Phytoplankton ecology of two floodplain pools near Olomouc

Ekologie fytoplanktonu dvou tůní u Olomouce

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Abstract

A three-year study of selected environmental variables, species composition and phytoplankton abundance was carried out in two floodplain pools. Altogether, 123 taxa of algae and cyanobacteria were identified. Euglenophyta, Cryptophyta and Bacillariophyceae were diverse and dominant groups, especially species *Cryptomonas curvata*, *C. marssonii*, *C. reflexa*, *Euglena hemichromata*, *Trachelomonas hispida* and *T. volvocina* occurred in samples regularly. Mass occurrence of *Hydrodictyon reticulatum* was observed in one of the pools.

Introduction

Pools are circular or oval shaped, small water bodies originating from oxbows and/or from the activity of a flooding river (KYLBERGEROVÁ et al. 2002). Pools are often characterized as small water basins with a relatively large littoral zone and a small or missing profundal zone (ODUM 1977). Shallow pools are strongly influenced by sediments (POULÍČKOVÁ & KRŠKOVÁ 2000). Phytoplankton of pools has been intensively studied only last decade (BUREŠOVÁ 1997, RULÍK et al. 1997, KOPECKÝ & KOUDELKOVÁ 1997, PITHART 1999). Phytoflagellates (namely Cryptophyceae) seem to be very abundant or dominant; on the other hand, non-motile, coccal forms (cyanobacteria, green Chlorococcales or diatoms), typical for other eutrophic waters, are almost missing (KYLBERGEROVÁ et al. 2002).

The Litovelské Pomoraví Protected Landscape Area is situated in the floodplain of the Morava River between the towns of Olomouc and Mohelnice. Litovelské Pomoraví is a wetland of an international importance. It forms a zone along the naturally meandering river with a great number of periodical and permanent branches, oxbow lakes, temporary and permanent pools, well-preserved floodplain forests and wetland communities.

Algae and cyanobacteria have been studied there by several authors (SEIDLEROVÁ 1995, BUREŠOVÁ 1997, KOPECKÁ 1998, PALOCHOVÁ 1998, SKÁCELOVÁ 2000, PITHART et al. 2000, POULÍČKOVÁ 2000).

Material and methods

Investigations were carried out during the years 2000 – 2002. Selected environmental variables (pH, oxygen, temperature, conductivity) were measured in situ using mobile instruments (WTW company). Mixed water samples were taken with a Plexiglas tube to plastic bottles monthly from March to October. Phosphates, nitrates, nitrites and ammonium ions were checked with a DR 2000 spectrophotometer by HACH (ANONYMUS 1992). Chlorophyll *a* was measured by UV-VIS Super Aquarius CE 900 spectrophotometer (PECHAR 1987). Alkalinity was measured according to HORÁKOVÁ et al. (1989).

Mixed water samples for phytoplankton determination were kept overnight in a refrigerator (4 °C). Phytoplankton was observed in live material (after the centrifugation at 1500 rpm for 10 minutes) or after fixation in 0.5% Lugol´s solution. The abundance of main phytoplankton groups was carried out by centrifugation and counting of 400 individuals in a counting chamber (Bűrker chamber). Nomenclature of cyanobacteria and algae is according to HINDÁK ed. (1978).

The study was carried out in small floodplain pools Kolečko and Pontonová in the Nature Reserve Plané loučky in the Litovelské Pomoraví Protected Landscape Area (Central Moravia, Czech Republic). Kolečko is a man-made permanent shallow water body with a circular shape, 11 m in diameter and maximum depth of 150 cm in wet season. The locality is surrounded by meadows; the periphery is overgrown by *Typha latipholia*. The pool bottom is covered with *Utricularia australis* (KOČÁRKOVÁ et al. 2003). Pontonová is a natural permanent shallow water body with an oval shape (17x25m) and the depth of 30 cm. The pool is connected by a gutter with the Mlýnský potok Brook. It is shaded by trees (shading 20%; LELKOVÁ 2003).

Results and discussion

Tables 1-2 present annual means of selected environmental variables and phytoplankton quantity in the investigated pools. Significant differences in water chemistry were observed between the studied pools; higher temperature, oxygen concentration, pH, alkalinity, and phosphate, nitrate and nitrite ions concentrations were found in pool Pontonová (Wilcoxon test, in all cases $p < 0.032$).

