BASE-LINE SURVEY IN THE GEMENC PROTECTED LANDSCAPE AREA: hydrological, morphological, water quality and ecological data of the Vén-Duna, River Danube and Nyéki-Holt-Duna in 1997-1998, prior to restoration

Contractor:

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1. Introduction

The extension of the flood plains connected to large European rivers have desreased considerably during the last century. This environment has very important role in the life of the rivers providing large variety of habitat types for the riverine flora and fauna. The dynamic connection between the main river channel and the side arms has the most important diversity maintaining effect on the aquatic biota. Therefore, flood plains generally have considerably larger species numbers and greater amenity and nature conservation value than other, usually impounded river sections.

The flood plain of the Danube has been decreased also, due to the river regulation works carried out in Hungary since the last century. The only existing large side arm systems are still present in the Szigetköz and the Gemenc area but both of them suffer from several recent human impacts. One site of them situated in the Gemenc area includes the Vén-Duna side arm that is closed from the River Danube by a rock fill dam at its upper section. The partial removal or the reopening of this dam was planned in the frame of a Dutch-Hungarian side arm rehabilitation programme.

According to the contract and scientific co-operation between the RIZA (Institute for Inland Water Management and Waste Water Treatment of the Netherlands) and some Hungarian Institutions (Eötvös József High School, Baja, Water Resources Research Centre, Budapest), a base line study was carried out in the Vén-Duna side arm (u/s Baja) in order to monitor the effect of the reopening procedure. The research program contains a three years series of investigations in the area.

Hydrological, morphological, water quality and ecological monitoring was carried out in order to describe the most important abiotic and biotic processes following the hydraulic intervention. This base line report introduces the preliminary results of this on-site study carried out prior to the reopening of the Vén-Duna. One chapter is separately enclosed to the Base-line Sudy Report: the **Report on birds** is a detailed description of the ornithological state of the Gemenc Protected Landscape Area. Although it does not focus on the particular Vén-Duna site it is a comprehensive collection of valuable data. Therefore the editor encloses this report separately.

2. Hydrology

Author: J. Sziebert

2.1. Introduction

Within the framework of the rehabilitation of the water system of the Vén-Duna side branch and the connected floodplain dead branch-system, the partial removal of the cross closing dam of the side branch was completed in 1998, while certain stretches of the bed were dredged. The analysis of the discharge conditions in the side branch before the operations was carried out in order to have the preliminary state recorded.

The discharge of the river Danube varies considerably throughout the year, the mean discharge is 2300 m^3/s, the average small discharge is 600 m^3/s, and the hydraulic parameters connected to the discharge, like the water depth, the slope, the velocities and the sediment load are also changing. On the reach downstream of Dunaújváros the suspended sediment is characterising, the average slope between Dunaújváros and Fajsz is about 10 cm/km, downstream of Fajsz it is about 5 cm/km.

The valley of the river averages 20-25 km in width on the Hungarian stretch, from Dunaföldvár down to the throat of the Sió channel it is widening (here it is 32 km wide), from here to the south it becomes narrower and the narrowest is at Báta: 10 km. The river valley goes from the north to the south, and it is bordered by the Northern-Bácska plain from the east, that is composed of river sediment, loess and sand, and it is bordered by the Transdanubian hills from the north, that is a thick layer of loess.

The river valley is 25-30 meters deeper than it's surrounding. It's geologically built up as follows. The deepest explored layers are lime remnants typical for the Tries age, above that Pliocene sediment layer of inhomogeneous gravel and sand can be found, that is nearly 100m thick. On it one can find gravel of sediment origin from the Pleistocene age, that form a 80 m thick layer, its lower approximately 20 meters being gravel and relatively big grain size sand, or, less frequently, fine sand or silt. The upper layers are built up by medium and big grain size quartz sand.

The top layer that indeed forms the real bed of the river is approximately 10m thick, containing fine sand, powder sand, and silt. According to this, the average diameter of the sediment particles is usually less than a millimetre.

Upstream of the throat of the Sió channel, in the Bogyiszló cut-through the floodplain is narrow, and from the deepening main bed the river takes up sediment that is after deposited downstream from the Sió throat, where the slope is smaller. At the Sió throat the flood protection dam is turning away from the river Danube and is continuing on the left bank of the Sió channel, so the floodplain becomes suddenly much wider. Due to this flood speed is decreasing also suddenly, so the sediment is here deposited and forms sandbanks randomly. The big angle of the bottom line at Fajsz also adds to this, so the river cannot even take the sediment coming from upper reaches further and puts it down.

In ancient ages when the slope of the riverbed was bigger, the gravel sediment that is now only moving on the upstream stretches of the Danube, came down to the reach near the village Uszód. But, as the Big Hungarian Plain was rising and the Small Plain was lowering, the slope has decreased and the transport of gravel size sediment has stopped here.

The gravel deposited in the riverbed has formed a protecting layer (against erosion), the riverbed is stable, but, because the banks are built up from finer grain size material as it has already been mentioned, it intends to widen. On the reach downstream of Paks and Uszód, in the geologically younger and not so dense soil the river could horizontally move: it formed meanders, than with the development of the bends an intricate network of side and dead branches has been born.

On the floodplains of the river Danube, due to the natural processes of riverbed development, the meandering and the cut-through of bends, furthermore the wandering of the main bed, the side branches were sometimes excluded from the water system. The sediment deposition of floods has caused the silting up of these branches relatively quickly, and the siltation of the floodplain surface has also been observed. So in the Danube valley a living, changing, developing and self-renewing water system has existed - till the beginning of the river regulation and training works in the last century.

The training works started in the middle of the XIX. century have brought significant changes. The river regulation and flood protection that was a goal of economical reasons, has set boundaries for floods with dams, has stabilised the main flow, so to decrease the risk of ice jams and to establish the safe shipping route.

The horizontal movements of the riverbed have been stopped, but deepening started, among the reasons for which the gravel dredging for industry has also to be mentioned.

2.2. Methods of the survey

2.2.1. Discharge Measurement

Discharge measurements in given sections of the side branch, according to the velocity-area method, taking cross-sections by a rod and measuring the velocities in each point, according to the VMS 231/4 standard. For the processing of the data and presenting the results the VÍZHOZAM software was used, based on the VMS 251/4 standard.

Methodology: after choosing a section suitable for the execution of the measurement a rope was fixed across the section, then the measurement of the distance and the depth was done along the rope.

Position of the sections: just downstream the upstream throat of the side branch and at the sections no. 1. and 2. shown by map no. 1., according to the water levels.
Distance was determined by counting the scale of the rope.

Depth measurement: by an ultrasonic depth meter with automated temperature compensation, accuracy rate is 1/10 m.

The calibration of the depth meter was carried out in the depths ranging from 1 to 5 m, by a rod scaled 2 cm, in the depths bigger than 5 meters. A lead weight hanging on a rope from a winch was used equipped with a counter that is of the accuracy of 1 centimetre. The data of the ultrasonic depth meter are equalling the measured decimetre values. The distance between the verticals of depth measurements was 2 m.

The number of the verticals was 7, the number of the measurement points per vertical was 10, and the distance between points was not the same. The duration of the measurements was 40 sec each.

The type of the velocity meter was M1, signalling every turn, signal produced electro-mechanically, the counting done by electronic counter. Hanging from ϕ=4 mm wire rope with a 35 kg weight, moving by a winch with a display of 1 cm accuracy. Data stored in hand-written protocol.

2.2.2. Bed Load Sampling

It is already impossible to discover, what method was used for sampling between the years 1951-65 in the main riverbed. Both bottle and pumping methods were used, the equipment and the size has changed more times. Nowadays ADUVIZIG uses pumping in most of the cases, but, sometimes they also have used an OTT brand electronically semi-automatic sediment sampler. Since the methods were not the same and the documentation was not always appropriate, the errors in data processing can be increased.

2.3. Results

2.3.1. Discharge Measurement

The processing of the results of the measurements was carried out on PC using the VÍZHOZAM software. We provide the summarised results as a board in appendix no. 2.
We have, using the data obtained, determined the relations between the water level and the discharge in the Vén-Duna side branch, and we present it as a graph in appendix no. 3.

The curve of the relation was achieved using the method of minimal squares, and can be described by the equation below:

$$Q= A^* (H-H_k)^n$$, where

A is a multiplicative constant=8,29E-09
H_k is the water level of the limit of flowthrough=320 cm (Baja gauging station)
n is an exponential constant=4,117122

2.3.2. Bed Load Sampling

In the section of discharge measurements on the main bed of the *river Danube at Baja, sediment* sampling was executed 110 times in the period from 1951 to 1965, and two times in 1998. The section in question is located 200 m downstream from the downstream throat of the Vén-Duna branch (1480,6 river km). Bogárdi János has studied the sediment transport of the river Danube. The sediment discharge calculated by him is shown on picture no. 1. The discharge-suspended sediment concentration curves, obtained from the collected data are shown on picture no. 2. Here we also give the data measured in 1998. For understanding these results we also have to mention, that, not far upstream of the section of the measurement industrial dredging was executed in 1998. For better understanding we also indicate on picture no. 3. the discharge curve calculated from the discharge measurements' results between 1992 and 1997.

Figure 2. Hydrograph of the Danube at Baja (1997)

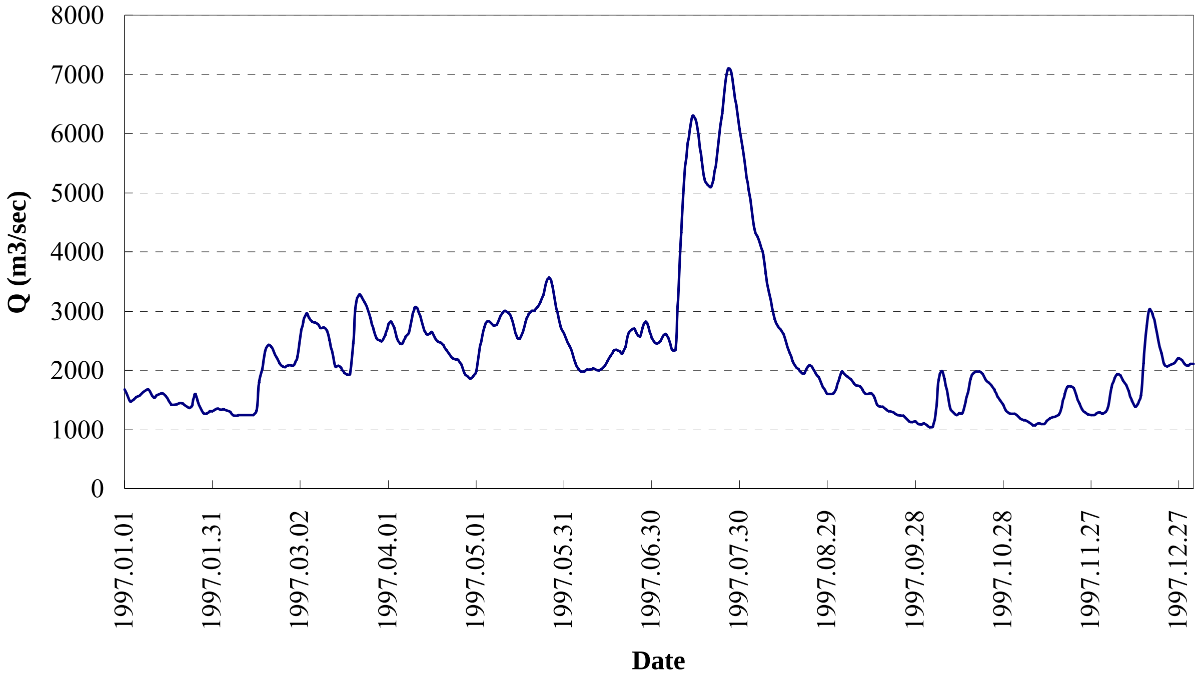
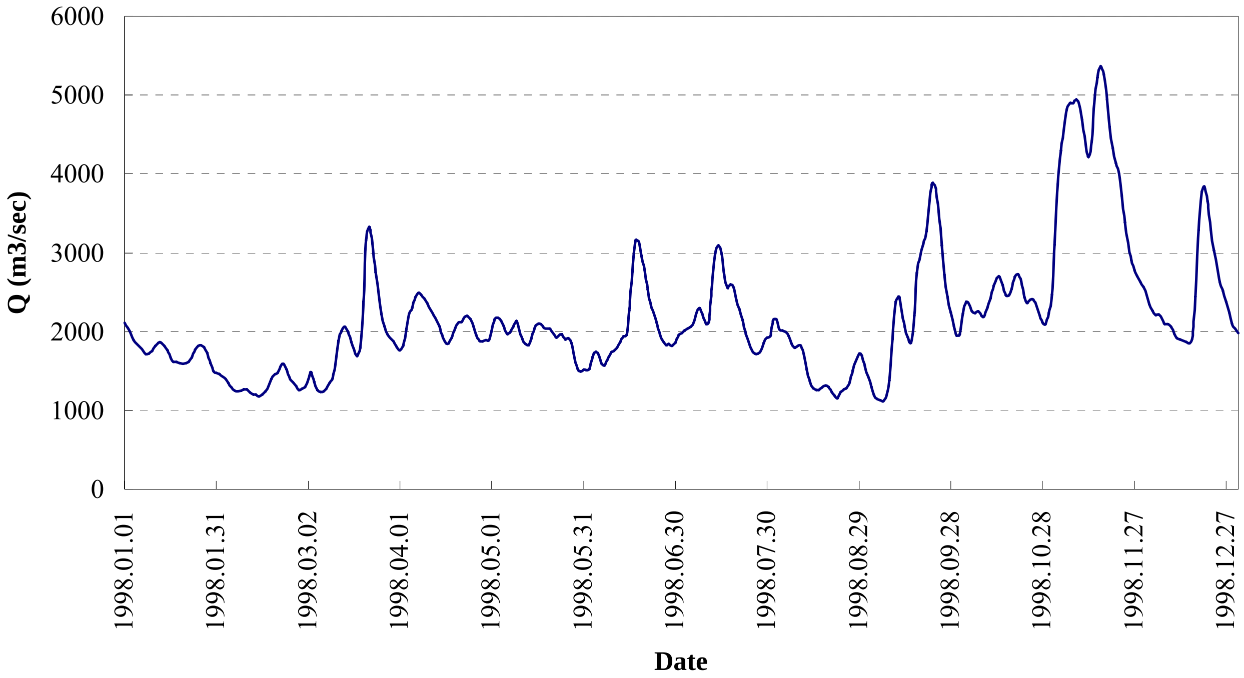


Figure 3. Hydrograph of the Danube at Baja (1998)



3. Morphology

Author: J. Sziebert

3.1. Introduction

Partial opening of the closing cross dam in the side branch and dredging certain stretches of it are to be executed in 1998 as the first steps of the restoration of the water system of the Vén-Duna side branch and the connected floodplain parts. The survey of the side branch is not only intended to describe the flow conditions and to record the riverbed morphology, but also to determine the conditions of sediment transport. According to discussion with the project co-ordinator and verbal agreement the undertaker started working in February and March 1998.

