The Composition and Biomass of Phytoplankton of the Sava River

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Abstract

The Sava river is the right-sided tributary of the Danube river, which joins it at Belgrade. Sava runs through Serbia by its lower stretch that has all the characteristics of a plane river. Republic Hydrometeorological Service of Serbia and The Management For Environmental Protection of Serbia organized march-route water and sediment quality examination of this river from 21st until 24th August 2006. This paper presents the results of analysis on phytoplankton community and physical-chemical water characteristics. The results of physical-chemical water analysis, according to ICPDR classification, show that all examined parameters matched the first and the second class of water quality. Heterogenity of phytoplankton composition has been noted, 121 taxa from 7 algal divisions. The biggest heterogenity showed green algae (56 taxa). Diatoms were subdominant with 43 taxa. All other algal divisions were presented with small number of taxa. The quantitative analysis pointed out on poverty of phytoplankton composition. The smallest phytoplankton abundance was noted at Sremska Mitrovica in the middle of the river course (36 800 ind. dm^{-3}), and the biggest at Ostruznica on the right side of the river (282 800 ind. dm^{-3}). At the same localities phyoplankton biomass was between minimal 33.52 µg dm^{-3} and maximal 183.01 µg dm^{-3}. The concentration values of Chlorophyll a matched the oligothrophic status, that is characterized by the low primary production. According to ICPDR standard of classification these values matched the I class of water quality.

Keywords: phytoplankton, abundance, biomass, chlorofill-a, nutrients

Introduction

The Sava river is international river. It is formed in Slovenia, by coupling of two Alpine rivers, Sava Dolinka and Sava Bohinjka. It is 945.5 km long and its basin covers the area of 95 719 km^2. Its basin has mostly developed in the hill-mountain ground of Alpine and Dinaridian system, whilst its plane part covers 21.9 % of its total area. The Sava river runs through Serbia by its lower stretch, with all the characteristics of the plane river. The part of the basin through Serbia is 15 687 km^2 (Gavrilović et al. 2002). It is the right-sided tributary of the Danube river which joins it at Belgrade. It is the richest Danube tributary in water., Phytoplankton analysis of the upper stretch of Sava river, was published in the papers by Matonickin & Pavletic 1972, Matonickin et al. 1975, of the whole stretch in the paper of Obuskovic et al. 1987. The examinations of the lower stretch of Sava are numerable since Protic 1939, Sencanski 1972, Obuskovic et al. 1987, Martinovic-Vitanovic 1996, Lausevic et al. 1998., Martinovic-Vitanovic et al. 2003, 2004, Cadjo et al. 2006. Republic Hydrometeorologic Service of Serbia and The Management for the Environmental Protection carried out the march-route water and sediment quality examination of Sava river in its lower stretch, from croatian-serbian border up to its join, from 21-24.08.2006. with the assistance of ship-laboratory Argus. This paper presents the results of the qualitative and quantitative composition of phytoplankton and physical-chemical characteristics of water.

Material and methodology

Table 1 shows the localities and dates of examinations. The standard sampling methodology for physical-chemical water examinations has been used (Standard Methods 1989). Qualitative phytoplankton analysis has been carried out from samples taken by plankton net, mesh-size 25 µm, and the quantitative from samples taken directly to plastic bottles of 1 dm^3 volume from 0.5 m under water surface (Schwoerbel 1970, Sournia 1978). The samples have been preserved in the field by formaldehyde to 4 % concentration. The physical-chemical analysis were taken in accordance to standard methodology (JUS-ISO, EPA). Classification of chemical parameters was done following the ICPDR standard classification. The phytoplankton analysis was carried out on inverted microscope with phase contrast, Zeiss type Axiovert and Nikon. Determination of diatoms was carried out from the durable preparations. The cell contents was treated by acid and oxidizing agent (Husted 1966, according to Kramer, Lange-Bertalot 1986). The durable preparations of diatoms were made by using Canada balsam. Determination was made mostly to the level of species, variety or form, rather than to the level of genus. Taxa have been classified in 10 divisions (Blazencic 1988). Quantitative analysis was carried out by Utermöhl methodology (Utermöhl 1958). The absolute abundance of taxa is expressed as the number of individuals in 1 dm^3 (it refers to the number of cells in 1 dm^3, except with bluegreen algae of trichal organisation, where it represents the number of trichoms in 1 dm^3). Biomass is expressed in mass units in 1 dm^3. Cell biomass is given on the basis of real cell volume that was calculated by geometric approximations, mathematical formulas. For the average volume of species, at least 25 at random cell of each species were measured, the volume of each cell was calculated and then the average volume of each species was calculated (Hindak 1978, Nemet et al. 2002). The analysis of chlorophyll a was taken on ship. The samples were filtered and the frozen filters were sent to lab where the contents was extracted in ethanol and the concentration was measured spectrophotometrically (ISO 10260, 2001). ICPDR classification standard was used for the interpretation of results (Water Quality in the Danube River Basin TNMN Yearbook, 2001).

Table 1. The examined localities on Sava river in August 2006

River	Locality	rkm		Sampling point	Date
SAVA	Jamena	200	Jl	left bank	21.08.2006.
			Jm	middle	
			Jr	right bank	
	Sremska Mitrovica	136	SMl	left bank	22.08.2006.
			SMm	middle	
			SMr	right bank	
	Sabac	108	Sl	left bank	23.08.2006.
			Sm	middle	
			Sr	right bank	
	Ostruznica	17	Ol	left bank	24.08.2006.
			Om	middle	
			Or	right bank	

