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Epiphytic diatoms of the Tisza River, Kisköre Reservoir and some oxbows of the Tisza River after the cyanide and heavy metal pollution in 2000

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The Tisza River is a large tributary of the Danube River. The largest reservoir of the river is the Kisköre reservoir, and there are furthermore a great number of oxbows in the vicinity of the river. In February and early spring 2000 serious amounts of cyanide and heavy metal pollution were spilled into the Tisza River. The Kisköre Reservoir of the Tisza was less polluted than the river itself. However, the four oxbows investigated were flooded by the Tisza River in April 2000. Epiphytic diatom samples were taken in February and October 2000 along the Tisza River, in November and December 2000 at the Kisköre Reservoir and in May and July 1996, October 2000 and June 2001 at the four Tisza oxbows. The aims of this study were to obtain preliminary data about the species composition of the attached diatoms of these waters, to evaluate the impact of the pollution on epiphytic diatoms and to evaluate the natural protection value of these waters. Epiphyton of the Tisza River was dominated by *Achnanthidium minutissimum*, *Amphora pediculus*, *Cocconeis placentula*, *Diatoma moniliformis* in February and by *Achnanthidium minutissimum* and several *Nitzschia* spp. in October. A number of teratological frustules were observed. In the Kisköre reservoir, *Amphora pediculus, Cocconeis pediculus, C. placentula*, *Cyclotella meneghiniana*, *Gomphonema angustum*, *Nitzschia dissipata* were dominant. In 1996 *Staurosira*, *Staurosirella* and *Navicula* species dominated in the oxbows, whereas in 2000 *Aulacoseira distans*, *Achanthidium minutissimum* and *Nitzschia* spp. became dominant. Based on results from the literature, we are of the opinion that the characteristic *Achnanthidium minutissimum* – *Nitzschia* spp. dominance of the Tisza River and the oxbows is partly due to the heavy metal pollution. A number of endangered species, two new elements for the Hungarian diatom flora – *Navicula austrocollegarum* and *Navicula streckerae* – and two probably invasive species, *Diadesmis confervacea* and *Didymosphenia geminata* were found.

Key words: Invasive species, diatoms, *Navicula austrocollegarum*, *Navicula streckerae, Diadesmis confervacea, Didymosphenia geminata,* pollution, community, tolerance, Tisza River, Hungary

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Introduction

The Tisza River is the second largest river in Hungary and one of the most important rivers in Central Europe (Fig. 1). The river is 964 km long, and its catchment area covers 157000 km^2. The water discharge and water level of this river are extremely changeable. Except for low water periods, the river has high suspended matter content and for that reason it was traditionally called »blond Tisza« in Hungary. In the nineteenth century, there was a major control (regulation) process of the Tisza. As a result of this, hundreds of little oxbows were left along the river. Most of these became real standing waters that are only connected to the river in times of major floods. Since the oxbows are relatively isolated in this way, it is to be expected that a unique diatom flora should breed there. The first dam on the Hungarian stretch was constructed in 1954 at Tiszalök. The second water barrage system with the Kisköre Reservoir (Fig. 1) was built between 1967 and 1973. This reservoir was built for a power station and as a source of water for irrigation. Beside these, it functions as an important bird refuge and nature protection area. The barrages, especially the large Kisköre Reservoir (127 km^2), have a vast effect on the whole ecosystem of the Tisza River. As a result of them, water velocity and suspended matter content decrease and transparency increases. This allows the potentially eutrophic water of the Tisza to become actually eutrophic. This eutrophication process occasionally leads to water blooms in the river, caused mostly by cyanobacteria. A remarkably large water bloom was observed in 1975, caused by *Anabenopsis raciborskii*, *Aphanizomenon flos-aquae* and *Microcystis aeruginosa* (HAMAR 1977).

Although the Tisza River is of primary importance to Hungary, its epiphytic diatom flora has not been thoroughly investigated before. Phytosestonic algae (phytoplankton and algae stirred up from the periphyton and benthos) were studied over a long period of time and summarised by UHERKOVICH (1971); later on, psammic diatoms were investigated by DOBLER and KOVÁCS (1981). Kisköre Reservoir has become an important, organic part of the Tisza River. Even so, it had never been investigated from an epiphytic algal point of view. prior to this study phytoplankton investigations were carried out by HAMAR (1976a, b, c).

In this project, we investigated the epiphytic diatom flora of the Tisza River, Kisköre Reservoir and four oxbows (Kacsa-tó, Marót-zugi-holt Tisza, Oláh-zugi-holt Tisza, Remete-zugi-holt Tisza) in the vicinity of the settlement of Balsa. Samplings were carried out twice along the Tisza River (February and October 2000), twice around the reservoir (November and December 2000) and four times at the four oxbows (May and July 1996, October 2000, June 2001). An unexpected environmental calamity has made this study of special interest.

The Tisza River was affected by a strong cyanide and heavy metal pollution event in February 2000 after the bursting of a cyanide-storing pond of a mine in the property of the Aurul company in the vicinity of Baia-Mare, Romania. The polluted water flowed into Lápos Stream then into the Szamos River and into the Tisza River. The pollution reached the country on 1st February with a maximum cyanide concentration value of 32.6 mg L^{-1} (in the River Szamos) and left it on February 12, with a concentration of 1.49 mg L^{-1}. The pollution also contained 1,95 mg L^{-1} zinc and 18 mg L^{-1} copper. As a protective arrangement, the reservoir had been locked and the water level of Kisköre Reservoir had already been raised before the pollution from the Tisza River reached it. As soon as the polluted water (of the Tisza River) arrived, the dam of the reservoir was opened. This way, the polluted

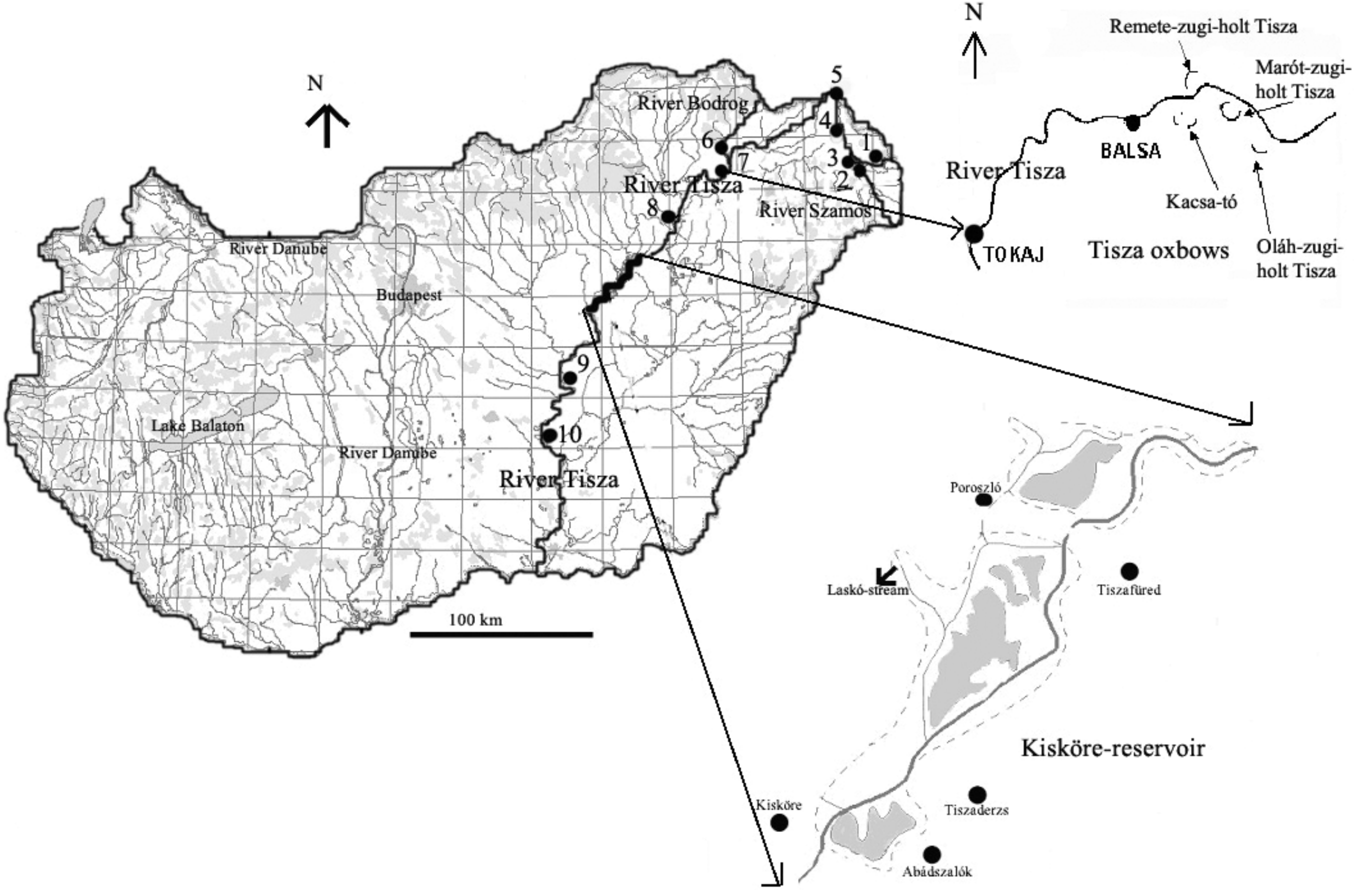

Fig. 1. Sketch map of Hungary, the Tisza River, Kisköre Reservoir and the four oxbows. Sampling sites: Tisza River: 1 – Tivadar, 3 – Gergelyiugornya, 4 – Aranyosapáti, 5 – Záhony, 7 – Tokaj, 8 – Tiszacsege, 9 – Szolnok, 10 – Tiszakécske; River Szamos: 2 – Gergelyiugornya; River Bodrog: 6 – Tokaj.

water was not only diluted by the reservoir's water, but it also flowed across the reservoir rather speedily. Thus the reservoir was nearly totally protected from the pollutants. Also, the oxbows Marót-zugi-holt Tisza, Oláh-zugi-holt Tisza, Kacsa-tó and Remete-zugi-holt Tisza in the vicinity of Balsa (Fig. 1) were saved this time from the pollutants, since these link up with the Tisza River only during major floods. Soon after the first pollution event, in early spring, several waves of heavy metal pollution – containing mainly lead, zinc and copper – were released into the Tisza river. Because of a big flood of the Tisza in April, the water of Kisköre Reservoir could only be partly protected from the pollution. This was of special concern, since – as mentioned above – the water reservoir is a bird refuge area of high priority. The flood in April 2000 rinsed out a large part of the pollutants from the Hungarian stretch of the Tisza, but even so, the pollution had partly settled into the river bed (SÁNDOR 2001). This flood also had an effect on the oxbows, since this time the Tisza River inundated them.

Water ecosystems all over the world are exposed to different pollutants, among them toxic chemicals. The exposure to toxins results in structural and functional changes of certain communities or in changes to the whole ecosystem (SCHINDLER 1987). Attached communities also respond to heavy metal stress on structural, functional and ecosystem levels, which can result in the decrease of algal biomass and diversity; species composition can change, carbon assimilation can decrease. We are also likely to be confronted with a destabilization process in the whole community, which can even cause water blooms (XU et al. 1999). Attached diatoms are ideal bioindicator organisms of heavy metal pollution because the species composition and relative dominance values of these diatom communities very probably change in response to heavy metal stress (IVORRA et al. 1999, CLEMENTS in NEWMAN et al. 1991). After long-term exposure to heavy metals, sensitive species tend to be replaced by tolerant ones, thus the benthos becomes more resistant against pollutants (SABATER et al. 1998). This phenomenon is also called *pollution induced community tolerance* (PICT) (SOLDO and BEHRA 2000). Another frequently observed stress reaction of diatoms is the formation of teratological frustules (cell wall ornamentation and frustule deformities) (DICKMAN 1998). A common reaction is the production of phytokelatins, too (AHNER et al. 1995a, b, SABATER 2000).

The aims of this study were to obtain preliminary data about the composition of the epiphytic diatom flora of the Hungarian stretch of the Tisza River, Kisköre Reservoir and some oxbows of the Tisza River. An important aspect of the survey was to evaluate the epiphytic diatoms of these waters from a biodiversity and nature protection perspective, and to explore the presence of Red List species – based on the German Red List. Furthermore, our intention was to assess the impact of the pollution on the attached diatoms of these waters. Since the epiphytic diatom flora of the oxbows had already been investigated by us prior to the pollution (in 1996), these data allowed us to compare the state of these waters before and after the calamity. Given the scarcity of information on the attached diatoms of the Tisza River and the reservoir before the pollution, the conclusions about the effects of the heavy metal load are largely based on comparisons with literature data reporting analogous situations. This approach might be a subject of debate; however, because of the almost utter lack of information about the attached diatom flora of these waters, we consider that the publication of our results serves a useful gap-filling function and is therefore of importance.

Tab. 1. Sampling points at the River Tisza, Kisköre reservoir and Tisza oxbows with the dates of samplings. Abbreviations of the names of the samples also given here. These abbreviations are used in the figures.

River Tisza and tributaries	February 2000	October 2000	**Kisköre reservoir and Laskó stream**	November 2000	December 2000	**Oxbows of River Tisza**	May 1996	July 1996	October 2000	June 2001
Tivadar		TI10	Laskó stream	L11	L12	Oláh-zugi-holt Tisza	O96M	O96J	O00O	O01J
Szamos	SA02	SA10	Laskó mouth	LM11	LM12	Marót-zugi-holt Tisza	M96M	M96J	M00O	M01J
Gergelyiugornya	GU02	GU10	Poroszló	P11	P12	Remete-zugi-holt Tisza	R96M	R96J	R00O	R01J
Aranyosapáti		AP10	Tiszafüred	TF11	TF12	Kacsa-tó	K96M	K96J	K00O	K01J
Záhony		ZA10	Tiszaderzs	TD11	TD12					
Bodrog	B02		Abádszalók	AS11	AS12					
Tokaj	T02	T10	Kisköre	KK11	KK12					
Tiszacsege	TC02									
Szolnok	SZ02									
Tiszakécske	TK02									

Material and methods

Epiphytic diatom samples were taken from the Tisza River in February at Gergelyiugornya, Tokaj, Szolnok, Tiszakécske, Tiszacsege, and in October 2000 at Tivadar, Gergelyiugornya, Aranyosapáti, Záhony and Tokaj (Fig. 1). In February, the Szamos River and the Bodrog, in October the Szamos River were also sampled. From the Kisköre reservoir, epiphytic diatom samples were taken in November and December 2000 at Abádszalók, Poroszló, Tiszafüred, Kisköre and Tiszaderzs. Samples were also taken from Laskó stream and from the Kisköre Reservoir close to the mouth of Laskó stream. The Tisza oxbows – named Oláh-zugi-holt Tisza, Marót-zugi-holt Tisza, Remete-zugi-holt Tisza and Kacsa-tó – in the vicinity of Balsa were sampled four times, in May and July 1996, in October 2000 and in June 2001. The samples were taken in five replicates from the surfaces of submerged plants (at Záhony sampling site, we could only take psammon samples). The samples were placed in plastic sample holders containing water of defined volume and fixed with Lugol's solution. The periphyton was scraped in the laboratory from the substrata. For the names of the sampling points, sampling data, as well as the abbreviations used here consult table 1.