Phytoplankton abundance ranged from 270 to 9 390 individuals per 1 ml in pool Kolečko and from 350 to 10 080 individuals per 1 ml in pool Pontonová. Chlorophyll *a* ranged from 1.2 to 39.05 $\mu g.l^{-1}$ in pool Kolečko and from 2.42 to 60.7 $\mu g.l^{-1}$ in pool Pontonová. Chlorophyll *a* values corresponded with phytoplankton abundance in both pools. No significant differences in phytoplankton abundance and chlorophyll *a* were found. Fig. 1 summarizes the

annual average representation of important phytoplankton groups. Higher representation of flagellates was observed in pool Kolečko.

Flagellates (especially Cryptophyta, Euglenophyta, Dinophyta and Chlamydophyceae) and Bacillariophyceae played a key role in the studied phytoplankton communities. Kolečko was dominated by flagellates while Pontonová was dominated by diatoms. Cyanobacteria occurred only sparsely in both pools and water bloom was not observed at all. A total of 123 taxa of algae and cyanobacteria were found; 88 species were identified in pool Kolečko and 85 in pool Pontonová.

Kolečko can be characterized by the following species: *Chrysococcus* sp., *Cosmarium punctulatum, Cryptomonas curvata, Cryptomonas marssonii, Cryptomonas reflexa, Euglena acus, Euglena hemichromata, Navicula* sp., *Pinnularia* sp., *Spirogyra* sp., *Trachelomonas hispida,* and *Trachelomonas volvocina*. Phytoplankton community of pool Pontonová was dominated by species *Chlamydomonas* sp., *Cryptomonas curvata, Cryptomonas marssonii, Cryptomonas reflexa, Cymatopleura librilis,, Fragilaria* sp., *Navicula* sp., *Phacus orbicularis, Pinnularia* sp., *Scenedesmus quadricauda,* and *Trachelomonas hispida*. Mass occurrence of *Hydrodictyon reticulatum* was observed in this pool every year. These results are in good agreement with previously published data (PALOCHOVÁ 1998). Some species occurred regularly while other appeared sporadically, for instance *Merismopedia tenuissima, Dinobryon divergens,* and *Tetraëdron minimum*. Dinophyta were observed in both pools in the years 2000 and 2002, not in the year 2001.

KYLBERGEROVÁ et al. (2002) reported prevailing dominance of flagellates and low contribution of Chlorococcales, diatoms and cyanobacteria. BUREŠOVÁ (1997) and PALOCHOVÁ (1998) studied phytoplankton in several alluvial pools in the Morava River floodplain. Phytoplankton was dominated by genera *Cryptomonas*, *Trachelomonas*, *Pandorina*, *Peridinium*, *Phacus*, *Gymnodinium,* and *Euglena*. Prevailing dominance of Cryptophyceae throughout the whole year was described by PITHART el al. (1996) and PITHART (1999).

KYLBERGEROVÁ et al. (2002) reported prevailing dominance of flagellates especially in pools of a greater relative depth and protected against wind by the surrounding vegetation Stratification is enhanced in such pools. The relatively poor light conditions as a result of shading, and the absence of mixing, favor flagellates with their ability to move actively in the water column (JONES 1988). The vertical distribution of phytoplankton community was studied in pool Kolečko. Vertical gradients of environmental variables were observed, as well as diurnal vertical migration of flagellates (KOČÁRKOVÁ et al. 2003).

The representation of diatoms is higher in Moravian pools than in the Lužnice River floodplain pools (KYLBERGEROVÁ et al. 2002). Bacillariophyceae form about 62% of the total phytoplankton abundance in pool Pontonová. These diatoms probably originate from the Mlýnský Brook; therefore, majority of them are big pennate diatoms. Centric diatoms were observed only sporadically.

Long-term changes in the occurrence of common planktonic species in the investigated pools

Although environmental and quantitative data are sporadic before the year 2000, phytoplankton species composition was studied during the years 1996-2002 in pools Kolečko and Pontonová. (PALOCHOVÁ 1998, LELKOVÁ 2003, KOČÁRKOVÁ unpublished data). Tables 3-4 present selected common planktonic species (except diatoms) and their occurrence in the investigated localities in the years 1996-2002.