Results and discussion

Air temperature on the first sampling day, at the locality of Jamena, was lower than the average temperature in August. The field examinations onwards were carried out under weather stabilization and temperature increase for about 10ºC. Water temperature is between 21.9 and 24.1 (Tab. 2). Water is slightly alkaline. Concentration for soluble oxygen is mainly within the II class of water quality. BOD_5 and COD values are mainly within the I class of water quality that points out to a slight organic water pollution. The contents of nutrients is very similar to that from September 1995. (Lausevic et al. 1998). The concentrations of ammonia, nitrates and nitrites, respectively, match the standard for the I class of water quality (exception, nitrates at Jamena on the both left and right banks, match the II class). The concentrations of orthophosphates match the limit values between I and II class, on locality of Jamena slightly increased (II class). The total phosphor concentration is also low, it matches the I class of water quality. The concentrations of secondary nutrient (SiO_2) are also similar to that from September 1995. (Lausevic et al. 1998). Only the momentary state of physical-chemical parameters of water quality is shown and no general conclusions can be made. The qualitative phytoplankton analysis showed great floristic variety, the presence of 121 taxa, from 7 algal divisions. The majority of taxa belongs to green algae (56 taxa, 46.28 %). Their domination in a qualitative way is expected, due to the fact that it was summer time. The subdominant species are diatoms (43 taxa, 35.54 %). The rest of the algal divisions are present with less taxa: Cyanoprokaryota (9 taxa, 7.44 %), Chrysophyta (2 taxa, 1.65 %), Xanthophyta (2 taxa, 1.65 %), Pyrrhophyta (2 taxa, 1.65 %) i Euglenophyta (7 taxa, 5.79 %). Phytoplankton is considerably rich in species characteristics for phytobentos and periphyton, which got there by water flowing, which is in accordance with previous examination (Martinovic-Vitanovic 1996, Lausevic et al. 1998, Cadjo et al. 2006). Two species of green algae not seen before in lower Sava flow are noted (Sencanski 1972, Martinovic-Vitanovic 1996, Lausevic et al. 1998, Cadjo et al. 2006). They are: *Scenedesmus grahneisii* (Heynig) Fott and *Scenedesmus gutwinskii* Chod. The number of taxa in quantitative samples is 32-50 (Fig. 1).

Table 2 Results of physical-chemical water analysis of Sava river in August 2006

	Jamena			Sremska Mitrovica			Sabac			Ostruznica		
Parameter	Jl.	Jm.	Jr.	SMl.	SMm.	SMr.	Šl.	Šm.	Šr.	Ol.	Om.	Or.
Air temp. (^{0}C)	18,9	19,2	18,8	26,8	28,6	28,9	25,6	26,2	26,4	28,6	28,4	28,1
Water temp. (^{0}C)	22,0	21,9	22,2	22,4	22,3	22,5	23,0	22,8	23,0	24,1	24,1	24,0
Suspend. solids (mg dm^{-3})	16	16	17	6	5	9	2	2	9	3	2	2
Dissolved oxygen (mg dm^{-3})	6,2	6,5	6,3	6,0	7,8	6,3	6,4	6,5	6,4	6,5	6,2	6,0
pH	7,8	7,9	7,8	7,9	7,7	7,7	7,8	7,8	7,7	7,6	7,6	7,5
Conducti-vity (µS cm^{-1})	448	452	454	417	418	417	420	421	422	412	411	412
BOD_5	3,16	1,3	1,87	2,1	1,7	1,3						
COD_{Mn}	3,24	3,4	1,91	2,4	2,6	2,6	2,1	3,1	3,6	3,8	3,0	3,5
Ammonium -N (NH_4-N) (mg dm^{-3})	<0.1	0,17	<0.1	<0.1	0,03	0,07	0,04	0,06	0,03	0,06	0,06	0,03
Nitrite (NO_2-N) (mg dm^{-3})	0,007	0,006	0,012	0,004	0,007	0,004	0,002	0,003	0,002	0,005	0,004	0,008
Nitrate (NO_3-N) (mg dm^{-3})	1,10	0,17	1,20	0,50	0,40	0,20	0,50	0,70	0,50	0,80	0,50	0,70
Organic nitrogen (N) (mg dm^{-3})	0,8	1,1	0,2	0,8	0,8	1,1	0,8	0,6	0,9	0,6	0,8	0,4
Total nitrogen (N) (mg dm^{-3})	1,9	1,5	1,4	1,3	1,2	1,4	1,4	1,3	1,5	1,4	1,3	1,1
Ortho-phosphate (PO_4-P) (mg dm^{-3})	0,060	0,070	0,076	0,054	0,052	0,053	0,054	0,051	0,053	0,054	0,053	0,054
Total P (mg dm^{-3})	0,095	0,097	0,096	0,073	0,070	0,070	0,059	0,063	0,065	0,068	0,060	0,066
Sillica (SiO_2) (mg dm^{-3})	5	5	5	5	5	5	5	5	6	6	5	6