Epiphytic diatom samples were treated with H_2O_2, cleaned with distilled water, partly mounted in Naphrax for light microscopy (LM) investigations and partly used for scanning electron microscopy (SEM) studies. 400 diatom valves were counted and identified in each sample, small species and centrics were identified under SEM. Nomenclature and identification is based on KRAMMER and LANGE-BERTALOT (1986, 1988, 1991a, 1991b). In the case of recently described or redefined taxa, more recent literature was applied (ROUND et al. 1990, BUKHTIYAROVA and ROUND 1996a, b, LANGE-BERTALOT and METZELTIN 1996, LANGE-BERTALOT et al. 1996, REICHARDT 1996, KRAMMER 1997a, b, METZELTIN and LANGE-BERTALOT 1998, LANGE-BERTALOT and GENKAL 1999, METZELTIN and LANGE-BERTALOT 2000, WITKOWSKI et al. 2000, LANGE-BERTALOT 2001, KRAMMER 2000, 2002, 2003). Relative abundance values were calculated. Species with more than 5 % relative abundance were regarded as dominant. Cluster analysis was carried out on the basis of non standard data using BRAY-CURTIS (CZEKANOWKSI 1909) index. For the assessment of the level of taxa frequency, the German Red List was used (LANGE-BERTALOT 1996). No Hungarian Algological Red List has yet been prepared. However, according to other authors (LANGE-BERTALOT 1999, DENYS 2000) and our experiences (SZABÓ et al. 2004b), the German Red List can be used reliably in our country.

Results

We found 133 Pennales and 12 Centrales species and varieties in the Tisza River, Szamos River and Bodrog River (Tab. 2). In February 2000, the dominant species were *Achnanthidium minutissimum, Amphora montana, A. pediculus, Cocconeis placentula, C. pediculus, Diatoma moniliformis, Eolimna minima, Fragilaria capucina, Navicula lanceolata, N. tripunctata, Nitzschia dissipata, Planothidium lanceolatum, Rhoicosphenia abbreviata* (Fig. 2). In the Szamos River, only two living cells were present in our sample.

In October, the composition of epiphytic diatoms was different. *Achnanthidium minutissimum* had assumed an overwhelming dominance in two samples, and furthermore several *Nitzschia* species, such as *Nitzschia amphibia, N. closterium, N. communis, N. gracilis, N. linearis* were strongly dominant, too (Fig. 3).

The ratio of *Achnanthidium minutissimum* was between 7 and 21 % in February. The percentage value of this species ranged between 2 and 58 in October, with the maximum value at Tivadar and a very high value at Gergelyiugornya (Fig. 4).

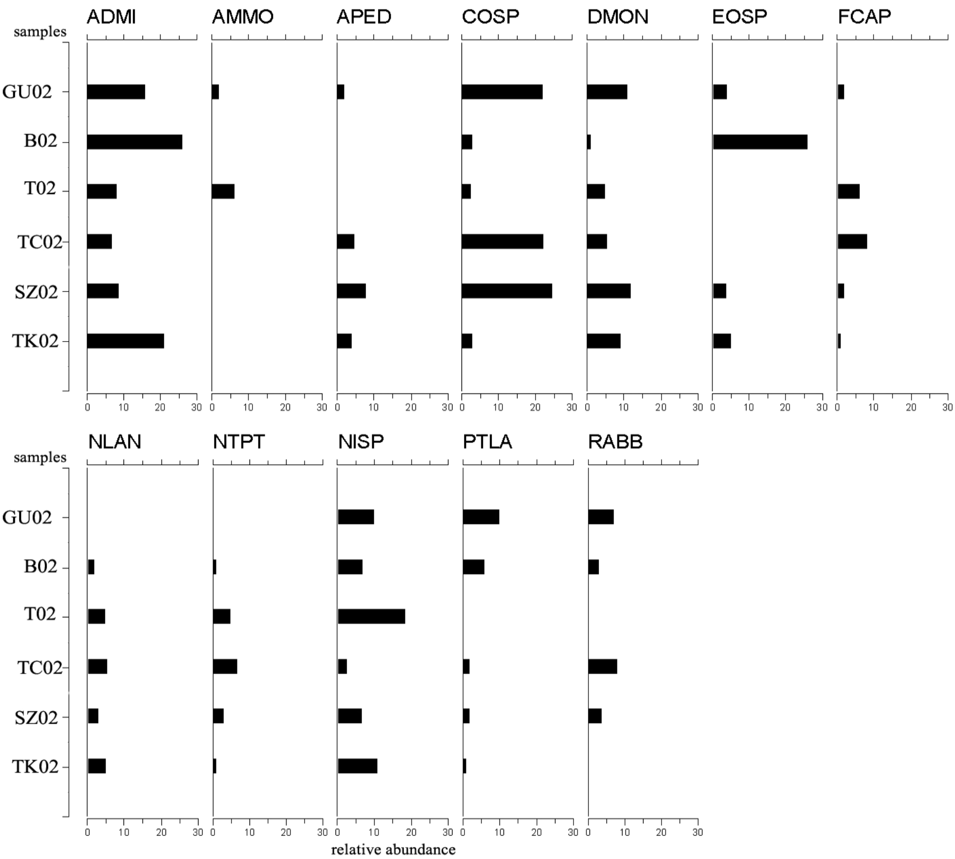

Fig. 2. Dominant species in the Tisza in February 2000. List of abbreviations of taxa names: *Aulacoseira distans* AUDI, Centrales spp. CENT, *Cyclotella meneghinana* CMEN, *Melosira varians* MVAR, *Stephanodiscus minutulus* STMI, *Stephanodiscus* spp. STSP, *Thalassiosira pseudonana* TPSN, *Achnanthidium minutissimum* ADMI, *Amphipleura pellucida* APEL, *Amphora montana* AMMO, *Amphora pediculus* APED, *Bacillaria paradoxa* BPAR, *Cocconeis pediculus* CPED, *Cocconeis placentula* CPLA, *Cocconeis* spp. COSP, *Diadesmis confervacea* DCOF, *Diatoma moniliformis* DMON, *Eolimna minima* EOMI, *Eolimna* spp. EOSP, *Epithemia adnata* EADN, *Fragilaria rumpens* FRUM, *Fragilaria capucina* FCAP, *Gomphonema angustum* GANT, *Gomphonema parvulum* GPAR, *Gyrosigma acuminatum* GYAC, *Hippodonta capitata* HCAP, *Navicula austrocollegarum* NAUS, *Navicula capitatoradiata* NCPR, *Navicula cincta* NCIN, *Navicula cryptocephala* NCRY, *Navicula cryptotenella* NCTE, *Navicula gregaria* NGRE, *Navicula lanceolata* NLAN, *Navicula streckerae* NSTR, *Navicula tripunctata* NTPT, *Navicula viridula* NVIR, *Navicula trivialis* NTRV, *Nitzschia* spp. NISP, *Pinnularia interrupta* PINT, *Planothidium lanceolatum* PTLA, *Rhoicosphenia abbreviata* RABB, *Staurosira construens* f. *subsalina* FCSS, *Staurosira venter* SCVT, *Staurosirella pinnata* FPIN.

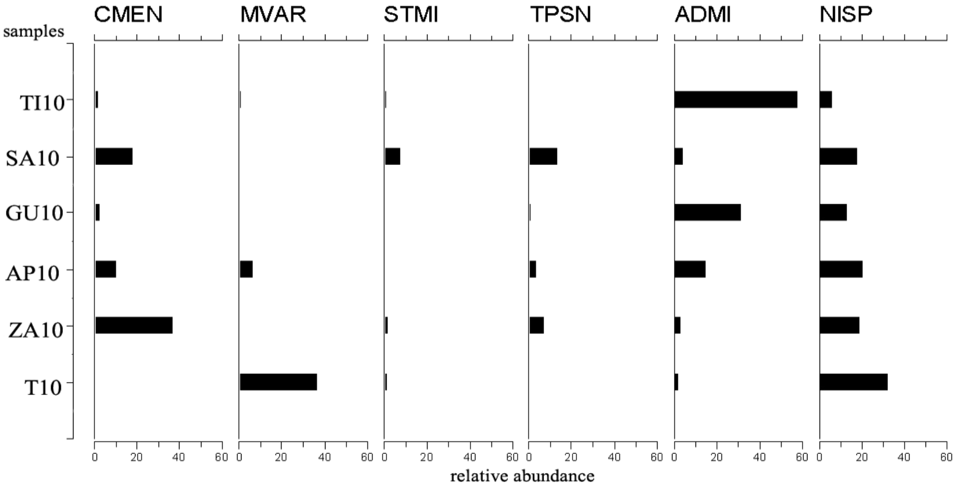

Fig. 3. Dominant species in the Tisza in October 2000. For abbreviations of taxa names, see Figure 1.

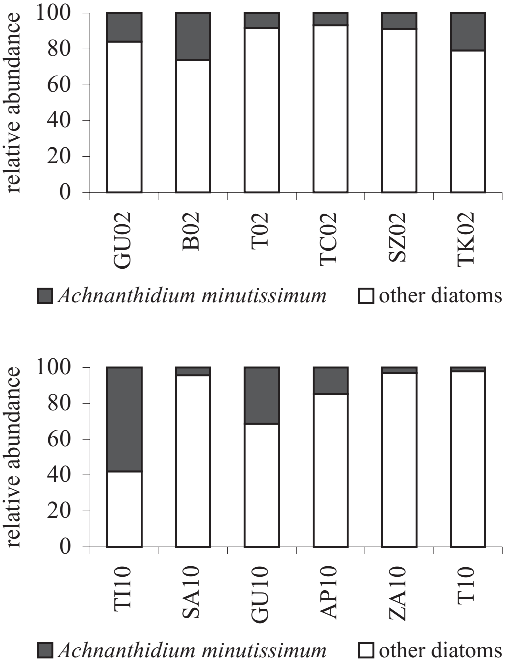

Fig. 4. Relative abundance ratio of *Achnanthidium minutissimum* in Tisza River.

The ratio of *Achnanthidium minutissimum* decreased along the river. The invasive species, *Didymosphenia geminata* (Morphotyp *geminata* and Morphotyp *capitata* sensu METZELTIN and LANGE-BERTALOT 1995) was also found (Fig. 5).

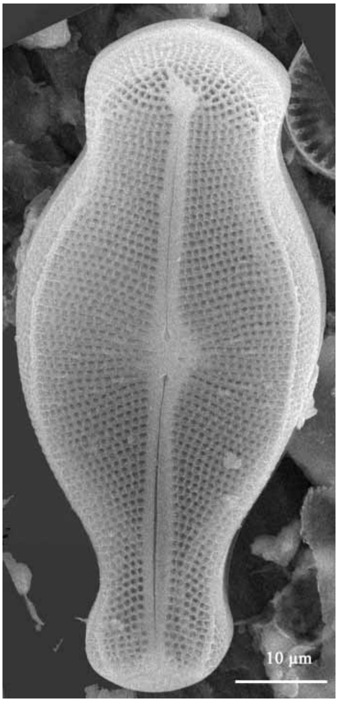

Fig. 5. Scanning electron micrograph of *Didymosphenia geminata*.

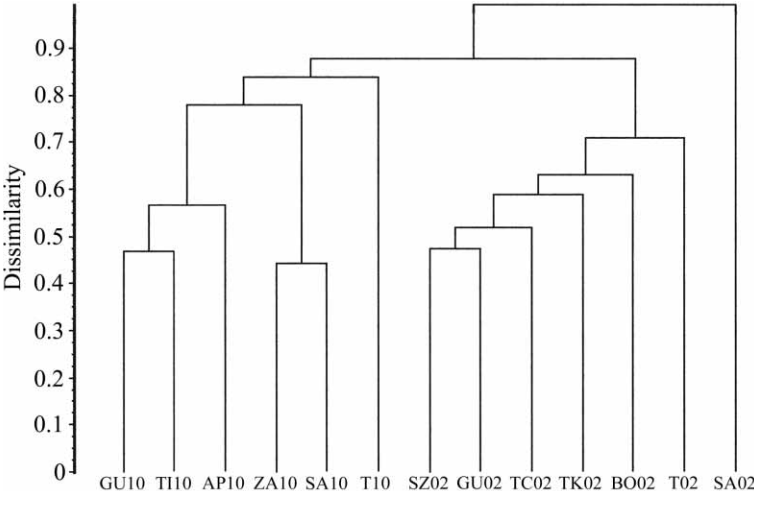

Fig. 6. BRAY-CURTIS dendrogram of Tisza River samples. For abbreviations see Tab. 1.