3.2. Methods of the survey

According to field studies and previous riverbed surveys 13 cross-sections have been established on the left side, by indicating the direction and the starting point with two horizontal and vertical point signs at each location (15x15x60 cm triangle-shaped stones).
The definition of the co-ordinates of the point signs have been executed by an electronic tachometer. Computer has done the calculation of co-ordinates, the depiction have been made in the ITR system. The defined co-ordinates are according to the Unified Hungarian System, the defined levels are according to the Baltic Sea level.

3.2.1. River Bed Survey

Determination of bed bottom points

Method of the survey: wet cross section, floating boat in the riverbed, depth measurement and horizontal positioning at the same time. On dry parts of the sections are records of the significant points by tachometer.

Depth measurement

Equipment: ultrasonic depth meter, with automatic temperature compensator. Display accuracy 1/10 meter. Calibration of depth meter: In the depths of 1 to 5 meters by a rod divided each 2 centimetres, in the depths bigger than 5 meters by a lead weight hung on a rope from a winch equipped with a counter that is of the accuracy of 1 centimetre. The data of the ultrasonic depth meter equal the measured decimetre values.

Comparative level: the mean water level of the surveyed area calculated during the measurements. Downstream the cross closing dam the water levels belonging to the 1480,8 flow km, upstream from it the water levels measured at the 1483,4 flow km are used.

Positioning

The horizontal positioning of the depth measurement points was done by an electronic tachometer, measuring polar co-ordinates, by shooting at a round shaped prism placed at the vertical of the depth meter, at the same time with the recording of the water depth.

Density of the recorded points: using the possibilities provided by the measuring boat floating freely on the water surface in order to improve the information contents of the results sometimes we executed denser measurements according to the changes in the bed morphology (at the throats to the main bed, the throat of the Cserta-Duna, and the stretch downstream from the cross closing dam).

3.2.2. River Bed Sampling

Having agreed on the number and location of sampling points with VITUKI Co., we defined these to be sufficient and significant for the description of the present status. The number of the sampled cross-sections is 12, the number of sampled points is 5 by each cross-section at equal distances, and we have taken some more sampling points in the supposed line of the main flow of the side branch like a longitudinal section. Total number of sampled points is 95. Average density of sampled points is 4 point/acre.

The equipment used was Van Veen type sampler, applied from a boat, hung down by a convenient rope from a winch. We have recorded the location of each point and the water depth during sampling.

3.3. Results

3.3.1. River Bed Survey

The measured data are given as altitudes according to Baltic Sea level, and horizontal data according to the Unified Hungarian State Co-ordinate System.. Mapping M = 1:2500 and M = 1:1000, depicting leveller lines, data given on digital carriers. A PC computer using an interactive mapping system did the processing of the obtained data. The bed bottom points are displayed indicating their altitudes according to Baltic Sea level, and horizontal data according to the Unified Hungarian State Co-ordinate System. Leveller lines drawn by interpolating each meter's altitudes between the measured points of the bed by a software, and displayed in the given ratios.

3.3.2. River Bed Sampling

The analysis of the samples have been executed by screening and by hydrometer method depending on the size of the grains. We have depicted our results as grain size distribution diagrams for each section. The analysis of the samples according to the grain distribution was executed by mechanical or hydrometric method.

When using hydrometry, the determination of the co-ordinates of the points of the grain distribution curve was done according to the Stokes-equation.
Determination of weight percentage:

$S\% = f*(R \pm m)*\frac{100}{m_s}$, where

- m_s - is the dry weight in grams
- R - is the value read on the Papfalvy-equipment
- f - is a correction of density
- m - is a correction of temperature

Determination of the diameters of the grains: according to (R±m), as a function of the time, from a board. We have depicted the results on grain distribution curves.

4. Water quality

Authors: dr. Csányi B., dr. László F.

4.1 Introduction

A baseline survey of macrocomponents, nutrients, inorganic and organic micropollutants was carried out in the Vén-Duna, Nyéki-Duna and Danube main channel in 1997 and 1998 prior to the reopening of the dam. The aim of the investigations was to evaluate the quality of water and sediment in the above noted Danube arms. Although the investigation of the Cserta-Duna was planned in the beginning of the project, there was no water in this smaller side arm during the sampling period of September-November 1997. The investigation of the Nyéki-Duna was dropped out of the further monitoring program due to financial reasons.

4.2 Material and method

Water and sediment samples were taken simultaneously with the hydrobiological studies (Figure 1). During the first sampling campaigne (19 September 1997) water and sediment samples were taken from the Vén-Duna at sites 1, 3, 4 (u/s, middle and lower section of the side arm), from the Danube at 1482,5 river km (site 6) and from the middle part of the Nyéki-Duna (site 8). The samples were taken from the Nyéki-Duna on the 4th of November.

Another two series of water samples samples were collected in the Vén-Duna (sites 1,2,3,4), and in the Danube (site 6, see Figure 1) prior to the reopening: in April and July. The sediment was sampled only in April 1998.

Approximatelly 2 l of water samples were taken at each site from the surface of the water body. An Ekman-Birge grab sampler was used for the sediment sampling. Approximatelly 5-10 cm thick sediment layer was grabed from the middle of the Vén-Duna and from a silent water body of the River Danube below a rock bar. The sample was put in a glass jar and taken to the laboratory in the same day. The analysis was carried out on the next day, after its storage in refrigerator. The standard methods applied during the analysis are written in the series of standards MSZ 318 and the accredited individual method of ÁVL-5 referring to the sediment investigations.

Analysis was done on the next day after storing samples in refrigerator also. The following standards were used during the analysis:

the standard series of MSZ 448, MSZ 12750;
standards of MSZ ISO 7150-1;
MSZ ISO 5813;
and the accredited individual methods of ÁVL-2 and ÁVL-4.

4.3 Results

The results of the measurements of the water quality variables are listed in Tables 4.3.1-4.3.3 (Appendix). The series of the results of the chemical samples collected on 19 September clearly indicate that the flow through the Vén-Duna was lacking that time. The values of several components measured in the Danube (site 6) were very different from that of the Vén-Duna (TOC, Nitrate, Total N,Chlorophyll-a). This phenomenon indicates that stagnant water periods inducate eutrophycation in the side arm (Table 4.3.1).

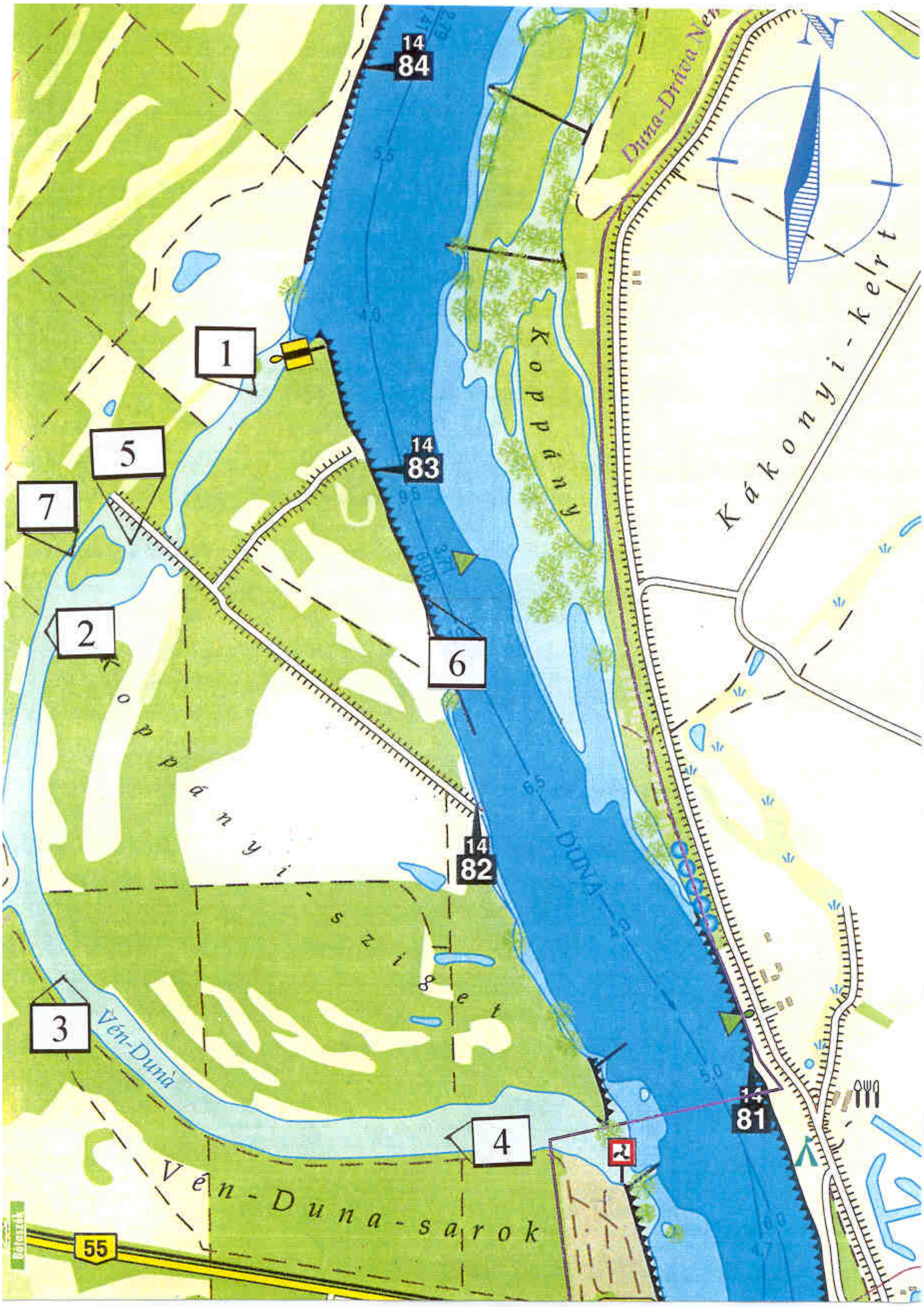


Figure 1. Map of the Vén-Duna indicating the sampling sites

Some of variables of the samples collected on 15 April 1998 (Table 4.3.2) shows different values measured in the Danube and different locations of the Vén-Duna (Specific conductivity, suspended solids, TDS, COD, Chlorophyll-a) but generally the amount of other biotic elements is not very different from each other (Nitrite, nitrate, total N, orthophosphate P). However, stagnant water period was experienced on the side arm at that time.

In July 1998 the water level of the side arm increased up to the upper level of the dam resulting in a very stron flow through the narrow opening. The velocity of the water flow in the opening was very large (approximatelly 2 m/sec). This velocity was considerably smaller in the further downstream sections but a very well defined through-flow was observed that is shown in the values of the different physical and chemical components in Table 4.3.3.

According to the results of the analysis carried out in September 1997, the sediment was rich in organic carbon and nutrients (Table 4.3.4, 4.3.5), especially the fine particle size sediment in the side arms. The concentrations of the analyzed toxic micropollutants (heavy metals, atrazine, PCB-s, PAH-s) are below the ”severe effect level”.

The analyzed toxic heavy metals were in low concentrations at all sampling sites. Their concentration level in the water does not threaten the ecology of the studied Danube arms.

Aktinit PK (atrazine) is the representative pesticide in the river water in this region. Atrazine was in insignificant concentration in the water samples. Oil is typical pollutant along the Danube. Its concentration was rather high in the main arm. The analyzed sediment samples represent the composition of the surface layer (upper 5 cm) of the river bed. The grain size distribution indicates dominantly sandy, silty sediment composition.

4.4 Discussion

Based on the base-line study it can be concluded that there were no significant amount of toxic micropollutants in the aquatic and sediment phase of the investigated region. Thus, according to our expectations, the grain size distribution of the side arm after the dam reopening is going to be changed towards larger sediment particles which contain generally lower amount of micropollutants. Therefore both the results of the analysis and the forecasting show that the importance of the micropollutants in the investigated area is not significant. The hydrochemical monitoring should focus on the macrocomponents (inorganic nutrients causing eutrophication) in the water body, as it was decided in the proposal formulated in the beginning of the project already.

5. Ecology

Authors: Németh J. (phytoplankton), Gulyás P. (zooplankton), Csányi B., Juhász P. (macrozoobenthon), Vida A. (fish), dr. Felföldy L. (botany)

5.1 Introduction

The Vén-Duna situated in Gemenc has serious water supply problem due to navigation improvements and flood defence installations. Beside of the main channel regulation, a rock dam was built in the upper section of the Vén-Duna (approximately 800 m from its inlet) in order to inhibit water transport through the side arm during middle and low flow conditions. The regulation works resulted in the permanent upfilling process of the side arm together with several adverse ecological changes in the Vén-Duna side arm.

