Acta Musei Nationalis Pragae, Series B, Historia Naturalis, 62 (1–2): 71–80 issued June 2006
Sborník Národního muzea, Serie B, Přírodní vědy, 62 (1–2): 71–80

CONTRIBUTION ON THE ALGAL FLORA OF SLOVENIA, WITH EMPHASIS ON NEWLY RECORDED ALGAL TAXA

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Krivograd Klemenčič, A., Vrhovšek, D., Smolar-Žvanut, N. (2006): Contribution on the algal flora of Slovenia, with emphasis on newly recorded algal taxa. – Acta Mus. Nat. Pragae, Ser. B, Hist. Nat., 62 (1–2): 71–80. Praha. ISSN 0036-5343.

Abstract. For the purpose of the present study, algae were investigated in two eutrophic lakes, two peat bogs, three different waterfalls, four different springs, a brackish lake, three types of wastewater, four types of aerial habitat, and the flysch river of Dragonja, all in Slovenia. The study was carried out in the environments in Slovenia that have been only partly or never investigated before. Samples were taken seasonally at 26 sampling sites from 1998 to 2001. There were altogether 537 algal taxa registered, with prevailing occurrences of Bacillariophyceae (295 taxa). Of the identified taxa, 146 were recorded for the first time in Slovenia, 107 of which belong to Bacillariophyceae, 28 to Cyanophyceae, 6 to Chlorophyceae, 4 to Zygnematophyceae and 1 to Xanthophyceae. The occurrence of almost half of all algal taxa was limited to individual sampling sites. *Achnanthes minutissima*, *Cymbella affinis*, *C. silesiaca*, *Gomphonema angustum*, *Navicula veneta*, and *Trentepohlia aurea* were the most widespread species.

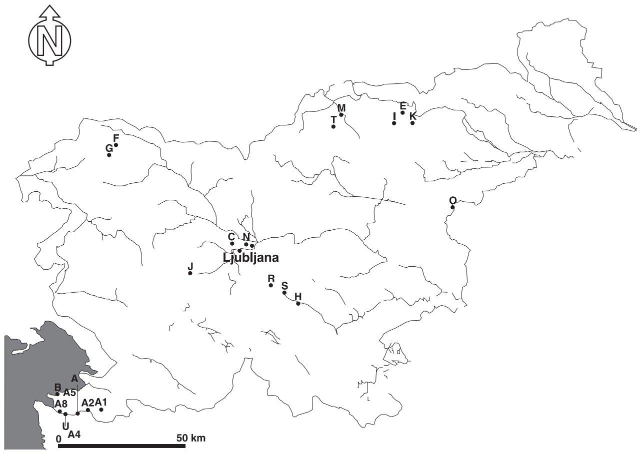
■ Algae, extreme environments, periphyton, phytoplankton, Slovenia.

Received January 17, 2006

Introduction

Slovenia is characterised by wide geographical diversity reflected in a variety of aquatic ecosystems, and therefore contains a diversity of algae. In the Alpine region, various communities of freshwater algae appear in springs, torrents, high-altitude lakes, bogs, and waterfalls. In the karst region, algae are found in karst springs and specific biotops, such as underground streams, temporary lakes, and tufa formations. In the Pannonian region, algae develop in oxbows, pools, wetlands, and thermal springs. Interesting algae species also appear in newly created ecosystems, such as gravel pits, water storage basins, drained wetlands, and revitalised aquatic ecosystems. Despite the exceptional species diversity, algae in such environments have not been thoroughly investigated. The biodiversity of algae in Slovenia is relatively high, as more than 2000 algal species have been recorded so far (Kosi and Vrhovšek 1996).

In our study we also investigated algae in some extreme environments in Slovenia (low pH, extremes in temperature, extremes in conductivity, low light, high water velocity, low humidity, variable food richness, long periods of desiccation, etc.) that have only been partly or never investigated before. There were altogether 26 sampling sites investigated. The purpose of the study was to establish the species structure and relative abundance of algal taxa in some extreme environments in Slovenia.