On the basis of BRAY-CURTIS dendrograms, our samples showed a marked difference between February and October (Fig. 6). We were able to distinguish between three groups. The samples from October were separated from the samples of February. The sample from

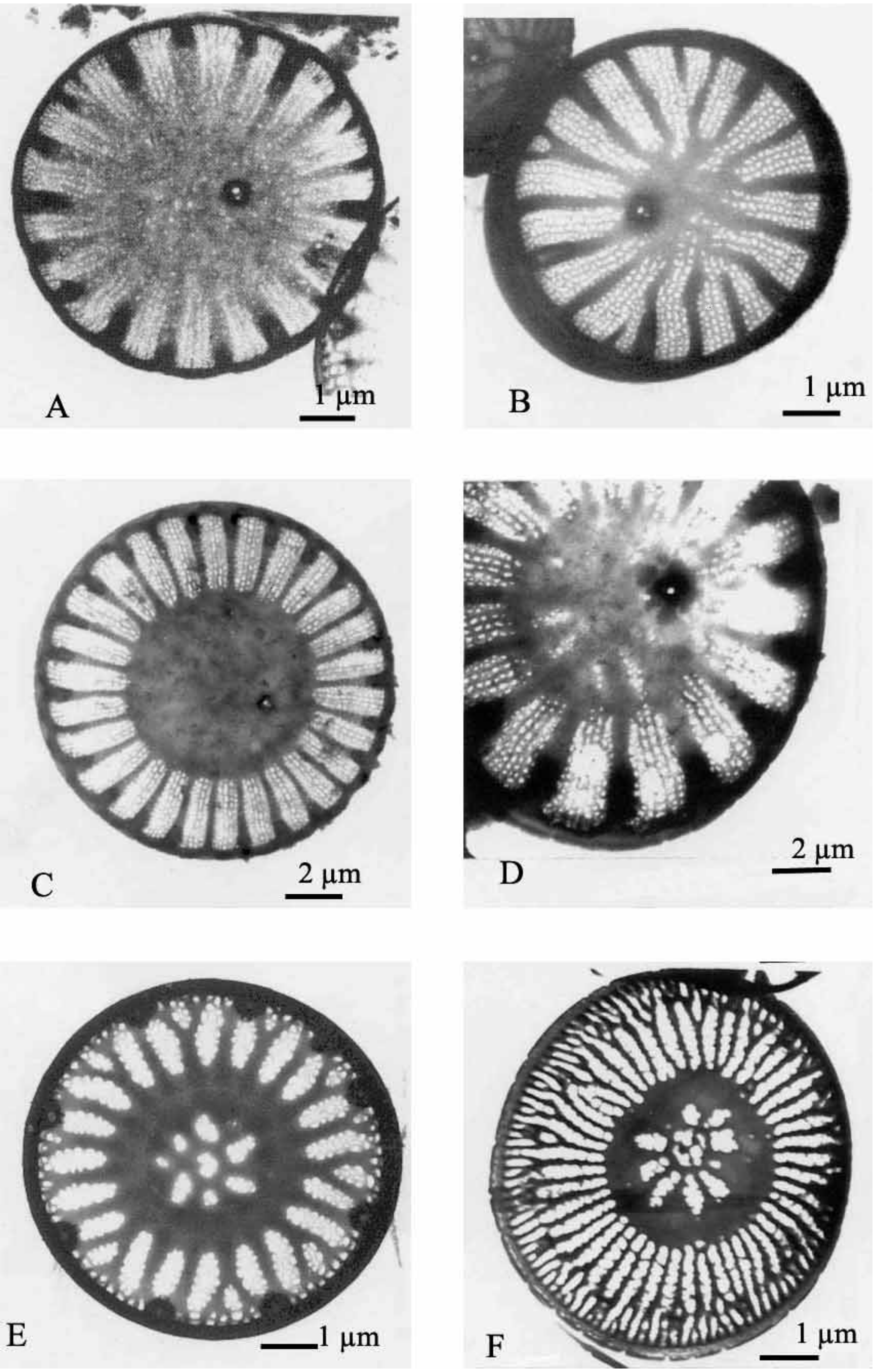

Fig. 7. Teratological valves of the species *Cyclotella atomus* (A, B), *C. meneghiniana* (C, D), *C. pseudostelligera* (E, F). Normal valves are on the left (A, C, E), teratological ones on the right (B, D, F) side.

the River Szamos in February differed from the others. We found several teratological frustules of the centric species *Cyclotella atomus*, *C. meneghiniana* and *C. pseudostelligera* (Fig. 7). Several Red List species also occurred in these samples, such as *Cymbella lanceolata*, *Gomphonema angustum*, *Gyrosigma acuminatum*, *Navicula menisculus*, *N. meniscus*, *N. placentula*, *Neidium ampliatum*, *Nitzschia sinuata*, *Surirella bifrons*, *S. tenera* (decreasing stock), *Fragilaria biceps*, *Gomphonema tergestinum* (probably endangered), *Gomphonema pseudotenellum* (endangered).

In the Kisköre Reservoir and Laskó stream, 21 Centrales and 152 Pennales species and varieties were found (Tab. 3). The species composition was very variable from place to place. Strongly dominant species were *Amphora pediculus, Cocconeis pediculus, C. placentula, Cyclotella meneghiniana, Diadesmis confervacea, Gomphonema angustum, Navicula cincta*, *Nitzschia dissipata, N. recta* (Fig. 8, 9).

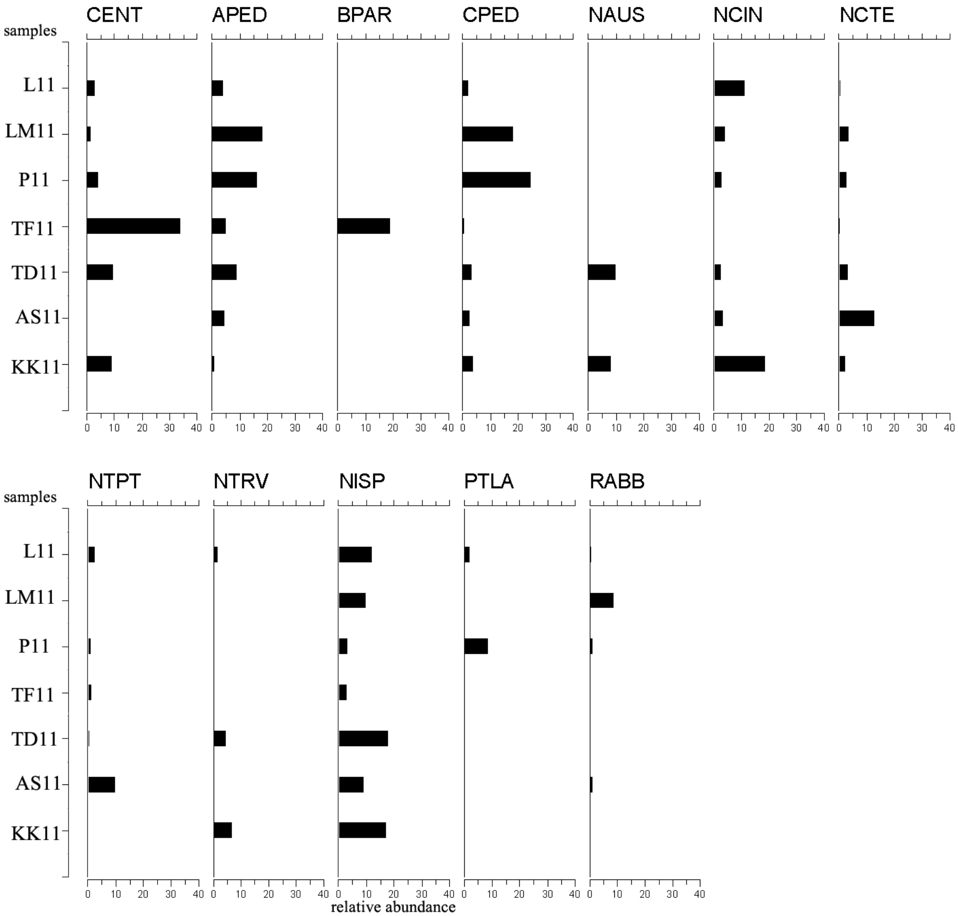

Fig. 8. Dominant species in Kisköre Reservoir in November 2000. For abbreviations of taxa names, see Figure 1. Y axis stands for sampling points; for the correct order, see Table 1.

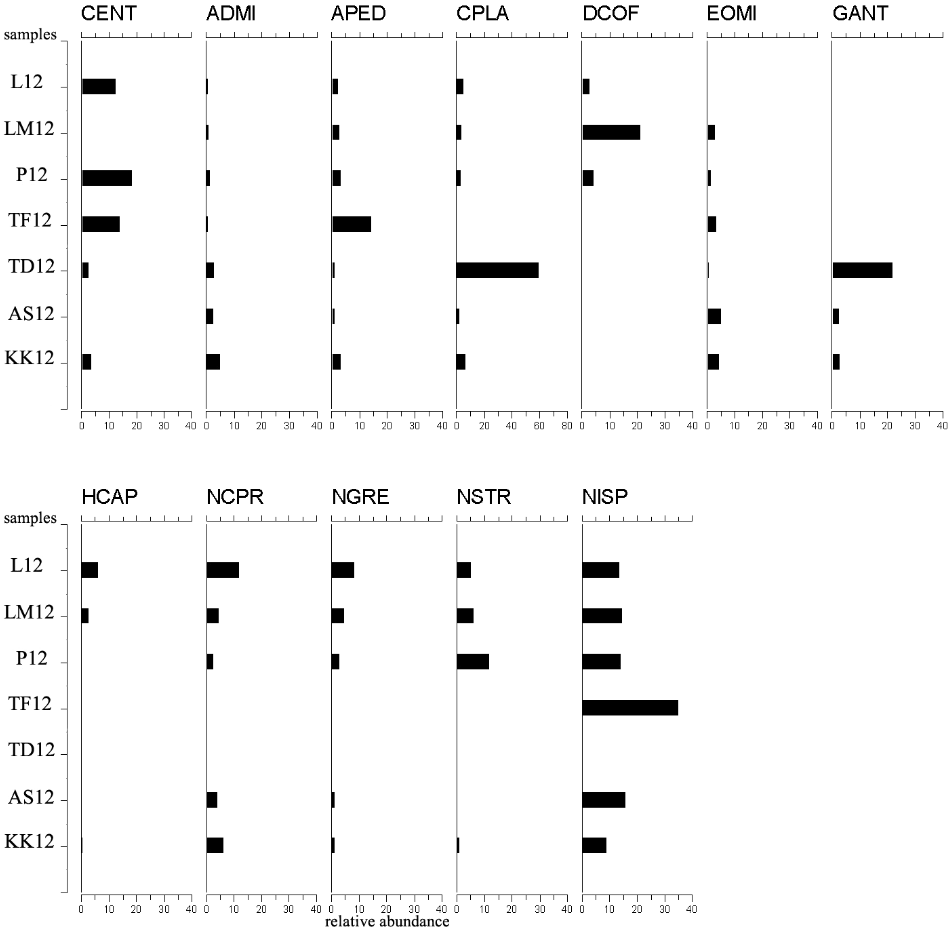

Fig. 9. Dominant species in Kisköre Reservoir in December 2000. For abbreviations of taxa names, see Figure 1.

The invasive species *Diadesmis confervacea* was found for the second time in Hungary (Fig. 10). We also found two new species for the Hungarian diatom flora: the species *Navicula streckerae* (Fig. 11) and *Navicula austrocollegarum.*

The ratio of *Achnanthidium minutissimum* was quite low in these samples, ranging from 0 to 5 % (Fig. 12). Bray-Curtis similarity grouped the samples mainly on the basis of sampling time (Fig. 13). Thus, the samples Kisköre, Poroszló, Laskó-stream and Laskó-mouth from November accounted for one group, while the samples from the same sampling points but collected in December made up another, distinct group. The samples from Abádszalók and Tiszafüred differed from the rest of the samples. A number of Red List species were found: *Caloneis schumanniana*, *Cymbella helvetica*, *C. lanceolata*, *Encyonema neomesianum, Eunotia formica*, *Gomphonema angustum*, *Gyrosigma acuminatum*, *Navicula gastrum*, *N. menisculus*, *Pinnularia microstauron* (decreasing stock), *Gyrosigma parkerii*, *Hippodonta lueneburgiensis*, *Navicula constans*, *Nitzschia subacicularis*, *Suri-*

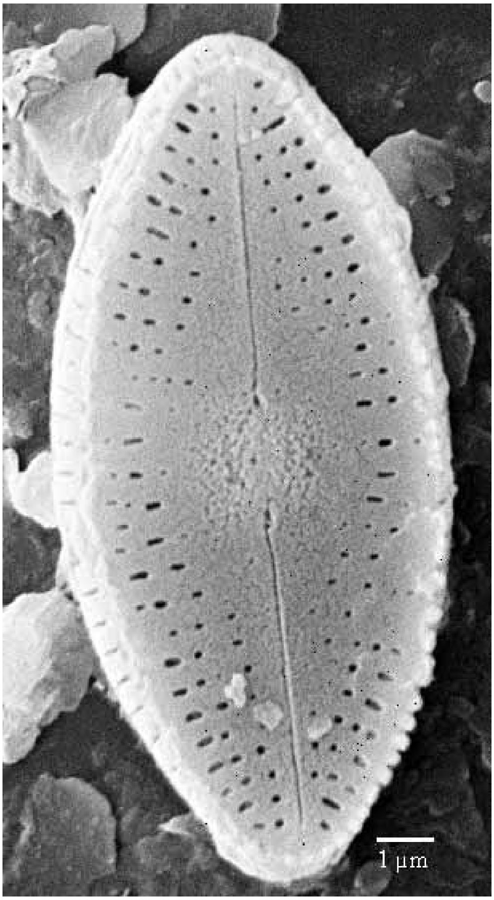

Fig. 10. Scanning electron micrograph of *Diadesmis confervacea*.

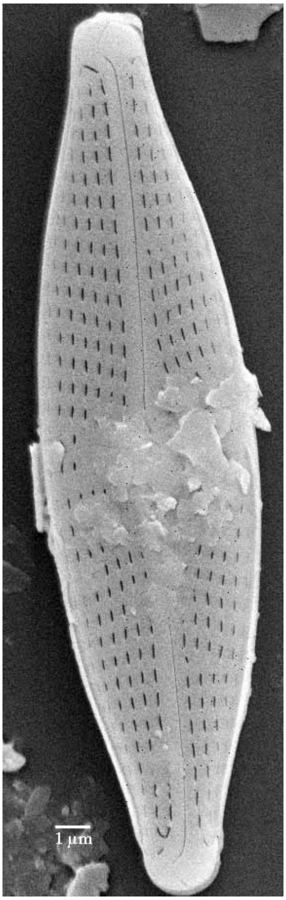

Fig. 11. Scanning electron micrograph of *Navicula streckerae*.

rella tenuis (very rare), *Aulacoseira distans* (probably endangered), *Amphora inariensis*, *Navicula angusta*, *N. stroemii* (endangered), *Navicula pusio* (almost extinct).

In the Tisza oxbows 20 Centrales and 168 Pennales species and varieties were found (Tab. 4). The species composition of the oxbows differed considerably in 1996 from that of the samples in 2000 and 2001 (Fig. 14, 15, 16, 17), as was also clearly shown by BRAY-CURTIS diagram (Fig. 18). In 1996, *Staurosira*, *Staurosirella* and *Navicula* species dominated primarily. After the flood in 2000, *Achnanthidium minutissimum* (Fig. 19) and several *Nitzschia* species became dominant.

Several Red List species were also observed here. These included *Caloneis schumanniana*, *Cymbella tumidula*, *Cymbella neocistula*, *C. helvetica*, *Eunotia pectinalis*, *Fragilaria delicatissima*, *Navicula menisculus*, *Neidium ampliatum*, *Nitzschia sinuata*, *Pinnularia microstauron* (decreasing stock), *Nitzschia hustedti*, *N. pumila*, *N. subacicularis*, *Pinnularia cuneola* (very rare), *Navicula angusta* (endangered).

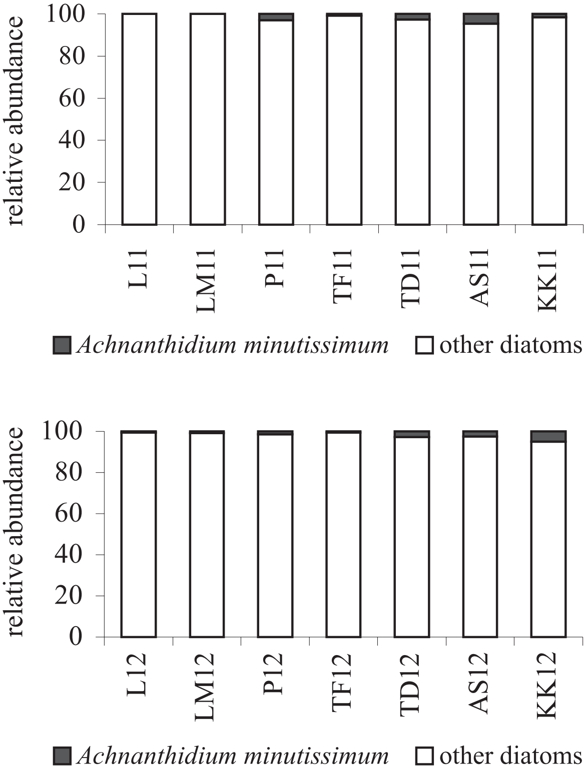

Fig. 12. Relative abundance ratio of *Achnanthidium minutissimum* in Kisköre reservoir.

