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THE DYNAMICS OF THE PHYTOPLANKTON POPULATION OF THE STARA DRAVA NEAR OSIJEK

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In 1987, 1988 and 1990 the dynamics of the phytoplantkon population was investigated in the Stara Drava (Old Drava) near Osijek, which was under the influence of the organically enriched sediment previously derived from industrial waste waters. A total of 240 phytoplankton taxa were established, with the dominance of *Chlorophyta* and *Chrysophyta* groups. Chemical analysis of the water of the Stara Drava indicated intense mineralization of the allochthonous and autochthonous organic mattter present. The results refer to the state of the ecosystem of the Stara Drava before the war in the period from 1987 to 1990.

Introduction

On account of its function in the metabolism of water ecosystems, the dynamics of the phytoplankton population holds a significant place in ecological research (Gucunski 1973, 1974, Herodek 1986, Komárková 1978, 1989, Brandl et al. 1989 and others). In addition, waters as the environment of phytoplankton are more and more endangered throughout the world and practice has proven that the state of endangered waters can be improved only on the basis of scientific research. Many authors (Odum 1971, Wetzel 1975, Welch 1980, Dykyjová 1989) emphasize the dependency of the dynamics of the phytoplankton population on the concentration of nutrients, the depth of the water ecosystem, the intensity and duration of daylight etc., all of which require research into the ecological factors present. The Stara Drava near Osijek (Croatia) represents a specific water ecosystem, since it is the remnant of the previus basin of the Drava river and extends parallel with its present day cours (Fig. 1). It is connected with

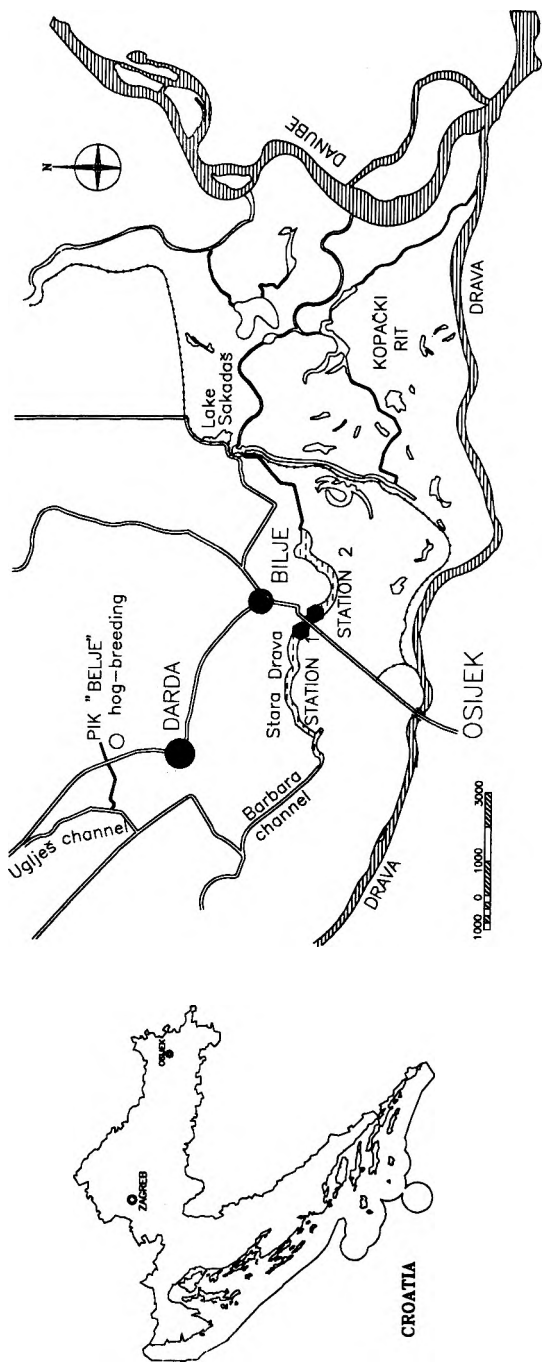

Fig. 1. Geographic map of special zoological reserve Kopački rit and the western area of Baranja

the Barbara canal which, with a number of other canals, makes up the most significant hydroamelioration system in the Baranja region. The water level of the Stara Drava depends on the water level of the Barbara canal. However, the water level of both the Danube and the Drava can have an impact on the Stara Drava in case of the Danube or Drava flooding. In such cases, the Kopačevo dam (Kopački Rit hydrological system reserve) opens and regulates the flood waters. The Stara Drava and its canal are 10 km long. The system is characterized by special sediment which developed during the period from 1969–1984 through the sedimentation of solid organic waste materials from the PIK Belje pig-breeding farm, the Meat-processing Industry of Darda and farming households. Because of the different character of the sediment, two stations on the Stara Drava were investigated (Fig. 1). Station I was chosen upstream of the Cingi-lingi čarda dam. This dam is permanently open and has a stonegravel threshold which partly blocks the passage of solid waste materials. Station II is downstream of the above mentioned dam and has a somewhat purified water due to sedimentation, but there is an inflow of waste water from a nearby catering establishment and surrounding settlements. The first algological investigations of the Stara Drava were carried out by Hortobagyi (1945) followed by Gucunski (1979, 1990), and the first measuring of the concentration of chlorophyll-a was done by Horvatić (1992). After the research the investigated area unfortunately became a battle field during the war in 1991, 1992.

The goal of the research was to determine the dynamics of the phytoplankton population of the Stara Drava near Osijek and on the basis of the results obtained to determine the trophic level, mineralization and the quality of the water.

Materials and Methods

During the period from August 30, 1987 to November 26, 1990, seasonal investigations were carried out at the surface and in the sediment-water interface at stations I and II. From the physical chemical traits the following were established: water and air temperature, depth and transparency of the water, dissolved oxygen, saturation of oxygen, pH, BOD_5, p – and m – alkalinity, hardness of water, COD ($KMnO_4$), CO_2, concentration of ammonia, nitrates, nitrites, phosphates (APHA 1975).

For a qualitative analysis of phytoplankton, samples were preserved in a 2% solution of formaldehyde. The phytoplankton taxa were determined according to the following manuals: Komárek 1958, 1974; Bourrelly 1968–1972; Felföldy 1972, 1981, 1985; Hindak 1977–1990; Hindak et al. 1975, 1978; Hustedt 1976; Komárek and Kovačik 1989, Huber-Pestalozzi 1961–1990. Indicators of the water saprobity were determined according to Sládeček (1973) and the index of saprobity was determined according to Pantle and Buck (1955). The concentration of chlorophyll-a was determined according to Jeffrey and Humphrey (1975).