A rehabilitation program was started in 1997 as a scientific cooperation between the Institute of Inland Water Management (RIZA, The Netherland) and some Hungarian research institutions (Eötvös József High School, Water Resources Research Centre Plc., Hungary) in order to improve the ecological state and biotic value of this side arm. The eciological monitoring is carried out by the Hydrobiologist Group of the VITUKI Plc. with special attention to the changes of planktonic, benthonic and fish communities.

This base-line report summarises the results of the monitoring carried out during the first period of time, before the reopening of the side arm. The reopening of the rock dam of the Vén-Duna was finalised only around 20th of August 1998, du to the unusually long lasting low water level on the River Danube. The investigation of the Nyéki-Duna was included in the beginning of the program (1997 autumn) only. As a consequence of financial reasons the further monitoring program was focused on the Vén-Duna and the River Danube.

5.2 Material and methods

Different habitat types occurred in the three investigated water bodies. The littoral zone of the River Danube is characterized by the large basalt rocks that were put on the shore line against bank erosion. The 3 km long side arm of the Vén-Danube is a predominantly lenitic (stagnant) water body with considerable amount of fine sediment layer on the bottom. The Nyéki-Danube is also lenitic, shallow water body with fine sediment particles, large area of the old arm is covered by *Typha latifolia* and *Phragmites australis* belt. The open water contains several submerged aquatic weed species. Both the pelagic and the bottom habitats were sampled during the autumn period.

Referring to the side arm of the Vén-Duna and the main river arm altogether the results of three series of sampling campaigne is summarized in this base line report prior to the reopening (19.09.97,15.04.98, 14.07.98). Due to the muddy bank around the Nyéki-Duna during low water period, the sampling program in this site was postponed from September to the beginning of November. The list of sampling sites of the water quality and ecological monitoring program are indicated in Table 5.2.1.

Table 5.2.1 List of the sampling sites and sample types during the baseline study (CH=chemistry; P=phytoplankton; Z=zooplankton; M=macrozoobenthon; F=fish)

No.	Localities	Date	Sample
1	Vén-Duna: u/s section (between the Danube and the rock dam)	19.09.97,15.04.98, 14.07.98,	**C, P, Z, M**
2	Vén-Duna: u/s section (600 m below the rock dam)	19.09.97,15.04.98, 14.07.98,	**C,P, Z, M, F**
3	Vén-Duna: middle section (400 m d/s Cserta-Duna confluence)	19.09.97,15.04.98, 14.07.98,	**C, P, Z, M**
4	Vén-Duna: d/s section (200 m u/s the lower confluence)	19.09.97,15.04.98, 14.07.98,	**C, P, Z, M**
6	Danube: u/s Baja (1482.5 river km)	19.09.97,15.04.98, 14.07.98,	**C, P, Z, M, F**
5	Vén-Duna:water body 10 m d/s the dam	15.04.98,	**M**
8	Nyéki-Duna	04.11.97	**C, M**

Altogether five sites on the 4.1 km long Vén-Duna (1, 2, 3, 4, 5), one site on the Danube (6), and one in the Nyéki-Duna (8) were investigated during the baseline study. The location of the sampling sites is indicated on the map of the Vén-Duna side arm, as well (Figure 1).

Sampling site 1 is situated in the upper section of the Vén-Duna, approximatelly 300 m d/s the upper end (inlet) where predominantly fine sediment fraction is available. Gravel bars are occasionally present, too.

Sampling site 2 is the sampling point 600 m d/s the rock dam (at approximatelly 1.4 km from the inlet), **sampling site 3** is the middle-lower section of the side arm, approximatelly 2.3 km d/s the inlet, and, **sampling site 4** is just 300 m u/s the lower Danubian confluence (outlet).

Sampling site 5 lays immediatelly after the rock dam where enormous depth of water (around 10 m) was measured. The river bed material was washed away during high floods, due to the strong current. This sampling site was included in the monitoring network because the study of the benthonic animals living in such depth of a Danubian side arm seemed to be interesting. Therefore we decided that later on this site will be regularly checked during the monitoring program. Only macrozoobenthon samples were taken from this site with the help of the Ekman-Birge grab.

The River Danube was sampled at 1482.5 river km as **sampling site 6** that is situated between the inlet and outlet (d/s confluence) of the Vén-Duna.

During 1997, one sampling site of the Nyéki-Duna was included in the program also (**sampling site 8**).

Phytoplankton samples were taken from the surface of the open water bodies of the investigated river sections. All of the samples were fixed and preserved with Lugol`s - iodine and formaldehyde respectively. Volume of the samples were 40 cm^3. The population density of the planctonic algal communities as well as the relative abundances of the particular taxa were estimated by counting with an Opton-type Utermöhl invertoscope using sedimentation chambers of 2 cm^3 in volume (NÉMETH and VÖRÖS 1986).

The dominance conditions based on cell number was expressed by the following logarithmic interval scale (Table 5.2.2):

Table 5.2.2.

Relative abundance class	Range	
	Rate (ind.numb. of a given taxon/total numb.)	‰
1	0-1/16	0-63
2	1/16-1/8	64-125
3	1/8-1/4	126-250
4	1/4-1/2	251-500
5	1/2-3/4	501-750
6	3/4-7/8	751-875
7	7/8-15/16	876-938
8	15/16-1	939-1000

The population density of phytoplankton can be used for the evaluation of the actual trophic state (FELFÖLDY 1987) of a given water body (Table 5.2.3).

Zooplankton samples were taken by bucket with 10 l of volume form the water surface at each site. 50 l volume of water was filtered through a zooplankton net with 70 µm mesh size. The filtrate was conserved on site with Lugol-iodine solution. Quantitative sample assessment was made using an Utermöhl invertoscope in sedimentation chambers of 5 cm^3 in volume. Population density values are expressed as ind/100 l, and biomass according to BOTTRELL et al. (1976) in wet weight as mg/m^3.

Table 5.2.3. The actual trophic state after FELFÖLDY (1987) on the basis of the population density of phytoplankton

Trophic class		Population density (10^6 ind/dm^3)
0	atrophic	0
1	ultra-oligotrophic	< 0.01
2	oligotrophic	0.01 - 0.05
3	oligo-mesotrophic	0.05 - 0.10
4	mesotrophic	0.1 - 0.5
5	meso-eutrophic	0.5 - 1.0
6	eutrophic	1 - 10
7	eu-polytrophic	11 - 100
8	polytrophic	101 - 500
9	hypertrophic	> 500

Qualitative kick samples were collected in the Vén-Duna, the River Danube at 1482.5 river km (between the inlet and outlet of the Vén-Duna), and the Nyéki-Duna to investigate the **macroscopic invertebrate community** in September and November 1997, April and July 1998 (see Table 5.2.1). Kick samples were taken with the FBA pond net from the characteristic habitat types of the River Danube and the side arms. The River Danube has stony litoral zone and sandy bottom, the Vén-Duna side arm is filled up by thick sediment layer along its whole lenght consisting of fine particles and fine sand fraction, as well (see chapter 2 and 3). Approximately 10 m of the litoral section was kicked for 5 minutes at each site in order to collect the benthic organisms.

Quantitative macroinvertebrate samples were taken with the help of an Ekman-Birge grab sampler in the profundal region for estimating the abundance of the dominant bottom dwelling taxa. A Hargrave sampler was used in cases when the Ekman grab was not functioning well, due to the slopy, hard substrate. Three cross sections (site 1,3,4) were sampled in April 1998, three sites (right, middle, left) of the cross section (each of them containing 3 sub-samples) were grabed by the Ekman-Birge sampler. Samples were handled separately, the number of individuals of each sample were taken for the estimation of abundane at ech locus.

Individual numbers of taxa/m^2 were calculated at the sampling cross sections. The sampling was carried out during low water discharge conditions. Qualitative kick sampling in the Nyéki-Duna was carried out in the beginning of the winter when the bank side was dryer than before, and, the water body was accessible by foot.

Sampling of the **fish fauna** at eight sites of the side arm was performed with an international standard electric fishing equipment (EFKO 1500 type, portable, direct-current produced by an aggregator) that was applied from motor boat. According to the electric conductivity, 300-600 V and 2-10 A impulses were produced for the fishing in the Vén-Duna ***(VD1-VD6)***, at the downstream confluence ***(T1)***, in the Danube ***(D1)***, respectively.

The size of sampled sections (m^2) were chosen according to the habitat diversity in order to achieve representative catch at the given site. Larger areas were sampled in the homogenous sections, and smaller areas were investigated in the variable ones, having changing habitat structures, respectively.

The captured specimens were released back to the water after the taxonomic determination. Some species were determined in the laboratory (ie. *Petromyzontidae, Neogobiidae*) after conservation, using 4 v/v% formaldehide solution. Later on these species were provided to the Fish Collection of the Natural History Museum of Budapest.

5.3 Results

5.3.1 Phytoplankton

Detailed taxon lists due to their size are presented in the Appendix (Table 5.3.1.1, 5.3.1.2, 5.3.1.3). Only the summarised taxon lists indicating the dominant taxa are showed in this Report (Table 5.3.1.4, 5.3.1.5 and 5.3.1.6, respectively). The density of the phytoplankton community (Table 5.3.4) in the Danube upstream Baja (D) was 87 600 i/ml, having the dominant *Sceletonema* (4) and *Coscinodiscaceae* (3) species belonging to the group of *Centrales*.

The immediate effect of the River Danube is indicated by the big ratio of the *Sceletoma* (3) and *Coscinodiscaceae* (2) species in the upper section of the Vén-Duna (site 1) that is connected to the Danube. Several *Peridinium* species (3) are responsible for the red-brownish coloration of the water in this section. The phytoplankton stock is characterised by 99 800 i/ml value.

Table 5.3.1.4 Population density and relative abundance classes of dominant phytoplankton taxa in the Vén-Duna (1-5), River Danube (6) and Nyéki-Duna (8), 19.09.1998

	1	2	3	4	5	6	8
Cell number	99800	79400	248400	85200	89400	87600	57600
Dominant taxa							
Cryptomonas spp.							**1**
Peridinium spp.	**3**						
Synura uvella		**5**	**7**	**7**	**4**		**6**
Dinobryon spp.					**4**		
Sceletonema spp.	**3**					**4**	
Centrales spp.	**2**					**3**	

The largest density of the phytoplankton (248 400 i/ml) caused also by *Synura uvella* (7) was measured in the middle part of the side arm (3). This taxon formulated almost 90 % of the whole community.

The lower section of the side arm (site 4) was very similar to the site 5 in individual numbers (85 200 i/ml). The taxon *Synura uvella* (7) dominated the phytoplankton here but in a rich community with several euglenoid flagellates, *Peridinium species,* and *Ceratium hirundinella* occurred here, as well.

The Nyéki-Duna (site 8, NYD) had the lowest community density (57 600 i/ml) with also *Synura uvella* (6) dominance. The low community density of the phytoplankton was caused probably by the competition of the rich benthonic eutrophication (dense macrophyton stock of *Typha angustifolia* and *Phragmites australis*) in this oxbow, and, the simultaneous seasonal effect (late autumn).

The sampling site 5 forming an isolated bay in the water body is situated 10 m downstream the rock dam, and contained mostly *Dinobryon* species (4) with the individual number of 89 400 i/ml. Site 2 is 600 m downstream the dam and had also stagnant water in autumn. The population of the species *Synura uvella,* a colony-forming yellow alga was dominating (5), with the 79 400 i/ml abundance value.

The most eutrophic middle section of the Vén-Duna belonged to the polytrophic (8) class on the 10 degree ranged trophity scale according to FELFÖLDY (1987). Based on the results of the phytoplankton community study, other sampling sites of the Vén-Duna, the River Danube and the Nyéki-Duna belonged to the eu-polytrophic class (7).