Text-fig. 1: The map of Slovenia with marked sampling sites. Legend: A – Dragonja River, B – Fiesa Lake, C – Koseški bajer Lake, D – Sotelsko Lake, E – Lovrenška Lakes bog, F – Šijec bog, G – Savica Waterfall, H – Krka waterfall, I – small waterfall at Pohorje, J – spring at Medvedje Brdo, K – spring at Pohorje, L – thermal spring at Terme Čatež, M – Rimski Vrelec mineral spring, N – concrete wall, O – stony wall, P – lime tree trunk, R – limestone rock, S – Krška jama cave, T – manure, U – Dragonja constructed wetland, V – Barje constructed wetland

Material and Methods

Description of sampling sites

The sampling sites are presented in Text-fig. 1. and their description given in Tab. 1.

The lakes of Koseški bajer and Fiesa originate from abandoned clay pits. The Fiesa Lake is located on the coast of the Adriatic Sea, and it is the only brackish lake in Slovenia. The Sotelsko Lake is a water storage basin where the locks are normally open and closed only in the event of

Table 1: Description of sampling sites.

Sampling sites	Habitat type	Microbiotope type	ground
A	river	periphyton, phytoplankton	flysh terrain
B	lake	periphyton, phytoplankton	clay
C	lake	periphyton, phytoplankton	clay
D	lake	periphyton, phytoplankton	limestone
E	peat bog	periphyton, phytoplankton	acid-silicate
F	peat bog	periphyton, phytoplankton	acid-silicate
G	waterfall	periphyton	limestone
H	waterfall	periphyton	travertine
I	waterfall	periphyton	acid-silicate
J	spring	periphyton	limestone
K	spring	periphyton	acid-silicate
L	thermal spring	periphyton	limestone
M	mineral spring	periphyton	acid-silicate
N	wall	algal growth on the substrate	concrete
O	wall	algal growth on the substrate	limestone
P	tree trunk	algal growth on the substrate	lime tree trunk
R	rock	algal growth on the substrate	limestone
S	cave	algal growth on the substrate around the lights	limestone
T	manure	algal growth on the manure	acid-silicate
U	constructed wetland	algal growth in wastewater from the bed amongst *Phragmites communis*	flysh terrain
V	constructed wetland	algal growth in the wastewater accumulation basin	limestone

Legend: A – Dragonja River, B – Fiesa Lake, C – Koseški bajer Lake, D – Sotelsko Lake, E – Lovrenška Lakes bog, F – Šijec bog, G – Savica Waterfall, H – Krka waterfall, I – small waterfall at Pohorje, J – spring at Medvedje Brdo, K – spring at Pohorje, L – thermal spring at Terme Čatež, M – Rimski Vrelec mineral spring, N – concrete wall, O – stony wall, P – lime tree trunk, R – limestone rock, S – Krška jama cave, T – manure, U – Dragonja constructed wetland, V – Barje constructed wetland

flood waves. The lake bed has started to become overgrown, developing a forested appearance. The peat bogs of the Lovrenška Lakes and Šijec are situated on the top of a hill; thus precipitation is their only source of water, and influences from the surroundings are minimal since there is no inflow or surface runoff. The Krka River is the only Slovenian river with travertine barriers and travertine waterfalls. The mineral spring of Rimski vrelec is a "Ca-Mg-Na-hidrogen-carbonate acid water" with very high values of iron (Rogelj et al. 1972). The karst cave is open to tourists, and is lighted only during visiting hours.

Samples were collected seasonally from 1998 to 2001. At each site, five samples were taken for qualitative analysis.

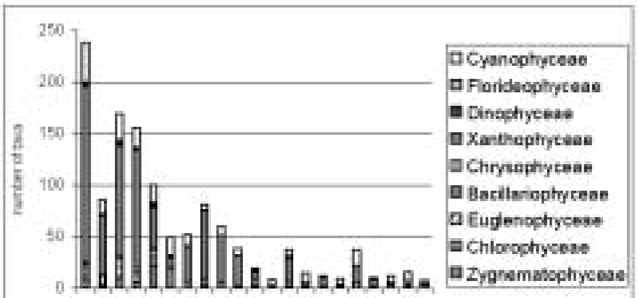
In lakes, springs, waterfalls, and the Dragonja River, samples of periphyton were taken by scratching the surface of gravel, rocks, wood, macrophytes, and other submersed materials (glass and plastic bottles, iron rods, etc.). In peat bogs, samples were taken from the surface of pine tree roots (*Pinus mugo* Turra) in water and in the moss-covered overgrowth. In the mineral spring of Rimski vrelec and the thermal spring at Terme Čatež, samples of periphyton were scratched from the bottom and the walls of the fountains. In lakes, peat bogs, and the sampling site in the Dragonja estuary, samples of phytoplankton were also taken. We used a plankton net with 25 µm mesh size. The aerial algae were scratched from limestone rock, a concrete wall, a stone wall, and the trunk of a lime tree. In the cave of Krška jama, algae were scratched from the lighted rock most distant from the cave entrance. Samples of manure were taken from the grassland above the manure basin of a farm. Samples of wastewater from the Barje constructed wetland were taken from the wastewater storage basin, and samples of wastewater from the Dragonja constructed wetland were taken from the bed of *Phragmites australis* (Cav.) Trin.