Results and Discussion

Physical and chemical characteristics of the water of the Stara Drava are shown in Tables 1 and 2 as well as in Figures 2–5. The water temperature ranged (Table 1) from 5.00 to 24.00 °C in 1987; from 3.00 to 24.00 °C in 1988; from 2.50 to 24.00 °C in 1990. On account of the low depth (0.30–1.65 m) of the stations investigated water temperature corresponded to the changes in the

Table 1. Physical and chemical characteristics of Stara Drava upstream (I) and downstream (II) of the Čingi-lingi čarda dam

Date	Temperature of water, °C		Temperature of air, °C		Depth of water, m		Secchii disc depth, m	
	I	II	I	II	I	II	I	II
31.08.1987	22.50	24.00	23.00	25.00	1.50	1.00	0.85	0.75
22.10.1987	14.90	15.00	15.00	15.00	1.60	1.00	0.50	0.48
22.12.1987	5.00	5.00	8.00	8.00	0.60	0.70	0.40	0.65
15.06.1988	24.00	23.80	26.00	26.00	1.50	1.50	1.40	1.40
12.09.1988	20.00	20.00	25.00	25.00	1.50	1.50	0.43	0.62
17.11.1988	3.00	3.00	0.00	0.00	0.65	1.50	0.85	0.80
28.12.1988	3.20	3.80	4.10	4.10	0.65	1.50	0.65	1.00
29.03.1990	12.00	12.00	13.00	15.00	1.50	1.63	0.90	0.61
16.07.1990	23.00	24.00	20.00	18.50	0.87	1.01	0.87	0.77
26.07.1990	24.00	23.00	22.50	22.50	0.80	1.00	0.76	0.74
17.09.1990	17.00	17.00	15.00	15.00	1.00	1.00	0.41	0.51
26.11.1990	8.00	8.00	10.50	12.50	0.30	1.20	0.30	0.76
16.12.1990	2.50	4.00	3.00	3.00	0.50	1.10	0.50	0.50

air temperature (0.00–26.00 °C). The transparency of the water ranged from 0.30 to 1.40 m and the strongest influence on the transparency was probably caused by the phytoplankton and abioseston which occurred during the movement of the shallow water due to the raising of the particles from the water bottom. The pH values varied from 7.67 to 8.96 (Table 2) and confirmed an alkaline reaction in the water of the Stara Drava. The high values of m-alkalinity (3.40–7.40 mval L^{-1}) indicate intensive mineralization of organic matter. The concentration of ammonia (2.143 mg L^{-1}) in August 1987 was most probably a consequence of the mineralization of the organic matter present, as well as fresh fecal pollution from nearby settlements. The oxygen saturation of water (Fig. 2, 3, 4 and 5) was the highest (157.43 %) at station II at the end of March 1990, during the maximum density (5) of phytoplankton, and the lowest at the same station in September 1988, when the oxygen was consumed due to the decomposition of allochthonous and autochthonous organic matter. The quantity of the total nitrogen measured in 1988 was lower (3.856–5.470 mg L^{-1}) at station I than at station II (4.907–7.465 mg L^{-1}) which received waste waters from a catering establishment. The quantity of phosphorus at both stations varied to a small extent (Table 2). According to Forsberg et al. (1978), phosphorus was a limiting factor of growth at stations I

Table 2. Chemical characteristics of water of the Stara Drava upstream (I) and downstream (II) of the Čingi-lingi čarda dam

	1987						1988							
Date	31. 08.		22. 10.		22. 12.		15. 06.		12. 09.		17. 11.		28. 12.	
Station	I	II	I	I	I	II	I	II	I	II	I	II	I	II
pH	8.03	7.85	7.98	8.41	7.86	8.24	8.44	8.43	7.67	8.71	8.71	8.96	8.60	8.77
Alkalinity -p, mval L^{-1}	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.50	0.01	0.90	1.05	0.70	0.45	0.70
Alkalinity -m, mval L^{-1}	6.90	6.20	7.40	4.90	7.10	6.60	6.65	6.85	6.45	5.25	4.15	4.70	3.40	5.00
Hardness of water	18.70	18.20	17.60	16.40	13.50	14.80	19.65	19.70	15.00	13.50	12.90	13.30	15.00	14.60
BOD_5, mg O_2 L^{-1}	5.00	6.00	12.00	9.00	8.50	10.75	6.00	4.00	3.00	7.00	8.00	12.00	8.00	12.00
COD (KMn_4) mgO_2 L^{-1}	17.50	17.50	14.31	17.74	8.00	11.61	39.56	41.44	86.48	97.41	74.68	77.96	56.60	64.80
NH_3 – N, mg L^{-1}	0.281	2.143	1.625	0.364	0.518	0.709	0.235	0.206	1.187	0.228	0.411	0.483	0.659	0.361
NO_2 – N, mg L^{-1}	0.005	0.003	0.041	0.022	0.022	0.022	0.003	0.002	0.004	0.008	0.009	0.009	0.009	0.010
NO_3 – N, mg L^{-1}	0.009	0.023	0.613	0.034	0.116	0.079	0.008	0.005	0.019	0.010	0.013	0.018	0.016	0.013
PO_4^{+3} – P, mg L^{-1}	0.089	0.026	0.035	0.046	4.84	0.00	0.012	0.003	0.012	0.003	0.007	0.015	0.010	0.013
CO^2, mg L^{-1}	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.240	0.00	0.00	0.00	0.220	0.00
Total N, mg L^{-1}	/	/	/	/	/	/	3.856	6.493	4.725	6.505	5.470	7.465	4.558	4.907
Total P, mg L^{-1}	/	/	/	/	/	/	0.263	0.063	0.283	0.069	0.909	1.029	0.325	0.376