Table 5.3.1.5 Population density (i/ml) and relative abundances of the dominant phytoplankton taxa in the Vén-Duna (1-4) and River Danube (6), 15.04.1998

	Number of sampling sites				
	1	2	3	4	6
Cell number	**69500**	**45000**	**95500**	**35300**	**48500**
Dominant taxa					
CYANOPHYTA					
Anabaena spp.			1		
Microcystidaceae spp.		1			
Pseudanabaena spp.	1	1			
EUGLENOPHYTA					
Euglena spp.			1		
PYRROPHYTA					
Cryptomonas spp.	1	1	1	1	1
Rhodomonas spp.	1	1	1	2	1
Peridinium spp.			1		
CHRYSOPHYCEAE					
Dinobryon sp.		1	1	1	
Synura spp.		1	1	1	
DIATOMOPHYCEAE					
Coscinodiscaceae spp.	5	3	1	2	6
Asterionella formosa	1			1	
Nitzschia cf. acicularis + Synedra cf. acus	1		4	1	
Nitzschia (Lanceolatae) spp.	1	1			
Synedra spp.	1	1			
Pennales spp.					1
CHLOROPHYCEAE					
Volvocales spp.		1		1	1
Chlorococcales spp.	1	1	1	1	2
Actinastrum hantzschii		1			
Ankistrodesmus acicul. var. acicularis			1		
Ankistrodesmus angustus	1	3	3	1	1
Hyaloraphidium contortum		1	1		
Kirchneriella spp.				1	
Lagerheimia genevensis	1	1		1	
Scenedesmus spp.		1	1		
Treubaria triappendiculata		1			
Koliella longiseta	1		3	1	1
FLAGELLATAE					
Flagellatae spp.	1	3	1	5	1

Table 5.3.1.6 Population density (i/ml) and relative abundances of the dominant phytoplankton taxa in the Vén-Duna (1-4) and River Danube (6), 14.07.1998

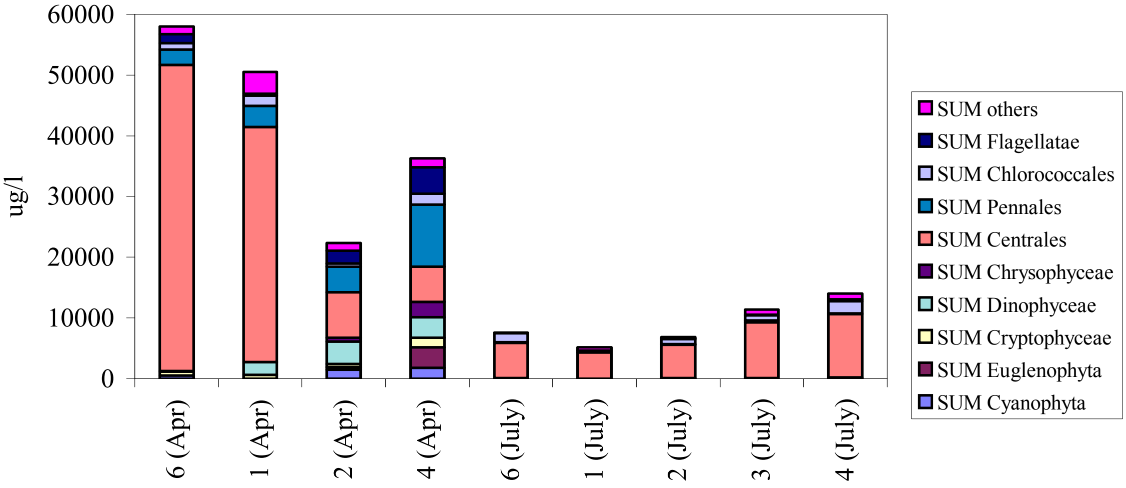
	Number of sampling sites				
	1	2	3	4	6
Cell number	**15500**	**34000**	**65000**	**82000**	**33000**
Dominant taxa					
CYANOPHYTA					
Aphanocapsa sp.					1
Merismopedia sp.					1
Rhodomonas spp.		1		1	
DIATOMOPHYCEAE					
Sceletonema spp.	4	4	4	5	4
Coscinodiscaceae spp.	4	2	4	4	3
Melosira granulata		1	1	1	1
Asterionella formosa		1			
Nitzschia cf. acicularis + Synedra cf. acus				1	
Nitzschia (Lanceolatae) spp.		3	1		2
CHLOROPHYCEAE					
Chlorococcales spp.	2	1	2	1	2
Ankistrodesmus acicul. var. acicularis					1
Ankistrodesmus angustus	2	1	1	1	1
Crucigeniella apiculata				1	
Chodatella quadriseta				1	
Dictyosphaerium spp.			1		
Didymocystis planctonica				1	
Golenkinia radiata					1
Hyaloraphidium contortum				1	
Kirchneriella spp.		2	1		2
Micractinium pusillum				1	
Pediastrum boryanum				1	
Scenedesmus spp.	1	1	1	1	1
Schroederia setigera	1				1
Schroederia spiralis		1			
Tetraedron incus			1		1
Tetrastrum punctatum				1	
Tetrastrum staurogeniaeforme		1			1
Koliella longiseta		1			
Closterium sp.					1

Based on the spatial changes of the phytoplankton biomass data the results of the three sampling campaigne are compared to each other (Figure 4).

The biomass of the phytoplankton in the Danube in April 1998 was very high, according to the spring time *Centrales* mass productions. There was an isolating sand bar, a separated water body (site 5) and the rock dam between sites 1 and 2, resulting in the individual character of the phytoplankton community during this time that can be seen on the diagram well.

In contrast, the picture of the full flow through the side arm can be recognised in July.

Fiure 4. Spatial and temporal changes of the phytoplankton biomass. Danube and Vén-Danube, 1998.



5.3.2 Zooplankton

The taxon lists of the zooplankton investigations are presented in the Appendix (Table 5.3.2.1-5.3.2.6) among the other lists containing results in table form. The species composition and the abundance of the Rotatoria and Crustacea plankton as number of individuals per 100 l (Table 5.3.2.1) and biomass data as mg wet weight per 100 l at various sampling sites (Table 5.3.2.2) clearly indicate the eutrophic state of both the side arm and the River Danube during 19.09.1997.

There was a long-lasting small flow discharge following the flood in August 1997 in the River Danube, resulting in the absence of flow in the Vén-Duna. The effect of the low discharge on the zooplankton community structure in the side arm is well indicated by the summarized quantitative (abundance and biomass) data (Table 5.3.2.7 and 5.3.2.8).

Table 5.3.2.7 Zooplankton abundance (number of individuals per 100 l) during the preliminary study at various sampling sites

	Sampling sites					
Date	**1**	**2**	**3**	**4**	**6**	**8**
19.09.1997	16513	-	282520	347502	838	20872
15.04.1998	3010	10060	10550	9670	1308	-
14.07.1998	290	2152	12258	5282	312	-

Table 5.3.2.8 Zoolpankton biomass (mg/m^3) during the preliminary study at various sampling sites

	Sampling sites					
Date	**1**	**2**	**3**	**4**	**6**	**8**
19.09.1997	2378	-	46103	25545	152	2392
15.04.1998	446	1771	2791	3004	395	-
14.07.1998	55	415	5480	1046	109	-

The results of the first zooplankton sampling indicate that both the abundance and biomass values are increasing along the side arm of the Vén-Duna. The individual numbers have increased from 17 000 to 350 000 individuum/100 l. This maximum value occurred at site 4, near the outlet of the side arm. The biomass also increased from 2400 mg/m^3 to the maximum value of 46 000 mg/m^3 also at site 3, that was modified to 25600 mg/m^3 at the lower end of the side arm. There were much lower values measured in the neighborhood of the side arm, at 1482.5 rkm in the Danube (800 individuum/100 l and 150 mg/m^3, respectively).

The side arm section contained mostly eutrophic species in the autumn of 1997 during low water period. The taxon list of Table 5.3.2.1 includes those dominant Rotatoria species (*Brachionus angularis, B. calyciflorus, B. diversicornis, Filinia longiseta, Keratella cochlearis, Pompholyx complanata*) and Crustacea species (*Bosmina longirostris, Acanthocyclops robustus, Thermocyclops oithonoides*), that occur mostly in eutrophic and polytrophic lenitic waters in Hungary. Such figures are characteristic for fish ponds, and, in low water discharge period to the side arms of the river that have no further direct contact to the main channel. The zooplankton abundance in the Nyéki-Duna indicates eutrophic conditions, as well (20900 i/100 l and 24000 mg/m3). The individual character of this isolated side arm may explain this phenomenon.

The lack of flow through the Vén-Duna was experienced during the sampling campagne in 15 April 1998, too. The abundance of zooplankton in the Danube (1300 i/100 l) changed to 3000 in the first section of the side arm and increased to 10 000 further on. Approximately this value was measured at the lower end of the Vén-Duna (site 4) also.

The only flowing hydrological situation was found during 14 July when a medium flood was seen in the area (~ 3000 m^3/sec). In spite of this fact the zooplankton community has increased
its abundance and biomass. The maximum abundance of the zooplankton was observed at site 3 at this time (12 300 i/100 l, and 5500 mg/m^3 biomass). The abundance values of the zooplankton community did not indicate well the change of the hydrological conditions (i.e. stagnant and flowing periods).

5.3.3 Macrozoobenthon

The qualitaive and quantitative results of the investigated four cross section in the Vén-Duna and one of the Danube sampled during the preliminary period are discussed in this chapter. Altogether 29 macroinvertebrate taxa were detected in the study area during the sampling program of 19 September 1997 (Table 5.3.3.1 in the Appendix). Very similar faunal results were found during the other two sampling campaigne, too. More taxa are presented in the list of samples taken in April 1998 (47) because the collected Chironomids were determined taxonomically by Kálmán Bíró (Schwitzerland).

In this lower Hungarian Danube three *Mollusca* species characterize the typical Danubian edge community of the lotic habitats: *Dreissena polymorpha, Radix ovata, Sphaerium corneum*. Three three leech species were detected *(Dina lineata, Erpobdella octocullata, Helobdella stagnalis*), the last one is only occasionally found in lotic conditions. The *Malacostraca* group was represented by one species only (*Dicerogammarus villosus*), a frequently found taxon in the River Danube along the entire Hungarian stretch. Only two insect taxa were found in the Danube during the autumn period. The list was completed during spring and summer time with some other organisms (Table 5.3.3.2 and 5.3.3.3).

The periodic change of lotic and lenitic conditions in the Vén-Duna side arm result in homogenous habitats along the whole section because this arm is situated in a low land area. Upstream the dam gravel bars are frequently found with several elements of the Danubian community. The whole section downstream the rock dam contains homogenous fine sediment layer as the only available habitat type for macroinvertebrates in each cross section. Altogether 19 taxa were determined in the investigated section of the Vén-Duna. Five *Unionidae* species are present in the muddy bottom. *Anodonta anatina* was found at each sites and ech sampling time, together with the *Viviparus acerosus* snail species. *Sinanodonta woodiana, Unio pictorum* and U. tumidus were detected in different sites (1, 3, 4, 5). *Pseudanodonta complanata* was present in site 1, 3, 4. *Dreissena polymorpha* inhabits solid surfaces everywhere in the side arm, similarly to the River Danube.

Leeches (*Erpobdella octoculata, Glossiphonia complanata*) and one *Malacostraca* taxon (*Dicerogammarus villosus*) were characteristic in autumn 1997 only to the uppermost sampling site of the Vén-Duna and the River Danube, respectively. In April 1998 an interesting and rare leech species was detected in the lower end of the Vén-Duna (*Glossiphonia paludosa*). The amphipod Crustacean taxon (*Dikerogammarus villosus*) occurred later on in the other locations of the side arm together with the common and widespread ponto-caspic species *Corophium curvispinum*, too. *Oligochaeta* and *Chironomidae* taxa are the most abundant organisms in the Vén-Danube occuring in each sampling sites in high density. *Chaoborus crystallinus* (site 3, 4) was detected in the lower arm section, *Platycnemis pennipes* in the site 1 and in the Danube also, as a characteristic eutrophic *Odonata* species. The aquatic macroinvertebrate fauna collected in the Nyéki-Danube consists of 11 taxa. *Radix ovata, Chironomidae* sp. and *Platycnemis pennipes* are those organisms that occurred in the River Danube, as well. The species group of *Mollusca* (*Acroloxus lacustris, Lymnaea stagnalis, Planorbarius corneus*) and *Insecta* (*Cloeon dipterum, Coenagrionidae sp., Parapoynx stratiotata, Sigara striata*) represents a typical stagnant water body.

Several empty shells of the Molluscs are shown in the taxon list (Table 5.3.3.2) due to the large number of grab samples taken for the quantitative data collection. Three large aquatic beetle species were also detected at the site 4 during the spring time (*Acilius sulcatus, Cybister laterimarginalis, Hydrous piceus*).

Quantitative results indicate that the most abundant taxa living in the Vén-Duna side arm are the *Oligochaeta* and the *Chironomidae* taxa. Table 5.3.3.4 illustrates the quantitative data of these two groups as the dominant organisms in the sediment of the Vén-Danube. The data are based on the grab samples collected on 15 April, 1998 in three cross sections (see 5.2 chapter, p. 15). Data of of the taxa in the same table means presency only.

The results show well that the kick samples contain more species than the grabbed ones due to the relatively much larger area of sampled sediment surface during kicking. Table 5.3.3.4 indicates that only four Mollusca species (Anodonta anatina, Dreissena polymorpha, Unio pictorum, U. tumidus) were detected by the Ekman grab. There were altogether 15 midge fly species among the Insecta group representing the *Chironomidae*. Only one other insect taxon (*Chaoborus crystallinus*) was found in the benthonic community using the grab sampling method.

The largest number of *Oligochaeta* taxa was experienced in the middle and lower cross section (site 3) whereas the most abundant location in *Chironomidae* taxa was found in the middle part of the arm bed in the first cross section (site 1 *see numbers with italics*).

Table 5.3.3.5 Abundance of the dominant taxa as number of individuals/m^2 at various sampling sites, 15 April 1998

Sampling sites	***Oligochaeta*** **Location in the cross section**			***Chironomidae*** **Location in the cross section**		
	right	middle	left	right	middle	left
1	4725	3140	2251	148	*1185*	430
3	*11066*	*10606*	*18339*	89	267	133
4	7969	1585	*17021*	474	59	74

It can be stated that these organisms are very abundant at those sites where the fine sediment with high organic material is available for them. Such kind of side arms as the Vén-Duna have many appropriate habitats for the bottom dwelling taxa. Figure 5 shows the longitudinal distribution of the average particle size of the Danube bed material, Figure 6 contains the summarised taxon number of the lower Hungarian Danube, based on former Danubian studies (CSÁNYI 1998).

The average particle size is very small downstream Paks in the lower Hungarian Danube section. The number of benthic taxa registered through the same river stretch is also decreasing downstream. Summarising the results of the preliminary macrozoobenthic study it can be concluded that the macrozoobenthic communities of the lower Hungarian Danube and the Vén-Duna side arm are not as rich as the flood plains of the Danube in its upper sections (i.e. Szigetköz). Mostly stagnant and eutrophic taxa are characteristic in these water bodies. However, the rehabilitation works will most probably increase the biodiversity of the biota living in the upfilled side arm. The detection of this phenomenon is the target of the further monitoring program.