The representation of Cryptophyta and Euglenophyta increases in pool Kolečko. The increasing tendency was observed in case of the following species: *Cryptomonas curvata, C. marssonii, C. reflexa, Euglena acus, E. hemichromata,* and *Trachelomonas volvocinopsis.* On the other hand, the representation of some Chrysophyceae, Dinophyta and Zygnematophyceae decreases.

Pool Pontonová was silted after the flood in 1997 and has become shallower. This event accelerated the process of drying and aging. The abundance of planktonic species was high in the years 1996 and 1997 (before the flood; e.g. *Cryptomonas marssonii,* and *C. reflexa*). Mass occurrence of filamentous algae (*Spirogyra* sp.) and other macroscopic algae (*Hydrodictyon reticulatum*) was observed after the flood. *H. reticulatum* was observed for the first time in 1998 (SKÁCELOVÁ pers. comm.). Mass occurrence of *H. reticulatum* was reported in June 1999 (KOČÁRKOVÁ & POULÍČKOVÁ 1999) and became regular in the following years (LELKOVÁ 2003).

H. reticulatum dominated usually from May to September, although the timing and duration of its occurrence varied from year to year. The changes in phytoplankton community and environmental variables were observed during the occurrence of *H. reticulatum*. While the phytoplankton abundance maxima reached 20 000 individuals per 1 ml in 1996 and 1997 (PALOCHOVÁ 1998), they decreased to 5 000 individuals per 1 ml during the occurrence of *H. reticulatum* in the years 2000-2002 (LELKOVÁ 2003), and species richness decreased during its occurrence, too.

Both pools were remarkably influenced by the flood in 1997. Species richness increased after the flood. The number of species indicating higher pollution, which were rare or absent at the sites before the flood, increased in 1998, e. g. the representatives of genera *Euglena, Phacus,* and *Closterium*. The same tendency was observed in the case of *Scenedesmus* sp. div. and *Hydrodictyon*, representing the „littoral way of life".

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Table 1: Annual averages of selected parametres in pool Kolečko

	2000	2001	2002
Temperature (°C)	15.1±3.7	12.9±4.9	12.9±5.4
pH	6.57±0.33	6.83±0.44	6.60±0.26
Oxygen (mg.l^{-1})	8.0±5.6	4.9±4.1	3.0±1.4
Conductivity (µS.cm^{-1})	244.5±39.4	268.6±40.5	296.0±26.2
Alkalinity (mmol.l^{-1})	1.16±0.311	1.27±0.21	1.11±0.14
PO_4^{3-} (mg.l^{-1})	0.31±0.30	0.75 ±1.68	0.21±0.20
NH_4^+ (mg.l^{-1})	0.98±0.46	0.76±0.47	1.07±0.61
NO_3^- (mg.l^{-1})	0.54±0.66	0.56±0.44	0.37±0.17
NO_2^- (mg.l^{-1})	0.05±0.03	0.09±0.10	0.07±0.02
Abundance*	1760±660	1530±1520	2180±3290
Chlorophyll *a* **	-	6.78±4.89	9.33±13.50

* in individuals per 1ml, ** in µg . l^{-1}

Table 2: Annual averages of selected parametres in pool Pontonová

	2000	2001	2002
Temperature (°C)	16.1±5.2	14.1±5.7	13.6± 7.1
pH	7.97±0.96	7.51±0.99	7.59±0.88
Oxygen (mg.l^{-1})	10.8±4.8	9.9±5.6	9.8 ±3.1
Conductivity (µS.cm^{-1})	288.7±37.7	275.1±49.1	274.5±58.1
Alkalinity (mmol.l^{-1})	1.97±0.64	1.49±0.49	1.60±0.14
PO_4^{3-} (mg.l^{-1})	0.55±0.40	0.85±1.67	0.42±0.34
NH_4^+ (mg.l^{-1})	1.13±0.58	2.05±3.16	1.26±1.51
NO_3^- (mg.l^{-1})	0.94±1.50	1.00±3.16	2 .00±1.51
NO_2^- (mg.l^{-1})	0.08±0.07	0.14±0.14	0.1±0.05
Abundance *	2640±3090	3790±2850	1330±1540
Chlorophyll *a* **	-	19.13±16.96	16.83±21.51