The samples were immediately bottled and preserved in a solution of four percent formaldehyde, except the wastewater samples, which were first examined and then preserved. For diatom determination, samples were pre-treated with saturated HNO_3 (APHA, 1985). We identified algae using a light microscope (1000 × magnification) and the following identification monographs: Lazar (1960), Bourrelly (1966, 1968, 1970), Starmach (1966, 1968, 1972, 1974, 1977, 1980, 1983), Golubić (1967), Krammer and Lange-Bertalot (1986, 1988, 1991a, 1991b), Popovsky and Pfiester (1990), Hindak et al. (1978), Hindak (1996), Cvijan and Blaženčić (1996), Lenzenweger (1996, 1997). Relative abundance was estimated with the numbers 1, 3, and 5 (1 – rare, 3 – frequent, 5 – abundant) (Pantle and Buck 1955).

Results and Discussion

There were altogether 537 taxa of algae identified, of which 295 belong to Bacillariophyceae, 116 to Cyanophyceae, 58 to Chlorophyceae, 44 to Zygnematophyceae, 8 to Xanthophyceae, 6 to Dinophyceae, 5 to Euglenophyceae, 3 to Chrysophyceae, and 2 to Florideophyceae.

The composition of algal taxa at all sampling sites is presented in Text-fig. 2. In terms of the number of species, Bacillariophyceae dominated in lakes, waterfalls, two of the four springs (Medvedje Brdo, the Rimski vrelec), the Lovrenška jezera bog, the Krška jama cave, and the flysch river of Dragonja. The Bacillariophyceae was also found to be the most frequently occurring class of algae in various rivers and lakes in Slovenia in the research of other authors (Vrhovšek 1994, Vrhovšek et al. 1994, Smolar 1997, Krivograd 1997). Zygnematophyceae were prevalent in the Šijec bog, followed by Cyanophyceae and Bacillariophyceae.



Text-fig. 2: Algal community structure measured in some extreme environments in Slovenia from 1998 to 2001.
Legend: A – Dragonja River, B – Fiesa Lake, C – Koseški bajer Lake, D – Sotelsko Lakes, E – Lovrenška Lakes bog, F – Šijec bog, G – Savica Waterfall, H – Krka waterfall, I – small waterfall at Pohorje, J – spring at Medvedje Brdo, K – spring at Pohorje, L – thermal spring at Terme Čatež, M – Rimski vrelec mineral spring, N – concrete wall, O – stony wall, P – lime tree trunk, R – limestone rock, S – Krška jama cave, T – manure, U – Dragonja constructed wetland, V – Barje constructed wetland