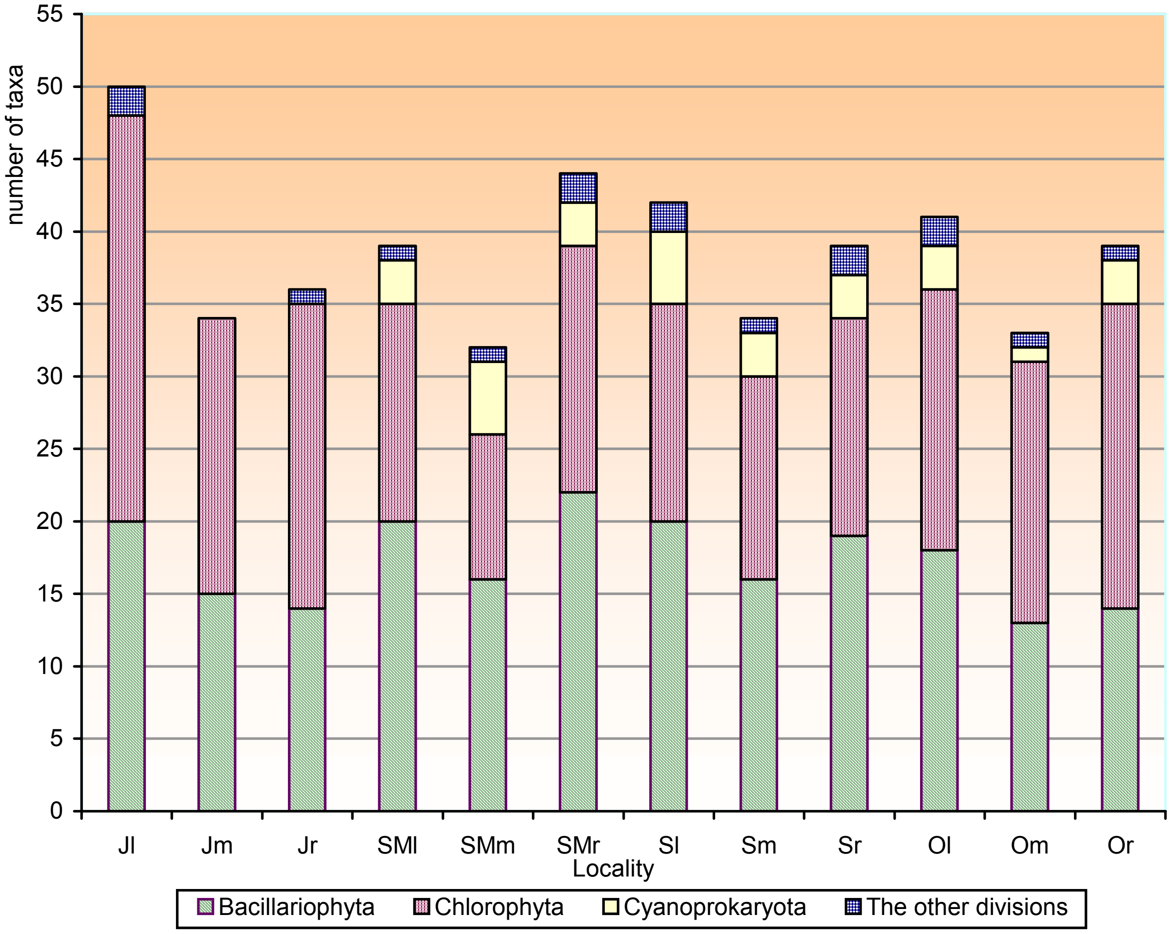
The poverty of phytoplankton society is noted by quantitative examination. The total abundance varies between 36 800 ind dm^{-3} at Sremska Mitrovica, the middle of the river course, and 282 800 ind dm^{-3} at Ostruznica, the right bank of the river. The highest algal biomass was at Ostruznica, at the right bank 183.01 µg dm^{-3} and the lowest at Sremska Mitrovica in the middle of river course 33.52 µg dm^{-3} (Fig. 2). Diatoms have the greatest biomass, first of all the centric forms. The percental share of diatoms in total algal biomass is from 78.44 % at Sremska Mitrovica, in the middle of water flow, up to 96.05 % at Ostruznica at the right bank of the river (Fig. 3). Percental share of centric forms in total algal biomass is from 24.05 % (Sabac, left bank) up to 89.39 % (Ostruznica, right bank). Centric diatoms achieve the maximal biomass at Ostruznica: *Cyclotella meneghiniana* (94.67 µg dm^{-3}, right bank), *Stephanodiscus hantzschii* (42.11 µg dm^{-3}, left bank), *Skeletonema potamos* (17.89 µg dm^{-3}, right bank) and *Aulacoseira granulata* (11.36 µg dm^{-3}, right bank). Penat diatoms *Gyrosigma acuminatum*, *Navicula cuspidata*, *Fragilaria ulna* and *Cocconeis placentula* achieve the maximal biomass at Sabac, left bank, 96.28 µg dm^{-3} (58.99 % of total biomass). The abundance of green algae vary from 8 600 ind dm^{-3} (23.37 %) at Sremska Mitrovica, in the middle of river course, up to 71 400 ind dm^{-3} (59.01 %) at Jamena, left bank. Comparing to population density, biomass of green algae is low and at the same localities varies from 0.6 µg dm^{-3} (1.79 %) up to 8.22 µg dm^{-3} (11.46 %). The greatest biomass amongst green algae is that of *Scenedesmus acuminatus*, *Actinastrum hantzschii*, species of genus *Dictyosphaerium*, *Scenedesmus quadricauda*, *Coelastrum microporum*, *Coelastrum astroideum*, *Pediastrum duplex*, *Didymocystis planctonica*. However, maximal biomass values of these species are small and within range of 0.5-1.3 µg dm^{-3}.

Floristic list of algae in phytoplankton of Sava river, August 2006:

Cyanoprokaryota
Anabaena Bory sp.
Aphanizomenon flos-aquae (L.) Ralfs
Aphanizomenon issatschenkoi Prošk-Lavr.
Geitlerinema amphibia (Agardh ex Gom.) Anagn.
Merismopedia elegans A. Braun
Merismopedia tenuissima Lemm.
Oscillatoria limosa (Roth) Agardh
Oscillatoria Vaucher sp.
Phormidium tenue (Agardh ex Gom.) Anagn. et Kom.
Chrysophyta
Dinobryon divergens Imhof
Dinobryon sertularia Ehrb.
Bacillariophyta
Achnantes Bory sp.
Amphora ovalis Kützing
Asterionella formosa Hassall
Aulacoseira granulata (Ehrb.) Simonsen
Cocconeis pediculus Ehrb.
Cocconeis placentula Ehrb.
Cyclostephanos sp.
Cyclotella meneghiniana Kützing
Cymatopleura elliptica Bréb.
Cymatopleura solea (Bréb.) W. Smith
Cymatopleura solea var. apiculata W. Smith
Cymbella affinis Kützing
Cymbella lanceolata (Ehrb.) Heuck
Cymbella minuta Hilse
Cymbella prostrata Cleve
Diatoma vulgaris Bory
Didymosphaenia geminata (Lingb.)
Fragilaria capucina Desm.
Fragilaria crotonensis Kitton
Fragilaria ulna (Nitzsch) Lange-Bert.
Fragilaria ulna (Nitzsch) Lange-Bert. *var. acus* (Kütz.) Lange-Bert.
Gomphonema olivaceum (Hornem.) Bréb.
Gomphonema parvulum (Kütz.) Grun.
Gyrosigma acuminatum (Kütz.) Rab.
Meridion circulare (Greville) Agardh
Navicula cryptocephala Kützing
Navicula cuspidata Kützing
Navicula gracilis Ehrb.
Navicula viridula Kützing
Neidium dubium (Ehrb.) Cleve
Nitzschia acicularis W. Smith
Nitzschia actinastroides (LEMM.)
Nitzschia linearis W. Smith
Nitzschia palea (Kütz.) Smith
Nitzschia sigmoidea (Ehrb.) Smith
Nitzshia dissipata (Kütz.) Grun.
Rhoicosphaenia abbreviata (C. Agardh) Lange-Bert.
Skeletonema potamos (Weber) Hasle
Stephanodiscus Ehrb. sp.
Stephanodiscus hantzschii Grun.
Surirella minuta Bréb.
Surirella splendida (Ehrb.) Kütz.
Surirella tenera Gregory
Tabellaria fenestrata (Lingb.) Kützing
Xanthophyta
Centritractus belenophorus Lemm.
Pseudostaurastrum hastatum Chodat
Pyrrhophyta
Ceratium hirundinella (O.F.M.) Bergh
Peridinium cinctum (O.F.M.) Ehrb.
Euglenophyta
Euglena acus (Duj.) Hubner
Euglena limnophila Lemm.
Euglena oxyuris Schmarda
Euglena viridis Ehrb.
Phacus longicauda (Ehrb.) Duj.
Strombomonas acuminata (Schmarda) Deflandre
Trachelomonas volvocina Ehrb.
Chlorophyta
Actinastrum hantzschii Lagerheim
Ankistrodesmus bibraianus (Reinsch) Korš.
Chlamydomonas sp.
Closterium acerosum Ehrb.
Closterium strigosum Bréb.
Coelastrum astroideum De Not
Coelastrum microporum Näg.
Coelastrum reticulatum (Dang.) Senn
Coenochloris ovalis Korš
Cosmarium Corda sp.
Crucigenia lautebornii Schmidle
Crucigenia tetrapedia (Kirchn.)W & G.S.West
Crucigeniella apiculata (Lemm.) Kom.
Dicelulla planctonica Svir.
Dictyosphaerium ehrenbergianum Nag
Dictyosphaerium tetrachotomum Printz
Didymocystis planctonica Korš.
Eudorina elegans Ehrb.
Gloeotila Kützing sp.
Golenkinia radiata Chodat

Gonium pectorale Muller
Hyaloraphidium contortum Pasch & Korš.
Lagerheimia ciliata (Lagerh.) Chod.
Lagerheimia genevensis (Chod.) Chod.
Micractinium bornchaemiense (Conr.) Korš.
Micractinium pusillum Fres.
Micractinium quadrisetum(Lemm.) G. M. S.
Monoraphidium contortum (Thur.) Com.-Leg.
Monoraphidium griffithii (Berk) Com.-Leg.
Oocystis lacustris Chodat
Pandorina morum (Bory)
Pediastrum boryanum var. boryanum (Turp.) Meneghini
Pediastrum duplex var.duplex Meyen
Pediastrum simplex Meyen *var. echinulatum* Wittz
Pediastrum simplex var. simplex Meyen
Pediastrum simplex Meyen *var. sturmii* (Reinsch) Wolle
Pediastrum tetras Ralfs
Polyedriopsis spinulosa Schmidle
Scenedesmus acuminatus (Lag.) Chod.
Scenedesmus bicaudatus (Hansg.) Chod.
Scenedesmus disciformis (Komarek) Chod.
Scenedesmus grahneisii (Heynig) Fott
Scenedesmus gutwinskii Chod.
Scenedesmus intermedius Chod. *var. intermedius*
Scenedesmus magnus Meyen
Scenedesmus Meyen
Scenedesmus opoliensis Richt.
Scenedesmus quadricauda (Turp.) Bréb.
Scenedesmus sempervirens (Chod.)
Scenedesmus smithii Teiling
Schroederia setigera (Schrod) Lemm.
Staurastrum chaetoceros (Schr.) G. M. Smith
Tetraedron minimum (A. Br.) Hansg.
Tetrastrum triangulare (Chod.) Kom.
Tetrastrum heteracanthum (Nordst.) Chod.
Tetrastrum staurogeniaeforme (Schr.) Lemm

Figure 1. Number of algal taxa in quantitative samples in Sava river in August 2006



Cyanoprokaryota were not noted in quantitative samples at Jamena. With somewhat greater abundance they are noted at Sremska Mitrovica and Sabac, where, at the left bank, they achieve the greatest abundance and biomass (23.64 µg dm^{-3}), (Fig. 3). At that locality, the greatest share in biomass of Cyanoprokaryota has the species *Geitlerinema amphibia* (97 %). The presence of this species in lower Sava stretch is reported only in recent examinations of phytoplankton of this river

(Cadjo et al. 2006). The concentration of chlorophyll *a*, as indirect parameter of algal biomass, varies from 1,15 µg dm^{-3} at Jamena in the middle of the flow up to 1,50 µg dm^{-3} at Sabac, left bank (Fig. 4).

Figure 2. Total abundance and biomass of algae in phytoplankton of Sava river in August 2006.