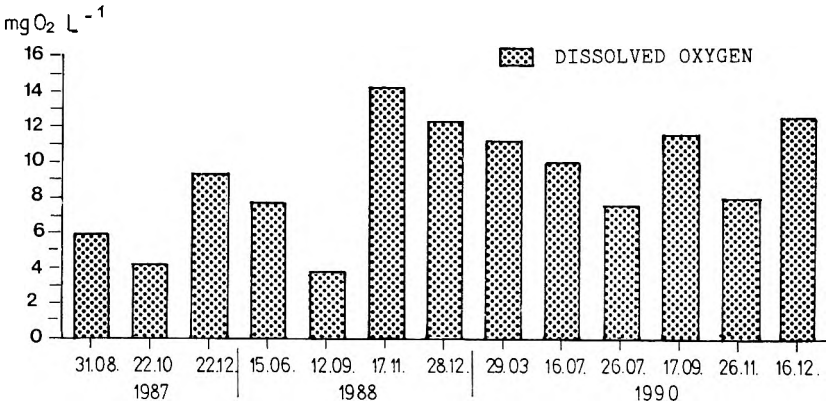

Fig. 2. Concentration of dissolved oxygen at station I

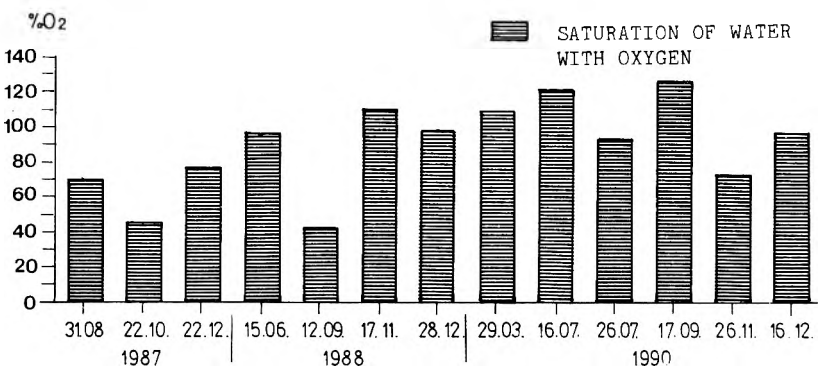

Fig. 3. Saturation of water with oxygen in station I

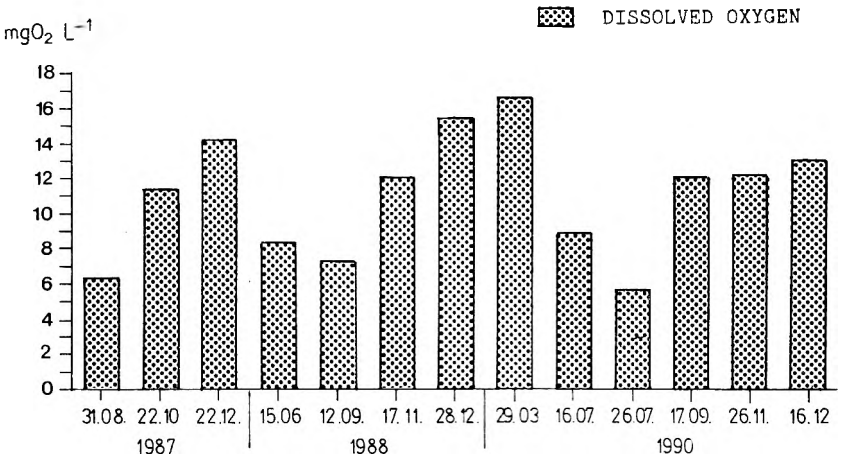

Fig. 4. Concentration of dissolved oxygen in station II

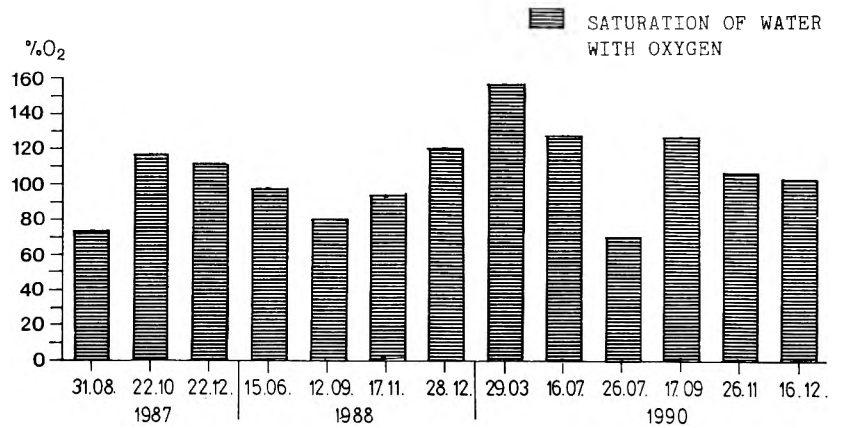

Fig. 5. Saturation of water with oxygen in station II

and II (Table 2) in June, September and December 1988 when the totN/tot P amounted to 13.05–103.06. Nitrogen (totN/tot P = 6.02) was the potentially limiting factor of growth only at station I in November 1988. Only in October 1988 at station II (totN/totP = 7,25) the above mentioned nutrients were not limiting factors (Table 2).

Phytoplankton

In 1987, 1988 and 1990 a total of 240 phytoplankton taxa (Table 4) were determined at stations of the Stara Drava. The phytoplankton community consisted of *Chlorophyta* (116 taxa) and *Chrysophyta* (59 taxa). *Cyanophyta* and *Euglenophyta* were represented with 28 taxa, *Pyrrophyta* 6 taxa and 1 type belonged to the group *Mycophyta*. A total of 174 was found at station I while 203 taxa were found at station II. During the period of investigation, the number of phytoplankton taxa (Table 4) was in most cases greater in the surface layer than in the contact layer of the sediment-water. Only in December 1987 an equal number (22) of taxa was established in both water layers at station I. At station II a greater number of taxa was present in the contact layer of the sediment-water in December 1987 and July 1990 (Table 4).

In the late spring phytoplankton community (15. 06. 1988) *Chlorophyta* prevailed at both stations. However, due to optimal ecological conditions (Tables 1 and 2) the total number of taxa in the surface layer amounted to 57–63, and in the contact layer of the sediment-water 47–52 (Table 4). An abundant quantitative development of phytoplankton was confirmed by the high values (100.2–119.40 mg m^{-3}) of clorophyll-a (Table 3) due to which the

Table 3. Concentration of chlorophyll-a (mg m^{-3}) in phytoplankton of the Stara Drava upstream (I) and downstream (II) of the Čingi-lingi čarda dam
S – surface layer of water (I); C – contact layer of sediment-water (I); s – surface layer of water (II); c – contact layer of sediment–water (II)

	Chlorophyll-a (mg m^{-3})			
	I		II	
Station	S	C	s	c
31.08.1987	106.00	88.20	128.60	130.40
22.10.1987	76.20	88.00	58.20	118.65
22.12.1987	35.00	22.80	25.95	49.35
15.06.1988	104.20	100.60	119.40	100.20
12.09.1988	66.40	77.00	93.15	101.85
17.11.1988	48.00	75.80	56.40	61.65
28.12.1988	26.80	28.00	52.20	59.40
29.03.1990	30.60	39.00	75.32	65.80
16.07.1990	78.40	84.00	119.00	98.80
26.07.1990	65.20	68.60	–	–
17.09.1990	156.80	136.00	128.20	106.00
26.11.1990	45.20	–	68.00	90.50

Table 4. LIST OF PHYTOPLANKTON TAXA AND ITS DENSITY IN THE STARA DRAVA UPSTREAM (I) AND DOWNSTREAM (II) OF THE ČINGI-LINGI ČARDA DAM

YEAR					1987												1988																				1990												
DATE	31.08.				22.10.				22.12.				15.06.				12.09.				17.11.				28.12.				29.03				16.07.				26.07.				17.09.				26.11.				
LOCALITY	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II	
WATER LAYER	S	s	C	c	S	s	C	c	S	s	C	c	S	s	C	c	S	s	C	c	S	s	C	c	S	s	C	c	S	s	C	c	S	s	C	c	S	s	C	c	S	s	C	c	S	s	C	c	
TAXA																																																	SAPROBITY
CYANOPHYTA																																																	
Anabaena constricta (SZAFER.) GEITLER	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	p
Anabaena flos-aquae (LYNG.) BREB.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	b
Anabaena solitaria KLEBS.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	1	.	1		.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	b – c
Anabaena spiroides KLEBAHN.	1	.	1	.	.	1	.	.	.	.	.	.	.	.	1	.	1	1	1	1	1	.	1	1	.	.	.	.	.	.	.	.	1	1	.	1	1	.	.	.	1	.	1	.	.	.	.	.	o – b
Anabaenopsis arnoldii APT.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Aphanizomenon flos-aquae (L.)RALFS.	1	3	3	1	1	1	1	1	1	.	1	1	3	3	1	1	.	1	1	1	1	.	3	.	1	3	3	3	1	3	1	3	1	.	.	3	1	.	.	.	1	1	1	3	1	3	1	3	b
Aphanothece clathrata W. et G. S. WEST.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	b
Chroococcus minutus (KUTZ.)NAG.	.	1	.	.	1	.	.	.	.	.	.	.	1	.	.	1	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	1	1	1	1	.	.	.	.	–
Chroococcus turgidus (KUTZ.)NAG.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	1	.	1	1	1	.	–
Coelosphaerium kutzingianum NAG.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	b – o
Dactylococcopsis rhaphidioides HANSG.	1	1	.	.	1	.	.	.	.	.	.	.	1	1	1	.	.	1	.	1	1	1	1	1	5	3	3	1	.	1	.	.	1	.	.	.	1	.	.	.	1	1	.	1	1	.	.	.	–
Gomphosphaeria lacustris CHOD	.	1	.	.	1	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	3	3	3	3	1	3	3	–
Gomphosphaeria naegeliana (UNG.)LEMM.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Lyngbya limnetica LEMM.	1	3	1	1	1	.	.	.	.	1	.	.	.	.	1	.	.	1	.	.	1	.	1	.	1	1	1	1	.	.	.	.	1	.	.	.	1	.	1	.	.	3	.	3	.	.	.	.	–
Merismopedia glauca (EHR.)NAG.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	–
Merismopedia punctata MEYEN.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	–

