophic in other seasons.
When the annual water discharge was low, the phytoplankton abundance became higher in the Soroksár Danube compared to the main arm, caused by a high abundance of centric diatoms. When the annual water discharge was high, the abundance of phytoplankton was similar to the main arm. In the other cases, the abundance of phytoplankton of the upper part of the Soroksár-Danube was similar to the main arm, but that of the lower part was different from it (two-three times higher). The much abundant phytoplankton of the side arm flowing back to the main arm can increase the trophic level of the river.

Zusammenfassung: Im Zeitraum von 1984 bis 1987 und im Jahr 1999 wurden der Chlorophyll-a Gehalt, die Abundanz und die taxonomische Zusammensetzung des Phytoplanktons in der Soroksárer Donau untersucht. Die Wasserproben wurden 1984-1987 zweiwöchentlich und 1999 monatlich bei der Siedlung Dunaharaszti (der obere Abschnitt des Seitenarmes), bei der Siedlung Ráckeve (der untere Abschnitt des Seitenarmes) und aus dem Hauptarm der Donau geschöpft, um die qualitativen und quantitativen Eigenschaften des Phytoplanktons zu vergleichen. Der potentielle Trophiegrad des Soroksár-Armes ist hypertroph, die aktuelle Trophie (der aktuelle Trophiegrad) des Wassers war jedoch meso-eutroph im Winter und eu-hypertroph während der anderen Jahreszeiten. Bei geringerem jährlichem Wasserabfluß hatte die Abundanz des Phytoplanktons in dem Soroksár-Arm im Vergleich zu dem Hauptarm zugenommen. Die Ursache war eine erhöhte Abundanz der zentralen Kieselalgen. War der jährliche Wasserabfluß gross, so konnte eine dem Hauptarm ähnliche Phytoplanktonabundanz beobachtet werden. In den anderen Fällen wurde im oberen Abschnitt der Soroksárer-Donau eine dem Hauptarm ähnliche Phytoplanktonabundanz festgestellt, aber die Phytoplanktonabundanz des unteren Abschnitts unterschied sich von der des Hauptarmes dadurch daß sie zwei bis drei Mal so groß war. Wenn diese stark zugenommene Phytoplanktonmasse in den Hauptarm zurückströmt, kann sie einen erhöhten Trophiegrad im Hauptarm hervorrufen.

Key words: phytoplankton, trophic state, chlorophyll-a, river

Introduction

The Soroksár-arm of the Danube River is the second largest and longest side arm on the Hungarian stretch of the river, with a length of 58 km. The water level is regulated independently from the water discharge of the main arm, by two locks. The upper lock is found on left side of the Danube River in the Southern part of Budapest (1642- and lower lock at 1586 riv. km). This large side arm has a recreational, industrial and agricultural water supply function for the region although it receives half of the treated wastewater of Budapest. The water is very polluted on the upper part (58-38 riv. km) of the arm (unsuited for bathing) and less polluted (caused by the good self purification effect) on the lower part (22-0 riv. km) with some beaches. On the upper part of the side arm the river bed is narrow (40-80 m wide) and the water depth is 2-3 m. On the middle part the riverbed is relatively wide (400-500 m), the water depth is mostly the same as above. On the lower part the riverbed is a little bit narrower then on the middle part, but the water is deeper (7-10 m) then above. Current velocity is very low (annual average is about 0,1 m/s), so it can be regarded in many respects as a still water. Water-level fluctuation is only a few decimetres. The retention time is depended on the water discharge of the main arm. When there are big floods in the main arm, the water discharge in the Soroksár-Danube is higher than usually, the current can reach 0.3-0.4 m/s. The phytoplankton composition is affected by the main arm's one on the upper part of the side arm. Caused by the low current an important part of the „river phytoplankton" can settle down and the "own" phytoplankton of Soroksár-Danube develops.

First data about the algae of the side arm were published by CHOLNOKY (1922). In the years 1934-36 algae of the Soroksár-Danube were observed by MÁRTA HALÁSZ (HALÁSZ, 1936, 1937). She took 57 samples from the upper part of the side arm. On the basis of the investigated habitats she divided the algae into planktonic, benthic and reed-belt algae. These investigations were semiquantitative and characterised the abundance with the attributes: mass, many, few, scattered. SCHIEFNER and URBÁNYI (1970) took samples along the side arm at 8 point between 1966-67. 287 algal taxa were published from the phytoplankton. The algal number increased from the upper part to the lower part of the side arm. The highest value was 46.000 ind/ml close to the lower lock at Tass. Planktonic diatoms were abundant during their investigation. Between 1981-1983 Kiss kept on with the phytoplankton-observation with fortnightly to monthly frequency (KISS and GENKAL, 1993). They observed several Centrales blooms: caused first of all by *Stephanodiscus hantzschii* f. *tenuis* Grunow and in February by *Stephanodiscus minutulus* (Kütz.) Cleve et Möller in November. During high water periods the phytoplankton of the main- and side-arm was similar, but during low water periods, caused by the decreased velocity and suspended matter content, the algal composition of the side-arm was different from that of the main-arm. In 1983 centric diatoms were dominant in the phytoplankton during the whole year, like *Cyclotella atomus*