Other authors (Duthie 1965, Kingston 1982, Scherer 1988) also found the Zygnematophyceae to be the most frequent algae in different peat bogs, while Bacillariophyceae and Cyanophyceae occurred less commonly. Chlorophyceae were prevalent in the spring at Pohorje, and Cyanophyceae in the thermal spring at Terme Čatež. Cyanophyceae has been found to be the most frequent class of algae in various thermal springs worldwide (Doemel and Brock 1971, Carr and Whitton 1973, Round 1973, Noguerol 1991). Ecological conditions in thermal springs show a higher degree of consistency, with very high water temperatures. Eukaryotic algae are less adapted to high water temperatures, and thus Cyanophyceae is the most frequent class in such springs (Vrhovšek 1985). Of the other classes of algae, only Bacillariophyceae are also common in thermal springs, though they appear only when the water temperature is below 40 °C (Cvijan and Blaženčić 1996). Cyanophyceae was the most frequent class of algae in manure and wastewater from the Dragonja constructed wetland, as revealed also in research on hypertrophic waters (Whitton 1975, Sedmak and Kosi 1997). Cyanophyceae was absent in wastewater from the storage basin in the Barje constructed wetland, where Bacillariophyceae and Chlorophyceae prevailed. The main reason for the differences between wastewater samples from both constructed wetlands was probably the place of sampling. In the Dragonja constructed wetland, we took samples of algae in wastewater from the bed of *Phragmites australis*, while samples were taken from a water storage basin in the Barje constructed wetland. Drews et al. (in Whitton 1975) found that Chlorophyceae were the prevalent algae in the phytoplankton of ventilating basins of wastewater treatment systems, with Cyanophyceae occurring only rarely. Cyanophyceae also dominated two of the four aerial biotopes (the concrete wall and the lime tree trunk). At the other two aerial biotopes (the stone wall and the limestone rock), most algal species belonged to Bacillariophyceae which, according to research on algal flora of selected wet walls, also predominate in Zion National Park, Utah, USA (Johansen et al. 1983), followed by Cyanophyceae and Chlorophyceae. The species distribution of aerial algae associations depends mostly on moisture. In dryer places, Bacillariophyceae such as *Pinnularia borealis* Ehrenberg, *Navicula mutica* Kützing, and *Hantzschia amphioxys* (Ehrenberg) W. Smith appear. In places with more moisture, the number of Bacillariophyceae and Cyanophyceae (*Aphanocapsa*, *Gloeocapsa*, *Nostoc*, *Oscillatoria*) species increases and the Chlorophyceae species appears (Round 1973).

Rivers

The highest number of algal taxa (238) was found in the flysch river of Dragonja. Most Slovenian water streams are polluted, especially in the lowland areas (Vrhovšek et al. 1983, 1994, Smolar 1997, Krivograd 1997, Krivograd Klemenčič 2001). The Dragonja River is one of the very few unpolluted rivers in Slovenia. In the interest of protecting its natural ecosystems and their constituent parts, including algae, it has been decided to give the Dragonja River valley the status of a natural park. We took samples from six sites on the Dragonja River, from its source to the estuary. The water at the estuary sampling site is brackish. No investigation concerning the brackish waters of Slovenia has been carried out prior to this research. The total number of different planktonic and periphyton taxa at the sampling site in the Dragonja estuary was 121. By their nature, estuaries are generally eutrophic and dynamic systems. Consequently, the number of flora species is variable and sometimes high (Kilham and Mavuti 1990). Freshwater, brackish, and marine algal species were present in the Dragonja estuary, and the marine and brackish algae were almost exclusively diatoms (Krivograd Klemenčič et al. 2003).

Lakes

There were 85 algal taxa identified in samples from Fiesa Lake, the only brackish lake in Slovenia. In addition to freshwater species there also occurred one marine species, *Amphora angusta* (Gregory) Cleve, and many brackish species: *Achnanthes amoena* Hustedt, *Nitzschia commutatoides* Lange-Bertalot, *Nitzschia dubia* W. Smith, *Nitzschia tryblionella* Hantzsch, *Mastogloia smithii* Thwaites, *Navicula crucicula* (W. Smith) Donkin, *Navicula salinarum* Grunow, *Surirella striatula* Turpin, and *Phormidium dimorphum* Lemmermann (Krivograd Klemenčič 2003).

High species diversity was also found in the eutrophic lakes of Koseški bajer (169) and Sotelsko jezero (155). In the sample taken in the Koseški bajer in August 1998, the predominant species was *Microcystis aeruginosa* Kützing. Cyanophyceae from the *Microcystis* genera is the most common cause of water blooms in Slovenian freshwater bodies (Sedmak and Kosi 1997). Kosi (1999) examined the appearance of potentially toxic cyanobacteria in the standing waters of Slovenia. He traced 33 phytoplanktonic cyanobacteria, of which 12 were known as potentially toxic. The most frequent species was *Microcystis aeruginosa*. Many species identified in the Sotelsko jezero samples indicated the organic pollution of the lake (Krivograd Klemenčič 2002).