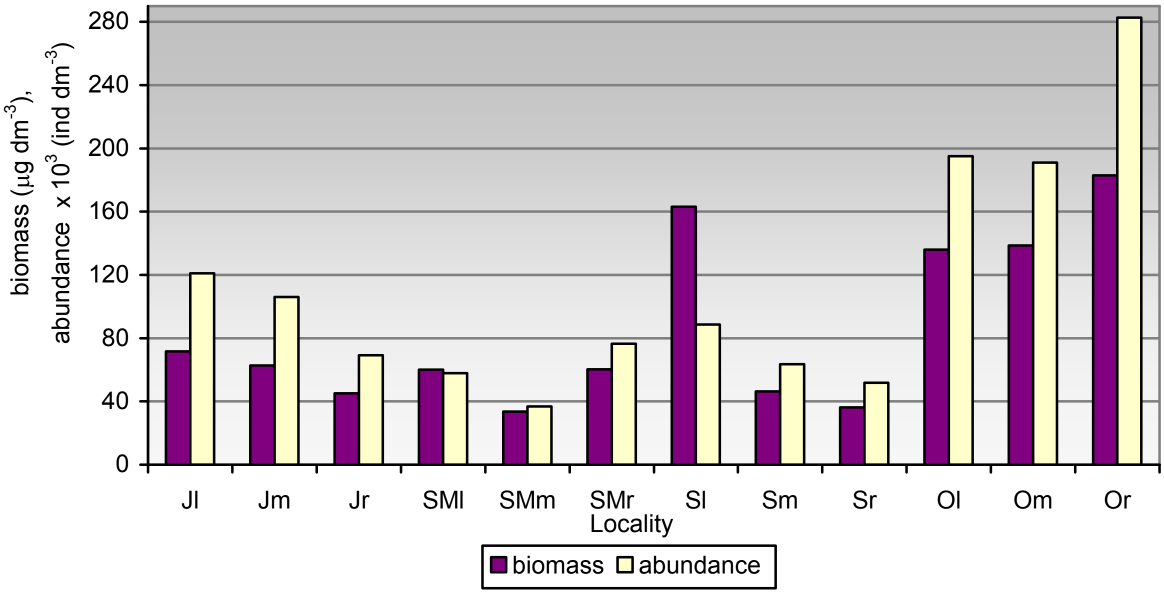
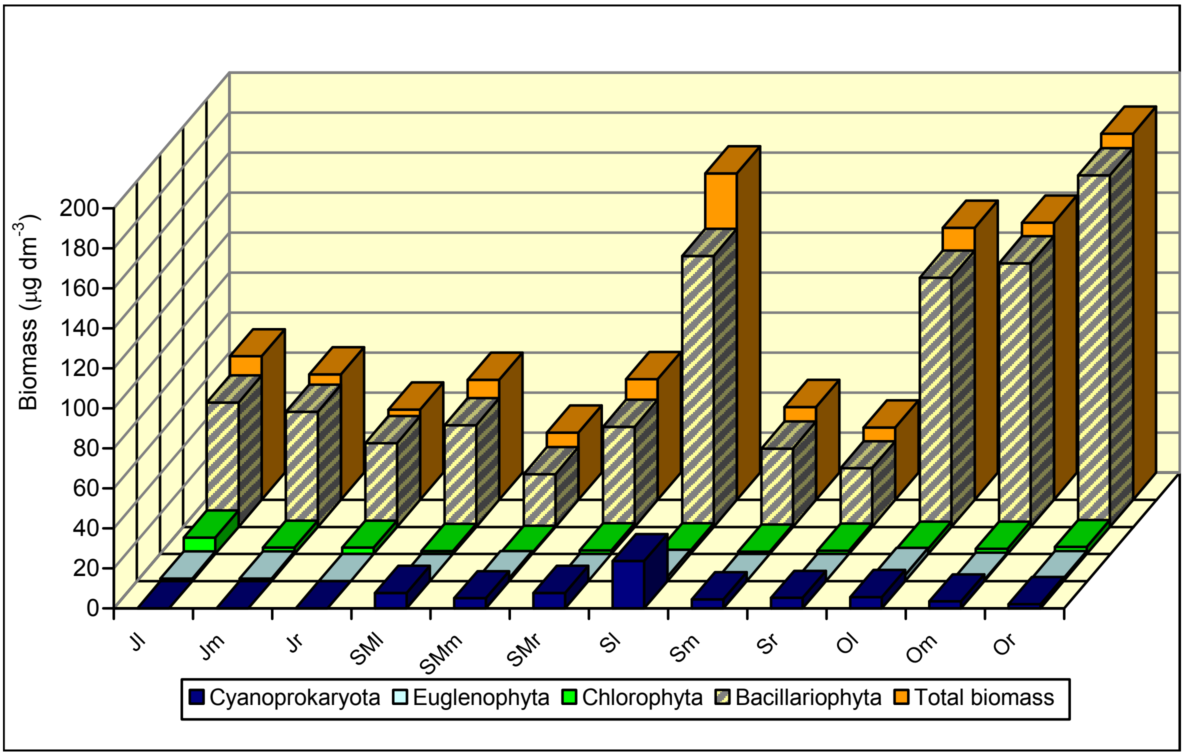


Figure 3. Ratio between biomass of certain phytoplanktonic groups and total biomass



Number of algal taxa of lower Sava stretch is less than that between 1982 and 1989 (227 taxa, Martinovic-Vitanovic 1996) and between 2003 and 2004 (185 taxa, Cadjo et *al*. 2006), due to the fact that previous examinations took longer period and all the aspects. The number of algal taxa is slightly higher than that between 1995-1996 (96 taxa, Lausevic et al. 1998) that is comprehensible, because our examinations were taken in August, and the summer period is characterized by increased numerosity of taxa of green algae, whilst the previous examinations were taken in September, December and May. The number of taxa in quantitative samples is bigger than in previous examinations and rather matches the number of taxa of phytoplankton net of previous examinations (Lausevic et al. 1998).