I

Merismopedia tenuissima LEMM.	1 . . . 5 1 . . . . 1 1 1 1 . . 1 . . . . . . 1 . . . 1 . . . 1 . . . 1 1 1 1 . 1 . .	b – a
Microcystis aeruginosa KUTZ.	. . 1 . 1 . . . . 1 . . . 1 1 1 . . . . 1 . . 1 1 1 1 1 . 1 . 5 3 3 3 . 1 . .	b
Microcystis flos-aquae (WITTR.) KIRCHN.	1 . . . . 1 . . . . 1 1 1 . . . . . 1 . 1 . . . . . . 1 . . . . . . 3 . 1 1	b
Microcystis incerta LEMM.	. . . . 1 . 1	b
Oscillatoria agardhii GOM.	. . . . 1 . 1	b
Oscillatoria angusta KOPPE.	. . . . 1 . . . . 3 5 3 3 . . . . 1 .	–
Oscillatoria limnetica LEMM.	. . . . . 1 1 . . . . . 1 3 . 1 . . . . 1 1 . . . 5 1 1 1 . . . . 1 1 3 .	o – b
Oscilatoria limosa (ROTH.)AGARDH.	. 3 . 1 . . . . 1 . . . . 1 . . . . 1	a – b
Oscillatoria planctonica WOLOSZ.	3 . . . . 1 . 1 . 1 1 . . . . 1 . .	–
Oscillatoria redekei WAN GOOR.	. . . . 1 . . . . 1 3 1 3 3 3 3 1 1 5 1 1 1 . . . . 5 . 1 1 5 . 5	b – o
Oscillatoria sp.	. . . 1 . 1 . 1 . . . . 1 1 . . . . 1	–
Woroninchia hungarica (UNG.)ELENK.	. . . . 1 3 . 1 . . . . 1 . . 1 . . . . 1	–

EUGLENOPHYTA

Colacium minimum *FOTT et KOM.*	. . . . 1	–
Euglena acus EHR.	1 . 1 . . 1 . . 1 . . . 1 1 1 1 . . . . . 1 . 1 . . . . 1 . . 1 1 . . . 1 1 1 1	b
Euglena ehrenbergii KLEBS.	1	b
Euglena klebsii (LEMM.)MAINX.	. . . . 1	o
Euglena limnophyla LEMM.	. . 1 . . 1 1 . . . . 1 . . . . 1	o – b
Euglena oxyuris SCHMARDA f. minor DEFL.	1 . . . . . 1 . . . . 1 . . . . 1 . 1 . 1 . 1	b – a
Euglena polymorpha DANG.	1 . 1 . . 1 . . . . . 1 . . . . 1 1 1 1 1 1 . . . . 3 . . 1 1 1 1 1 . . . 1 1 1 1 1 . 1 1	a
Heteronema acus (EHRENB.)STEIN.	. . . . . 1 . . . . 1	–
Lepocinclis ovum (EHRENB.)LEMM.	. . . . 1 . . . . . 1 . . . . 1 . 1 . 1 . 1 . 1 1 1	a – b
Lepocinclis sphagnophyla LEMM. var. podolica DREZ.	. . . . 1 1 . 1	–
Lepocinclis texta (DUJ.)LEM. et CONR.	. . . . 1 . . . . 1	a – b

Monomorphyna pyrum (EHRENB.)MEREŠK.	. . . . 1 1 1 . . . . . 1 1 1 1 . 1 . 1 1 1 1 1 . . 3 . . . . . 1 1 1 . 1 . 1 . . 1	b
Phacotus lenticularis EHRENB.	. . . . 1	–
Phacus helicoides (LEMM.)SKV.	. . . . 1 . . . . 1 . 1	–
Phacus longicauda (EHR.)DUJ.	. . . . 1 . 1 . . . . 1	b – a
Phacus orbicularis HUBN.	. . . . 1	b
Phacus pleuronectes (O.F.M.)DUJ.	. . . . . 1 . . . . . . 1 1 1 1 . . 1	b
Phacus pyrum (EHR.)STEIN.	1 . . . . 1 . . . . 1 1	–
Phacus suecicus LEMM.	. . . . 1 1 1 1 . . . . 1	b
Phacus tortus LEMM.	. . 1 1 . . . . 1 . . . . . 1 . 1	–
Trachelomonas hispida (PERTY)STEIN.	. . . . 1 . . . . 1 . . . 1	b
Trachelomonas intermedia DANG.	. . . . 1	–
Trachelomonas lefevrii DEEFL.	1 1 1 1 1 1 1 1 1 . . 1 3 1 1 1 1 . 1 . 1 1 1 1 1 1 3 1 1 1 1 1 . 1 1 1 1 . 1 . 1 1 1 1 1 1 1 1	–
Trachelomonas oblonga LEMM.	. . . . 1	–
Trachelomonas volvocina EHR.	. . . . 1 . 1 . . . . . 1 1 . . 1 . 1 . . 1 . . . 1 . 1 1 1 . 3 1 1 . . . . 1 . 1 1 1 1 1 1 . 1	b
Trachelomonas volvocina EHR. var. *punctata* PLAYF.	. . . . 1	–
Trachelomonas planctonica SVIR.	 1	–
Trachelomonas sp.	. . . . 1 . . . . 1 1 1 . 1 . . . 1 3 1	–
PYRROPHYTA		
Ceratium hirundinella (O.F.M.)BERGH.	. 1 . . . 5 . . . . . . 1 1 3 5 5 3 3 1 1 1 1 1 . . . . 1 1 . 1 1 . . . 1 1 1 1	o
Ceratium hirundinella (O.F.M.)BERGH. *f. furcoides*	. . 1 . . . 3 . . . . 1	–
Cryptomonas ovata EHRENB.	. . 1 . . 1 . 1 3 1 3 3 . . . . 1 . 1 . . . . . 5 5 5 3 . . . . 1 1 . .	a
Glenodinium gymnodinium PENARD.	. 1 1 . . . . . 1 . 1 . 1 1 1 1 1 1 1 . . 1 . . . 1 . . 1 1 3 3 1 3 1 1 1 . 1 . 1 1 1 1	–
Peridinium aciculiferum LEMM.	3 1 3 1 . 1 1 1 1 . . 1 3 1 3 1 1 1 1 1 . . . . 3 . . 1 3 1 5 1 . 1 . 1 1 1 1	–
Peridinium bipes STEIN. f. *tabulatum* (EHR.)LEFEVRE	. . . . 1 1 1 1 1 . . . 1	–
Peridinium cinctum (MULL.)EHR.	5 5 1 1 1 1 . . . 1 1 . 1 . 1 3 1 1 1 1 1 1 . . . . . . 5 5 3 3 1 3 1 3 1 . 1 . . 1 1 . . . 1 .	–