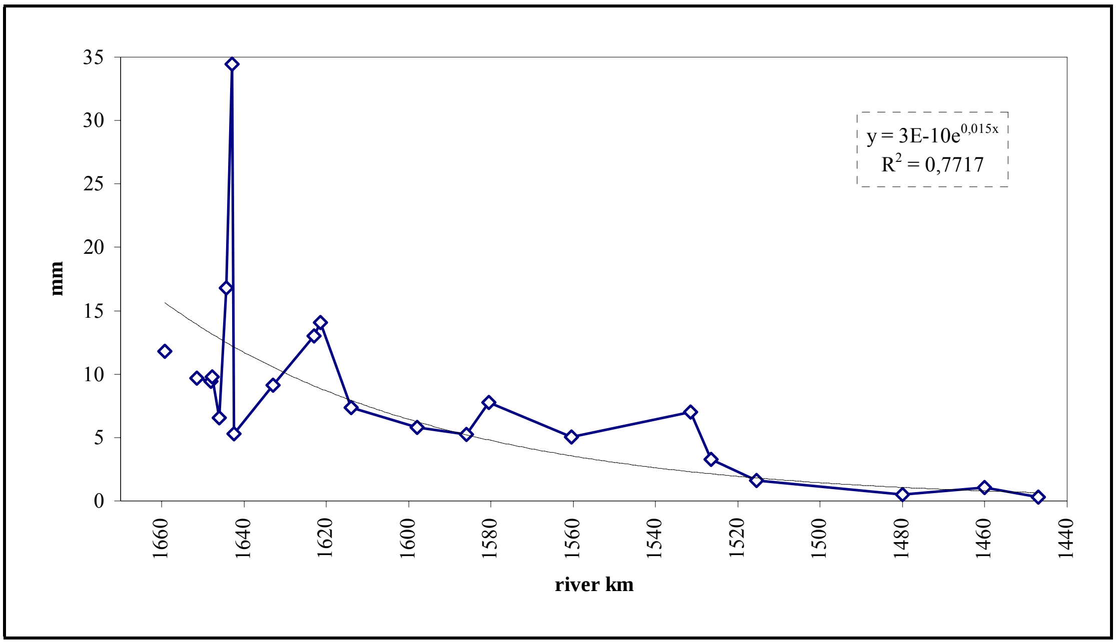


Figure 5. Longitudinal distribution of the average size of bed particles in the Danube

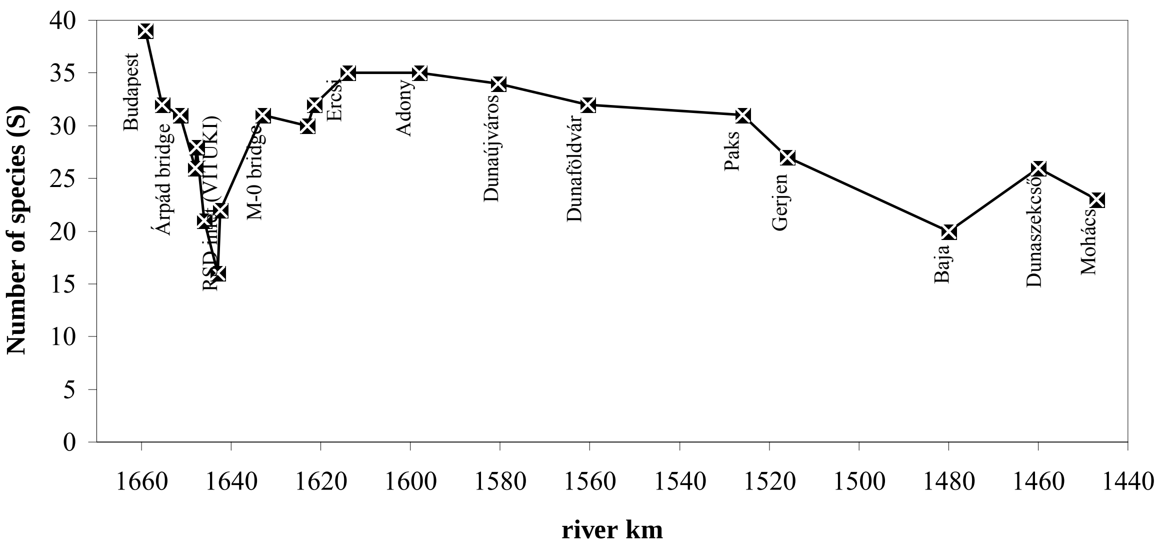


Figure 6. Cummulative number of bethic taxa in the Danube (1659.2-1447 rkm)

5.3.4 Fish

The sampling time of the fishes was in the autumn period in 1997. Due to the low air temperature, the water of the shallow side arms cooled down faster than in the deeper main arm. This is the explanation of the detected relatively low species number and the small population size. Although the size of the investigated surface area was large (973 m^2), the number of captured individuals was relatively small (110), similarly to the species number (13). The downstream confluence zone this time was found to be the zone of the temporary occurrence for the rheophilic and limnophilic species, too. This is the reason that 3/4 of the Vén-Danube species was detected in this small area (300 m^2).

The selected 300 m^2 area had 5 species with 21 individual number (Table 5.3.4.1):

Table 5.3.4.1 Total numerical abundance and number of species at various sampling sites (18 September 1997)

Sample site	Length	Average width	Surface area	Number of individials	Spesies number
3	300 m	1,5 m	450 m^2	10	6
4	300 m	1,5 m	450 m^2	4	3
3	40 m	1,5 m	50 m^2	0	0
3[1]	10 m	1,5 m	15 m^2	77	10
2[1]	2 m	1,5 m	3 m^2	15	2
1[1]	3 m	1,5 m	5 m^2	2	1
6[2]	200 m	1,5 m	300 m^2	32	10
6	200 m	1,5 m	300 m^2	21	5

[1] *special habitats (submerged tree trunks, srubs)*
[2] *d/s confluence of the side arm*

Table 5.3.4.1 shows that the fishes are cummulated in certain wintering sites. Altogether 18 species were detected during this autumn sampling (Table 5.3.4.2). Roach (*Rutilus rutilus*) was the species most caught together with perch (*Perca fluviatilis*) and bleak (*Alburnus alburnus*). No protected species were caught in the Vén-Duna arm. Due to the lack of earlier fish capture data, it can be concluded that the fish fauna is poor in ichtyological point of view, comparing to other investigated Danubian flood plains (i.e. Szigetköz).

Table 5.3.4.2 Captured fish species and their occurrences during the sampling of 1997

Name	Sampling site	Number	Nature
PETROMYZONTIDAE			
Danubian lamprey	6^2	2	Protected
ANGUILLIDAE			
Eel	6^2	1	Not protected
ESOCIDAE			
Pike	6^2	2	Not protected
CYPRINIDAE			
Carp	2^1	2	Not protected
Bleak	$3, 3^1, 4, 6$	24	Not protected
Asp	2	1	Not protected
Goldfish	3	5	Not protected
Whitefin gudgeon	6^2	2	Protected
Common gudgeon	6^2	1	Not protected
Dace	1	2	Not protected
Chinese rasbora	4	2	Not protected
Bitterling	4	6	Not protected
Roach	$1, 2^1, 3, 3^1, 4, 6,$	46	Not protected
GADIDAE			
Burbot	6^2	2	Not protected
PERCIDAE			
Perch	$3, 3^1, 4$	22	Not protected
GOBIIDAE			
River goby	$6, 6^2$	14	Protected
Kessler's goby	6^2	18	Not protected
Tubenose goby	$3, 4, 6^2$	8	Not protected
Total number of individuals		161	

5.3.5 Botany

There are no observable rooting and floating aquatic macrophyton species in the Vén-Duna and the River Danube, due to the frequent changes of the water level. Edge community formed by the reed is absent, too, due to the same reason.

Species of the Hungarian flora are grouped according to their nature conservation values by SIMON (1988: Abstracta Botanica 12, 1-23). The state of the perturbation and degradation of any plant association can be described by this method.

The groups of SIMON are as follows:

Species referring to natural state

- U = unique, very rare, endemic or relict
- KV = strictly protected, rare
- V = officially protected, not very rare
- E = edificator, characteristic, natural element
- K = natural accompanying
- TP = natural pioneer

Species referring to intermediate state

TZ = disturbance tolerating

Species referring to degradation

A = adventive

G = cultivated

GY = weeds

Any plant associaction (forest, swamp, meadow, etc.) can be characterised by its nature conservation value spectrum. The nature conservation value spectrum of the four investigated area is shown in Table 5.3.5.1

Table 5.3.5.1 Number of terrestrial plant species and nature conservation value spectrum of the investigated areas

	Flood plain forest	Swamp in forest	Bank of Vén-Duna	Side of route
V	0 (0%)	1 (2.3%)	1 (0.9%)	0 (0%)
E	6 (12.8%)	9 (20.5%)	14 (12.8%)	4 (4.3%)
K	14 (29.8%)	18 (40.9%)	29 (26.6%)	1011%)
TP	0 (0%)	0 (0%)	0 (0%)	1 (1.1%)
TZ	12 (25.5%)	7 (15.9%)	26 (23.9%)	29 (31.5%)
A	5 (10.6%)	2 (4.5%)	5 (4.6%)	5 (5.4%)
G	3 (6.4%)	0 (0%)	4 (3.7%)	0 (0%)
GY	7 (14.9%)	7 (15.9%)	30 (27.5%)	43 (46.7%)
Total	**47 (100%)**	**44 (100%)**	**109 (100%)**	**92 (100%)**

Based on the botanical survey of the four types of area led to the following conclusions:

- Neither submerse nor emerse aquatic plant species are found in the Vén-Duna due to the frequent and extended water flow and water level changes in the side arm and the Danube.
- The south-western part of the side arm is an inhabited and disturbed site with mixed forest containing numerous adventive elements.
- The most natural vegetation is found on the right side in a swamp that is situated above the dam section. The association forming and natural accompanying species are dominating this flora. The one protected plant species lives also here (Iris pseudacorus).
- The vegetation of the flood plain forest and the bank side of the Vén-Duna are very similar. There are numerous large trees on the bank remained here. The ratio of natural elements (43% in the forest, 40% on the bank) and the disturbance tolerating species (25.5% in the forest, 23.9% on the bank) are similar but the stronger disturbance of the bank is expressed by the increased number of weeds on the bank (30 instead of 7).
- The vegetation of the site of the walking route is poorer also. The ratio of the natural elements is low (16.4%), The disturbance tolerating (31.5%) and the weeds (46.7%) are dominating the plant community.

Table 5.3.5.2 contains the names of plant species in alphabetic order that were found in different types of the sites with the following symbols: r = rare; + = present; ++ = abundant.

Table 5.3.5.2 Spesies list registered on the right side of the Vén-Duna in different sites: 1=flood plain forest; 2=forest swamp; 3=bank of Vén-Duna; 4=side of walking route

	TAXA	1	2	3	4
K	Acer campestre	-	-	+	-
TZ	A. negundo	+	-	++	-
K	Achillea asplenifolia	-	+	-	+
TZ	A. collina	-	-	+	++
TZ	Agrimonia eupatoria	-	-	-	+
GY	Agropyron repens (1)	-	-	+	++
E	Agrostis stolonifera	-	+	+	+
K	Alisma plantago-aquatica	-	+	-	-
E	Alopecurus pratensis	-	+	+	-
GY	Amaranthus chlorostachys	-	-	-	+
GY	A. retroflexus	-	-	+	+
G	Amorpha fruticosa	-	-	+	-
TZ	Anthriscus trichospermus	+	-	-	-
GY	Arctium lappa	-	-	+	+
GY	Aristolochia clematitis	-	-	r	-
TZ	Arrhenatherum elatinus	-	-	+	+
GY	Artemisia vulgaris	-	-	+	+
K	Asperula cynanchica	-	-	+	-
A	Aster juv.	+	+	+	+
GY	Ballota nigra	-	-	+	+
TZ	Bellis perennis	-	-	-	r
A	Bidens frondosus	-	+	+	-
TZ	Bidens tripartitus	-	-	+	-
GZ	Bilderdykia convolvulus	-	-	+	+
K	Brachypodium silvaticum (2)	+	-	+	-
K	Bromus inermis	-	-	-	+
TZ	B. mollis	-	-	-	+
GY	B. sterilis	+	-	+	+
TP	B. tectorum	-	-	-	+
TZ	Calamagrostis epigeios	-	-	+	+
K	Calystegia sepium	-	+	+	-
A	Cannabis sativa	-	-	-	+
GY	Capsella bursa-pastoris	-	-	+	+
E	Carex acutiformis	-	++	+	-
K	C. cuprina	-	+	-	-
GY	C. hirta	-	-	r	-
K	C. remota	+	-	-	-
E	C. riparia	-	+	-	-
K	C. spicata	+	-	-	-
G	Celtis occidentalis	+	-	+	-
TZ	Cerastium fontanum	-	-	-	+

GZ	Chenopodium album	-	-	-	+
GY	Cichorium intybus	-	-	-	+
K	Circaea lutetiana	r	-	-	-
GY	Cirsium arvense	-	+	+	+
GY	Conium maculatum	-	-	+	+
GY	Convolvulus arvensis	-	-	+	+
K	Cornus sanguinea (3)	++	-	++	-
K	Coronilla varia	-	-	-	+
K	Crataegus monogyna	+	-	+	-
TZ	Cynodon dactylon	-	-	-	+
TZ	Dactylis glomerata	r	-	+	+
TZ	Daucus carota	-	-	+	+
GY	Descurainia sophia	-	-	-	+
GY	Dipsacus laciniatus	-	-	-	+
GY	Echinocloa crus-galli	-	+	+	-
K	Epilobium hirsutum	-	+	+	+
GY	Equisetum arvense	+	-	+	+
GY	Eragrostis minor	-	-	-	+
GY	Erigeron canadensis	-	-	+	+
K	Euonymus europaeus	-	-	+	-
GY	Euphorbia cyparissias	-	-	-	+
GY	Falcaria vulgaris	-	-	+	+
TZ	Festuca arundinacea	-	+	+	-
K	F. gigantea	++	-	+	-
E	F. pratensis	-	+	+	+
G	Fraxinus pennsylvanica	+	-	r	-
E	F. pannonica	+	-	-	-
GY	Galium aparine	+	+	+	+
K	G. mollugo	-	-	+	-
K	G. palustre (4)	+	+	-	-
K	G. verum	-	-	-	+
K	G. urbanum	+	-	+	-
K	Glechoma hederacea	-	-	+	-
E	Glyceria maxima	-	-	+	-
GY	Hordeum murinum	-	-	+	+
TZ	Humulus lupulus	+	-	+	-
TZ	Hypericum perforatum	-	-	+	+
K	Impatiens noli-tangere	r	-	-	-
A	I. parviflora	+	-	++	+
GY	Inula britannica	-	-	-	+
V	Iris pseudacorus	-	+	+	-
TZ	Juncus inflexus	-	+	-	-
K	Knautia arvensis	-	-	+	+
TZ	Lapsana communis (5)	++	-	+	-
E	Lemna minor	-	+	-	-
E	Ligustrum vulgare	+	-	+	-
TZ	Linaria vulgaris	-	-	-	+