Peat bogs

There were altogether 116 algal taxa identified in peat bogs, of which 100 were found in the Lovrenška jezera bog and 49 in the Šijec bog. Four diatom taxa that are typical of acidic and dystrophic peat bogs occur in the Lovrenška jezera, among which the most frequent are *Eunotia denticulata* (Brebison) Rabenhorst and *Navicula subtilissima* Cleve. Most diatoms prefer water that is richer in electrolytes (Krivograd Klemenčič and Vrhovšek 2003a). In the Šijec bog, the common species was *Staurastrum pokljukense* Pevalek, which is typically found on the Pokljuka plateau (Pevalek 1924).

Waterfalls

We registered 143 taxa of algae in three different waterfalls. There were 81 taxa identified in the waterfalls of the Krka River, 60 in the small waterfall at Pohorje, and 52 in the Savica Waterfall. The species diversity in samples from all three waterfalls was higher in the summer and autumn than in other seasons; this finding has also been confirmed by other authors (Vrhovšek et al. 1994, Szarek 1994, Smolar 1997). In the Savica samples, *Gloeocapsa sanguinea* (Agardh) Kützing – a typical species of the drizzle zone in waterfalls (Starmach 1966) – was common. *Hydrurus foetidus* Kirchner was common in spring samples, which can be explained by low water temperature (Ward 1974). Among the diatoms identified in the small waterfall at Pohorje, most species were typical of waters that are low in electrolytes and poor in nutrients (Krivograd Klemenčič and Vrhovšek 2003b).

Springs

There were 83 taxa of algae identified in four different springs, of which 38 taxa were determined in the spring at Medvedje Brdo, 37 in the Rimski vrelec mineral spring, 19 in the spring at Pohorje, and 8 in the thermal spring at Terme Čatež. No seasonal changes were found in the algal communities of the mineral and thermal springs, probably due to insignificant fluctuations of the water temperature throughout the year (Krivograd Klemenčič 2001). In the springs at Medvedje Brdo and Pohorje, high species richness was found in summer samples, and low in autumn and winter samples. The predominant species in the mineral spring samples were *Tribonema minus* Hazen and *Achnanthes lanceolata* (Brebisson) Grunow. Many of these species are typical of waters with high levels of electrolytes, while some of them are even typical of brackish waters (*Gomphonema gracile* Ehrenberg, *Navicula cincta* (Ehrenberg) Ralfs, *Navicula veneta* Kützing, *Nitzschia linearis* (Agardh) W. Smith, *Nitzschia sinuata* var. *delognei* (Grunow) Lange-Bertalot), which can be explained by the high conductivity (1,667–1,755 µS/cm) of the spring water (Krivograd Klemenčič 2001). The algal community in the spring at Pohorje was very different than those of the spring at Medvedje Brdo and the mineral spring, most likely because of different geological structure of the ground and different environmental parameters. Many of the species are typical of acid waters: *Netrium digitus* (Ehrenberg) Itzing and Roth, *Bambusina brebissonii* Kützing and *Botryochloris minima* Pascher (Krivograd Klemenčič 2001).

The most common species in the thermal spring were *Gloeocapsa alpina* Naegeli and *Phormidium angustissimum* W. and G. S. West. Cvijan (1986) studied algae in the thermal springs of Serbia, and found that the algae occur in water up to the temperature of 73 °C. At this temperature he found only one species of algae in the water, *Phormidium angustissimum*. Stockner (1967) found that some diatoms could live at very high water temperatures, although their optimum conditions are below 30 °C.

Aerial habitats

In aerial habitats there were altogether 58 algal taxa recorded, 14 of which were from a concrete wall, 12 from a stone wall, 9 from a lime tree trunk, and 37 from limestone rock. In samples from the concrete wall, stone wall, and tree trunk, the predominant species was *Pleurococcus vul-*

garis Naegeli, a common aerial species in Slovenia (Lazar 1960). The species diversity in these three habitats was low, probably due to the lack of moisture and nutrients. In the samples from the stone wall, *Navicula contenta* Grunow, and *Navicula suecorum* var. *dismutica* (Hustedt) Lange-Bertalot were also common species. *Navicula contenta* and *Trentepohlia aurea* (Linné) Martius were the most frequent species in the samples from the limestone rock.