Hustedt, *Cyclotella meneghiniana* Kützing, *Skeletonema potamos* (Weber) Hasle, *Stephanodiscus hantzschii* f. *hantzschii* Grunow. (BOTHÁR and KISS, 1984).

In this paper we present the results of phytoplankton studies carried out between 1984-87 and 1999.

Material and Methods

The samples were taken biweekly between 1984-87 and monthly in 1999 at the upper part (Dunaharaszti - 40 riv. km) and at the lower part of the side-arm (Ráckeve - 18 riv. km - Figure 1) and from the main arm of the Danube River (Budafok 1636 riv.km) before the branch out of the Soroksár-Danube.

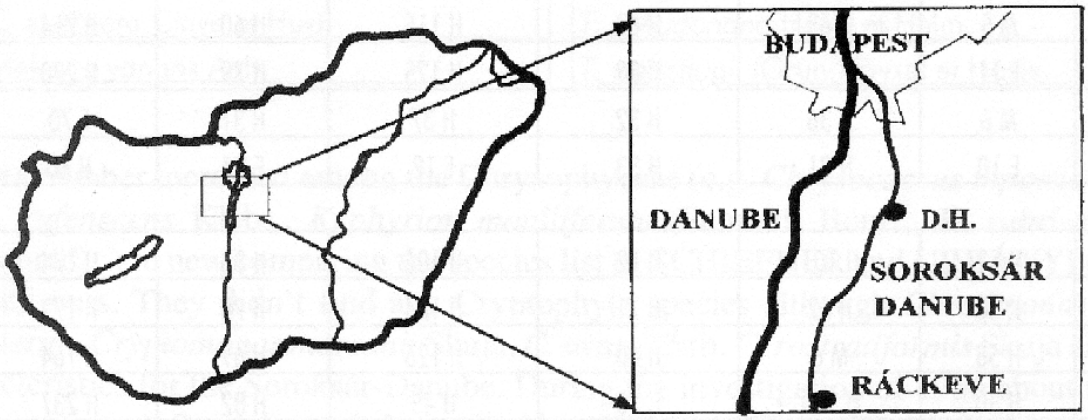

Figure 1. Sampling stations. D.H. = Dunaharaszti. So colled "main arm"samples were taken from the main arm of River Danube at the begining of Soroksar side-arm

The samples were taken with a special sampler (a modified Meyer-flask), in the current-line 20 cm. below the water surface. The chlorophyll-a content (phytoplankton biomass) was measured on the basis of GOODWIN (1976). The abundance was determined by the UTERMÖHL (1958) method according to Lund's statistical instructions (1958), with an OPTON Invertoscop D, using a magnification 600x for counting. To determine the Centrales species, a part of the samples was treated by H_2O_2, three times washed with distilled water and examined by transmission electron microscopy (see in detail KISS, 1986).

Results and Discussion

The Soroksár-Danube is a potentially hypertrophic water based on the nutrient content mineral N, P - (KISS and GENKAL, 1993). Considering the chlorophyll-a concentration of phytoplankton the actual trophic level of Soroksár Danube was meso- or eutrophic in winter at Dunaharaszti and in some years also at Ráckeve. It was hypertrophic in the other seasons (Table 1).

Table 1. The chlorophyll-a content of phytoplankton (mg/m^3) indicating the trophic state according to OECD (1982) standard (M= mesotrophic, E= eutrophic, H= hypertrophic).

main arm	winter mean	spring mean	summer mean	autumn mean	annual mean	maximum
1984	M 8	H 78	H 77	E 22	H 45	H 120
1985	E 13	H 82	H 64	H 30	H 62	H 150
1986	E 14		H 84	H 96	H 71	H 157
1987	M 6	H 34	H 29	H 35	H 29	H 77
1999	M 3	H 32	H 27	E 22	E 25	E 46
Dunaharaszti						
1984	E 10	H 84	H 105	E 26	H 58	H 167
1985	M 5	H 63	H 67	H 115	H 60	H 214
1986	E 11		H 89	H 125	H 79	H 220
1987	M 6	H 36	H 32	H 37	H 31	E 70
1999	E 10	H 31	H 33	E 12	E 24	H 80
Ráckeve						
1984	H 52	H 101	H 62	H 106	H 83	H 174
1985	H 30	H 62	H 71	H 164	H 78	H 172
1986	H 58	M 6	H 60	H 126	H 69	H 164
1987	H 30	H 174	H 70	H 45	H 82	H 237
1999	E 12	H 47	H 34	E 13	H 29	E 66

In every season the centric diatoms are the most abundant group in the phytoplankton of the Danube River and also in the Soroksár-Danube. The algal composition of the sidearm strongly resembles that of the main arm, because the main source of phytoplankton is the Danube River. It is an interesting difference that the *Cyclotella* species are more abundant in the main arm than the Soroksár Danube. Perhaps they can sediment more quickly than the *Stephanodiscus* species.