GY	Lolium perenne	-	-	+	++
TZ	Lotus corniculatus (6)	-	-	-	+
K	Lycopus europaeus	-	+	+	-
K	Lysimachia nummularia	+	-	-	-
K	L. vulgaris (7)	-	-	+	-
K	Lythrum salicaria	-	+	+	+
K	L. virgatum	-	-	+	+
GY	Malva silvestris	-	-	-	+
GY	Matricaria inodora	-	-	-	+
TZ	Medicago falcata	-	-	-	+
GY	M. lupulina	-	-	+	+
GY	Melilotus albus	-	-	-	+
TZ	M. officinalis	-	-	+	+
K	Myosotis palustris	+	+	-	-
GY	Myosoton aquaticum	-	+	+	-
GY	Oenothera biennis	-	-	-	+
GY	Onopordum acanthium	-	-	-	+
A	Oxalis dillenii	+	-	-	-
GY	Papaver rhoeas	-	-	-	+
TZ	Pastinaca sativa	-	-	+	-
E	Phragmites australis	-	+	+	+
GY	Picris hieracioides	-	-	-	+
TZ	Plantago lanceolata	-	-	-	+
GY	P. major	+	-	+	+
E	Poa angustifolia	-	-	-	+
GY	P. annua	+	-	-	+
K	P. palustris	-	+	+	-
K	P. pratensis	-	+	+	+
TZ	P. trivialis	-	+	+	-
K	Polygonum amphibium	-	-	+	-
GY	P. arenastrum	-	-	-	+
GY	P. aviculare	-	-	-	+
GY	P. cf. mite	-	+	+	-
E	Populus canescens	+	-	+	-
E	P. alba	+	-	+	-
E	P. nigra	-	-	+	-
G	P. canadensis	+	-	+	-
GY	Potentilla anserina	-	+	-	+
TZ	P. reptans	-	-	+	+
TZ	Prunella vulgaris	+	-	+	+
E	Quercus robur	r	-	+	-
TZ	Ranunculus acer	-	-	-	+
GY	Robinia pseudacacia	+	-	+	-
K	Rorippa amphibia	-	+	-	-
TZ	Rubus caesius	++	-	+	-
TZ	Rumex conglomeratus	+	-	+	-
TZ	R. crispus	-	-	-	+

TZ	R. obtusifolius	+	-	+	-
E	Salix alba	+	-	+	-
K	S. fragilis	+	-	+	-
E	S. purpurea	-	-	+	-
GY	Sambucus ebulus	-	-	+	-
TZ	S. nigra	+	-	+	-
TZ	Saponaria officinalis	-	-	-	+
TZ	Scrophularia nodosa (9)	+	-	-	-
GY	Setaria glauca	-	-	-	+
GY	S. viridis	-	-	+	-
K	Silene vulgaris	-	-	-	+
TZ	Sisymbrium loeselii	-	-	+	+
K	Sium latifolium	-	+	+	-
A	Solidago serotina	+	-	+	+
TZ	Sonchus arvensis	-	-	+	+
K	Spirodela polyrrhiza	-	+	-	-
K	Stachys palustris	-	+	+	-
GY	Stellaria media	+	-	+	-
A	Stenactis annua	+	-	+	+
K	Symphytum officinale	-	+	+	+
GY	Taraxacum officinale	-	-	+	+
K	Tilia cordata	-	-	+	-
GY	Torilis arvensis	-	-	-	+
TZ	Tragopogon orientalis	-	-	-	+
K	Trapa natans	-	+	-	-
TZ	Trifolium campestre	-	-	-	+
TZ	T. pratense	-	+	-	+
TZ	T. repens	-	+	+	+
E	Typha angustifolia	-	+	+	-
E	T. latifolia	-	+	-	-
K	Typhoides arundinacea	+	+	+	-
K	Ulmus glabra	-	-	+	-
K	U. laevis	+	-	+	-
TZ	Utrica dioica	++	+	++	+
K	Verbascum lynchnitis	-	-	-	+
TZ	V. phlomoides	-	-	+	+
GY	Verbena officinalis	-	+	+	+
K	Viburnum opulus	-	-	+	+
GY	Vicia villosa	-	-	+	-
GY	Xanthium strumarium	-	+	+	+

Legend

(1) Agropyron repenes (L.) P.B. ssp. repens - var. subulatum (Schreb.) Rchb. f. leersianum (Wulf. et Schreb.) Rchb.
(2) Brachypodium silvaticum (Huds.) R. et Sch. f. silvaticum
(3) Cornus sanguinea L. ssp. hungarica (Kárp.) Soó

(4) Galium palustre L. ssp. elongatum (Presl.) Lange (p.p.)
(5) Lapsana communis L. var. communis - f. pubescens (Hornem.) Rchb
(6) Lotus corniculatus L. ssp. hirsutus (Koch) Rothm. var. ciliatus Koch
(7) Lysimachia vulgaris L. f. ternifolia Peterm.
(8) Prunella vulgaris L. var. vulgaris - f. pratensis (Schur) Domin (p.p.).
(9) Scrophularia nodosa L. var. glandulosa (Schustrler) Soó - f. schustleri Soó

6. General discussion and conclusions

Based on the Hydrological Reports, water flow was started through the Vén-Duna dam only above 350 cm Danube water level (measured on the gauge at Baja) that is corresponding to approximatelly 2500 m^3/sec flow rate. Basically two different kind of hydrological situation were observed during the preliminary (prior to the reopening) sampling programmes in 1997-98. In September 1997 (Figure 2) and April 1998 (Figure 3) there was too low water level on the River Danube resulting no flow through the side arm of the Vén-Duna. The calculated flow rates of the Danube at Baja based on the Q-H curve were 1990 and 1960 m^3/sec, respectively (Table 6.1) that is not identical with low flow but middle. In this case the level of the water in the side arm is well below the lowest level of the dam, inhibiting the flow through the arm.

In July the water level of the side arm increased up to the upper level of the dam resulting in a very stron flow through the narrow opening. The velocity of the water flow in the original opening (which was created by local anglers) was very large (approximatelly 2 m/sec). This velocity was considerably smaller in the further downstream sections but a very well defined through-flow was observed.

The hydrological situation has direct effect on the physico-chemical variables and the abundance conditions of plankton communities, too. The smoothing of these different values along the Vén-Duna during through-flow conditions is evident from the tables introducing both the chemical and plankton data (Figure 4).

Table 6.1 Calculated flow rates in the River Danube at Baja during the sampling campagne

Date	Danube flow (m^3/sec)
18.09.1997	1990
15.04.1998	1960
14.07.1998	3060

Earlier investigations of the Danube section situated downstream Budapest illustrated that both the number of the plankton species and the biomass of these taxa generally increase in the longitudinal direction of the river, according to the trophic and saprobic conditions. This phenomenon occurs during the whole vegetation perion, but can be observed very definitly at increased water temperature and decreased flow discharge values, when the direct contact between the main and the side arm is stoped.

Consequently, enormous biomass values of the phyto- and zooplankton develop in the stagnant water body of the side arms that lasts until the next flooding which has a washing out effect on the plankton community (CSÁNYI et al. 1992). This way the high degree of individualization of the side arms can happen based on their plankton communities. The largest chlorophyll-a values measured during another side arm rehabilitation project was more than 2500 mg/m^3 in the lower end of the Rezéti-Duna and more than 200 mg/m^3 in the River Danube at Baja, respectively.

Based on the phyto- and zooplankton investigations it can be concluded that very different planktonic communities develope in those side arms that are isolated from the main river arm during low flow discharge conditions. This way the side arms are individualized with their special species composition and the stock densities, as well.

The macrozoobenthic community indicates the extended up-filling of the Vén-Danube along its whole length and width. The most abundant group of organisms are the *Oligochaeta* and *Chironomidae* taxa living in the thick sediment layer characterized by high organic matter. Quantitative sampling of the community is continued during the early spring period before the engineering intervention in order to describe the original ecological situation along the Vén- and the Nyéki-Danube.

At present 18 fish species were registered on an area of 1600 m^2, that was devided to 8 different sites capturing 161 specimens. The detailed function of those habitats for fishes that are situated in the Vén-Danube can not be estimated in this stage of the preliminary sampling. At least seasonal sampling is needed for the description of the natural value of the fish stock living in this side arm area.

The movements, the migration of fish species during the spawning/reproductive and non-reproductive periods, the existence and the role of available spawning and growing territory for the hatchlings have to be investigated in the future also, together with the relationship of the stocks living in the main arm and the side arm. According to the further research plan, the effect of the engineering intervention on the fish fauna (with special emphasis on the diversity and the species number in the area) will be evaluated on the base of the interaction of the main arm stock and the side arm stock.

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APPENDIX

Basic measured data during the preliminary study in the Vén-Duna, River Danube and Nyéki-Duna

September 1997-July 1998

Table 4.3.1 Baseline survey of water quality in Vén-Duna (1-5), River Danube (6) and Nyéki-Duna (8), 19.09.1997

	Number of sampling sites				
Parameter	1	3	4	6	8
Temperature (C^o)	19.5	20.3	19.8	17.2	13,1
pH	7,88	7,85	7,64	8,72	8,31
Total dissolved solids (mg/l)	410	450	477	480	252
Suspended solids (mg/l)	24	17	11	27	9,7
BOD5 (mg/l)	5,8		8,5	5,7	12,5
TOC (mg/l)	6,9	9,0	9,5	3,1	9,5
Dissolved oxygen (mg/l)	16,1	14,4	16,0	15,0	14,7
Ammonium (mg/l)	0,83	0,13	0,28	0,14	0,20
Nitrite (mg/l)	0,08	0,04	0,04	0,07	0,01
Nitrate (mg/l)	1,0	1,0	1,0	5,4	1,0
Total nitrogen (mg/l)	2,1	2,17	1,7	6,0	2,6
Orthophosphate-phosphorus (mg/l)	0,03	0,04	0,03	0,03	0,02
Total phosphorus (mg/l)	0,09	0,25	0,08	0,13	0,08
Chlorophyll-a (mg/m^3)	65	77	93	47	27
Mercury (µg/l) *0.1	<0,1	<0,1	<0,1	<0,1	<0,1
Cadmium (µg/l)) *0.1	<0,1	<0,1	<0,1	<0,1	0,5
Lead (µg/l)) *0.5	0,54	0,72	0,79	0,76	0,1
Arsenic (µg/l)) *1.0	4,6	2,4	2,8	1,3	2,3
Chromium (µg/l)) *0.1	1,2	1,2	1,3	1,7	11,0
Nickel (µg/l)) *0.5	10,7	9,2	6,9	9,6	38
Copper (µg/l)) *0.1	1,3	1,2	1,4	2,7	3,5
Zinc (µg/l)) *0.005	13	8	13	11	59
Iron (mg/l)) *0.04	0,1	0,06	0,09	0,1	0,09
Manganese (mg/l)) *0.02	0,07	0,33	0,34	0,02	0,005
Aktinit-PK (µg/l)	0,02	0,02	0,03	0,03	0,02
Oil (petroleum hydrocarbons) (µg/l)	40	140	40	310	90

*value of detection limit

Table 4.3.2 Physical and chemical components measured and determined in the water in Vén-Duna and River Danube, 15.04.1998

	Number of sampling site				
Variable	1	2	3	4	6
Temperature (C^o)	11.5	12.2	12.5	12.0	10.8
pH	8.73	8.57	8.09	8.56	8.77
Specific conductivity (µS/cm)	397	388	540	388	388
Suspended solids (mg/l)	23	9.5	18	6.5	35
Total dissolved solids (mg/l)	250	276	376	302	274
BOD5 (mg/l)	6.2	5.6	8.9	2.7	4.7
TOC (settled) (mg/l)	3.5	3.4	7.8	3.2	3.2
COD k (original) (mg/l)	17.1	16.1	36	23	15.2

Dissolved oxygen (mg/l)	16.1	14.6	9.7	12.6	13.9
Ammonium N (mg/l)	0.06	0.12	0.05	0.03	0.02
Nitrite N (mg/l)	0.02	0.03	0.02	0.02	0.02
Nitrate N (mg/l)	1.4	1.4	1.4	1.3	1.2
Kjeldahl N (mg/l)	0.94	0.77	1.6	0.83	1.01
Total nitrogen N (mg/l)	2.4	2.2	3.0	2.2	2.2
Ortophosphate P (mg/l)	0.01	<0.01	0.03	<0.01	<0.01
Total P (mg/l)	0.09	0.05	0.28	0.06	0.14
Chlorophyll-a (mg/m^3)	103	67	59	89	128

Table 4.3.3 Physical and chemical components measured and determined in the water in Vén-Duna and River Danube, 14.07.1998