Caves

A total of 10 algal taxa were found in subaerial samples from the Krška jama cave. Most algae were typical aerophilic species (Krivograd Klemenčič 2001), with *Trentepohlia aurea* being the most abundant. *Trentepohlia aurea* is the most common algal species of subaerial habitats in caves with artificial lighting in Slovenia (Lazar, 1960). The flora in the Krška jama cave was species poor relative to other caves (Rushforth et al. 1984, Dayner and Johansen 1991, Vinogradova et al. 1998), most likely because of the lack of light.

Wastewaters

There were 12 species of algae identified in manure, 7 in wastewater from the storage basin in the Barje constructed wetland, and 14 in wastewater from the bed of *Phragmites australis* in the Dragonja constructed wetland. Altogether, there were 27 algal taxa recorded. In the manure samples, *Microcystis hansgirgiana* (Hansgirg) Elenkin, *Chlorella* sp., *Oscillatoria* sp., and *Nitzschia umbonata* (Ehrenberg) Lange-Bertalot were the most common taxa. *Nitzschia umbonata* is often found in the outflows of treatment systems (Krammer and Lange-Bertalot 1988). In the Barje constructed wetland samples, *Nitzschia umbonata* and *Chlorella vulgaris* Beyer were the predominant species. In the Dragonja constructed wetland samples, *Navicula veneta* Kützing, *Nitzschia umbonata* and *Oscillatoria tenuis* Agardh were the most frequent. In the Dragonja constructed wetland, the number of determined species did not differ significantly between the seasons. In the Barje constructed wetland, the species diversity was higher in winter than in summer, probably because the outflow waters were most toxic in the summer (dry season) (Bulc 1998). Changing the quality of outflow waters thus has a high impact on the quantitative and qualitative structure of algal associations (Bulc 1998).

Conclusions

The occurrence of almost half (248) of algal taxa was limited to individual sampling sites (Krivograd Klemenčič 2001). *Achnanthes minutissima* Kützing, *Cymbella affinis* Kützing, *Cymbella silesiaca* Bleisch, *Gomphonema angustum* Agardh, *Navicula veneta* Kützing and *Trentepohlia aurea* were the most widespread taxa – they were identified in more than half of all extreme environments.

146 algal taxa were recorded for the first time in Slovenia (according to Limnos and the Slovenian National Institute of Biology algal data base DABA) (Tab. 2), of which the majority (67) were identified in samples from the Dragonja River. The sampling site with the highest number (38) of newly recorded taxa was the Dragonja River estuary. Marine and brackish species were predominant, which did not occur at other Dragonja sampling sites. 107 first-recorded taxa belong to Bacillariophyceae, 28 to Cyanophyceae, 6 to Chlorophyceae, 4 to Zygnematophyceae, and 2 to Xanthophyceae. The most frequent genera among the newly recorded taxa were *Navicula* with 29 and *Nitzschia* with 26 taxa.

Table 2: List of newly recorded algal taxa in Slovenia.

Taxon	A	B	C	D	E	F	G	H	I	J	K	L	M	O	P	R	S	T
CYANOPHYTA																		
CYANOPHYCEAE																		
Anabaena affinis Lemm.		*																
Borzia trilocularis Cohn.	*																	
Calothrix thermalis (Schw.) Hansg.												*						
Gloeocapsa bituminosa (Bory) Kütz.	*												*			*		
Lyngbya cryptovaginata Schkorb.	*																	
Lyngbya hieronymusii Lemm.			*															
Lyngbya perelegans Lemm.	*																	
Microcystis hansgirgiana (Hansg.) Elen.															*			*
Microcystis viridis (Br.) Lemm.					*													
Nostoc spongiaeforme Ag.						*												
Oscillatoria laetevirens (Cro.) Gom.	*																	
Phormidium angustissimum W. and G.S. We.	*											*	*					
Phormidium dimorphum Lemm.	*	*		*														
Phormidium henningsii Lemm.		*						*										