In the warm water periods the proportion of non-diatom species (especially Chlorophyceae) is higher than in the other seasons, except of *Skeletonema potamos* (Figure 2). From the 70s-80s this warm-stenothermic species became more and more dominant in the Danube River in connection with the increasing of the trophic level of the river (KISS et al. 1994). In winter mainly *Stephanodiscus minutulus, S. invisitatus* and *S. hantzschii* f. *tenuis* were the dominant species in the Soroksár Danube, in other seasons there are several other centrics, too (Table 2).

Comparing the species composition of the phytoplankton of our study and that of 1966 (SCHIEFNER and URBÁNYI, 1970) several differences were found. The spe-

Table 2. List of centric diatoms species found in the Soroksár-Danube.

Aulacoseira granulata (Ehr.) Sim.	*Rhizosolenia eriensis* H.L. Smith
A. gran. var. angustissima (O. Müll) Sim.	*Skeletonema potamos* (Weber) Hasle
A. italica var. tenuissima (Grun.) Sim.	*Stephanodiscus delicatus* Genkal
A. subarctica (O. Müll.) Haworth	*S. hantzschii* f. *hantzschii* Grun.
Cyclostephanos dubius (Fricke) Round	*S. hantzschii* f. *tenuis* (Hust.) Hak. et Sloer.
Cyclotella atomus Hust.	*S. invisitatus* Hohn et Hellerman
C. meduane Germain	*S. minutulus* (Kütz.) Cleve et Möller
C. meneghiniana (Kütz.)	*S. neoastrea* Hak. Et Hickel
C. pseudostelligera Hust.	*Thalassiosira guillardii* Hasle
C. radiosa (Grun.) Lemm.	*T. lacustris* (Grun.) Hasle
C. stelligera Cleve et Hust.	*T. pseudonana* Hasle et Heim.
Melosira varians Agh.	*T. weissflogii* (Grun.) Fryxel et Hasle

cies number increased among the Chrysophyceae (e.g. *Chrysococcus biporus* Skuja, *C. rufenscens* Klebs., *Kephyrion moniliferum* (Schmid) Bourr., *K. rubri-claustri* Conrad), are new comparing the species list of SCHIEFNER and URBÁNYI (1970) with ours. They didn't find any Cryptophyta species although *Chroomonas acuta* Uterm., *Cryptomonas marsonii* Skuja, *C. ovata* Ehrb. *C. rostratiformis* Skuja are characteristics for the Soroksár-Danube. During the investigation of 1966 about two times as many Pennales and about a half or third of the Centrales species were found. Among the Pennales the proportion of epiphytic (tychoplanktonic) species was much higher than during our studies. We found three times as many Chlorococcales species (which are mostly euplanktonic) and less Desmidiales species (tychoplanktonic). This phenomenon in change of species composition when comparing the 60s and 80s were characteristic for the main arm of the Danube River (see in detail in KISS and SCHMIDT, 1998).

When the annual water discharge was low (e.g. 1984, 1985), the phytoplankton abundance became higher in the Soroksár-Danube compared to the main arm (Figure 2). Centric diatoms caused the increasing of abundance in the side arm. When the annual water discharge was high (e.g. 1986, 1999), the abundance of phytoplankton was similar to that of the main arm. In other cases the abundance of phytoplankton of the upper part of the Soroksár-Danube was similar to the main arm, but that of the lower part was different from it (it can be two-three times higher, e.g. 1987). Parallel with the increasing of abundance the species composition of phytoplankton changes. The abundance and dominance of many species characteristic for the main arm of the Danube decreases and several species characteristic in lacustrine habitats starts to develop important population. Caused by the low current velocity in the side arm, the suspended matter coming from the main arm is sedimented, and the transparency becomes high. The high level of nutrient supply is favourable to the proliferation of