Peridinium sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
CHRYSOPHYTA																																																	
Heterokontae																																																	
Centritractus africanus FRITSCH. et RICH	1	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	–
Cetritractus belenophorus LEMM.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o – b
Chrysophyceae																																																	
Dinobryon divergens IHM.	1	1	.	.	.	.	.	.	.	.	1	.	3	5	3	3	.	1	.	1	.	1	1	.	.	.	.	.	5	5	1	3	1	.	1	1	.	.	.	.	1	.	1	.	.	1	.	.	o – b
Dinobryon sociale EHRENB.	.	.	.	.	.	.	.	.	.	.	.	.	5	3	1	5	.	.	.	.	.	1	.	1	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Dinobryon stipitatum LEM.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o – b
Bacillaryophyceae																																																	
Achnanthes lanceolata BREB.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	o – b
Achnanthes minutissima KUTZ.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	1	.	.	.	1	.	.	.	.	1	.	.	1	.	1	.	.	.	.	.	1	.	.	.	1	.	1	.	.	.	.	.	o – b
Amphora ovalis KUTZ.	1	.	.	.	.	.	1	.	1	.	1	.	1	.	1	1	1	.	1	.	1	.	1	.	.	.	.	.	1	1	1	1	1	1	1	1	1	.	1	.	1	1	.	1	1	1	1	1	o – b
Amphora veneta KUTZ.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	–
Anomoeoneis sphaerophora KUTZ.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	.	.	b – a
Asterionella formosa HASS.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o – b
Caloneis amphisbaena (BORY.)CLEVE.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	1	.	1	.	.	.	.	b – a
Cocconeis pediculum EHR.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	b
Cocconeis placentula EHR.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	b
Cyclotella bodanica EULENST.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	o
Cyclotella comta (E.)KG.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	1	1	1	.	1	.	.	1	o
Cyclotella meneghiniana KG.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	1	.	.	.	.	1	.	.	a – b
Cyclotella sp.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1	1	.	1	.	.	.	1	.	.	.	.	.	.	.	1	.	.	1	.	1	.	1	1	.	.	1	1	1	.	–
Cymatopleura solea (BREB.)W.SM.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	b – a
Cymbella cistula (HEMP.)GRUN.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	b
Cymbella lanceolata (EHR.)VAN HEURCK.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	1	.	.	.	.	.	.	.	b
Cymbella tumida (BREB.)V. HEURCK.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	1	.	.	.	.	–
Cymbella ventricosa KUTZ.	.	.	1	.	.	.	1	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	1	1	.	1	.	1	.	.	.	.	.	.	.	.	.	b

Cymbella sp.	. . . . 1 . . . . 1	–
Epithemia turgida (EHR.)KUTZ.	. 1 . . . . . 1 . . . . 1	b
Fragillaria crotonensis KITTON.	. . . . 5 . 1	o – b
Gomphonena constrictum EHR.	1 . 1 . . . . 1 . . . . 1	b
Gomphonema olivaceum (LYNG.)KUTZ.	. . . . 1	b
Goniochloris fallax FOTT	. . 1 1 . . 1	–
Gyrosigma attenuatum (KUTZ.)RAB.	. . . . 1	b
Melosira granulata (EHR.)RALFS.	. . . . . 1 . . 1 . . . . 1 1 . 1 . 1 . . . . . 1 . 1 . . 3 . 3 . . . . 1 3 1 3 1 1 1 1	b
Melosira granulata (EHR).RALFS. var. *angustissima* (MULL.) HUST	1 . . . . 1 . . . . 1 . 1 . . . . 1 1 1 1 1 . 1 .	b
Melosira italica KUTZ.	. . . . 1 . 1 . . . . 1 . 1 . . . . 1 . 1 . .	o – b
Melosira varians AG.	. . . . . 1 . . 1 1 1 . . . . . 1 . 1 . 1 1 1 1 . . . . 1 . . . 1 . 1 1 1 . 1 . 1 1 1 1 1 1 1 .	b
Meridion circulare W.SM.	. . . . 1 . 1 . 1 . . . 1	x – o
Navicula cryptocephala KUTZ.	. . . . . 1 . 1 1 . . 1 . . . 1 1 1 . 1 1 . . . . 1 . . . . 1 . 1 . 1 1 1 . 1 . 1 1 1 . . 1 1 .	a
Navicula dicephala (EHR.)W.SMITH.	. . . . 1 . 1	o – b
Navicula hungarica GRUN.	. . . . 1 1 . 1 . . . . . 3 . . . 1 1 . . . . 1 . . . . 1 3 1 1 1 . 1 . 1 1 1 . . 1 . .	b
Navicula mutica KUTZ.	. . . . 1 . . . . 1 . . . . 1 . . . . 1 . . 1 . . .	–
Navicula oblonga KUTZ.	. . . . 1 . . . . 1	–
Navicula radiosa KUTZ.	. . . . 1	o – b
Navicula rhynchocephala KUTZ.	. 1 . . . . . . 1 . . . 1 . . 1 . 1 . . 1 1 . . . . 1 1 . 1 . 1 . 1 . . 1 . .	a
Navicula sp.	. . . . 1 . . . . 1 . . . . . . 1 . 1 . 1 . 1 .	–
Nitzschia acicularis W. SMITH.	. . . . 1 . . . . 1 . . . 1 . 1 1 . . . . . . 1 . . . . . 1 . . 1 . . .	a
Nitzschia capitellata HUST.	. . . . 1	–
Nitzschia gracilis HANTZSCH.	. . . . 1 . . . 1 . . . . 1	–
Nitzschia palea (KUTZ.) SMITH	1 . 1 . . . 1 . . 1 . . . . 1 1 . . . . 1 . . . . . 1 . . . . . . 1 . .	a
Nitzschia sigmoidea EHR.	. . . . 1	b
Nitzschia vermicularis GRUN.	. . . . 1 . . . . 1 . . . . . 1	b
Ophiocytium capitatum WOLLE.	. . . . . 1 . . . . 1	–