	Number of sampling site				
Variable	**1**	**2**	**3**	**4**	**6**
Temperature (C^o)	20.0	20.3	20.2	20.4	20.2
PH	8.34	8.37	8.54	8.58	8.97
Specific conductivity (µS/cm)	298	296	297	302	295
Suspended solids (mg/l)	28	11	13	14	8
Total dissolved solids (mg/l)	198	182	174	192	178
BOD5 (mg/l)	3.8	2.4	2.9	3.9	7.5
TOC (settled) (mg/l)	2.9	3.1	3.1	3.7	3.4
KOI k (original) (mg/l)	6.1	6.1	13.2	9.1	8.1
Dissolved oxygen (mg/l)	8.9	9.1	10.3	10.8	16.0
Ammonium N (mg/l)	0.02	0.01	0.01	0.01	0.02
Nitrite N (mg/l)	0.05	0.05	0.06	0.07	0.07
Nitrate N (mg/l)	1.31	1.24	1.2	1.02	0.93
Kjeldahl N (mg/l)	1.16	1.22	1.17	1.62	1.4
Total nitrogen N (mg/l)	2.52	2.51	2.43	2.71	4.91
Ortophosphate P (mg/l)	0.08	0.05	0.03	0.02	<0.01
Total P (mg/l)	0.16	0.14	0.13	0.16	0.13
Chlorophyll-a (mg/m^3)	35	33	33	32	36

Table 4.3.4 Baseline survey of bottom sediment in the Vén-Duna (1-4), River Danube (6) and Nyéki-Duna (8), 19.09.1997

	Number of sampling sites				
Variable	**1**	**3**	**4**	**6**	**8**
TOC (mg/kg)	50000	24000	32000	18000	47000
Total nitrogen (mg/kg)	3900	410	860	140	3500
Total phosphorus (mg/kg)	3500	1100	900	210	400
Mercury (mg/kg)	0.33	0.37	0.37	0.44	0.35
Cadmium (mg/kg)	0.70	0.70	0.80	0.75	0.60
Lead (mg/kg)	38	37	38	43	36
Arsenic (mg/kg)	34	11	21	14	28
Chromium (mg/kg)	52	48	59	55	53
Nickel (mg/kg)	32	28	34	31	30
Copper (mg/kg)	40	36	42	41	42
Zinc (mg/kg)	180	160	200	220	210
Iron (mg/kg)	43000	27000	30000	26000	38000
Manganese (mg/kg)	740	630	910	580	680
Aktinit-PK /atrazine/ (mg/kg)	0.07	0.03	0.05	0.06	0.04
PCB-s (mg/kg)	0.065	0.033	0.042	0.030	0.030
PAH-s (mg/kg)	6.8	3.2	4.5	4.0	3.9
Oil /petroleum hydrocarbons/	49	28	32	86	19

Table 4.3.5 Physical and chemical components measured and determined in the sediment in Vén-Duna and River Danube, 15.04.1998

	Number of sampling site				
Variable	**1**	**2**	**3**	**4**	**6**
Total nitrogen N (mg/g dry weight)	2.0	1.36	3.5	3.6	1.13
Total P (mg/g dry weight)	1.25	0.97	1.0	1.23	0.67
KOI k (original) (mg/g dry weight)	41	40	70	59	14.5
Dry matter content (%)	98.8	86.8	97.2	72.9	99.5
Combustion residuals (%)	91.5	90.9	88.6	90.8	95.1

Table 5.3.1.1 Population density and relative abundance classes of dominant phytoplankton taxa in the Vén-Duna (1-5), River Danube (6) and Nyéki-Duna (8)

	1	2	3	4	5	6	8
Cell number	99800	79400	248400	85200	89400	87600	57600
Dominant taxa							
Cryptomonas spp.							**1**
Peridinium spp.	**3**						
Synura uvella		**5**	**7**	**7**	**4**		**6**
Dinobryon spp.					**4**		
Sceletonema spp.	**3**					**4**	
Centrales spp.	**2**					**3**	

Table 5.3.1.2 Population density (i/ml) and relative abundances of the dominant phytoplankton taxa in the Vén-Duna (1-4) and River Danube (6), 15.04.1998

	Number of sampling sites				
	1	**2**	**3**	**4**	**6**
Cell number	**69500**	**45000**	**95500**	**35300**	**48500**
Dominant taxa					
CYANOPHYTA					
Anabaena spp.			**1**		
Aphanizomenon issatschenkoi					
Aphanocapsa sp.					
Merismopedia sp.					
Microcystis flos aquae					
Microcystidaceae spp.		**1**			
Oscillatoria spp.					
Pseudanabaena spp.	**1**	**1**			
EUGLENOPHYTA					
Euglena spp.			**1**		
PYRROPHYTA					
Cryptomonas spp.	**1**	**1**	**1**	**1**	**1**
Rhodomonas spp.	**1**	**1**	**1**	**2**	**1**
Peridinium spp.			**1**		
CHRYSOPHYCEAE					
Chrysococcus sp.					
Dinobryon sp.		**1**	**1**	**1**	
Synura spp.		**1**	**1**	**1**	
DIATOMOPHYCEAE					
Sceletonema spp.					
Coscinodiscaceae spp.	**5**	**3**	**1**	**2**	**6**
Melosira granulata					
Melosira cf. distans					
Melosira varians					
Asterionella formosa	**1**			**1**	

Navicula spp.					
Nitzschia cf. acicularis + Synedra cf. acus	**1**		**4**	**1**	
Nitzschia (Lanceolatae) spp.	**1**	**1**			
Synedra spp.	**1**	**1**			
Pennales spp.					**1**
CHLOROPHYCEAE					
Volvocales spp.		**1**		**1**	**1**
Chlorococcales spp.	**1**	**1**	**1**	**1**	**2**
Actinastrum hantzschii		**1**			
Ankistrodesmus acicul. var. acicularis			**1**		
Ankistrodesmus angustus	**1**	**3**	**3**	**1**	**1**
Crucigenia tetrapedia					
Crucigeniella apiculata					
Chodatella quadriseta					
Dictyosphaerium spp.					
Didymocystis planctonica					
Golenkinia radiata					
Hyaloraphidium contortum		**1**	**1**		
Kirchneriella spp.				**1**	
Lagerheimia genevensis	**1**	**1**		**1**	
Micractinium pusillum					
Nephrochlamys allanthoidea					
Pediastrum boryanum					
Pediastrum duplex					
Scenedesmus spp.		**1**	**1**		
Schroederia setigera					
Schroederia spiralis					
Tetraedron incus					
Tetraedron minimum					
Tetrastrum punctatum					
Tetrastrum staurogeniaeforme					
Treubaria triappendiculata		**1**			
Koliella longiseta	**1**		**3**	**1**	**1**
Closterium sp.					
FLAGELLATAE					
Flagellatae spp.	**1**	**3**	**1**	**5**	**1**

Table 5.3.1.3 Population density (i/ml) and relative abundances of the dominant phytoplankton taxa in the Vén-Duna (1-4) and River Danube (6), 14.07.1998

	Number of sampling sites				
	1	2	3	4	6
Cell number	15500	34000	65000	82000	33000
Dominant taxa					
CYANOPHYTA					
Anabaena spp.					
Aphanizomenon issatschenkoi					
Aphanocapsa sp.					1
Merismopedia sp.					1
Microcystis flos aquae					
Microcystidaceae spp.					
Oscillatoria spp.					
Pseudanabaena spp.					
EUGLENOPHYTA					
Euglena spp.					
PYRROPHYTA					
Cryptomonas spp.					
Rhodomonas spp.		1		1	
Peridinium spp.					
CHRYSOPHYCEAE					
Chrysococcus sp.					
Dinobryon sp.					
Synura spp.					
DIATOMOPHYCEAE					
Sceletonema spp.	4	4	4	5	4
Coscinodiscaceae spp.	4	2	4	4	3
Melosira granulata		1	1	1	1
Melosira cf. distans					
Melosira varians					
Asterionella formosa		1			
Navicula spp.					
Nitzschia cf. acicularis + Synedra cf. acus				1	
Nitzschia (Lanceolatae) spp.		3	1		2
Synedra spp.					
Pennales spp.					
CHLOROPHYCEAE					
Volvocales spp.					
Chlorococcales spp.	2	1	2	1	2
Actinastrum hantzschii					
Ankistrodesmus acicul. var. acicularis					1
Ankistrodesmus angustus	2	1	1	1	1
Crucigenia tetrapedia					

Crucigeniella apiculata				**1**	
Chodatella quadriseta				**1**	
Dictyosphaerium spp.			**1**		
Didymocystis planctonica				**1**	
Golenkinia radiata					**1**
Hyaloraphidium contortum				**1**	
Kirchneriella spp.		**2**	**1**		**2**
Lagerheimia genevensis					
Micractinium pusillum				**1**	
Nephrochlamys allanthoidea					
Pediastrum boryanum				**1**	
Pediastrum duplex					
Scenedesmus spp.	**1**	**1**	**1**	**1**	**1**
Schroederia setigera	**1**				**1**
Schroederia spiralis		**1**			
Tetraedron incus			**1**		**1**
Tetraedron minimum					
Tetrastrum punctatum				**1**	
Tetrastrum staurogeniaeforme		**1**			**1**
Treubaria triappendiculata					
Koliella longiseta		**1**			
Closterium sp.					**1**
FLAGELLATAE					
Flagellatae spp.					

Table 5.3.2.1 Zooplankton abundance as number of individuals per 100 l at various sampling sites
(19. 09. 1997.).

	Sampling sites				
TAXON	**1**	**3**	**4**	**6**	**8**
ROTATORIA					
Asplanchna priodonta	260	10850	217	87	440
Brachionus angularis	3472	10850	103075	22	2160
B. budapestinensis	521	10850	52080		1300
B. calyciflorus calyciflorus	1302	32550		87	1740
B. c. anuraeiformis	521	10850			
B. diversicornis	608	5300	2170		
B. quadridentatus brevispinus					860
B. urceus	347				
Filinia longiseta	2604	37975	5425		
Keratella cochlearis cochlearis	2170	43400	56420	12	4340
K. c. tecta	1953	10850	32550		2160
K. quadrata				12	
Lecane bulla					440
Platyas quadricornis				4	
Polyarthra vulgaris	1302	54250	82460	12	
Pompholyx complanata					1740
Synchaeta pectinata			6510	12	4340
Testudinella parva				2	
T. patina				4	
Trichocerca pusilla		10850	2170		
CLADOCERA					
Alona affinis				2	
A. rectangula				4	
Alonella nana				2	
Bosmina longirostris	25	95	12	4	12
Chydorus sphaericus	12				8
Pleuroxus aduncus				2	
COPEPODA					
Eudiaptomus gracilis	5	50			
Acanthocyclops robustus		35			8
Thermocyclops oithonoides		65	25		6
nauplius larvae	1389	43400	4340	564	1300
kopepodit larvae	22	300	48	6	18
Total	16513	282520	347502	838	20872

Table 5.3.2.2 Zooplankton abundance as number of individuals per 100 l at various sampling sites
(15. 04. 1998)

Legend					
i - individuum/100 liter	Sampling sites				
TAXON	1	2	3	4	6
ROTATORIA					
Asplanchna priodonta		86	32	346	16
Brachionus angularis	434	4340	1518	1474	22
B. calyciflorus calyciflorus	130	1300	920	1736	260
B. c. anuraeiformis	348	770	780	1518	86
B. leydigi tridentatus			22	22	12
B. quadridentatus brevispinus			22		
B. rubens	22	12	434		86
B. urceus	44	346	868	174	44
Filinia longiseta	86	520	650	434	12
Keratella cochlearis cochlearis	130	216	434	346	260
K. c. tecta		174	346	174	
K. quadrata	608	520	520	216	86
Lecane bulla			22		
Notholca acuminata	12	12		260	12
N. squamula	130	260	782	216	22
Polyarthra vulgaris	1042	998	44	520	86
Pompholyx complanata			260		
Synchaeta pectinata	12				12
CLADOCERA					
Bosmina longirostris	8	18	16	36	12
Chydorus sphaericus			12	12	
Macrothryx hirsuticornis	4				
COPEPODA					
Acanthocyclops robustus			8	10	6
Cyclops strenuus		4	16	12	
Mesocyclops leuckarti			12		4
nauplius larvae		478	2820	2148	260
kopepodit larvae		6	12	16	10
Total	**3010**	**10060**	**10550**	**9670**	**1308**

Table 5.3.2.3 Zooplankton abundance as number of individuals per 100 l at various sampling sites
(14.07.1998)

Legend					
i - individuum/100 liter	Sampling sites				
TAXON	1	2	3	4	6
ROTATORIA					
Ascomorpha ecaudis	86	478			
Asplanchna priodonta	8	44	22	44	
Brachionus angularis	22	304	216	564	22
B. budapestinensis	12	86	174	216	8
B. calyciflorus calyciflorus	12	86			22
B. c. anuraeiformis	8	304	1128	2916	12
B. diversicornis		16	174	44	8
B. quadridentatus brevispinus		44	44	44	12
B. urceus	8			22	12
Euchlanis dilatata	8	44		22	8
Keratella cochlearis cochlearis	22	44	216	86	44
K. c. tecta	16	260	564	130	22
K. quadrata			86	44	
Lecane bulla		44			8
L. closterocerca		24	44	86	
L. luna	4				
L. lunaris					12
Polyarthra vulgaris	12	174		260	12
Pompholyx complanata	8		44		22
Synchaeta pectinata	16		130	434	8
Testudinella patina			22		
Trichocerca pusilla	8	12	22		8
T. similis		12			
CLADOCERA					
Alona quadrangularis					4
Bosmina longirostris	4	36	24		4
Chydorus sphaericus		16	16	12	4
Diaphanosoma brachyurum			12		4
Disparalona rostrata	4	8			
COPEPODA					
Acanthocyclops robustus		8	24	12	8
Thermocyclops oithonoides			32	20	4
nauplius larvae	24	86	9240	304	44
kopepodit larvae	8	22	24	22	

Total	**290**	**2152**	**12258**	**5282**	**312**

Table 5.3.2.4 Zoolpankton biomass as mg wet weight per 100 l at various sampling sites (19. 09. 1997.)