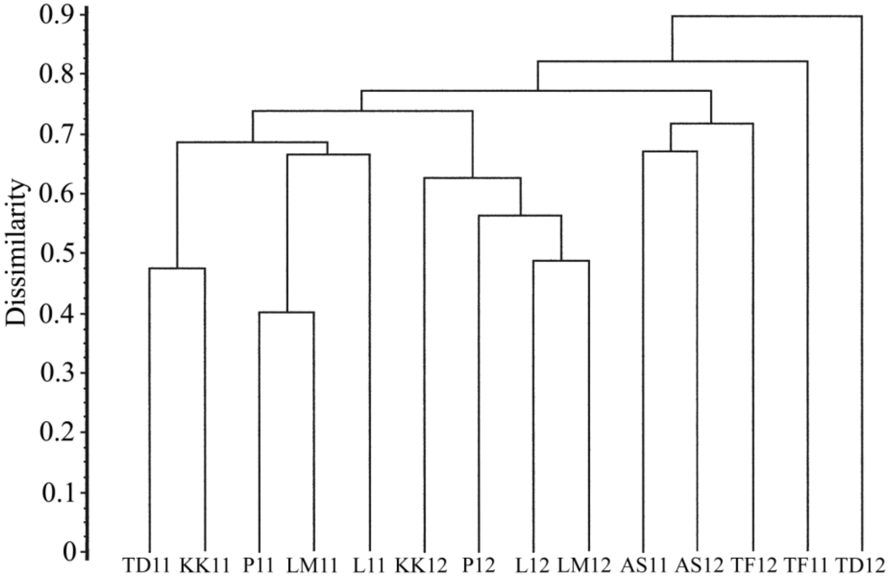

Fig. 13. Bray-Curtis dendrogram of Kisköre reservoir. For abbreviations see Table 1.

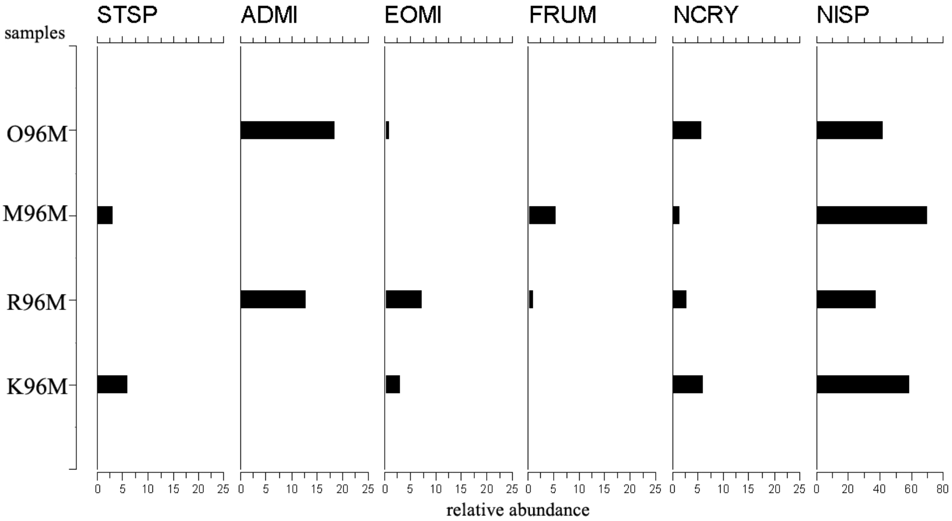

Fig. 14. Dominant species in the oxbows in May 1996. For abbreviations of taxa names see Figure 1. Y axis stands for sampling points; for the correct order, see Table 1.

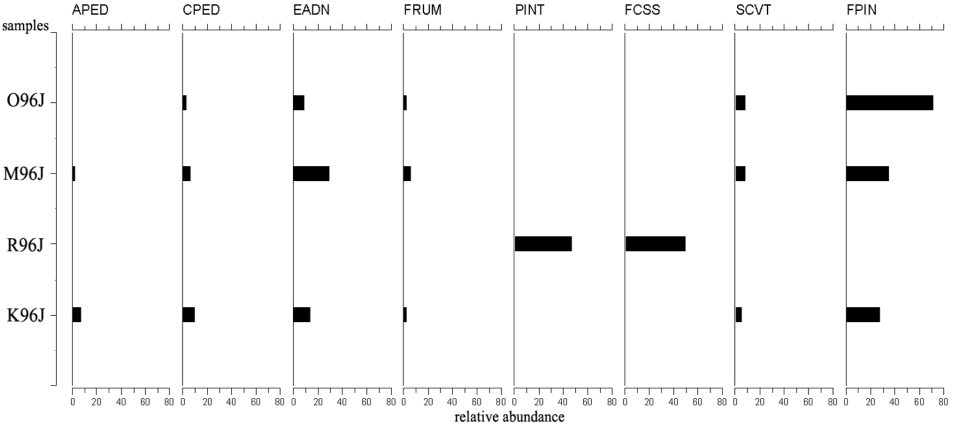

Fig. 15. Dominant species in the oxbows in July 1996. For abbreviations of taxa names see Figure 1.

Discussion

Preliminary data about the epiphytic diatom composition of the Tisza River, Kisköre Reservoir and four Tisza oxbows have been provided by this study. Since the investigated waters had partly been affected by several major heavy metal pollutions prior to sampling, it should be assumed that these had a strong effect on the attached diatom composition. As far as comparisons – based on diatom literature – have made it possible, we have tried to consider this impact critically. Periphytic diatoms are considered as good indicators of heavy metal pollution, because their species composition and the relative abundance ratios are very likely to suffer changes following heavy metal pollutions (IVORRA et al. 1999,

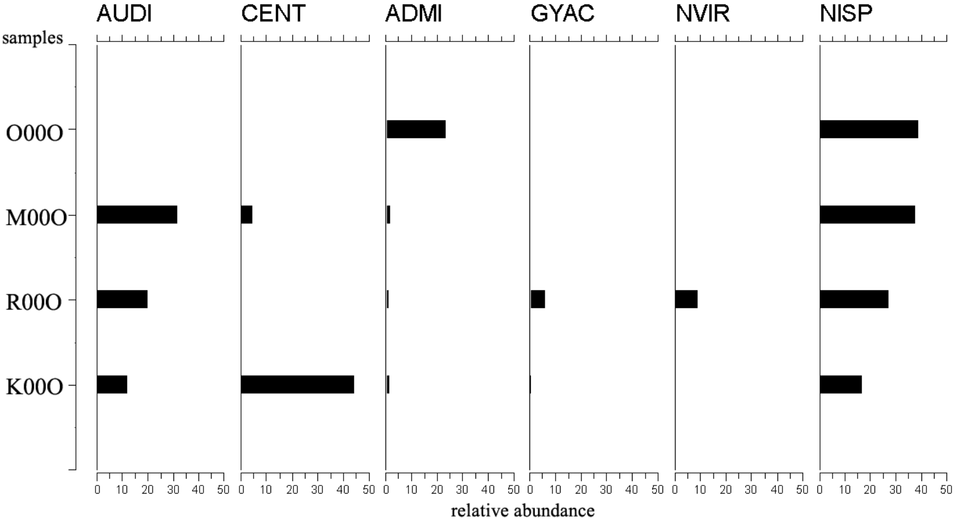

Fig. 16. Dominant species in the oxbows in October 2000. For abbreviations of taxa names see Figure 1.

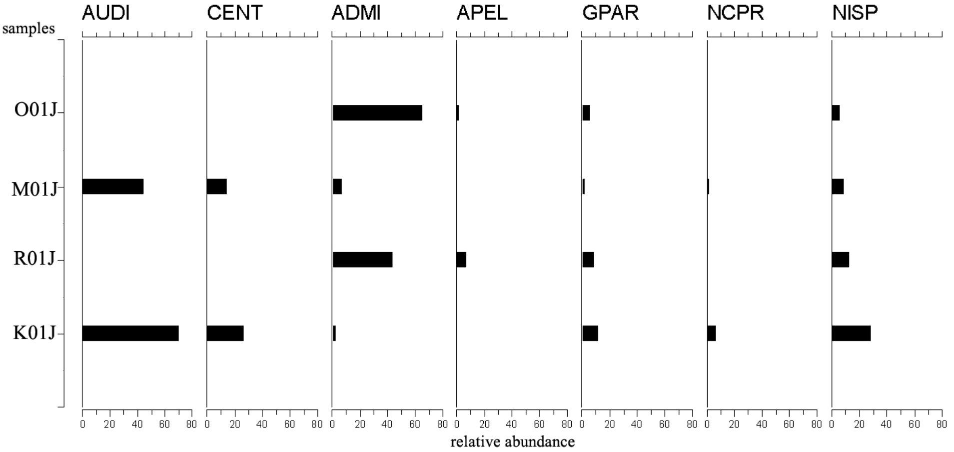

Fig. 17. Dominant species in the oxbows in June 2001. For abbreviations of taxa names see Figure 1.

CLEMENTS in NEWMAN et al. 1991). Moreover, on a long time scale, sensitive species tend to be replaced by tolerant ones, thus forming a tolerant community. This phenomenon is also known as *pollution induced community tolerance* (SOLDO and BEHRA 2000). *Achnanthidium minutissimum*, *Eolimna minima, Gomphonema parvulum* and *Nitzschia palea* are considered to be species that are fairly tolerant to heavy metals (SABATER et al. 1998, IVORRA et al. 1999, SOLDO and BEHRA 2000). These data from the literature seem to be well in accordance with our own findings.

Epiphytic diatom flora of the Tisza River was poor in species number in February, after the pollution, and was composed mainly of shearing-stress tolerant species such as *Cocconeis* spp. and *Rhoicosphenia abbreviata*. This first pollution consisted mainly of cya-

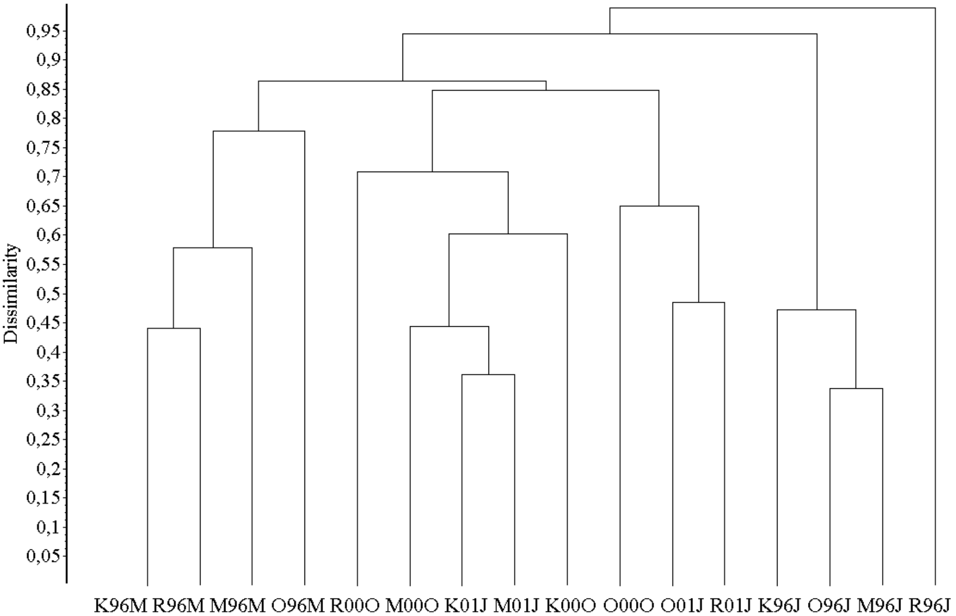

Fig. 18. Bray-Curtis dendrogram of the oxbows. For abbreviations see Table 1.

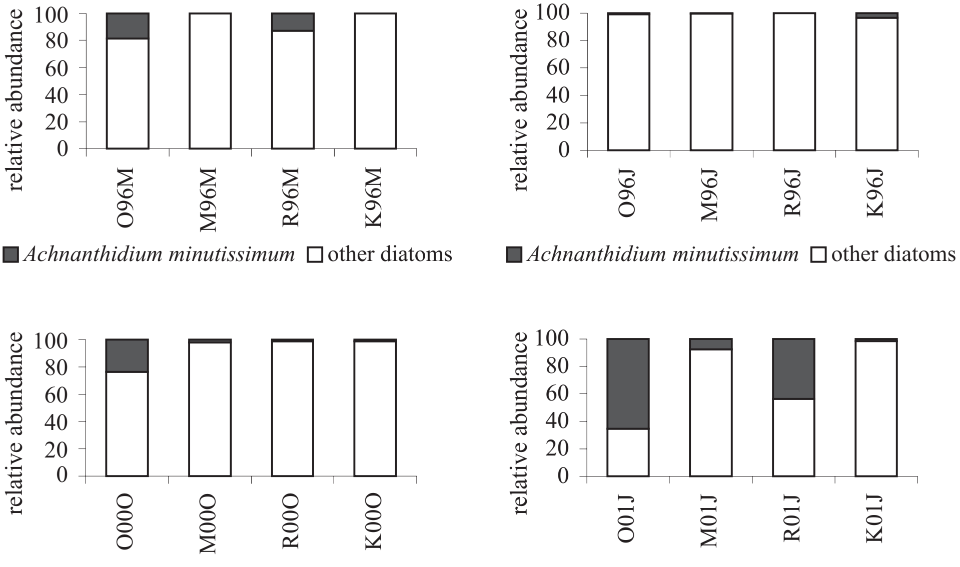

Fig. 19. Relative abundance ratio of *Achnanthidium minutissimum* in the oxbows.

nide and since most photosynthethic organisms – and thus also algae – have a cyanide-resistant respiratory pathway (ERIKSEN and LEWITUS 1999), this accounted for their survival in the periphyton. The low species numbers can be explained by two circumstances: there

Tab. 2. Relative abundance of diatoms found in Tisza River (and Szamos River, Bodrog River) in February and October 2000.