Pinnularia viridis (NITZSCH.)EHR.	. . . . . 1	b
Stauroneis anceps EHRENB.	. . . . . 1 . 1 . . . . . 1 . 1 . . . . . 1 . 1	b
Stephanodiscus dubius (FRICKE)HUST.	. . . . 1 . . . 3 3 3 3 . 1 . 1 1 . 1 . . . . . 1 1 1 . . . . . 1 . . . 1 . . . 1 1 1 1 1 1 1 1 1	b
Stephanodiscus hantzschii GRUN.	3 3 3 1 5 1 3 1 5 5 5 5 1 1 . 1 1 1 1 . 1 1 1 1 1 1 1 1 1 1 1 1 1 1 3 1 5 1 . 1 . 3 1 3 1 1 1 1 1	a
Synedra acus KUTZ.	. 1 . 1 . 1 . . 1 1 1 1 1 . 1 1 1 1 1 . 1 . 1 . 1 1 . . 1 1 1 1 . 5 1 1 1 . 1 . 1 3 1 3 . 1 1 1	b
Synedra ulna (NITZSCH)EHRENB.	. . 1 1 . 1 . 1 1 1 1 1 . 1 . . 1 1 1 1 . . . . . 1 . . 1 1 . . 1 5 1 1 1 . 1 . 1 3 1 3 . 1 1 1	b
Synura uvella EHR. et KORŠ.	. . . . . 1 . 1	–
Surirella robusta var. *splendida* EHR.	. . . . . 1 . . . . . 1 . 1 . 1 . 1 . . . 1 . 1	b
Tabellaria fenestrata (LYNGB.)KUTZ.	. . . . . 1 . . . . 1 . . . . . 1	o – b
CHLOROPHYTA		
Acanthosphaera zachariasi LEMM.	. . . . . 1 1 . . . . . 1 . . . . . 3 . 1	–
Actinastrum hantzschii LAGERH.	. 1 3 1 . . 1 . . . . . 1 1 . 1 1 1 1 . 1 . . . . . 1 3 1 3 1 . 1 . 1 3 1 1 1 1 1 1 1	b
Actinastrum hantzschii LAGERH. var. *fluviatile* SCHROD.	. 1 . . 1 . . . . . 1 . . 1 1 . . . . . 1 . . . 1 1 . 1 . . . 1 1 1	–
Actinastrum schroeteri HUB.–PEST.	. . . . . 1 . . . 1	–
Ankistrodesmus acicularis (A.BR.)KORSCH.	. 1 . . . . . 1	b
Ankistrodesmus convolutus CORDA	1 . . . 1 . 1 . . . . . 1 . 1 . 1 . 1 . . . 1	–
Ankistrodesmus falcatus (CORDA)RALFS.	1 3 1 . 1 . 1 . 1 1 . . 1 1 . . . 1 . . . 1 . 1 . 1 . . 1 1 . . 1 1 1 3 1 . 1 . 1 1 . 1 1 1 1 .	b – a
Ankistrodesmus falcatus (CORDA)RALFS. var. *spirilliformis* G.S.WEST.	. . . . . 1 . . . 1	–
Ankistrodesmus fusiformis (CORDA)KORŠ.	. . . . 1 1 . . . . . 1 . . . . . 1 3 1 3 1 1 . . 1 . 1 . . 1 1 . . . 1 . 1 1 1 1 1 1 1 1	–
Ankistrodesmus gracilis	. . . 1 . 1 . . . . . 1 . 1 . . . 1 . . . 1 . . . 1 . 1	–
Ankistrodesmus stipitatus (CHOD.)KOM.–LEGN.	. . . . . 1 . . . . . 1 . .	–

Chlamydomonas ehrenbergii GOR.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	1	.	.	1	.	1	.	.	1	.	.	.	.	a
Chlamydomonas globosa SNOW.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	–
Chlamydomonas reinhardtii DANG.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	a
Chlamydomonas pertusa CHOD.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	–
Chlamydomonas simplex PASCH.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Chlamydomonas sp.	.	1	.	.	.	1	.	.	1	.	.	.	.	3	1	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	.	1	.	.	.	.	.	1	.	.	.	.	.	3	3	–
Chlorella vulgaris BEYERINCK.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	3	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	1	.	3	3	1	1	.	.	.	.	p – a
Chodatella ciliata (LAG.)LEMM.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	b
Chodatella citriformis SNOW.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Cladophora glomerata (KUTZ)BRAND.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	b
Closterium aciculare T.WEST.	.	1	.	.	.	1	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	
Closterium acutum BREB.	.	.	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	b – a
Closterium leibleini KUTZ. et RALFS.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	a
Closterium limneticum LEMM.	.	.	1	.	1	.	1	.	1	1	1	1	.	1	1	1	.	1	1	.	1	.	1	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	1	1	1	1	1	1	1	.	–
Closterium lineatum (EHR.)RALFS.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	
Closterium monoliferum (BORY.)EHR.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	–
Coelastrum astroideum DE-NOT.	1	1	.	1	1	1	.	.	.	.	.	.	1	1	1	1	.	1	1	1	.	1	.	1	.	.	.	.	.	.	.	.	1	1	1	1	1	.	1	.	.	1	.	1	.	.	.	.	–
Coelastrum microporum NAG.	.	.	.	.	.	.	1	.	.	.	.	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	.	1	.	.	.	.	.	b
Coelastrum sphaericum NAG.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	1	.	1	1	1	1	1	1	.	.	–
Cosmarium bioculatum BREB.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	–
Cosmarium granatum BREB.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	–
Cosmarium Meneghinii BREB.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	–
Crucigenia apiculata (LEMM).SCHMID.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	b
Crucigenia fenestrata SCHMIDLE.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–

Crucigenia rectangularis (A.)BR.GAY.	. . . . 1 1 1 . . . 1 . 1 . . . . 1 . . . 1 . . 1 . 1	a – b
Crucigenia tetrapedia (KIRCH.) G. et G.S.WEST.	1 1 . . 1 . . . . 1 1 1 . . . . 1 . . 1 . 1 . . 1	o – b
Crucigenia quadrata MORREN.	. . . . 1 . . . . 1 . 1	–
Dictyosphaerium Ehrenbergianum NAEG.	. . . . 1 1 1 . . 1 . 1 . . . . 1	b
Dictyosphaerium pulchellum WOOD.	1 1 . 1 1 1 1 1 3 . . . . 1 . 1 . 1 . . . . 1 . 1 1 1 . 1 . 1 . 1 1	b
Didymocystis incospicua KORŠ.	. . . . 1 . 1	–
Dimorphococcus lunatus A.BR.	. . . . 1	–
Elakatothrix acuta PASCHER.	. . . . 1	–
Elakatothrix genevensis (REVERD.)HIND.	. . . . 1	–
Endochloridion polychloron PASCH.	. . . . 3	
Eremosphaera viridis DE BARY.	. . . . . 1 . . . . 1 1 1 . . 1 . 1 . . . . 1 1 1 1 1 1 . .	–
Errerella bornhemiensis CONRAD.	. . . . 1 . 1 . 1 . 1	–
Eudorina elegans EHR	. . . . 1 1 1 1 . 1 . 1 . . . . 1 . 1 . 1 . 1 . 1 1	b
Golenkinia radiata CHOD.	. . . 1 3 1 1 . 1 1 1 1 1 . 1 1 5 1 3 1 1 1 1 1 . . . . 3 3 1 3 3 . 1 . 5 3 3 1	–
Gonatozigon kinahanii (ARCH.)RABENH.	. . . . 1 . . . . 3 1 1 1 . 1	–
Hofmania lauterbornii (SCHMIDLE)WILLE.	1	–
Hyaloraphidium contortum PASCHER ET KORS.	. . . . 1 . .	–
Kirchneriella contorta (SCHMIDLE)BOHL.	. . . . 1 . 1 1 1 . 1 . . . . 1 . 1 1 . . .	–
Kircheriella lunaris (KIRCH.)MOEB.	. 1 . . . 1 . . . . 1 . 1 . . . . 1 . . .	b
Kirchneriella obesa (WEST.)SCHMIDLE	. . . . 1	b
Koliella longiseta (VISCH.)HIND.	. . . . 1 1 . . . . 3	–
Lagerheimia citriformis (SNOW.)G.M.SMITH.	. . . . 1	–