Figure 4. Longitudinal variations of Chlorophyll *a* in Sava river in August 2006

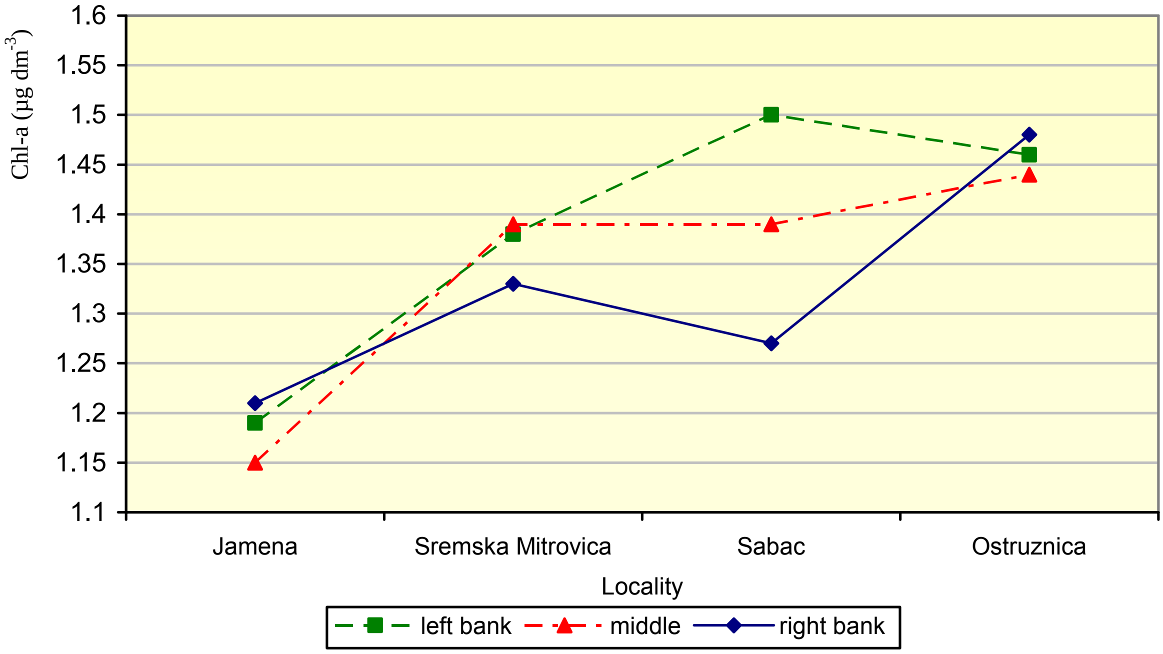
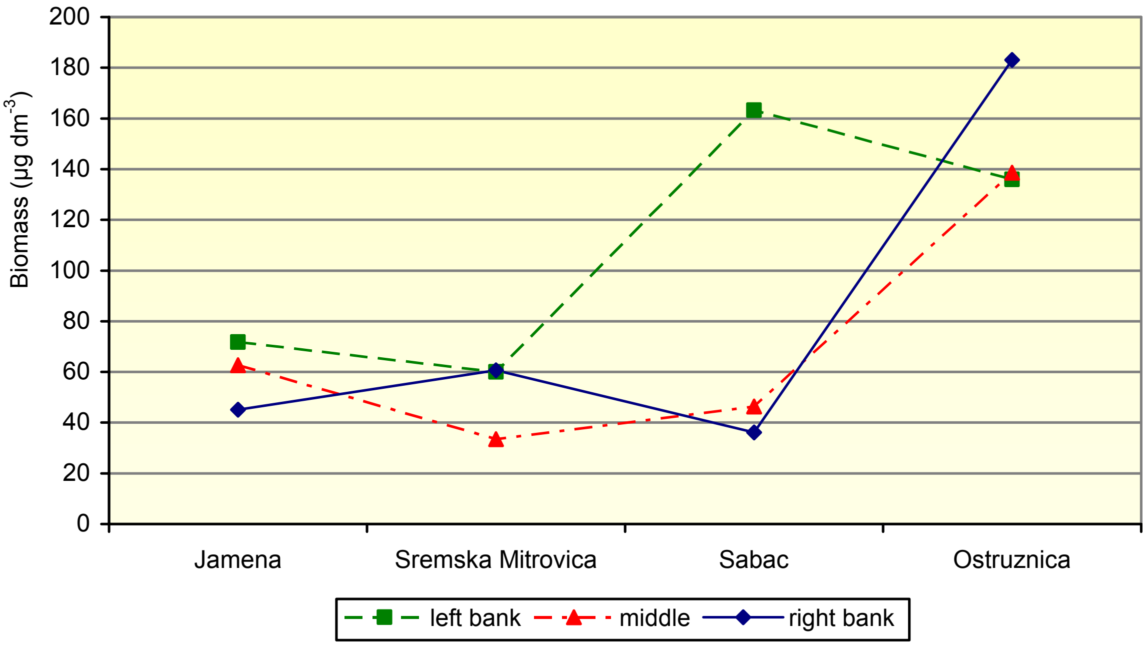


Figure 5. Longitudinal variations of phytoplankton biomass in Sava river in August 2006



Comparing the results with previous examinations, it can be also concluded that the abundance of phytoplankton is less than during 1970 (900 000 ind dm^{-3}, Sencanski 1972), similar as in September 1995. at Ostruznica, and less than in May 1996. at the same locality (25 000 do 500 000 ind dm^{-3}, Lausevic et al. 1998). The abundance of phytoplankton is similar as in September 1984. (57 000-221 000 ind. dm^{-3}, Obuskovic, 1987), same as in region of Belgrade 2002. (110 000-282 000 Martinovic-Vitanovic et al. 2003) and 2003. (10 000 do 265 000 ind. dm^{-3}, Martinovic-Vitanovic et al. 2004).