	SA02	GU02	B02	T02	TC02	SZ02	TK02	TI10	SA10	GU10	AP10	ZA10	T10
Cyclotella atomus Hust.									4.55	0.24	1.72		
Cyclotella atomus var. *gracilis* Genkal et Kiss											0.38		
Cyclotella meduane Germain								0.48		0.24			
Cyclotella meneghiniana Kütz.								1.68	17.68	2.40	10.11	36.93	
Cyclotella pseudostelligera Hust.									4.04		0.38	0.53	0.15
Melosira varians Agardh								0.96			6.30		36.60
Stephanodiscus delicatus Genkal									1.01			0.53	
Stephanodiscus invisitatus Hohn et Hellermann									0.51				
Stephanodiscus minutulus (Kütz.) Cleve et Möller								0.72	7.58		0.57	1.84	1.38
Thalassiosira guillardii Hasle												0.53	
Thalassiosira pseudonana Hasle et Heimdal									13.64	0.72	3.44	7.10	0.61
Thalassiosira weissflogii (Grun.) Fryxwll et Hasle									0.51	0.24	0.76		
Achnanthes biasolettiana Grun.								0.24					
Achnanthes exigua Grun. in Cleve et Grun.					2.73								
Achnanthidium minutissimum Kütz. (*Achnanthes minutissima* Kütz.)		16.00	26.00	8.16	6.76	8.82	21.00	57.93	4.42	31.25	14.89	3.02	2.30
Amphora montana Krasske		2.00		6.12					0.38	0.24		0.13	
Amphora ovalis (Kütz.) Kütz.								0.24					
Amphora pediculus (Kütz) Grun.		2.00			4.55	7.84	4.00			0.96	0.19	0.26	1.07
Amphora veneta Kütz.		1.00				3.92							
Asterionella formosa Hassall									2.53		0.38	0.13	
Caloneis amphisbaena (Bory) Cleve												0.13	
Caloneis bacillum (Grun.) Cleve									0.13	0.24	0.38		1.99
Cocconeis pediculus Ehrbg.		17.00			4.55	5.88				0.24		0.13	0.31
Cocconeis placentula Ehrbg.		5.00	3.00	2.48	17.57	18.63	3.00	0.24	0.25	2.16	0.38		
Craticula cuspidata Kütz. (Mann) (*Navicula cuspidata* Kütz.)											0.13		

Tab. 2. – continued

	SA02	GU02	B02	T02	TC02	SZ02	TK02	TI10	SA10	GU10	AP10	ZA10	T10
Cymatopleura solea (Bréb.) W. Smith										0.24		0.26	
Cymbella affinis Kütz.					1.35		2.00	1.20			0.19	0.13	
Cymbella lanceolata Krammer								0.24					0.15
Cymbella tumida (Bréb.) Van Heurck								0.48		0.24	0.19		0.15
Diatoma moniliformis Kütz.		11.00	1.00	4.82	5.45	11.76	9.00	2.16	0.13	2.40	0.95		0.15
Diatoma vulgare Bory						1.97	2.00	0.72		1.68		0.13	
Didymosphenia geminata (Lyngbye) W.M.Schmidt							1.00			0.24			
Encyonema caespitosum Kütz. (*Cymbella caespitosa* (Kütz.) Brun.)								1.92		0.72	0.38		0.31
Encyonema caespitosum Kütz. (*Cymbella prostrata* (Berkeley) Grun.)										0.48	0.38		
Encyonema minutum (Hilse in Rabenh.) Mann (*Cymbella minuta* Hilse ex Rabenh.)			2.00						0.19				
Encyonema silesiacum (Bleisch in Rabenh.) Mann (*Cymbella silesiaca* Bleisch in Rabenh.)	3.00		4.00		2.48	2.73	0.72		2.40	0.95	0.39		
Encyonopsis microcephala (Grun.) Krammer (*Cymbella microcephala* Grun.)							3.37	0.13	1.44	0.95			0.31
Eolimna minima (Grun.) Lange-Bert. (*Navicula minima* Grun.)		4.00	26.00			2.94			0.63	0.24	1.53		4.90
Eolimna subminuscula (Manguin) Lange-Bert. et Schiller (*Navicula subminuscula* Manguin)	0.98		5.00	0.76				1.15					0.15
Epithemia adnata (Kütz.) Bréb.								1.44		0.48			0.61
Epithemia sorex Kütz.						0.98							
Fistulifera saprophila (Lange-Bert. et Bonik) Lange-Bert. (*Navicula saprophila* Lange-Bert.)	1.00												
Fragilaria biceps (Kütz.) Lange-Bert.								0.24			0.00		
Fragilaria capucina Desmazieres		2.00		6.12	8.18	1.97	1.00			2.88	0.95		
Fragilaria capucina var. *gracile* (Oestrup) Hust.								4.33		1.68	0.95	0.26	

Tab. 2. – continued

	SA02	GU02	B02	T02	TC02	SZ02	TK02	TI10	SA10	GU10	AP10	ZA10	T10
Fragilaria capucina var. *perminuta* (Grun.) Lange-Bert.								0.48			0.19	0.00	
Fragilaria capucina var. *vaucheriae* (Kütz.) Lange-Bert.								0.24			0.38	0.13	0.31
Fragilaria fasciculata (Agardh) Lange-Bert.													0.15
Fragilaria sp.													0.31
Fragilaria ulna (Nitzsch) Lange-Bert.				1.25		0.98	3.00	0.24	0.13		0.38		0.15
Fragilaria ulna (Nitzsch) Lange-Bert. f. *acus*								0.24		0.48		0.13	
Frustulia rhomboides (Ehrbg.) De Toni										0.24			
Frustulia vulgaris (Thwaites) De Toni			5.00	4.82	2.73								
Gomphonema angustum Agardh					2.73								
Gomphonema augur Ehrbg.													
Gomphonema clavatum Ehrbg.						0.98				0.24			
Gomphonema gracile Ehrbg.					1.35			0.24					
Gomphonema minutum Agardh				2.48		1.97	1.00	0.72			0.76		0.15
Gomphonema olivaceum (Hornemann) Bréb.		3.00	3.00			0.98	1.00	0.48		0.48			0.00
Gomphonema parvulum (Kütz.) Kütz.		1.00	3.00			0.98	6.00	0.48	0.51	0.72	0.19	0.26	0.46
Gomphonema pseudotenellum Lange-Bert.										0.24			
Gomphonema sp.									0.13	0.72	0.57	0.13	0.46
Gomphonema tergestinum (Grun.) Fricke									0.13	0.24			
Gyrosigma acuminatum (Kütz.) Rabenh.					1.35					1.20			
Gyrosigma scalproides (Rabenh.) Cleve										0.48	0.95		
Hannea arcus (Ehrbg.) Patrick (*Fragilaria arcus* (Ehrbg.) Cleve)				4.82			2.00	0.24			0.19		
Hippodonta capitata (Ehrbg.) Lange-Bert., Metz. et Witk. (*Navicula capitata* Ehrbg.)			1.00								0.13		
Karayevia ploenensis (Hust.) Round et Bukht. (*Achnanthes ploenensis* Hust.)	1.00			0.98									
Luticola mutica (Kütz.) Mann (*Navicula mutica* Kütz.)													0.15

Tab. 2. – continued

	SA02	GU02	B02	T02	TC02	SZ02	TK02	TI10	SA10	GU10	AP10	ZA10	T10
Mayamea atomus (Kütz.) Lange-Bert. (*Navicula atomus* (Kütz.) Grun.)									0.13		0.19		0.15
Navicula bacillum Ehrbg.										0.24			
Navicula capitatoradiata Germain		1.00		1.25			3.00	1.44	0.13	1.20	0.76		0.15
Navicula cincta (Ehrbg.) Ralfs										0.48			
Navicula cryptocephala Kütz.							1.00	0.24					
Navicula cryptotenella Lange-Bert.				4.82				0.48	0.13		2.86		0.77
Navicula goeppertinata (Bleisch) H. L. Smith										0.24			0.15
Navicula gregaria Donkin									0.51			0.13	0.15
Navicula lanceolata (Agardh) Kütz.			2.00	4.82	5.45	2.94	5.00		0.13	0.48	0.19		0.31
Navicula menisculus Schumann			3.00		1.35				0.13	0.24		0.13	0.77
Navicula meniscus Schumann									0.13				
Navicula phyllepta Kütz.										1.44	1.15		0.15
Navicula placentula (Ehrbg.) Grun.										0.24			
Navicula pupula Kütz.								0.24		0.48		0.13	
Fallacia pygmea (Kütz.) Stickle et Mann (*Navicula pygmea* Kütz.)									0.13				
Navicula recens (Lange-Bert.) Lange-Bert.			2.00			1.97							
Navicula reichardtiana Lange-Bert.			2.00		1.35								
Navicula schroeterii Meister									0.25				0.77
Navicula sp.									0.13				0.15
Navicula subhamulata Grun.											0.38		0.15
Navicula subrotundata Hust.											0.38		0.31
Navicula subtilissima Cleve								0.24	0.13	0.48	0.19	0.13	0.31
Navicula tenelloides Hust.									0.51		0.38	0.00	
Navicula tripunctata (O. Müller) Bory		1.00	1.00	4.82	6.76	2.94	1.00	0.24	0.76	1.20	0.19	1.05	0.92
Navicula trivialis Lange-Bert.											0.19		
Navicula veneta Kütz.												0.13	

Tab. 2. – continued

	SA02	GU02	B02	T02	TC02	SZ02	TK02	TI10	SA10	GU10	AP10	ZA10	T10
Navicula viridula (Kütz.) Ehrbg.									2.90		0.19	3.29	0.31
Neidium ampliatum (Ehrbg.) Krammer									1.52	0.48	3.24	1.05	
Neidium dubium (Ehrbg.) Cleve									0.25				0.61
Nitzschia acicularis (Kütz.) W. Smith	1.00								0.13				
Nitzschia acidoclinata Lange-Bert.				4.82									
Nitzschia aequorea Hust.												0.13	
Nitzschia amphibia Grun.								2.16	10.73	2.16	3.44	16.29	0.61
Nitzschia angustatula Lange-Bert.									1.77			0.79	
Nitzschia calida Grun.								1.44			0.19	0.53	0.92
Nitzschia capitellata Hust.				6.12			2.00			0.48		0.39	
Nitzschia clausii Hantzsch			2.00										
Nitzschia closterium (Ehrbg.) W. Smith								3.37	1.01	9.13	15.84	0.92	0.92
Nitzschia communis Rabenh.													23.74
Nitzschia constricta (Gregory) Grun.			1.00					0.96		0.72	1.72	0.53	1.23
Nitzschia dissipata (Kütz.) Grun.		9.00	5.00	12.24	2.73	2.94	4.00				0.19		
Nitzschia filiformis (W. Smith) Van Heurck									1.14	2.40	0.57	3.68	
Nitzschia fonticola Grun. in Cleve et Möller			1.00				1.00		0.88	0.96	0.95	2.76	
Nitzschia frustulum (Kütz.) Grun.										0.48	0.95	0.26	
Nitzschia graciliformis Lange-Bert. et Sim.									2.53	0.24	3.05	0.13	0.31
Nitzschia gracilis Hantzsch								0.48	6.19		0.19		1.53
Nitzschia heufleriana Grun.									0.51	0.24	0.57	2.76	
Nitzschia incognita Legler et Krasske								0.72	0.00	0.72		0.66	
Nitzschia inconspicua Grun.		1.00	2.00			3.92	5.00	0.96	1.26	0.00	2.10	4.73	0.15
Nitzschia intermedia Hantzsch											0.38		
Nitzschia levidensis (W. Smith) Grun. in Van Heurck						0.98							
Nitzschia linearis (Agardh) W. Smith							2.00		0.13	1.68	1.15	2.10	5.67
Nitzschia palea (Kütz.) W. Smith				2.48	1.35		3.00	0.24	4.29	0.96	0.95	2.50	1.84

Tab. 2. – continued

	SA02	GU02	B02	T02	TC02	SZ02	TK02	TI10	SA10	GU10	AP10	ZA10	T10
Nitzschia palea var. *tenuirostris*										0.48	1.53		
Nitzschia paleacea (Grun.) Grun. in Van Heurck													0.31
Nitzschia perminuta (Grun.) M. Peragello								0.48		2.40	1.15	0.13	0.15
Nitzschia pura Hust.									0.38				
Nitzschia pusilla Grun.													0.15
Nitzschia recta Hantzsch ex Rabenh.						0.98		0.96			0.57	0.26	
Nitzschia reversa W. Smith							1.00			0.24			
Nitzschia sigma (Kütz.) W. Smith										3.61	0.76		0.77
Nitzschia sigmoidea (Nitzsch) W. Smith									0.51	0.24			1.23
Nitzschia sinuata (Thwaites) Grun.									1.01				
Nitzschia sociabilis Hust.										4.09	0.38	0.79	
Nitzschia sp.												0.13	
Nitzschia tubicola Grun.								0.72		0.24			0.46
Nitzschia vermicularis (Kütz.) Hantzsch											0.19		
Pinnularia interrupta W. M. Smith										0.24			
Planothidium lanceolatum (Bréb.) Round et Bukht. (*Achnanthes lanceolata* (Bréb.) Grun.)	10.00	6.00	1.00	1.97		1.82	0.48						
Pseudostaurosira brevistriata (Grun. in V. Heurck) Wil. et Round (*Fragilaria brevistriata* Grun.)	2.00		1.00										
Reimeria sinuata (Gregory) Kociolek et Stoermer (*Cymbella sinuata* Gregory)			1.00			1.35	0.24		0.48	0.38			
Rhoicosphenia abbreviata (C. Agardh) Lange-Bert.		7.00	3.00		8.18	3.92				1.20		0.13	
Staurosirella pinnata (Ehrbg.) Williams et Round (*Fragilaria pinnata* Ehrbg.)				4.92			0.96						0.61
Surirella angusta Kütz.							1.00	0.24		0.24			
Surirella bifrons Ehrbg.											0.19		
Surirella ovalis Bréb.	1.00		3.00	4.82									

Tab. 3. Relative abundance of diatoms found in Kisköre reservoir and Laskó-stream in November and December 2000.