Lagerheimia genevensis CHOD.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	1	1	1	1	.	.	.	.	b
Lagerheimia minor FOTT	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	b
Micractinium pusillum FRES.	1	.	.	.	5	3	5	.	.	3	1	3	.	.	.	1	1	1	1	1	1	1	1	1	1	.	1	.	.	.	.	.	3	1	.	1	1	.	.	.	1	.	1	1	.	.	.	.	b
Monoraphidium contortum (THUR.)KOM-LEGN.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Monoraphidium arcuatum (KORŠ.)HIND.	.	1	1	.	.	.	1	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	1	.	.	.	.	.	.	–
Monoraphidium griffithii (BERKEL)KOM.-LEGN.	.	.	1	1	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	–
Mougeotia sp.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	1	3	3	3	3	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	3	3	3	3	.	1	.	1	o
Nephrocytium limneticum G.M.SM.SKUJA	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	–
Oocystis elliptica W.WEST	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	1	.	1	.	.	.	.	.	.	.	.	.	–
Oocystis marsonii LEMM.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Oocystis submarina LAG.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Oocystis verucosa ROLL.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	.	.	.	.	.	.	.	–
Oocystis sp.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	1	.	1	.	1	1	.	.	.	.	–
Pandorina charkoviensis KORŠ.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Pandorina morum BORY.	1	1	1	.	.	.	.	.	.	.	.	.	5	3	1	1	1	5	1	3	.	.	.	.	.	.	.	.	.	.	.	.	5	1	5	1	3	.	3	.	1	.	1	.	.	.	.	.	b
Pediastrum boryanum (TURP.)MENEGH.	.	.	.	.	.	1	.	.	.	1	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	1	.	1	.	1	.	.	.	–
Pediastrum duplex MEYEN.	1	.	1	1	1	1	1	1	.	1	.	1	1	1	1	1	1	1	1	1	1	1	1	1	.	.	.	.	.	.	.	1	3	1	1	1	3	.	3	.	1	1	1	1	1	1	.	1	b
Pediastrum simplex MEYEN.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	3	3	1	3	3	.	1	.	.	1	.	.	.	1	1	.	–
Pediastrum simplex MEYEN. var *echinulatum* (WITTR. et NORDST.) LEMM.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	1	.	.	–
Pediastrum tetras RALFS.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	1	1	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	1	.	1	1	1	1	1	.	.	.	b
Phacotus lenticularis (EHR.)STEIN.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1	.	.	b
Polyedriopsis spinulosa SCHMIDLE	.	1	.	.	1	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	1	.	1	.	1	1	1	.	1	.	1	1	b
Radiococcus nimbatus (DE-WIDL)SCHMIDLE	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	–
Scenedesmus acuminatus (LAG.)CHOD.	1	1	1	1	1	1	1	1	.	.	1	.	1	3	1	1	1	1	1	1	1	.	1	.	.	.	.	1	.	1	.	.	1	3	1	3	1	.	1	.	3	1	3	1	1	1	.	1	b
Scenedesmus acutus MEYEN)CHOD.	1	1	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	1	1	.	1	.	.	1	.	.	.	1	.	1	.	1	.	1	.	.	1	1	1	.	.	–

X

Scenedesmus acutus (MEYEN)CHOD *f. alternans* HORTOB.	. . . . 1 . . . 1	–
Scenedesmus arcuatus LEMM.	1 1 . . . . 1 . .	b
Scenedesmus bicaudatus (HANG.)CHOD.	. . 1	–
Scenedesmus denticulatus LAGERH.	. . . . 1 1 . 1 . . . . 1 . . . . 1 . 1 . . .	b
Scenedesmus ecornis (RALFS.)SHOD.	. . . . . . 1 . . . . 1	–
Scenedesmus ecornis (RALFS.)CHOD. var. *disciformis* CHOD.	1 1 . 1 . . . 1 . . . . 1 1 . 1 . . . . 1 . . . 1 1 . 1 1 . 1 1	–
Scenedesmus granulatus W. et G. S. WEST.	. . . . 1 1 . . 1	–
Scenedesmus longispina CHOD. var. *asymetricus* HORTOB.	. 1 . . . . 1 1 . . . 1 . . . . 1 . 1 . . 1 1 . . . . 1	–
Scenedesmus opoliensis RICHT.	. . . 1 1 1 3 3 . 1 1 . . . 1 1 1 1 1 1 . 1 . 1 . . . . 3 3 1 . 3 . 1 . 1 1 1 1 . 1 . 1	b
Scenedesmus panonicus HORTOB.	. . . . 1 . . . . 1 . . . . 1 . . . . . 1	–
Scenedesmus spinosus CHOD.	. . . . 1 1 1 1 1 1 . 1 3 5 1 1 1 1 1 1 1 1 1 1 1 1 . . 1 1 . 1 . 1 . 1 . . . . 3 1 3 1 . 1 . .	–
Scenedesmus quadricauda (TURP.)BREB.	1 1 1 . 1 1 1 . 1 1 . 1 1 3 1 1 1 1 1 1 . 1 . 1 . 1 . 1 . 1 . . 1 3 1 3 1 . 1 . 3 1 3 1 3 1 3 1	b
Selenastrum bibrianum REINSCH.	. . . . 1 . . . . 1 . . . . 1 . . . . 1	b
Selenastrum gracile REINSCH.	1 1 . . . . 1 . . . . 1 . 1 . 1 . 1 . 1	–
Selenastrum westii G.M.SM.	. . . . 1	
Siderocelis ornata FOTT)FOTT	. . . . 1 . . . 1	–
Staurastrum paradoxum MEYEN.	. . 1 . 1 1 . . . . . . 1 1 1 . 1 1 1 . . 1 . 1 . . . . 1 1 . 1 1 . . . 1 1 1 1 . 1 . 1	–
Schroederia setigera (SCHROD.)LEMM.	1 1 . . 1 . . . . 1 . . 1 1 1 1 1 . 1 . . 1 . 1 1 3 1 1 1 . . 1 1 1 1 1 1 . 1 . 3 5 1 5 3 3 1 .	–
Schroderia spiralis (PRINTZ.)KORŠ.	. . . . . . 1 . . . . . . 1 . . . 1 . 1 . . . 1 1 1 . . . . 1 . 1 . 1 . 1 3 1 1	–
Tetrachlorella alternans (G.M.SMITH.)KORŠ.	. . . . 1 . 1	
Tetraedron arcus (HORTOB.)KISS	. 1 . . . . 1 1 . . 1 1 1 . . . . 1 . 1 . 1 . 1	–