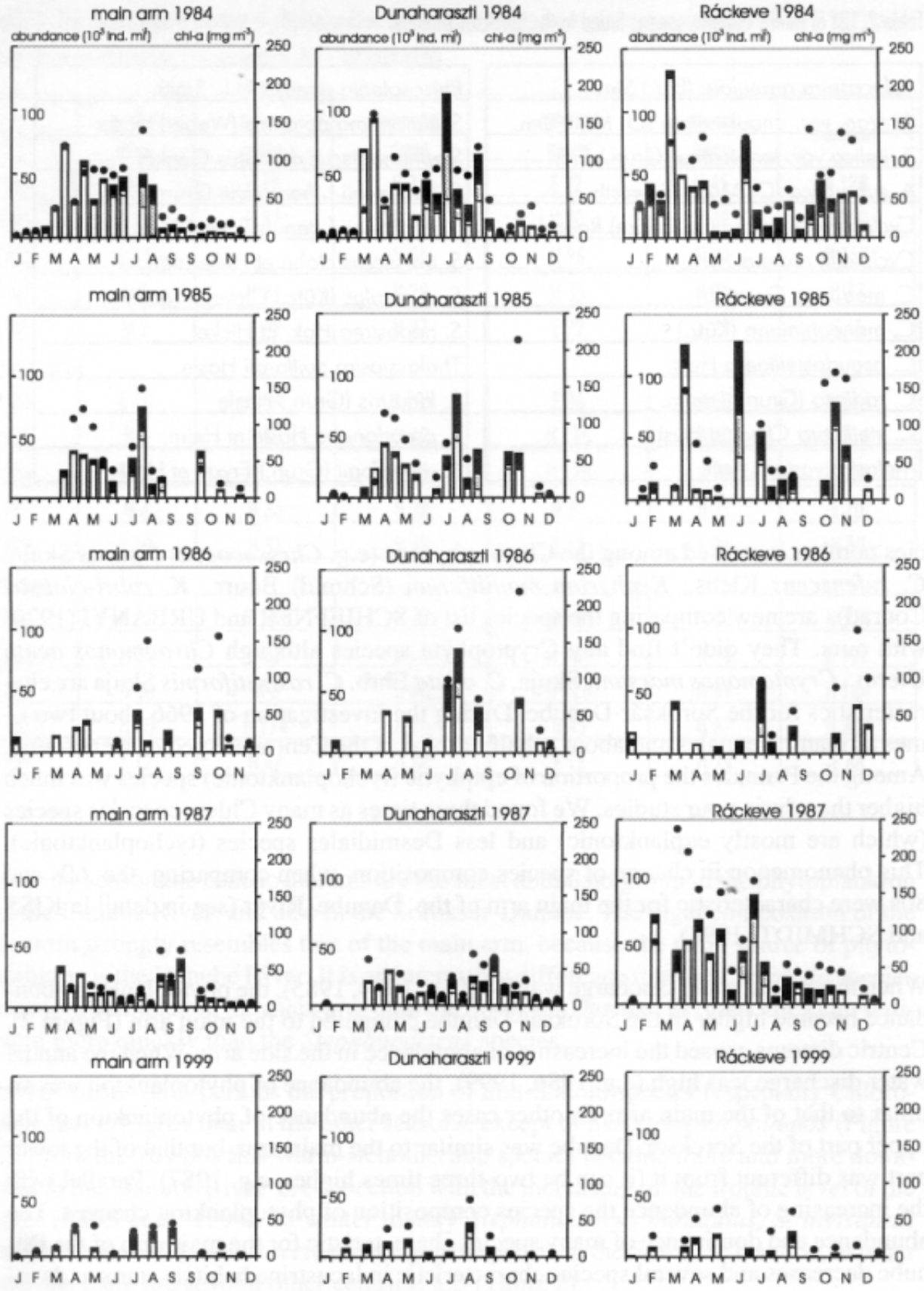

Figure 2. The phytoplankton abundance (column, white = Thalassiosiraceae, striped = Skeletonema, black = other) and chlorophyll-a content (black point) in the Soroksár Danube

phytoplankton. There is the reason of the frequent high abundance of euplanktonic algae. This abundant phytoplankton flowing back to the main arm and can affect a further increasing of the trophic level.

It is evident in the Table 1 and Figure 2 that the abundance and the trophic level of the Soroksár-Danube is higher in winter at Ráckeve than at Dunaharaszti. This phenomenon was observed already by KISS and GENKAL (1993). During winter time even the side arm is frozen and covered by snow, blooms of planktonic algae were developed (Figure 2 Ráckeve 1984, 1985 February-March). Usually some centric diatom, first of all *Stephanodiscus minutulus* was abundant (see in detail KISS and GENKAL, 1993).

Acknowledgement: This research was supported by the Foundation for the Hungarian Higher Education and Research (Zoltán Magyary postdoctoral grant) and by the Hungarian National Science Foundation (OTKA T 032069).

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