Taxon	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**O**	**P**	**R**	**S**	**T**
Phormidium lignicola Frem.																*		
Phormidium rotheanum Itzig.			*															
Phormidium setchelianum Gom.			*	*			*											
Phormidium valderiae (Delp.) Geit.									*			*	*	*				
Plectonema terebrans Born. and Flah.				*														
Pseudanabaena papillaterminata (Kiss.) Kukk.	*																	
Pseudospirulina amoena Pan. and Jahn.	*	*		*														
Schizothrix friesii (Ag.) Gom.	*																	
Spirulina flavovirens Wisl.			*															
Spirulina gomontiana (Setch.) Geit.	*																	
Spirulina meneghiniana Zanar.						*												
Spirulina tenuissima Kütz.	*																	
Synechocystis septentrionalis Sku.	*		*		*	*												
Tolypothrix cucullata Jaag	*																	
HETEROKONTOPHYTA																		
XANTHOPHYCEAE																		
Characiopsis minima Pasch.					*	*												
Gloeobotrys monochloron Ettl.											*							
BACILLARIOPHYCEAE																		
Achnanthes amoena Hust.		*																
Achnanthes catenata Bily and Marv.			*															
Achnanthes lanceolata ssp. *dubia* (Grun.) Lan.-Bert.								*										
Achnanthes lanceolata ssp. *frequentissima* Lan.-Bert.		*		*														
Achnanthes oblongella Oest.									*									
Achnanthes septata A. Cl.	*			*														
Amphora angusta (Greg.) Cl.	*	*																
Bacillaria paradoxa Gna.	*		*															
Caloneis molaris (Grun.) Kramm.	*												*					
Cymatopleura solea var. *apiculata* (W. Sm.) Ral.	*	*	*	*														
Cymbella caespitosa (Kütz.) Brun	*		*				*											
Cymbella cuspidata Kütz.			*															
Cymbella descripta (Hust.) Kramm. and Lan.-Bert.	*		*						*									
Cymbella gaeumannii Meist.																*		
Cymbella pusilla Grun.	*																	
Cymbella tumidula var. *lancettula* Kramm.	*																	
Denticula kuetzingii Grun.	*				*													
Denticula subtilis Grun.	*																	
Diatoma ehrenbergii Kütz.	*																	
Diatoma moniliformis Kütz.				*				*										
Epithemia turgida var. *granulata* (Ehr.) Brun									*									
Eunotia circumborealis Noerp. and Lan.-Bert.			*															
Eunotia denticulata (Breb.) Raben.					*	*												
Eunotia microcephala Krass.									*									
Eunotia paludosa Grun.					*	*			*									
Fragilaria biceps (Kütz.) Lan.-Bert.	*	*	*	*														
Fragilaria capucina var.*mesolepta* (Rab.) Rab.			*	*														

Taxon	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**O**	**P**	**R**	**S**	**T**
Fragilaria montana (Krass.) Lan.-Bert.	*																	
Fragilaria parasitica var. subconstricta Grun.			*	*														
Frustulia spicula Amo.	*				*	*												
Gomphonema amoenum Lan.-Bert.									*									
Gomphonema clevei Hust.								*										
Gyrosigma nodiferum (Grun.) Reim.	*							*										
Gyrosigma tenuissimum (W. Sm.) Cl.	*																	
Gyrosigma wansbeckii (Dan.) Cl.	*																	
Melosira moniliformis (Müll.) Ag.	*																	
Melosira nummuloides (Dill.) Ag.	*																	
Navicula accomoda Hust.	*																	
Navicula aerophila Krass.																*		
Navicula angusta Grun.										*								
Navicula bryophila Pet.	*								*									
Navicula capitata Ehren.				*														
Navicula cincta (Ehren.) Ral. and Prit.		*											*					
Navicula duerrenbergiana Hust.	*																	
Navicula erifuga Lan.-Bert.		*		*														
Navicula goeppertiana (Blei.) H.L. Sm.				*														
Navicula gregaria Donk.	*			*									*					
Navicula harderii Hust.																	*	
Navicula heufleriana (Grun.) Cl.				*														
Navicula incertata Lan.-Bert.	*																	
Navicula integra (W.Sm.) Ral.				*														
Navicula libonensis Schoe.	*																	
Navicula margalithii Lan.-Bert.	*																	
Navicula menisculus var. *upsaliensis* Grun.			*															
Navicula mutica var. *ventricosa* Cl. and Grun.				*														
Navicula nivalis Ehren.														*		*		
Navicula oppugnata Hust.	*																	
Navicula pseudokotschyi Lan.-Bert.	*				*													
Navicula recens Lan.-Bert.	*																	
Navicula salinarum Grun.	*	*						*										
Navicula schroeterii Meist.				*				*										
Navicula subhamulata Grun. and Van Heur.								*										
Navicula suecorum var. *dismutica* (Hust.) Lan.-Bert.														*				
Navicula viridula var. *linearis* Hust.				*				*										
Navicula viridula var. *rostellata* (Kütz.) Cl.		*		*														
Navicula vitiosa Schim.	*																	
Neidium bisulcatum (Lager.) Cl.	*								*									
Neidium ladogensis (Cl.) Fog.	*																	
Nitzschia angustatula Lan.-Bert.	*																	
Nitzschia calida Grun.				*														
Nitzschia capitellata Hust.				*														
Nitzschia commutatoides Lan.-Bert.		*																
Nitzschia compressa (Bail.) Boy.	*																	