	Sampling sites				
TAXON	**1**	**3**	**4**	**6**	**8**
ROTATORIA					
Asplanchna priodonta	13,0	542,5	10,8	4,3	22,0
Brachionus angularis	24,3	75,9	721,5	0,2	15,1
B. budapestinensis	3,1	65,1	312,5		7,8
B. calyciflorus calyciflorus	52,1	1302,0		3,5	69,6
B. c. anuraeiformis	20,8	434,0			
B. diversicornis	21,9	190,8	78,1		
B. quadridentatus brevispinus					18,9
B. urceus	6,3				
Filinia longiseta	41,7	607,6	86,8		
Keratella cochlearis cochlearis	13,0	260,4	338,5	0,1	26,1
K. c. tecta	7,8	43,4	130,2		8,6
K. quadrata				0,1	
Lecane bulla					3,9
Platyas quadricornis				0,1	
Polyarthra vulgaris	11,7	488,2	742,1	0,1	
Pompholyx complanata					3,5
Synchaeta pectinata			65,1	0,1	43,3
Testudinella parva				0,0	
T. patina				0,0	
Trichocerca pusilla		75,9	15,2		
CLADOCERA					
Alona affinis				0,1	
A. rectangula				0,2	
Alonella nana				0,1	
Bosmina longirostris	2,0	7,6	0,9	0,3	1,0
Chydorus sphaericus	1,4				1,0
Pleuroxus aduncus				0,1	
COPEPODA					
Eudiaptomus gracilis	3,7	37,5			
Acanthocyclops robustus		12,2			2,8
Thermocyclops oithonoides		18,2	7,0		1,7
nauplius larvae	13,9	434,0	43,4	5,6	13,0
kopepodit larvae	1,1	15,0	2,4	0,3	0,9
Total	237,8	4610,3	2554,5	15,2	239,2

Table 5.3.2.5 Zoolpankton biomass as mg wet weight per 100 l at various sampling sites (15.04.1998)

Legend					
b=biomass mg/100 l wet weight	Sampling sites				
TAXON	1	2	3	4	6
ROTATORIA					
Asplanchna priodonta		4,3	1,6	17,3	0,8
Brachionus angularis	3,0	30,4	10,6	10,3	0,2
B. calyciflorus calyciflorus	5,2	52,0	36,8	69,4	10,4
B. c. anuraeiformis	13,9	30,8	31,2	60,7	3,4
B. leydigi tridentatus			0,9	0,9	0,5
B. quadridentatus brevispinus			0,5		
B. rubens	0,4	0,2	7,8		1,5
B. urceus	0,8	6,2	15,2	3,1	0,8
Filinia longiseta	1,4	8,3	10,4	6,9	0,2
Keratella cochlearis cochlearis	0,8	1,3	2,6	2,1	1,6
K. c. tecta		0,7	1,4	0,7	
K. quadrata	6,7	5,7		2,4	0,9
Lecane bulla			0,2		
Notholca acuminata	0,2	0,2		0,5	0,1
N. squamula	0,4	0,8	2,3	0,7	0,1
Polyarthra vulgaris	9,4	9,0	0,4	4,7	0,8
Pompholyx complanata			0,5		
Synchaeta pectinata	0,1				0,1
CLADOCERA					
Bosmina longirostris	0,6	1,4	1,3	2,9	1,0
Chydorus sphaericus			1,4	1,4	
Macrothryx hirsuticornis	0,6				
COPEPODA					
Acanthocyclops robustus			2,8	3,5	2,1
Cyclops strenuus		1,4	5,6	4,2	
Mesocyclops leuckarti			3,6		1,2
nauplius larvae	1,1	23,9	141,0	107,4	13,0
kopepodit larvae		0,5	1,0	1,3	0,8
Total	**44,6**	**177,1**	**279,1**	**300,4**	**39,5**

Table 5.3.2.6 Zoolpankton biomass as mg wet weight per 100 l at various sampling sites (14.07.1998)

Legend					
b=biomass mg/100 l wet weight	Sampling sites				
TAXON	1	2	3	4	6
ROTATORIA					
Ascomorpha ecaudis	0,2	0,9			
Asplanchna priodonta	0,4	1,1	1,1	2,2	
Brachionus angularis	0,1	2,1	1,5	3,9	0,1
B. budapestinensis	0,1	0,5	1,0	1,3	0,1
B. calyciflorus calyciflorus	0,5	3,4			0,9
B. c. anuraeiformis	0,3	12,2	45,1	58,3	0,5
B. diversicornis		0,6	6,3	1,6	0,3
B. quadridentatus brevispinus		1,0	1,0	1,0	0,3
B. urceus	0,2		0,4	0,4	0,2
Euchlanis dilatata	0,3	1,8		0,9	0,3
Keratella cochlearis cochlearis	0,1	0,3		0,5	0,3
K. c. tecta	0,1	1,0	1,3	0,5	0,1
K. quadrata			2,2	0,5	
Lecane bulla		0,4	0,9		0,1
L. closterocerca		0,2		0,8	
L. luna	0,1		0,1		
L. lunaris					0,1
Polyarthra vulgaris	0,1	1,6		2,3	0,1
Pompholyx complanata	0,1		0,1		0,1
Synchaeta pectinata	0,2		1,3	2,2	0,1
Testudinella patina			0,1		
Trichocerca pusilla	0,1	0,1	0,1		0,1
T. similis		0,1			
CLADOCERA					
Alona quadrangularis					0,1
Bosmina longirostris	0,2	2,9	1,9		0,3
Chydorus sphaericus		1,9	1,9	1,4	0,4
Diaphanosoma brachyurum			0,8		0,3
Disparalona rostrata	0,2	0,5			
COPEPODA					
Acanthocyclops robustus		2,8	8,4	4,2	2,8
Thermocyclops oithonoides			9,0	5,6	1,1
nauplius larvae	1,6	4,3	462,0	15,2	2,2
kopepodit larvae	0,6	1,8	1,9	1,8	

Total	**5,5**	**41,5**	**548,0**	**104,6**	**10,9**

Table 5.3.3.1 Macrozoobenthic taxa of the Vén-Danube (1-5), Danube (6) and Nyéki Danube (8), 19.09.1997

	TAXA	Sampling sites						
		1	**3**	**4**	**5**	**6**	**8**	**Total**
	MOLLUSCA							
1	Acroloxus lacustris						1	**1**
2	Anodonta anatina	1	1	1	1			**4**
3	Dreissena polymorpha	1	1	1	1	1		**5**
4	Gyraulus albus						1	**1**
5	Lithoglyphus naticoides	1	1					**2**
6	Lymnaea stagnalis						1	**1**
7	Planorbarius corneus						1	**1**
8	Pseudanodonta complanata		1					**1**
9	Radix ovata	1				1	1	**3**
10	Sinanodonta woodiana		1	1	1			**3**
11	Sphaerium corneum					1		**1**
12	Unio pictorum		1	1	1			**3**
13	Unio tumidus	1						**1**
14	Viviparus acerosus	1	1	1	1			**4**
	ANNELIDA							
15	Criodrillus lacuum			1		1		**2**
16	Dina lineata					1		**1**
17	Erpobdella octocullata	1				1		**2**
18	Glossiphonia complanata	1						**1**
19	Helobdella stagnalis	1				1		**2**
20	Oligochaeta sp.	1	1	1	1			**4**
	CRUSTACEA							
21	Dicerogammarus villosus	1				1		**2**
	INSECTA							
22	Ceratopogonidae sp.			1	1			**2**
23	Chaoborus crystallinus		1					**1**
24	Chironomidae sp.	1	1	1	1	1	1	**6**
25	Cloeon dipterum						1	**1**
26	Coenagrionidae sp.						1	**1**
27	Parapoynx stratiotata						1	**1**
28	Platycnemis pennipes	1				1	1	**3**
29	Sigara striata						1	**1**
	Taxa/sampling site	**13**	**10**	**9**	**8**	**10**	**11**	

Table 5.3.3.2 Macrozoobenthic taxa of the Vén-Danube (1-4) and Danube (6)(15.04.1998)

	TAXA	Sampling sites				
		1	**2**	**3**	**4**	**6**
	Mollusca					
1	Acroloxus lacustris				1	
2	Anisus spirorbis	1*				
3	Anodonta anatina	1	1	1	1	
4	Bithynia tentaculata	1*		1*	1	1
5	Dreissena polymorpha	1	1	1*	1	1
6	Gyraulus albus			1		
7	Lithoglyphus naticoides	1	1	1*	1	1
8	Physella acuta			1		
9	Pisidium sp.			1	1	
10	Planorbis planorbis			1		
11	Potamopyrgus antipodarum			1*		
12	Radix ovata					1
13	Sinanodonta woodiana	1	1			
14	Sphaerium corneum					1
15	Sphaerium lacustre			1	1	
16	Sphaerium rivicola	1		1*		
17	Unio pictorum		1		1	
18	Unio tumidus		1		1	
19	Valvata naticina	1*			1	
20	Valvata piscinalis	1*		1*	1	
21	Viviparus acerosus	1*	1	1*	1	
	Annelida					
22	Alboglossiphonia heteroclita				1	
24	Dina lineata					1
25	Erpobdella octocullata					1
26	Glossiphonia paludosa				1	
27	Helobdella stagnalis	1			1	
28	Oligochaeta sp.	1	1	1	1	1
	Crustacea					
29	Corophium curvispinum	1	1	1	1	1
30	Dicerogammarus villosus	1	1		1	1
	Insecta					
30	Acilius sulcatus				1	
31	Ceratopogonida sp.		1	1	1	
32	Chaoborus crystallinus			1	1	
33	Chironomidae sp.		1			1
34	Chironomus anthracinus			1		
35	Chironomus nudiventris	1				
36	Chironomus plumosus	1			1	
37	Chironomus riparius	1		1		
38	Cybister laterimarginalis				1	

39	Dicrotendipes tritomus	1			1	
40	Einfeldia pagana	1			1	
41	Glyptotendipes pallens			1		
42	Hydrous piceus				1	
43	Microchironomus tener			1		
44	Parachironomus arcuatus gr.			1	1	
45	Polypedilum nubeculosum	1		1		
46	Procladius choreus	1				
47	Procladius ferrugineus	1		1	1	
48	Rhantus sp.				1	
49	Tanypus punctipennis			1		
50	Tanytarsus gregarius	1		1		
	Taxa/sampling site	**18**	**12**	**19**	**29**	**11**

Table 5.3.3.3 Macrozoobenthic taxa of the Vén-Danube (1-4) and Danube (6)(14.07.1998)

	TAXA	Sampling sites				
		1	**2**	**3**	**4**	**6**
	Mollusca					
1	Anodonta anatina	1	1	1	1	
2	Bithynia tentaculata	1			1	1
3	Dreissena polymorpha	1	1	1	1	1
4	Gyraulus albus			1		
5	Lithoglyphus naticoides	1	*	*	*	1
6	Physella acuta					1
7	Pisidium sp.			*	1	1
8	Planorbis planorbis			1		
9	Pseudanodonta complanata	1			1	
10	Radix ovata					1
11	Sinanodonta woodiana	1	1			
12	Sphaerium corneum					1
13	Sphaerium lacustre			1	1	
14	Sphaerium rivicola	1		1		1
15	Unio pictorum	1	1	1	1	
16	Unio tumidus	1	1	1	1	
17	Valvata naticina	*	*		1	
18	Valvata piscinalis	1			1	
19	Viviparus acerosus	1	1	1	1	
	Annelida					
20	Criodrillus lacuum	1				1
21	Dina lineata	1				1
22	Erpobdella octocullata	1				1
23	Glossiphonia complanata					1
24	Helobdella stagnalis	1			1	
25	Oligochaeta sp.	1	1	1	1	1
	Crustacea					
26	Corophium curvispinum	1	1	1	1	1
27	Dicerogammarus villosus	1			1	1
	Insecta					
28	Ceratopogonida sp.		1	1	1	
29	Chaoborus crystallinus				1	
30	Chironomidae sp.	1	1	1	1	1
31	Cloeon dipterum					1
32	Coenagrionidae sp.			1		
33	Platycnemis pennipes					1
	Taxa/sampling site	**19**	**10**	**14**	**18**	**18**

Table 5.3.3.4 Quantitative macrozoobenthon data of the Vén-Danube (15 April, 1998)

	TAXA	Sampling sites								
	Legend: 1=presency data only	**1**			**3**			**4**		
	Mollusca	**R**	**M**	**L**	**R**	**M**	**L**	**R**	**M**	**L**
1	Anodonta anatina				1	1		1		
2	Dreissena polymorpha							430		
3	Unio pictorum							1		
4	Unio tumidus				1					
	Annelida									
5	Oligochaeta sp.	4725	3140	2251	1106	1060	1833	7969	1585	1702
	Insecta									
6	Chaoborus crystallinus							1	1	
7	Chironomidae sp.	148	1185	430	89	267	133	474	59	74
8	Chironomus aprilinus					1				
9	Chironomus nudiventris		1							
10	Chironomus plumosus	1	1					1		1
11	Chironomus riparius	1			1	1	1			1
12	Dicrotendipes tritomus	1	1					1		1
13	Einfeldia insolata							1		
14	Einfeldia pagana		1							
15	Glyptotendipes pallens				1					
16	Microchironomus tener						1			
17	Parachironomus arcuatus				1			1		
18	Polypedilum	1	1		1		1			
19	Procladius choreus	1								
20	Procladius ferrugineus	1	1		1	1	1	1		
21	Tanypus vilipennis					1				
22	Tanytarsus gregarius					1				