Phytoplankton abundance of lower Sava stretch is incomparably lower than maximal phytoplankton abundance in big European rivers, rich in nutrients (40-90 x 10^6 ind dm^{-3}, Gosselain et al. 1994, according to Lausevic et al. 1998). Compared with maximal phytoplankton abundance of Danube from August 2004. (14.74 x 10^6 ind dm^{-3}, Cadjo et al. 2006) it is about 50 times lower. Green algae compared to abundance become dominant through summer, but compared to biomass, diatoms dominate during the whole year, it is, for the lower stretches of rivers very often noted (Reynolds 1992,1994, according to Lausevic et al. 1998).

The total biomass of Sava river is similar to values from 1995-1996. (Lausevic et al. 1998). The similarity is specially outstanding if the biomass results from May 1996. are excluded (maximal value of 703 µg dm^{-3}) and the results from September 1995. are compared (12 µg dm^{-3} to about 200 µg dm^{-3}, Lausevic et al. 1998) because it is, in this case, period more relevant to compare. Maximal bimass of phytoplankton of Sava river is for about 100 times lower than that of Danube, in August 2004. (15 856 µg dm^{-3}, Cadjo et al. 2006). Total phytoplankton biomass of Sava river matches the lower limit of average phytoplankton biomass for rivers (60-25 000 µg dm^{-3}, Rojo et al. 1994, according to Lausevic et al. 1998). The biomass maximum for centric diatoms *Cyclotella meneghiniana* noted during these examinations is at locality of Ostruznica, has also been noted in May 1996. on the same locality (610 µg dm^{-3}, Lausevic et al. 1998). It has frequently been observed as the dominant potamoplankton in many rivers: the Weser, the Danube, the Meuse, the Wye and the Po. Cyclotella meneghiniana is commonly found in both limnetic freshwater as well as brackish environments, especially in eutrophic reservoirs (Husted, 1930, Murakami et al., 1992, according to Lausevic et al., 1998). The biomass for *Aulacoseira granulata* at Ostruznica is in accordance with examinations from September 1995. (15.6 µg dm^{-3}, Lausevic et al. 1998). The species *Stephanodiscus hantzschii*, that has considerable share in phytoplankton biomass, was not noted in previous examinations Lausevic et al. 1998, but was noted in examinations of Obuskovic et al. 1987, where it has been reported as the dominant species of middle and lower stretch of Sava river with a share up to 48 %. Centric diatom *Skeletonema potamos* which at Ostruznica, the right bank, had the greatest abundance (164 200 ind dm^{-3}) and much less, but still considerable biomass (17.89 µg dm^{-3}) has not been noted in Sava river in previous examinations. The species is of small sizes (nanoplankton) and is more rarely seen in net phytoplankton, but is present in quantitative samples. It was also reported in Danube river in August 2004. with maximal numerosity of 3.52 x 10^6 ind. dm^{-3} (Cadjo et al. 2006). Diatoms appear to be the best adapted taxonomic group for living in the highly unstable riverine environment (Rojo et al. 1994, according to Lausevic et al. 1998). Taking into account rather long water residence time, the major portion of diatom assemblage is considered to be autochthonous potamoplankton which reproduce in the main stream. As silicon is available in suffficent quantities during the whole year the diatoms have extended their dominance (Lausevic et al. 1998), that is also shown by these examinations. Green algae does not represent significant phytoplankton component according to their biomass (Lausevic et al. 1998), that is also shown by these examinations.

The highest concentrations of chlorophyll *a* and high values of algal biomass (163.21 µg dm^{-3}), on the left bank at Šabac are due to hydromorphologic characteristics of river flow on that part of river stretch. The biggest width of river on the whole stretch of Sava is at Sabac and it varies from 650 to 700 m (Gavrilovic et al., 2002). During these examinations it was 438 m. On the left bank of Sava there are shallow waters and there is also a decrease of water velocity flow. During the low tides the drifts can be noted. These local characteristics conditioned the more intensive development of phytoplankton on the left bank, compared to the middle of river and the right bank. The highest biomass of bluegreen algae (23.64 µg dm^{-3}) was also located here, the elements of "water blossoming". However, it has to be pointed out that bluegreen algae do not represent significant component of potamoplanktonic community that is in accordance with previous examinations (Lausevic et al. 1998). Generally speaking, if this peak of algal biomass at Sabac is excluded, on the left bank, that is due to local characteristics, it can be concluded that low and relatively even values of algal biomass are noted from Jamena to Sabac, and its increase downstream up to Ostruznica, closely to join of Danube (Fig. 5). Total abundance and phytoplankton biomass in this and all other examinations (Sencanski 1972, Obusković et al. 1987, Martinovic-Vitanovic 1996, Lausevic et al. 1998, Martinovic-Vitanovic et al. 2003, 2004, Cadjo et al. 2006) put river Sava in low-productive ecosystems. The concentration values for chlorophyll *a* point out to oligotrophic status, that is characterized by the low primary production. According to ICPDR standard of river classification the values of chlorophyll a are within the first class of water quality. Comparing results of total algal biomass of lower Sava stretch with the results of march-route examinations of Danube river in summer period (beginning of September 2001., Nemet et al. 2002; August 2004., Cadjo et al. 2006) up to 100 times bigger production of algae can be noted in Danube river. If the most relevant factors that regulate the phytoplankton biomass are compared, like

water temperature, the nutrients' concentrations (first of all phosphates), it can be noted that they are very similar (the same or slightly lower values of orthophosphates concentrations and somewhat higher concentrations of total phosphor in Danube). It appears that the differences in water regime of these two rivers influenced the differences in primary production. According to data from literature (Gavrilovic et al. 2002) the special property of water regime of Sava river are the abrupt increases of water flow, in only 24 hrs the water flow at Sremska Mitrovica can increase for 1070 $m^3 s^{-1}$, that means the increase of water level for 154 cm. It is probable that physical factors, discharge and water retention time have the more important role in regulation of phytoplankton biomass.
Some algal species in the Sava river, taken in Biological Laboratory of Republic Hydrometeorological Service of Serbia in August 2006 (Photo 1,2,3,4,5,6).