* in individuals per 1ml, ** in µg . l^{-1}

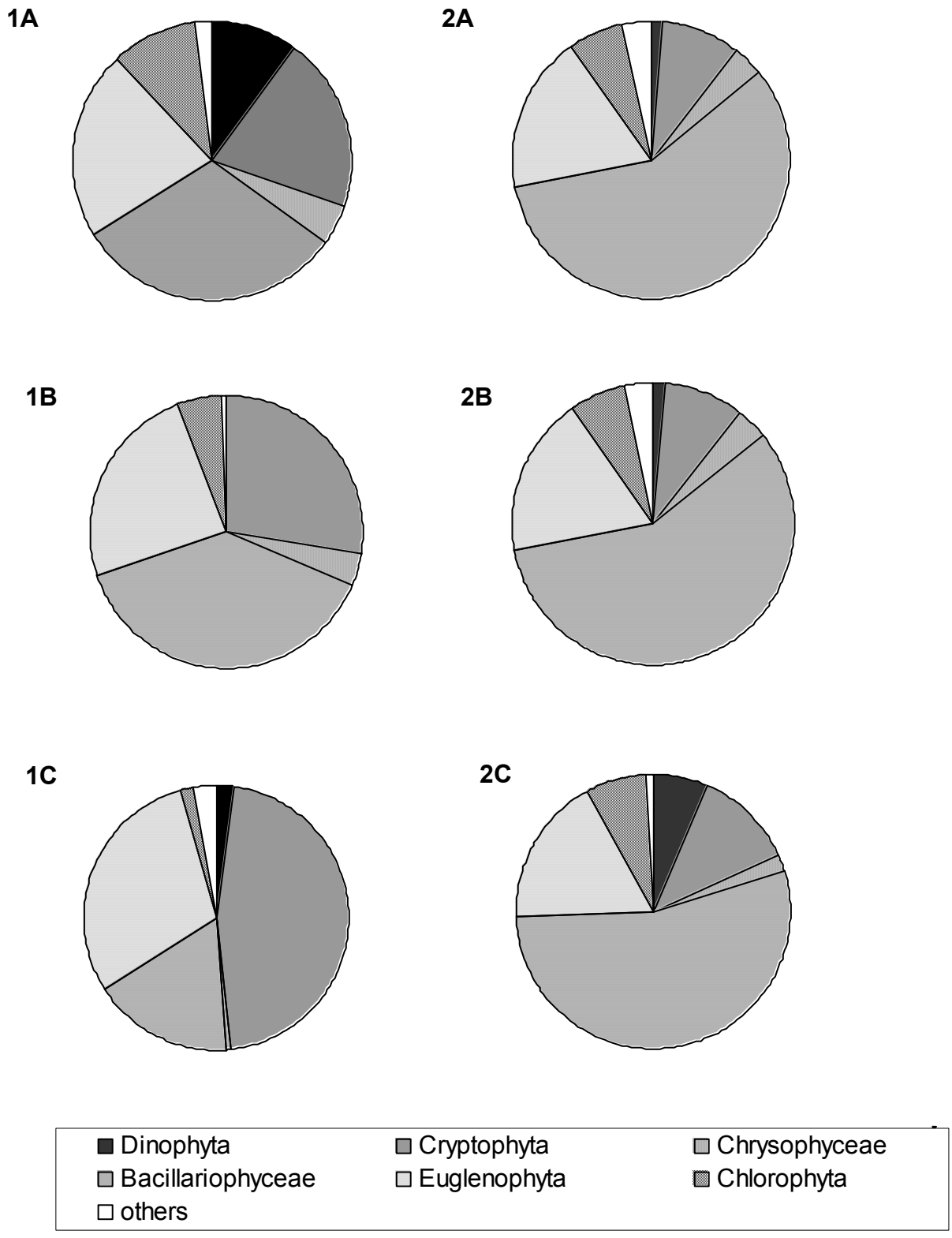

Fig. 1: Annual average representation of the main phytoplankton groups (1A – pool Kolečko 2000, 2A – pool Pontonová 2000, 1B – pool Koelečko 2001, 2B – pool Pontonová 2001, 1C – pool Kolečko 2002, 2C – pool Pontonová 2002)

Table 3: List of selected common planktic species (except diatoms) and their occurrence in pool Kolečko in the years of 1996-2002