	L11	LM11	P11	TF11	TD11	AS11	KK11	L12	LM12	P12	TF12	TD12	AS12	KK12
Aulacoseira distans (Ehrbg.) Sim.										3.33				
Aulacoseira granulata (Ehrbg.) Sim.	0.43							6.67		16.67				
Cyclostephanos dubius (Fricke) Round	2.59	3.15			0.46			5.83	0.25					
Cyclotella atomus Hust.		1.54		1.46	2.23		0.42				0.83	0.49		
Cyclotella atomus var. *gracilis* Genkal et Kiss				0.52	1.42									
Cyclotella comta (Ehrbg.) Kütz.				0.14										
Cyclotella glomerata Bachmann							0.42							
Cyclotella meduane Germain					0.23							0.96		
Cyclotella meneghiniana Kütz.	0.65		0.68	28.76	8.32		7.56			1.89	5.58	2.44		2.68
Cyclotella pseudostelligera Hust.	2.16	1.54	3.63	5.23	1.22		1.54		0.49	1.89	0.27			
Cyclotella woltereckii Hust.					1.62									
Melosira varians Agardh		3.36	3.63	1.46			0.84				8.26			0.89
Skeletonema potamos (Weber) Hasle	0.43													
Stephanodiscus delicatus Genkal	0.43	1.54		2.92	0.23						0.41			
Stephanodiscus invisitatus Hohn et Hellermann	0.43			4.76	0.69		2.18				0.41			0.89
Stephanodiscus minutulus (Kütz.) Cleve et Möller	4.95	4.41	0.45	1.46	0.81		0.42	1.46	0.49	0.76	0.62			2.89
Stephanodiscus neoastrea Hakkanson et Hickel		1.54												0.45
Stephanodiscus tenuis Hust.	2.16	0.42	0.45	2.92	0.69		1.90	2.78						1.34
Thalassiosira guillardii Hasle							0.42							
Thalassiosira pseudonana Hasle et Heimdal	0.43		0.45	0.52	0.81		0.63		0.25					2.89
Thalassiosira weissflogii (Grun.) Fryxwll et Hasle				0.52	0.23						1.34			0.45
Achnanthes biasolettiana Grun.				0.92	0.46		0.42							
Achnanthes hungarica Grun. in Cleve et Grun.	0.22	0.63	1.59						0.25	0.57				
Achnanthidium minutissimum Kütz. (*Achnanthes minutissima* Kütz.)			2.95	0.92	2.64	4.50	1.69	0.63	0.74	1.52	0.62	2.88	2.50	5.13
Amphora aequalis Krammer											0.27			
Amphora inariensis Krammer														0.22
Amphora libyca Ehrbg.	0.65	3.36	0.97		0.23	0.25		0.42	0.49		0.83		1.00	

Tab. 3. – continued

	L11	LM11	P11	TF11	TD11	AS11	KK11	L12	LM12	P12	TF12	TD12	AS12	KK12
Amphora montana Krasske			0.23						0.25		0.41		0.25	
Amphora ovalis (Kütz.) Kütz.						0.25								
Amphora pediculus (Kütz) Grun.	4.31	18.28	16.33	4.97	8.92	4.50	0.84	2.29	2.79	3.50	14.50	1.22	1.00	3.35
Amphora veneta Kütz.	1.94	0.22	2.27		0.81					0.76				0.45
Anomoeneis sphaerophora (Ehrbg.) Pfitzner	0.22													
Asterionella formosa Hassall				1.46	0.81		4.41							
Bacillaria paradoxa Gmelin				19.22										
Caloneis bacillum (Grun.) Cleve									0.49		0.62		0.50	
Caloneis schumanniana (Grun.) Cleve			0.68		0.46			0.42						0.45
Caloneis schumanniana var. *biconstricta* (Grun.) Rei	0.22													
Cocconeis pediculus Ehrbg.	2.38	18.28	24.72	0.52	3.25	2.50	3.99	0.28						
Cocconeis placentula Ehrbg.								5.28	3.69	3.22	0.27	59.62	2.00	6.92
Craticula accomoda (Hust.) Mann (*Navicula accomoda* Hust.)									0.25					
Craticula cuspidata (Kütz.) Mann) (*Navicula cuspidata* (Kütz.) Kütz.)			0.23											
Craticula minusculoides (Hust.) Lange-Bert. (*Navicula minusculoides* Hust.)								0.28						
Cymatopleura elliptica (Bréb.) W. Smith	0.22													
Cymatopleura solea (Bréb.) W. Smith				0.14						0.19				
Cymbella affinis Kütz.						0.25							0.50	
Cymbella helvetica Kütz.				0.14		0.75				0.19			0.25	
Cymbella lanceolata Krammer		0.22	0.23	0.26						0.19	0.27			
Cymbella tumida (Bréb.) Van Heurck			0.45	0.14			0.22			0.38				
Diadesmis confervacea Kütz. (*Navicula confervacea* Kütz.)	2.16	1.27	1.81				0.22	2.92	21.18	4.36				
Diatoma tenuis Agardh				0.14	0.69		0.22							
Diatoma vulgare Bory				0.14									0.25	
Encyonema caespitosum Kütz. (*Cymbella caespitosa* (Kütz.) Brun.)														0.22

Tab. 3. – continued

	L11	LM11	P11	TF11	TD11	AS11	KK11	L12	LM12	P12	TF12	TD12	AS12	KK12
Encyonema caespitosum Kütz. (*Cymbella prostrata* (Berkeley) Grun.)														0.22
Encyonema neomesianum Krammer (*Cymbella mesiana* Cholnoky)	0.22									0.19				
Encyonema silesiacum (Bleisch in Rabenh.) Mann (*Cymbella silesiaca* Bleisch in Rabenh.)			0.23	0.65	0.69	0.50		0.28			0.27			
Eolimna minima (Grun.) Lange-Bert. (*Navicula minima* Grun.)								0.42	2.79	1.52	3.36	0.49	5.00	4.18
Eolimna subminuscula (Manguin) Lange-Bert. et Schiller (*Navicula subminuscula* Manguin)	0.22	0.42			0.46					0.19	0.27			
Epithemia adnata (Kütz.) Bréb.			0.23							0.19				
Eunotia bilunaris (Ehrbg.) Mills		0.22	0.23								0.27			
Eunotia formica Ehrbg.														0.22
Eunotia sp.									0.25					
Fragilaria capucina Desmazieres	0.43		0.68	0.14				0.83	0.49	0.19	0.27			0.22
Fragilaria capucina var. *mesolepta* (Rabenh.) Rabenh.	0.22									0.38				
Fragilaria capucina var. *vaucheriae* (Kütz.) Lange-Bert.			1.13											
Fragilaria fasciculata (Agardh) Lange-Bert.			0.45											
Fragilaria parasitica (W. Smith) Grun.							0.42							0.22
Fragilaria ulna (Nitzsch) Lange-Bert.	0.43	0.22	0.45	0.14							0.41	0.24		
Fragilaria ulna (Nitzsch) Lange-Bert. f. *acus*				0.39			0.22	0.28			0.27			
Frustulia vulgaris (Thwaites) De Toni										0.19				
Gomphonema acuminatum Ehrbg.	0.22		0.23											
Gomphonema angustatum (Kütz.) Rabenh.	0.22													
Gomphonema angustum Agardh				0.14				0.28	0.25	0.38		21.88	2.50	2.92
Gomphonema augur Ehrbg.			0.45	0.26							0.27			
Gomphonema clavatum Ehrbg.						0.25		0.28			1.34	0.24		
Gomphonema gracile Ehrbg.			0.45				0.22							

Tab. 3. – continued

	L11	LM11	P11	TF11	TD11	AS11	KK11	L12	LM12	P12	TF12	TD12	AS12	KK12
Gomphonema minutum Agardh		0.22	0.68	0.14		0.75	0.42			0.38		0.49	0.50	
Gomphonema olivaceum (Hornemann) Bréb.				0.14				0.28					0.50	0.22
Gomphonema parvulum (Kütz.) Kütz.	0.43	0.22	2.72	0.14	0.23		0.63	0.28	1.23	0.76	0.27	0.24		1.79
Gomphonema sp.		0.42	0.45									0.96	0.25	
Gomphonema truncatum Ehrbg.											0.27			
Gyrosigma acuminatum (Kütz.) Rabenh.	0.22		0.23		0.23		0.42	0.28	0.25	1.89	0.41			0.45
Gyrosigma attenuatum (Kütz.) Rabenh.				0.26										0.22
Gyrosigma nodiferum (Grun.) Reimer	0.22			1.70		0.50								
Gyrosigma parkerii (Harrison) Elmore										0.38				
Hannea arcus (Ehrbg.) Patrick (*Fragilaria arcus* (Ehrbg.) Cleve)				0.14				0.28			0.27			0.45
Hantzschia amphyoxis (Ehrbg.) Grun.	0.65	0.84			0.23		1.54					0.49		1.79
Hippodonta capitata (Ehrbg.) Lange-Bert., Metz. et Witk. (*Navicula capitata* Ehrbg.)	3.45	0.22	0.23			0.50	0.22	6.25	2.79	0.38				0.45
Hippodonta hungarica (Ehrbg.) Lange-Bert., Metz. et Witk. (*Navicula capitata* var. *hungarica* (Grun.) Ross)						2.25								
Hippodonta lueneburgiensis (Ehrbg.) Lange-Bert., Metz. et Witk. (*Navicula capitata* var. *lueneburgiensis* (Grun.) Patrick)									0.25				1.00	
Karayevia ploenensis (Hust.) Round et Bukht. (*Achnanthes ploenensis* Hust.)						1.75		0.28					2.00	
Luticola mutica (Kütz.) Mann (*Navicula mutica Kütz.)*	0.43	1.90	2.72	0.26	5.27	3.50	0.42					0.24		
Mayamea atomus (Kütz.) Lange-Bert. (*Navicula atomus* (Kütz.) Grun.)				0.26	1.22			0.63						
Mayamea atomus var. *permitis* (Hust.) Lange-Bert. (*Navicula atomus* var. *permitis* (Hust.) Lange-Bert.)					0.46		0.22							
Navicula angusta Grun.			0.45				0.22	0.28						0.22

Tab. 3. – continued

	L11	LM11	P11	TF11	TD11	AS11	KK11	L12	LM12	P12	TF12	TD12	AS12	KK12
Navicula austrocollegarum Lange-Bert et Voigt					9.94		8.19	0.28				0.96	0.75	4.18
Navicula capitatoradiata Germain								11.88	4.43	2.46		0.24	4.00	6.27
Navicula cari Ehrbg.											0.27			
Navicula cincta (Ehrbg.) Ralfs	11.27	3.99	2.95	0.26	2.64	3.50	18.67	0.42						
Navicula constans Hust.													0.25	
Navicula cryptocephala Kütz.	0.65	0.22	0.97	0.14	1.62		2.52	1.67	2.46	2.65			0.25	2.23
Navicula cryptotenella Lange-Bert.	0.43	3.57	2.72	0.14	3.43	13.00	2.18	1.25	3.45	1.89	4.55	0.24	2.25	1.34
Diadesmis gallica var. *perpusilla* (Grun.) Lange-Bert. (*Navicula gallica* (W. Smith) Lagerstedt var. *perpusilla* (Grun.) Lange-Bert.)					0.23									
Navicula gastrum (Ehr.) Kütz.						0.50							0.50	
Navicula goeppertinata (Bleisch) H. L. Smith			0.23								0.62			0.22
Navicula gregaria Donkin	4.31	0.63	1.13			2.75	1.48	8.33	4.93	3.22	0.27		1.50	1.34
Navicula halophila (Grun.) Cleve									0.25					
Navicula lanceolata (Agardh) Kütz.	0.22			0.26	0.46		0.22				0.27			0.45
Navicula menisculus Schumann	0.43	0.42	0.23	0.14	5.27	3.00	2.52	0.63	2.79	1.14	2.89	0.24	1.00	1.79
Navicula phyllepta Kütz.									0.74				1.00	
Sellaphora pupula (Kütz.) Mann (*Navicula pupula* Kütz.)	0.22		0.23						0.25	0.38			0.25	0.22
Navicula pusilla W. Smith							0.22							
Navicula pusio Cleve					0.23									
Navicula radiosa Kütz.	2.38	0.63	0.68				0.42	1.46	0.25	0.38				
Navicula recens (Lange-Bert.) Lange-Bert.			0.23							0.38				
Navicula schroeterii Meister														0.22
Navicula seminulum Grun.		0.22			1.22				0.25		1.65			
Navicula sp.						0.25		0.28		0.19				0.22
Navicula streckerae Lange-Bert. et Witkowski	3.17				0.23		0.42	5.42	6.16	11.74	0.27			1.12
Navicula stroemii Hust.					0.23									

Tab. 3. – continued

	L11	LM11	P11	TF11	TD11	AS11	KK11	L12	LM12	P12	TF12	TD12	AS12	KK12
Navicula subhamulata Grun.			0.45	0.26	0.23									
Navicula tripunctata (O. Müller) Bory	2.59	0.42	1.13	1.46	0.46	9.75	0.22	0.83		0.76	4.13		4.00	0.89
Navicula trivialis Lange-Bert.	1.78				4.67		6.93	0.42	0.49	0.76		1.68		2.23
Navicula veneta Kütz.	0.43							1.67	0.74	0.57	1.45		0.25	2.23
Navicula viridula (Kütz.) Ehrbg.	0.43									0.19			0.75	
Nitzschia acicularis (Kütz.) W. Smith		0.22		0.14										
Nitzschia amphibia Grun.	1.72	2.18	0.68		6.85		0.22	0.63	0.74	2.65	0.41		0.25	0.67
Nitzschia calida Grun.	0.22													
Nitzschia capitellata Hust.								9.38	6.90	0.19	0.41			2.89
Nitzschia commutata Grun. in Cleve et Grun.	3.23	0.42		0.14	0.81	0.50	2.94	0.28						
Nitzschia constricta (Gregory) Grun.	8.19	0.22	0.23	0.26	0.46			1.42	3.45					0.22
Nitzschia dissipata (Kütz.) Grun.	0.22	1.90	1.37	1.57	4.26	9.00	2.18	0.63	1.23	1.33	17.36		1.25	1.79
Nitzschia dubia W. M. Smith	0.43													0.22
Nitzschia filiformis (W. Smith) Van Heurck	0.22	0.22	0.45	4.76	0.46		0.42			1.14	1.86			
Nitzschia fonticola Grun. in Cleve et Möller	0.22	2.52	0.23	0.39	4.67	1.00		0.28	2.22	2.27	2.27	0.24	0.25	0.22
Nitzschia frustulum (Kütz.) Grun.	0.65		0.68	0.39					0.25		0.27			
Nitzschia graciliformis Lange-Bert. et Sim.	0.22	0.22		0.14										
Nitzschia gracilis Hantzsch	1.94	1.54					0.42	3.13	1.97	0.19				0.22
Nitzschia heufleriana Grun.				0.14						0.19	0.27			
Nitzschia homburgiensis Lange-Bert.						0.25								
Nitzschia hungarica Grun.	2.16							0.63						0.22
Nitzschia incognita Legler et Krasske	0.22									0.19				
Nitzschia inconspicua Grun.	0.65	0.22	0.68	0.26			0.42		1.48	0.38	0.27		13.00	0.67
Nitzschia intermedia Hantzsch	1.94	0.63		0.14				1.88	0.74		0.27			
Nitzschia levidensis (W. Smith) Grun. in Van Heurck						0.42		0.49	0.38					0.45
Nitzschia linearis (Agardh) W. Smith	1.29	0.22		0.14	0.46	0.75		0.28	0.25		0.62			
Nitzschia palea (Kütz.) W. Smith	1.59					0.25			0.25	0.19				
Nitzschia paleacea (Grun.) Grun. in Van Heurck	1.59						1.69	0.42	0.74	0.57				