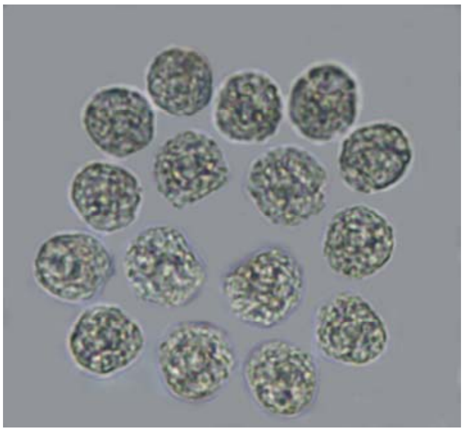


Photo 1. *Gonium pectorale*

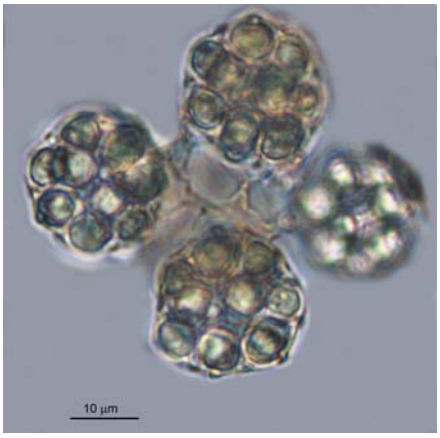


Photo 2. *Coelastrum reticulatum*

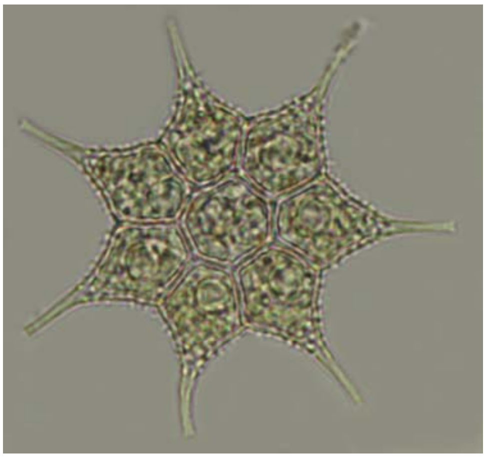


Photo 3. *Pediastrum simplex var. echinulatum*

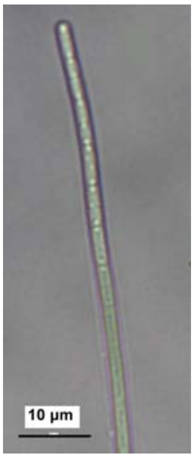


Photo 4. *Geitlerinema amphibia*

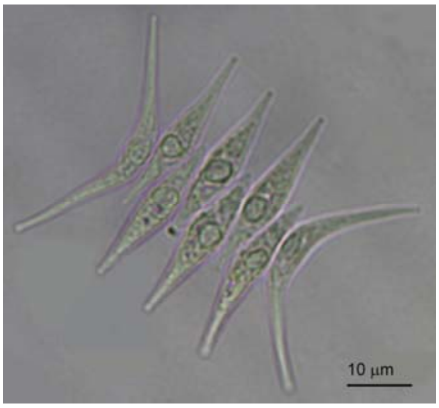


Photo 5. *Scenedesmus acuminatus*

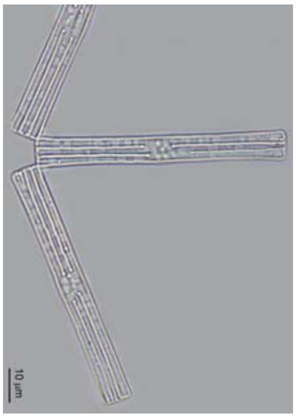


Photo 6. *Tabellaria fenestrata*

Conclusions

The results of physical-chemical analysis of water in lower stretch of the Sava river, in August 2006, show that the major of examined parameters lie within the range of I and II class of water quality. Satisfying condition of dissolved oxygen, slightly alcaline water reaction, slight organic pollution of water flow and lower concentrations of primary nutients were noted. The great floristic variety was reflected by presence of 121 taxa of seven algal divisions. Besides typical pothamoplanktonic forms, there were also noted forms characteristic for benthos and peryphyton. Relating to taxa number green algae are dominant, and diatoms are subdominant. The minimal abundance and phytoplankton biomass were noted at Sremska Mitrovica (136 rkm), in the middle of the water flow (36 800 ind dm^{-3}, 33.52 µg dm^{-3}), and maximal at Ostruznica (17 rkm), right bank (282 800 ind dm^{-3}, 183,01 µg dm^{-3}). Relating to bomass, diatoms are dominant with presence of 78.44 % up to 96.05 %. Relating to total biomass, share of centric diatoms is very significant (24.05 %-89.39 %). Comparing algal biomass values along the Sava river stretch, relatively low and even values of algal biomass were noted from Jamena to Sabac and its increase downstream up to Ostruznica. Abundance and phytoplankton biomass classify the Sava river as low-productive water ecosystems. Values of chlorophyill *a* concentrations point out to oligotrophic status. According to ICPDR standard for river classification values of chlorophyll a concentrations match I class of water quality.

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The Composition and Biomass of Phytoplankton of the Sava River. Snezana CADJO, Aleksandar MILETIC, Aleksandra DJURKOVIC Republic Hydrometeorological Service of Serbia Belgrade, Republic of SERBIA email: snezana.cadjo@hidmet.sr.gov.yu. Abstract The Sava river is the right-sided tributary of the Danube river, which joins it at Belgrade. Sava runs through Serbia by its lower stretch that has all the characteristics of a plane river. Republic Hydrometeorological Service of Serbia and The Management For Environmental Protection of Serbia organized march-route water and sediment quality examination