Taxon	1996	1997	1999	2000	2001	2002
Closterium ehrenbergii MENEGH.				*		
Closterium cf. *leibleinii* KÜTZ					*	
Closterium moniliferum (BORY) EHRENB.				*		
Closterium cf. *parvulum* NÄG.						
Closterium sp.		*		*		
Coelastrum sp.				***	*	*
Cosmarium punctulatum BRÉB.				*		
Cosmarium sp.				***		
Cryptomonas cf. *erosa* EHRENB.				*		
Cryptomonas splendida CZSON.			*			
Cryptomonas cf. *splendida* CZSON.					***	***
Cryptomonas curvata EHRENB.		*			***	***
Cryptomonas marssonii SKUJA	*			**		
Cryptomonas reflexa SKUJA			*			
Cryptomonas sp.	***	*		***		*
Dinobryon divergens IHM.			*	*	**	***
Draparnaldia sp.						
Euglena acus EHRENB.			*	***	***	***
Euglena anabaena MAINX					*	*
Euglena hemichromata SKUJA						*
Euglena physeter FOTT					*	***
Euglena proxima DANG.	*	**		**		
Euglena sanguinea EHRENB.					*	
Euglena spirogyra EHRENB.				*		
Euglena tripteris (DUJARD.) KLEBS	***	***		*		
Euglena sp.						*
Gymnodinium wawrikae SCHILLER			*			
Gymnodinium cf. *wawrikae* SCHILLER						*
Gymnodinium sp.				***	**	*
Chilomonas sp.			***	***	**	*
Chlamydomonas sp.		*				
Chrysococcus sp.				*		
Lagerheimia sp.			*			
Mallomonas sp.						*
Mallomonopsis cf. *robusta* MATV.		*		*		
Monoraphidium arcuatum (KORŠ.) HIND.		*		*	**	
Monoraphidium sp.					**	***
Mougeotia sp.				*		
Nostoc sp.			*			*
Oedogonium sp.			*		*	*
Oscillatoria sp.				*	*	*
Pandorina morum (O. F. MÜLLER) BORY		*		***		
Pediastrum duplex MEYEN				*		

Taxon	**1996**	**1997**	**1999**	**2000**	**2001**	**2002**
Peridinium bipes STEIN			**			
Peridinium cf. *cinctum* (O.F. MÜLLER) EHRENB.				***		
Peridinium sp.					*	
Peridinium willei HUIF. – KASS					*	
Phacus cf. *aenigmaticus* DREZ.				*	*	
Phacus longicauda (EHRENB.) DUJARD				*	*	
Phacus orbicularis HÜBN.					*	
Phacus pyrum EHRENB.		*				*
Phacus triqueter (EHR.) DUJARDIN					*	
Phormidium sp.				*		
Pleurotaenium cf. *ehrenbergii* (BRÉB.) DE-BARY				*		
Pleurotaenium trabecula (EHRENB.) NÄG.					*	
Pleurotaenium sp.					**	**
Rhodomonas lacustris PASCH. & RUTTNER					*	
Scenedesmus acuminatus (LAGERH.) CHOD.					*	
Scenedesmus acutus MEYEN				*		
Scenedesmus dimorphus (TURP.) KÜTZ				*		
Scenedesmus disciformis (CHOD.) FOTT & KOM.				*		
Scenedesmus ecornis (RALFS) CHOD.			*		*	
Scenedesmus linearis KOM.		*	*	***	*	*
Scenedesmus quadricauda (TURP.) BRÉB.		*				
Spirogyra sp.				*	**	***
Synura spinosa KORŠ.					*	
Synura uvella EHRENB. em. KORŠ.		*	*			*
Tetraëdron minimum (A. BR.) HANSG.			*	*	*	*
Tetrastrum sp.					*	
Trachelomonas hispida (PERTY) STEIN em. DEFL.		*		*		**
Trachelomonas nigra SVIR.					*	
Trachelomonas oblonga LEMM.		*		*		**
Trachelomonas pulcherrima PLAYF.		*				
Trachelomonas scabra PLAYF.			*			
Trachelomonas varians DEFL.		*		**		
Trachelomonas volvocina EHRENB.		**	*	**	***	**
Trachelomonas volvocinopsis SVIR.				*	*	***
Trachelomonas sp.	*	*		*		
Ulothrix sp.				*		
Volvox globator (L.) EHRENB.				*		
Zygnema sp.		*		**		