Tab. 3. – continued

	L11	LM11	P11	TF11	TD11	AS11	KK11	L12	LM12	P12	TF12	TD12	AS12	KK12
Nitzschia pellucida Grun.							0.22		0.25					
Nitzschia perminuta (Grun.) M. Peragello	0.65	1.54	0.45	2.35	0.69		0.22	0.83		0.76	0.27			0.22
Nitzschia pusilla Grun.	0.22								0.25					
Nitzschia recta Hantzsch ex Rabenh.	1.29	5.42	0.45	0.92	6.50	0.25	14.29	1.25	0.74	9.47	0.27	0.24	0.25	2.68
Nitzschia sigmoidea (Nitzsch) W. Smith				0.14				0.28		0.19				0.45
Nitzschia sociabilis Hust.								0.42	0.25	0.19	16.53		1.00	0.22
Nitzschia solita Hust.									0.25				0.50	
Nitzschia sp.			0.45					0.63					0.25	
Nitzschia subacicularis Hust.													0.25	
Nitzschia tryblionella Hantzsch		0.22		3.92		3.75		0.42						
Nitzschia tubicola Grun.	1.78													
Nitzschia umbonata (Ehrbg.) Lange-Bert.									1.97	0.38				
Nitzschia vermicularis (Kütz.) Hantzsch	4.31	0.63		0.65		0.25	0.42	0.83	0.49	2.46				0.22
Pinnularia microstauron (Ehrbg.) Cleve										0.19				0.45
Pinnularia sp.									0.25					
Planothidium lanceolatum (Bréb.) Round et Bukht. (*Achnanthes lanceolata* (Bréb.) Grun.)	1.94	0.42	8.62				0.22	2.29	4.43	0.95	0.41	0.24		1.12
Rhoicosphenia abbreviata (C. Agardh) Lange-Bert.	0.43	8.82	1.13	0.39	0.23	1.25		0.63	0.25	1.14	0.41	3.13	1.25	2.76
Rhopalodia gibba (Ehrbg.) O. Müller	0.22								0.25					
Stauroneis smithii Grun.														0.22
Staurosirella pinnata (Ehrbg.) Williams et Round (*Fragilaria pinnata* Ehrbg.)				0.14										
Surirella angusta Kütz.							0.22		0.25					0.22
Surirella minuta Bréb. in Kütz.		0.42						0.28	1.48	1.14				0.67
Surirella ovalis Bréb.	2.59	0.63			0.23		0.42	0.42	1.23	0.57	0.83			0.67
Surirella suecica Grun.										0.19				
Surirella tenuis Mayer									0.25					
Surirella visurgis Hust.		0.42												

Tab. 4. Relative abundance values of diatom species found in the Tisza oxbows in May and July 1996, October 2000 and June 2001.

	096M	M96M	R96M	K96M	O96J	M96J	R96J	K96J	O00O	M00O	R00O	K00O	O00J	M00J	R00J	K00J
Aulacoseira italica (Ehrbg.) Sim.	0.84															
Aulacoseira distans (Ehrbg.) Sim.		0.19					0.19			31.67	20.00	15.63		45.00		35.20
Aulacoseira granulata var. *angustissima* (Müll.) Sim.												0.36				
Aulacosira granulata (Ehrbg.) Sim.		0.95										6.25				1.37
Cyclostephanos dubius (Fricke) Round										1.26		0.85		1.50		
Cyclotella atomus Hust.										0.73		0.64				0.50
Cyclotella atomus var. *gracilis* Genkal et Kiss																0.37
Cyclotella meneghiniana Kütz.							0.19			0.73		1.27			0.25	1.24
Cyclotella pseudostelligera Hust.		1.53	3.20							3.30		2.56		7.75	0.25	1.00
Cyclotella sp.				1.00												
Cyclotella stelligera Cleve et Grun. in Van Heurck	1.68															
Melosira varians Agardh						0.60		3.21						0.25		0.12
Stephanodiscus delicatus Genkal	2.52											15.13		0.75		1.37
Stephanodiscus tenuis Hust.												1.16				
Stephanodiscus hantzschii Grun. in Cleve et Grun.												0.36				0.12
Stephanodiscus invisitatus Hohn et Hellermann	2.52									0.51		1.63				1.74
Stephanodiscus minutulus (Kütz.) Cleve et Möller										1.98		12.50	0.50	7.00	0.25	11.19
Stephanodiscus sp.		3.74		6.00												
Thalassiosira lacustris (Grun.) Hasle												0.36				
Thalassiosira pseudonana Hasle et Heimdal		1.53	3.76							0.37		4.55		0.25		1.24
Achnanthes delicatula (Kütz.) Grun.										0.73						
Achnanthes exigua Grun. in Cleve et Grun.						0.10										

Tab. 4. – continued

	096M	M96M	R96M	K96M	O96J	M96J	R96J	K96J	O00O	M00O	R00O	K00O	O00J	M00J	R00J	K00J
Achnanthes hungarica Grun. in Cleve et Grun.																0.12
Achnanthes lanceolata (Bréb.)Grun.	0.84	0.95			0.20	0.40		3.81		0.73						0.12
Achnanthidium minutissimum Kütz. (*Achnanthes minutissima* Kütz.)	18.49	0.19	12.78		0.80	0.40		3.21	23.50	1.83	1.00	1.31	65.50	7.50	43.75	1.37
Amphipleura pellucida Kütz.										0.73		0.14	1.50		7.50	
Amphora aequalis Krammer										0.73						
Amphora coffeaeformis (Agardh) Kütz.					0.20	0.30		1.00								
Amphora libyca Ehrbg.													0.50		0.50	0.12
Amphora montana Krasske												0.36		0.25	0.25	0.37
Amphora ovalis Kütz.																0.12
Amphora pediculus (Kütz.) Grun.					0.40	2.00		7.21	1.00		0.20	0.96			0.50	0.62
Amphora sp.												0.71				
Asterionella formosa Hassall				1.00												
Caloneis bacillum (Grun.) Cleve				1.00					0.75							0.25
Caloneis schumanniana (Grun.) Cleve												0.36				
Caloneis silicula (Ehrbg.) Cleve		0.85	0.38													
Cocconeis pediculus Ehrbg.					3.19	6.78	0.39	10.22			0.20					
Cocconeis placentula Ehrbg.						0.30		0.20	0.75	0.29	0.20	0.28	0.25	0.50		0.37
Craticula cuspidata (Kütz.) Mann (*Navicula cuspidata* Kütz.)											0.20					
Craticula halophila (*Navicula halophila* (Grun.) Cleve) (Grun.) Mann				1.00		0.20		0.40			0.20					
Cymatopleura solea (Bréb.) W.Smith	0.84					0.10			0.25		2.60					0.12
Cymbella affinis Kütz.		0.19							1.00							0.12
Cymbella helvetica Kütz.										0.73					1.50	0.50
Cymbella lanceolata Krammer													1.00	0.25		0.12

Tab. 4. – continued

	096M	M96M	R96M	K96M	O96J	M96J	R96J	K96J	O00O	M00O	R00O	K00O	O00J	M00J	R00J	K00J
Cymbella neocistula Krammer (*Cymbella cistula* (Ehrbg.) Kirchner)							0.19		0.50				0.25			
Cymbella tumida (Bréb.) van Heurck												0.71			0.25	0.12
Denticula kuetzingii Grun.									0.25							
Diatoma mesodon (Ehrbg.) Kütz.													0.25			
Diatoma moniliformis Kütz.											0.20	0.71	0.50			
Diatoma tenuis Agardh													0.25			0.12
Diatoma vulgaris Bory	0.84										0.40					0.25
Encyonema caespitosum Kütz. (*Cymbella caespitosa* (Kütz.) Brun.)									0.75	0.22	0.20		0.25			0.12
Encyonema minutum (Hilse in Rabenh.) Mann (*Cymbella minuta* Hilse ex Rabenh.)	0.84															
Encyonema silesiacum (Bleisch in Rabenh.) Mann (*Cymbella silesiaca* Bleisch in Rabenh.)									1.75	0.22	0.20	0.36	4.25	0.50	2.00	
Eolimna minima (Grun.) Lange-Bert. (*Navicula minima* Grun.)	0.84	0.95	7.14	3.00	0.60	0.30		1.00	4.75	1.69	0.60	0.50			0.25	0.25
Epithemia adnata (Kütz.) Bréb.					8.96	29.83	0.78	14.30	3.00		0.20	0.67		1.25		
Epithemia sorex Kütz.									2.50			0.21				
Eunotia bilunaris (Ehrbg.) Mills	0.84	0.28	3.95								0.20			0.25	0.75	
Eunotia glacialis Meister									1.00							
Eunotia pectinalis (Dyllwyn) Rabenh.																0.12
Eunotia tenella (Grun.) Hust.		0.18														
Fallacia pygmea (Kütz.) Stickle et Mann (*Navicula pygmaea* Kütz.)											0.20				0.50	0.12
Fragilaria capucina Desmazieres		1.35				0.30				0.22		0.17	0.25			
Fragilaria capucina var. *vaucheriae* (Kütz.) Lange-Bert.	0.84	0.57									0.20			0.25		0.50

Tab. 4. – continued

	096M	M96M	R96M	K96M	O96J	M96J	R96J	K96J	O00O	M00O	R00O	K00O	O00J	M00J	R00J	K00J
Fragilaria capucina var. *gracilis* (Oestrup) Hust.									0.73	0.60	0.71	0.25				
Fragilaria delicatissima (W. Smith) Lange-Bert.													1.50	1.25		0.75
Fragilaria dilatata (Bréb.) Lange-Bert.					0.40	0.70		2.20								
Fragilaria fasciculata (Agardh) Lange-Bert.											0.20			0.25		0.12
Fragilaria gracilis Ostrup		0.95	1.69	3.00												
Fragilaria rumpens (Kütz.) Carlson		5.54	1.13		2.79	6.18	0.19	2.81								
Fragilaria tenera (W. Smith) Lange-Bert.		0.37	0.19			0.30										
Fragilaria ulna (Nitzsch.) Lange-Bert.		0.28	0.19	1.00	0.40	2.20	0.19	1.60			0.20	0.36		0.25	0.25	0.25
Fragilaria ulna var. *acus* (Kütz.) Lange-Bert.		0.95	0.38	2.00	0.20			0.20		1.26		0.25	0.25		0.75	0.25
Fragilaria ulna var. *oxyrhynchus* (Kütz.) Lange-Bert.						0.10										
Geissleria schoenfeldii (Hust.) Lange-Bert. et Metz. (*Navicula schoenfeldii* Hust.)											0.20					
Gomphonema acuminatum Ehrbg.		0.19		1.00					0.25					0.50		
Gomphonema angustatum (Kütz.) Rabenhorst												0.36			0.75	
Gomphonema clavatum Ehrbg.			2.82	1.00											1.00	
Gomphonema gracile Ehrbg.			1.88			0.10			0.75	0.44				0.25	0.25	
Gomphonema insigne Gregory	1.68		2.82													
Gomphonema minutum Agardh															1.25	
Gomphonema olivaceum (Hornemann) Brébisson	0.84	0.19	0.56			0.20	0.19	0.60	0.25				0.50	1.00	8.75	0.25

Tab. 4. – continued

	096M	M96M	R96M	K96M	O96J	M96J	R96J	K96J	O00O	M00O	R00O	K00O	O00J	M00J	R00J	K00J
Gomphonema parvulum Kütz.	0.84	2.74	3.57	1.00	0.20	0.90		3.10	2.50	0.73	0.40	0.18	6.00	2.25		5.85
Gomphonema tergestinum (Grun.) Fricke															0.25	
Gomphonema truncatum Ehrbg.		0.19			0.20	0.20			0.25			0.36	1.50	0.25		0.37
Gyrosigma acuminatum (Kütz.) Rabenh.									0.25		6.00	0.17				0.12
Gyrosigma attenuatum (Kütz.) Rabenh.												0.36			0.25	0.12
Gyrosigma scalproides (Rabenh.) Cleve											0.20	0.36			0.25	
Gyrosigma spencerii (Quekett) Griffith et Henfrey											0.20					
Hannea arcus (Ehrbg.) Patrick (*Fragilaria arcus* (Ehrbg.) Cleve)	0.84		0.38								0.40					
Hantzshia amphioxys (Ehrbg.) Grun.															0.50	
Hippodonta hungarica (Ehrbg.) Lange-Bert., Metz. et Witk. (*Navicula hungarica* Grun.)	1.68															
Hippodonta lueneburgiensis (Ehr.) Lange-Bert., Metz. et Witk. (*Navicula capitata* Ehrbg. var. *lueneburgensis*)	0.84									0.29		0.71				0.12
Luticola mutica var. *ventricosa* (Kütz.) Mann (*Navicula mutica* Kütz. var. *ventricosa* (Kütz.) Cleve et Grun.)											0.20					
Mayamea agrestis (Hust.) Lange-Bert. (*Navicula agrestis* Hust.)										2.20	0.20	0.36		2.50	0.25	0.50
Mayamea atomus (Kütz.) Lange-Bert. (*Navicula atomus* (Kütz.) Grun.)	0.84	0.47	0.94		0.60	0.20	0.19	2.61								
Navicula angusta Grun.									0.25	0.15						
Navicula capitatoradiata Germain			3.38							0.66	0.20	0.71	0.75	1.50	1.25	3.36
Navicula cincta (Ehrbg.) Ralfs in Pritchard											0.40					
Navicula cryptocephala Kütz.	5.88	1.33	2.82	6.00					0.25	0.88	1.80	0.71	0.75	0.75	0.25	1.12

Tab. 4. – continued

	096M	M96M	R96M	K96M	O96J	M96J	R96J	K96J	O00O	M00O	R00O	K00O	O00J	M00J	R00J	K00J
Navicula cryptotenella Lange-Bert.	3.36		0.19	1.00					3.75	0.51	0.20	0.92		0.75		1.24
Navicula difficillima Hust.														0.25		
Navicula goeppertiana (Bleisch) H.L.Smith					0.20			1.20								
Navicula gracilis Ehrbg.		2.42								1.47	4.00	0.53	0.50	0.25	0.75	1.24
Navicula hustedtii Krasske										0.73						
Navicula lanceolata (Agardh) Ehrbg.	0.84	0.95	0.38	1.00							0.20					0.12
Navicula menisculus Schumann										1.25		0.36		0.25		0.25
Navicula obdurata Hohn et Hellermann			1.50													
Navicula radiosa Kütz.	0.84											0.71	0.25	0.50		0.37
Navicula recens Lange-Bert.												0.71				
Navicula rhynchocephala Kütz.			0.19												0.50	
Navicula salinarum Grun. in Cleve et Grun.	2.52	0.38	0.38			0.60		0.60							0.50	
Navicula salinicola Hust.											2.00					
Navicula tripunctata (Müller) Bory	0.84	2.14	2.44	4.00								0.36				0.12
Navicula trivialis Lange-Bert.											1.00	0.14			2.50	0.50
Navicula veneta Kütz.									0.50							
Navicula viridula (Kütz.) Ehrbg.											9.00					
Navicula viridula (Kütz.) Ehrbg. var. *linearis* Hust.											0.40					
Neidium ampliatum (Ehrbg.) Krammer															0.75	
Nitzschia acicularis (Kütz.) W. M. Smith						0.10			0.50	2.93	0.60	2.45	0.50	0.75		1.12
Nitzschia acicularoides Hust.										0.73		0.17				
Nitzschia acidoclanata Lange-Bert.									1.00	1.32				1.00	3.00	
Nitzschia aequora Hust.									1.00	6.52		0.67			1.00	1.87
Nitzschia agnita Hust.	0.84	4.19	0.56	1.00						0.73						