Tetraedron caudatum (CORDA)HANSG.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	b
Tetraedron caudatum (CORDA)HANSG. var. *incisum* LAG.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	1	.	1	.	.	.	1	–
Tetraedron hastatum (REINSCH)HANSG.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	–
Tetradron minimum (AL BRAUN)HANSG.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	b
Tetraedron muticum (AL BRAUN)HANSG.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	1	.	.	1	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	1	1	.	1	.	.	.	1	.	1	.	.	.	.	1	–
Tetraedron proteiforme (TURN.)BRUNTH.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	–
Tetraedron triangulare KORŠ.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Teatredron trigonum (NAEG.)HANSG.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	–
Tetraedron trilobatum (REINSCH.)HANSG.	1	1	.	.	1	.	1	.	.	.	.	.	1	3	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	1	1	.	.	.	3	1	.	1	1	.	.	.	–
Tetradron quadratum (REINSCH.)HANSG.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	–
Tetrastrum staurogeniaeforme (SCHROD.)LEMM.	.	.	1	.	.	.	.	.	.	1	.	1	1	.	1	.	.	1	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1	1	.	.	1	.	1	.	1	.	.	.	.	.	.	.	b
Treubaria triappendiculata BERN.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	1	.	.	.	.	.	.	.	–
Westella botryoides (W.WEST.)DE-WIDL.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	b
MYCOPHYTA																																																	
Planctomyces bekefii GIMESI	3	3	.	.	3	1	3	.	.	.	.	.	.	.	1	.	.	1	.	1	.	1	.	1	.	.	.	.	.	.	.	.	1	.	1	.	1	.	1	.	3	1	.	1	.	1	.	1	–

LEGEND:

I – the Stara Drava upstream of the Čingi-lingi čarda dam
II – the Stara Drava downstream of the Čingi-lingi čarda dam
S – surface layer of water (I)
s – surface layer of water (II)
C – contact layer of sediment-water (I)
c – contact layer of sediment-water (II)

Stara Drava was classified as polytrophic waters (Felföldy 1976). At the end of March 1990 the phytoplankton community of the Stara Drava was dominated by the *Chrysophyta*. At station II the species *Oscillatoria redekei (Planktothrix redekei), Peridinium cinctum, Dinobryon divergens* and *Dinobryon sociale* were most abundant. The massive spring development of *Dinobryon divergens* can be explained by the low concentration of phosphorus (0–0.046 mg L^{-1}) during 1987 and 1988, since for its development, according to Reynolds (1984) the P-concentration needed was less than 0.20 mg L^{-1}.

The species of *Cyanophyta, Pyrrophyta* and *Chrysophyta* were significant in the summer of 1987, 1988 and 1990. However, the species of *Chlorophyta* (Table 4) were also prominent during the summer in both the number of taxa and density of populations. By comparing our results of the qualitative content of the phytoplankton surface layer of the water from August 1987 with the results from 1943 (Hortobagyi 1944), it is apparent that in 1943 the total number of taxa was greater by 101 taxa. However, in August 1977 Gucunski (1979) identified the same number of taxa as we have found in our investigations. The greater number of taxa in 1943 can be explained as a consequence of favourable ecological conditions (see the hydrochemical results by Woynarowich 1944). Unfortunately, the balanced ecological conditions constantly deteriorated until 1987, thereby stimulating an increase in population density of certain taxa, while the total number of taxa decreased. This fact was confirmed also by the high values of chlorophyll-a at station II (Table 3) according to which only in November 1988 and 1990, December 1987 and 1988 as well as March 1990 the water was eutrophic, while during the rest of the investigation months it belonged to polytrophic waters (Felföldy 1976).

In all autumn seasons (1987, 1988 and 1990) the number of taxa slowly decreased in relation to the summer season (Table 4), when species from the groups *Chlorophyta* and *Chrysophyta* prevailed. A greater number of phytoplankton taxa at station II (32–52 in October 1987, 30–50 in November 1988, 29–51 in December 1990) than at station I (34–43 in October 1987, 30–36 taxa in November 1988 and 31–42 taxa in November 1990) indicate a higher concentration of nutrients at station II (Table 2). Saprobiological analyses of phytoplankton showed that the index of saprobity of the water varied in the surface layer of water from 2.00 to 2.40 at station I and 2.00–2.48 at station II. In the contact layer of the sediment-water, the index of saprobity of the water amounted to 1.88–2.38 at station I and 1.88–2.63 at station II. This means that both investigatd layers of water belonged to the beta-mesosaprobic degree in 1987, 1988 and 1990, with the exception of December 1987 when the alpha mesosaprobic degree was established at station II.

Conclusion

In 1987, 1988 and 1990 in the Stara Drava near Osijek, 240 phytoplankton taxa were determined, with the predominace of representatives of the *Chlorophyta* and *Chrysophyta* groups. The greatest ecological impact on the dynamics of the phytoplankton population was probably caused by the sediment which developed from allochthonous solid organic waste matter.

The results of a chemical analysis of the water of the Stara Drava indicate intense mineralization of the allochthonous and autochthonous organic matter present.

According to the values of chlorophyll-a, the water at station I was mostly eutropic while the water at station II belonged most frequently to polytrophic waters.

Saprobiological analyses of the phytoplankton showed that it belonged to the beta-mesosaprobic and beta-alpha-mesosaprobic degree of water, with the exception of December 1987 when the alpha-mesosaprobic degree was established at station II.

The results obtained support the presumption that polluted water of the Stara Drava during the investigation recovered in a natural manner.

Since the investigation area became a battlefield after our research, we consider it necessary to continue the research in times of peace in order to establish the influence of war activities on the ecosystem of the Stara Drava.

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SAŽETAK

DINAMIKA POPULACIJA FITOPLANKTONA STARE DRAVE KRAJ OSIJEKA

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U radu su prikazani rezultati istraživanja dinamike populacije fitoplanktona Stare Drave koja je bila pod utjecajem sedimenta nastalog od otpadnih organskih tvari tijekom 1969.–1984. godine.

U Staroj Dravi kraj Osijeka utvrđeno je u 1987., 1988. i 1990. godini ukupno 240 fitoplanktonskih taksa, a dominirali su predstavnici skupina *Chlorophyta* i *Chrysophyta*. Najjači ekološki utjecaj na dinamiku populacija fitoplanktona imao je sediment nastao od alohtonih krutih otpadnih organskih tvari.

Rezultati kemijske analize vode Stare Drave upućuju na intenzivnu mineralizaciju nazočne alohtone i autohtone organske tvari. Prema vrijednostima klorofil-a voda postaje I. bila je najčešće eutrofna, a postaja II. pripadala je uglavnom u politrofne vode.

Saprobiološka je analiza fitoplanktona dokazala II. i II.–III. klasu boniteta ili *beta* i *beta-alfa* mesosaprobni stupanj vode Stare Drave, osim u prosincu

1987. godine kada je utvrđena III. klasa boniteta ili alfamesosaprobni stupanj. Svi izneseni rezultati govore u prilog činjenici da su se onečišćene vode Stare Drave prirodno oporavljale. Budući da je istraživano područje nakon našeg istraživanja postalo bojišnica, smatramo potrebnim u vrijeme mira nastaviti istraživanja radi utvrđivanja negativnog utjecaja ratnih akcija na ekosistem Stare Drave.

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