* sporadic occurrence in the locality
** regular occurrence in the locality
*** dominant taxon at least once a year
** increasing representation

Table 4: List of selected common planktic species (except diatoms) and their occurrence in pool Pontonová in the years of 1996-2002

Taxon	1996	1997	1999	2000	2001	2002
Closterium acerosum (SCHRANK) EHRENB.					**	*
Closterium lineatum EHRENB.				*		*
Closterium moniliferum (BORY) EHRENB.		*			*	
Closterium sp.			*	**		
Cosmarium sp.			*	*		
Cryptomonas curvata EHRENB.			*	***	***	*
Cryptomonas marssonii SKUJA		*			***	**
Cryptomonas phaseolus SKUJA		*				
Cryptomonas reflexa SKUJA			*		***	**
Cryptomonas splendida CZSON.				*		
Cryptomonas sp.	*	*		*	*	
Chilomonas oblonga PASCH.					***	
Chilomonas sp.					**	*
Chlamydomonas sp.	*	**	*	***	*	*
Chlorella sp.					*	*
Chrysococcus sp.				**		*
Euglena ehrenbergii KLEBS				*	*	*
Euglena hemichromata SKUJA				*		*
Euglena spirogyra EHRENB.		*		*	*	
Euglena variabilis KLEBS		*				
Euglena viridis EHRENB.		*				
Euglena sp.		*			*	
Gymnodinium aeruginosum STEIN						***
Gymnodinium wawrikae SCHILLER						*
Gymnodinium sp.				*		
Hydrodictyon reticulatum (L.) LAGERH.		*	**	***	***	***
Merismopedia tenuissima LEMM.			*	*	*	
Merismopedia sp.				*		
Monoraphidium arcuatum (KORŠ.) HIND.				*		
Mougeotia sp.					*	
Oscillatoria formosa BORY ex GOM.		*			*	**
Oscillatoria sp.	*	*				
Pandorina morum (O. F. MÜLLER) BORY				*	*	*
Pediastrum duplex MEYEN					*	**
Penium cf. *spirostriolatum* BARKER						*
Phacus cf. *pleuronectes* (O.F. MÜLL.) DUJ.					*	
Phacus cf. *pyrum* EHRENB.				*		
Phacus longicauda (EHRENB.) DUJARD			*			
Phacus monilatus			*			
Phacus orbicularis HÜBN.			*	***	*	*
Phacus pyrum EHRENB.				*		
Phacus sp.		*		*		
Phacus triqueter (EHR.) DUJARDIN		*		**	*	*

Taxon	**1996**	**1997**	**1999**	**2000**	**2001**	**2002**
Rhodomonas lacustris PASCH. & RUTTNER					*	
Scenedesmus abundans (KIRCHN.) CHOD.			*			
Scenedesmus acuminatus (LAGERH.) CHOD.				*		
Scenedesmus acutus MEYEN			*	*		*
Scenedesmus cf. *serratus* (CORDA) BOHL.					*	
Scenedesmus dimorphus (TURP.) KÜTZ						*
Scenedesmus disciformis (CHOD.) FOTT & KOM.					*	
Scenedesmus ecornis (RALFS) CHOD.					*	*
Scenedesmus intermedius CHOD.				*		*
Scenedesmus linearis KOM.						**
Scenedesmus pannonicus HORTOB.					*	
Scenedesmus quadricauda (TURP.) BRÉB.		*	*	*	*	**
Schizochlamys gelatinosa A. BRAUN						*
Spirogyra sp.	*	*	*	*	**	***
Synura spinosa KORŠ.		*				
Synura uvella EHRENB. em. KORŠ.					*	*
Tetraëdron minimum (A. BR.) HANSG.				*	*	**
Tetraspora sp.					*	*
Trachelomonas hispida (PERTY) STEIN em. DEFL.				*	**	*
Trachelomonas oblonga LEMM.				**		
Trachelomonas pulcherrima PLAYF.		*				
Trachelomonas volvocina EHRENB.		*	*	***	***	**
Trachelomonas cf. *volvocina* EHRENB.		*	**	*		
Trachelomonas volvocinopsis SVIR.		*				**
Trachelomonas sp.		**				
Tribonema sp.		*				
Ulothrix sp.				*		

* sporadic occurrence in the locality
** regular occurrence in the locality
*** dominant taxon at least once a year
** increasing representation