Tab. 4. – continued

	096M	M96M	R96M	K96M	O96J	M96J	R96J	K96J	O00O	M00O	R00O	K00O	O00J	M00J	R00J	K00J
Nitzschia amphibia Grun.									4.00	0.73	0.60	0.71	0.25		2.00	0.75
Nitzschia angustata Grun.											0.40					
Nitzschia archibaldii Lange-Bert.										1.25		0.71				
Nitzschia calida Grun.											0.60					
Nitzschia capitellata Hust.										0.59	4.40	0.17	0.75	0.50		0.75
Nitzschia closterium (Ehrbg.) W.Smith		1.45	0.75	2.00												
Nitzschia dissipata (Kütz.) Grun.									2.25	0.66	0.40	0.71	0.50	0.25	0.50	0.88
Nitzschia dubiiformis Hust.											0.20					
Nitzschia filiformis (W. Smith) Van Heurck									21.75	0.59		0.64				
Nitzschia flexa Schumann										0.73						
Nitzschia fonticola Grun. in Cleve et Möller									8.25	11.29	1.20	3.80	1.50	7.00		4.86
Nitzschia frustulum (Kütz.) Grun.										0.73						
Nitzschia fruticosa Hust.											0.20					
Nitzschia graciliformis Lange-Bert. et Simonsen	2.52	1.95	0.38	6.00						0.95	6.40	0.17	0.75	0.25		0.37
Nitzschia hungarica Grun.											0.20			0.25		0.25
Nitzschia incognita Legler et Krasske	0.84	1.45	0.75	2.00						0.73		6.89			1.00	
Nitzschia inconspicua Grun.	0.84					0.20		0.80	0.75			0.71			0.50	
Nitzschia intermedia Hantzsch ex Cleve et Grun.										0.15	0.40		0.75	0.25		0.50
Nitzschia levidensis (W. Smith) Grun. in Van Heurck										0.73						
Nitzschia linearis (Agardh) W. Smith										0.73	1.40	0.17	0.25	0.75		0.12
Nitzschia nana Grun. in Van Heurck		0.37														
Nitzschia palea (Kütz.) W. Smith	14.29	18.37	9.77	16.00	0.20	0.20		1.80	0.50	0.44	6.00	0.82	0.50			
Nitzschia palea var. *debilis* (Kütz.) Grun. in Cleve et Grun.	19.33	27.65	13.53	16.00				0.40								

Tab. 4. – continued

	096M	M96M	R96M	K96M	O96J	M96J	R96J	K96J	O00O	M00O	R00O	K00O	O00J	M00J	R00J	K00J
Nitzschia paleacea (Grun.) Grun. in van Heurck	4.20	8.20	8.80	12.00		0.20		1.60	3.50	5.87	1.40	1.42	4.75	2.00		9.45
Nitzschia pellucida Grun.											0.20					
Nitzschia perminuta (Grun.) M. Peragallo									4.00	9.76		1.99			2.25	
Nitzschia pumila Hust.										0.73	2.40					
Nitzschia pura Hust.										0.15		0.36				
Nitzschia pusilla (Kütz.) Grun.											0.20	0.18				
Nitzschia recta Hantzsch ex Rabenh.										0.29	0.40		0.25		0.25	
Nitzschia reversa W. Smith										0.73	0.20	0.36	0.25			
Nitzschia sinuata (Thwaites) Grun.											0.20					
Nitzschia sociabilis Hust.										0.29		0.14	0.50			0.12
Nitzschia solita Hust.											0.80					
Nitzschia sp.											2.20					
Nitzschia subacicularis Hust. in A. Schmidt et al										0.15	0.20				0.50	0.12
Nitzschia tryblionella Hantzsch											0.20					
Nitzschia tubicola												0.71	0.25		0.50	
Nitzschia vermicularis (Kütz.) Hantzsch	0.84	10.67	4.89	8.00		0.10				0.15	12.40					
Pinnularia cuneola Reichardt											0.20					
Pinnularia gibba Ehrbg.											0.20					
Pinnularia interrupta W. M. Smith			1.13				47.50									
Pinnularia maior (Kütz.) Rabenh.					0.20	0.20										
Pinnularia microstauron									0.25	0.73						0.25
Pinnularia sp.												0.71				
Pinnularia viridis (Nitzsch) Ehrbg.											0.20					
Reimeria sinuata (Gregory) Kociolek et Stoermer (*Cymbella sinuata* Gregory)				1.00					0.25	0.73						

Tab. 4. – continued

	096M	M96M	R96M	K96M	O96J	M96J	R96J	K96J	O00O	M00O	R00O	K00O	O00J	M00J	R00J	K00J
Rhoicosphenia abbreviata (Agardh) Lange-Bert.					0.40	0.60		2.40	0.25	0.73		0.18		0.25		
Rhopalodia gibba (Ehrbg.) O. Müller									1.00			0.32		0.50		
Sellaphora pupula (Kütz.) Mereschk. (*Navicula pupula* Kütz.)	0.84									0.15		0.71				
Stauroneis anceps Ehrbg.		0.95	0.75			0.10										
Stauroneis kriegeri Patrick											0.20					
Stauroneis producta Grun.		0.95		1.00												
Staurosira construens var. *subsalina* (Hust.) Williams et Round (*Fragilaria construens* (Ehrbg.) Grun. var. *subsalina* Hust.)						0.80	49.84									
Staurosira venter (Ehrbg.) Cleve et Möller (*Fragilaria construens* (Ehrbg.) Grun. f. *venter*)					8.57	8.58		5.81								
Staurosirella pinnata (Ehrbg.) Williams et Round (*Fragilaria pinnata* Ehrbg.)			0.19		71.31	35.68	0.19	28.60								
Staurosirella pinnata (Ehrbg.) Williams et Round var. *intercedens* (*Fragilaria pinnata* var. *intercedens* (Grun.) Hust.)												0.36				
Stenopterobia anceps (Lewis) Bréb. ex Van Heurck	0.84															
Surirella angusta Kütz.	0.84		0.19										0.75	0.25		0.12
Surirella biseriata Bréb.											0.20					
Surirella minuta Bréb.											0.20					
Surirella ovata Kütz.		0.09		1.00												

was a flood in the river at that time and moreover, it was a cold winter period. These circumstances also contributed to the low species numbers of these samples (KISS et al. 2002). In October, epiphytic diatom composition and dominance ratios shifted. *Achnanthidium minutissimum* and *Nitzschia* spp. gained very strong dominance. This species composition was also observed in strongly heavy metal polluted waters by other authors (IVORRA et al. 1999). On the basis of Bray-Curtis dendrogram, the samples of February were quite different from the samples of October. Certainly, one has to take into consideration the difference of the sampling time and possible seasonal changes. However, seasonal differences do not generally account for such a strong difference between samples from the same or similar sampling sites (VILBASTE 2001, SZABÓ et al. 2004a). For this reason we think that the pollution and the longer-scale adaptation of attached diatoms also played a role in the different species composition in October. *Achnanthidium minutissimum* is considered to be a good indicator of disturbances (FORE and GRAFE 2002). The immigration and reproduction rates of this species are particularly high. This R-strategist is a typical dominant of biofilms after strong disturbances (BIGGS in STEVENSON et al. 1996). In our investigations, percentage values of *A. minutissimum* valves in each sample were also calculated. In the Tisza River, this species was dominant in February and October. However, the abundance values in October were much higher, with a maximum value of almost 58 percent. Low percentage values of the species were found in Kisköre Reservoir, where the species accounted for only 0–5 percent of total diatom abundance. In the Tisza oxbows, low values were found in 1996, but after the flood of the Tisza River in April 2000, *A. minutissimum* was present in all of the oxbow samples and in three samples it reached very high values indeed, with the maximum being more than 65 percent. These results seem to be well in accordance with the fact that these waters were severely disturbed by the heavy metal pollution.

Heavy metal pollution might exercise an effect not only on the structure of biofilms but also on the formation of diatom frustules. Cell deformities have been associated with contamination by heavy metals (MCFARLAND, HILL and WILLINGHAM 1997) and some authors have concluded that abnormal cell morphology of diatoms might be a valid indicator of ecosystem health (DICKMAN 1998). In a case study of Hong Kong beaches, more deformed species were found close to heavy metal polluted sources (DICKMANN 1998). We also found several teratological frustules in the Tisza River, which can probably be explained by the effects of heavy metal pollution. Teratological forms can also occur under other stressed circumstances, e.g. exposure to strong UV light (REIZOPOULOU et al. 2000).

In the reservoir, *Amphora pediculus*, *Cocconeis pediculus*, *C. placentula*, several *Navicula* and *Nitzschia* species dominated. The species composition and relative abundances showed a characteristic patchy distribution. Because of its extremely slow flow velocity, Kisköre Reservoir can be regarded as standing water and as such, this patchiness is considered characteristic. The samples from Abádszalók and Tiszafüred differed from the rest, which formed two groups, depending on seasonality. Abádszalók Bay differs in several respects from all the other sampling points of the reservoir because this part of the reservoir has the highest water level; furthermore, large numbers of tree and bush trunks can be found beneath the water, which modify the water chemistry (HAMAR 1976 c). Tiszafüred is at the main current of the Tisza, thus, the water here has lotic character, whereas in the other parts of the reservoir it has lentic character. This accounts for the differences in these samples. As a whole, the diatom composition of the reservoir differed considerably from that of the Tisza River. On the one hand this difference can probably be caused by the lower pollutant load of the reservoir and on the other hand by the different physical circumstances: less suspended matter content, better light supply, higher actual trophic state (»reservoir-effect«).

Diatom composition of the oxbows changed notably after the flood of the Tisza River in spring 2000. In the samples from 1996, *Epithemia adnata, Navicula cryptocephala, Pinnularia interrupta, Staurosira construens, Staurosirella pinnata* were strongly dominant. In May 1996, *Achanthidium minutissimum* was also dominant at two sampling points (Oláh-zugi-holt Tisza, Remete-zugi-holt Tisza). However, its dominance was much less than that observed in 2000 and 2001, even at these two points. In 2000 and 2001 the most important dominant species were *Achnanthidium minutissimum* and *Nitzschia* spp. Also, *Aulacoseira distans* reached high relative abundance values. We are of the opinion that this can be partly considered as the effect of the flooding of the Tisza River.

Freshwater diatom flora of the biosphere is still only partly explored. Preservation of biodiversity helps to maintain the ecological balance, and furthermore it can be important from a medical or food-supplement point of view (AMANN 2003) and therefore, exploration and conservation of biodiversity is of crucial importance. Presence of algal species with a decreasing stock is characteristic of volatile areas. Repression of their stocks can be the consequence of diminishing habitats. The presence of endangered species is important from floristic and nature conservation point of views, since they can be used as a sound argument for the protection of a habitat. This use of Red Lists is particularly important in the case of microscopical organisms (LANGE-BERTALOT 1996). We found a number of endangered species or species with decreasing stocks in all of the investigated waters. This also turns our attention to the necessity of increased protection of these ecosystems. We found two new elements for the Hungarian diatom flora, *Navicula austrocollegarum* and *Navicula streckerae*. *N. austrocollegarum* is so far only known from its type locality, an Austrian, chalk-rich, oligo-mesotrophic lake. *N. streckerae* was described in 2000, from the catchment area of the Weser River. It was also found in the estuary of the Weser near Bremerhaven.

We also observed two invasive species: *Diadesmis confervacea* in Laskó stream and in the reservoir and *Didymosphenia geminata* in the Tisza River. In the Hungarian stretch of the Tisza River, *Didymosphenia geminata* did not occur before 2000, although in 1991 it was found along the Ukrainian stretch (HAMAR and SÁRKÁNY-KISS 1999). In the Red List of LANGE-BERTALOT (1996), *Didymosphenia geminata* is still described as a nearly extinct species. In spite of this, the species is very likely to be in expansion. Recently, it has been found in several waters in Europe, for instance in Poland (KAWECKA and SANECKI 2003), in the Danube River and in its tributaries (ÉRCES 2002, ÁCS et al. 2003). Of note is the fact, that the species was originally described as stenothermic and oligotrophic (KRAMMER et LANGE-BERTALOT 1986). Lately, it has been found more and more frequently in meso- or eutrophic flatland rivers. In 1994 it reached such a high abundance value in the San River (Poland) that it blocked the water-clarifying system of the river. We can not preclude that this species in fact consists of a number of genetic varieties. This question has to be clarified in the future by laboratory studies. *Diadesmis confervacea* was found in the Laskó-stream and near to its mouth in the Kisköre Reservoir in the year 2000. One year later, we also found it in Rákos stream (SZABÓ et al. 2004a). It was observed for the first time in Hungary in a warm-water cave, under aerophitic conditions (SUBA 1957). The species used to be treated as a tropical one in Europe it mostly occurred in greenhouses. However, lately it has been found at several points on the continent, in cooling systems of power stations, but also in streams in England, France, Germany and Slovakia (ECTOR et al. 2001). COSTE and ECTOR (2000) are of the opinion that *Diadesmis confervacea* is an invasive species and that it might indicate the gradual warming process of European streams, which is the result of the greenhouse effect.

Summary

Preliminary studies on the epiphytic diatom flora of the Tisza River, Kisköre Reservoir and four Tisza oxbows were carried out. On the epiphytic diatoms of the Tisza River and the four oxbows we observed phenomena that can be considered the effect of heavy metal pollution. After the cyanide pollution, low diatom species numbers were found in the Tisza River, and, since there was a flood at that time, shearing-stress resistant species such as *Cocconeis placentula* and *Rhoicosphenia abbreviata* predominated. The poorly attached diatom flora was mostly due to the cold winter period and flooding. In October, several months after the pollution *Achnanthidium minutissimum* and *Nitzschia* spp. almost exclusively dominated the epiphyton. One invasive species, *Didymosphenia geminata* was found. Epiphytic diatom flora of the four investigated Tisza oxbows were very different between 1996, and 2000–2001. Whereas in 1996 mainly *Staurosira*, *Staurosirella* and *Navicula* species dominated, in 2000 and 2001 this composition shifted to a community largely dominated by *Achnanthidium minutissimum*, *Aulacoseira distans* and *Nitzschia* species. Due to the different physical conditions and the lower heavy metal load, epiphytic diatoms of Kisköre Reservoir differed from those of the Tisza: above all *Amphora pediculus*, *Cocconeis* and several *Navicula* species dominated. Two new species for the Hungarian diatom flora were observed in the reservoir: *Navicula austrocollegarum* and *Navicula streckerae* and an invasive diatom, *Diadesmis confervacea*. We also found several endangered species or species with declining stocks in all of the investigated waters.

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