Taxon	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**O**	**P**	**R**	**S**	**T**
Nitzschia constricta (Kütz.) Ral.	*	*		*				*										
Nitzschia dissipata var. *media* (Hant.) Grun.			*															
Nitzschia filiformis var. *conferta* (Rich.) Lan.-Bert.		*																
Nitzschia flexa Schum.				*														
Nitzschia granulata Grun.	*																	
Nitzschia levidensis var. *salinarum* Grun.	*			*														
Nitzschia linearis var. *subtilis* (Grun.) Hust.								*										
Nitzschia linearis var. *tenuis* (W.Sm.) Grun.			*	*														
Nitzschia littoralis Grun.				*														
Nitzschia longissima var. *genuina* A. Cl.	*																	
Nitzschia lorenziana Grun.	*																	
Nitzschia navicularis (Breb.) Grun.	*																	
Nitzschia perspicua Choln.					*													
Nitzschia recta var. *robusta* Hust.				*														
Nitzschia scalpelliformis Grun.	*			*														
Nitzschia sigma (Kütz.) W.Sm.	*																	
Nitzschia sinuata var. *delognei* (Grun.) Lan.-Bert.				*				*					*					
Nitzschia sinuata var. *tabellaria* (Grun.) Grun.			*	*														
Nitzschia sociabilis Hust.				*														
Nitzschia vermicularis (Kütz.) Hant.			*	*				*										
Nitzschia wuellerstorffii Lan.-Bert.			*					*										
Pinnularia divergens W. Sm.	*		*															
Pinnularia microstauron var. *brebissonii* (Kütz.) May.				*														
Pinnularia rupestris Hant.	*				*	*			*									
Pinnularia subcapitata var. *hilseana* (Jan.) Müll.	*																	
Pinnularia sudetica (Hil.) Perag.													*					
Pleurosigma salinarum Grun.	*																	
Pleurosigma strigosum W. Sm.	*																	
Rhizosolenia eriensis H.L. Sm.		*																
Rhopalodia brebissonii Kramm.	*																	
Rhopalodia constricta (W. Sm.) Kramm.	*																	
Surirella brebissonii Kramm. and Lan.-Bert.	*	*		*				*										
Surirella constricta W. Sm.	*																	
Surirella striatula Turp.		*																
CHLOROPHYTA																		
CHLOROPHYCEAE																		
Elakatothrix biplex (Nyg.) Hind.					*													
Elakatothrix spirochroma (Rev.) Hind.					*													
Koliella crassa Hind.											*							
Koliella variabilis (Nyg.) Hind.											*							
Scenedesmus velitaris Kom.			*															
ZYGNEMATOPHYCEAE																		
Cosmarium pseudamoenum Will.						*												
Spondylosium pulchellum Arch.					*													
Spondylosium tetragonum W. We.					*													
Staurastrum chaetoceras (Schr.) Sm.			*															

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◀ **Legend: A – Dragonja River, B – Fiesa Lake, C – Koseški bajer Lake, D – Sotelsko Lake, E – Lovrenška Lakes bog, F – Šijec bog, G – Savica Waterfall, H – Krka Waterfall, I – small waterfall at Pohorje, J – spring at Medvedje Brdo, K – spring at Pohorje, L – thermal spring at Terme Čatež, M – Rimski vrelec mineral spring, O – stony wall, P – lime tree trunk, R – limestone rock, S – Krška jama cave, T – manure**

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