Parameter (Min- Max)	Unit	Tisza	Lippe
		Min - Max	Min - Max
Water temperature	[T°C]	4.7 - 24.0	4.6 - 23.8
Oxygen	O_2 [mg/l]	5.4 - 12.3	9.1 - 11.8
pH		6.7 - 8.3	7.9 - 8.4
Conductivity	[µS/cm]	145 - 645	595 - 827
Total hardness	[German°]	3.2 - 8.2	16.3 - 17.9
Ferrous Iron	Fe^{2}+ [mg/l]	0.02 - 3.9	0.16 - 0.86
Ammonium	NH_4 -N[mg/l]	<0.1 - 3.8	<0.1 - 0.17
Nitrate	NO_3 -N[mg/l]	0.3 - 30	4.0 - 7.0
Phosphate	PO_4 -P[mg/l]	<0.05 - 1.0	0.05 - 0.15
Chloride	Cl- [mg/l]	7 - 85	35 - 81
Sulfate	SO_4^{2}- [mg/l]	0.9 - 65	30 - 47
Discharge	[m3/s]	107 - 2160	7.6 – 328
Water level	[cm]	280 - 687	58 - 400
Sediment, TOC	[%]	0.5	1.5
(Total Organic Carbon)			
Sediment, loss on ignition	[%]	3.2	1.7
[550°C]			

Table 1. Physical-chemical key parameters to rate water and sediment quality of Tisza and Lippe in the section of collection and reintroduction, respectively, of *Palingenia longicauda.* (Data from monthly water measurements during 2004–2007; sediment analysis was performed in 2007)

nique specifically developed for this purpose was applied (Tittizer et al. 2008). Plastic tubes with a diameter of 160 mm and a length of 60-120 cm (according to water depth) were used. The tubes were first pushed into the river sediment and then a defined number of young larvae were introduced *(Figure 5).* Since several (up to ten) tubes were used simultaneously they stayed at the same site for a while (ca. 15-20 min.), and during this time the young larvae could grab into the sediment. By using this technique a possible drift of the young larvae by currents could be avoided. After this procedure, the tubes were retrieved from the sediments and again positioned further downstream.

During three consecutive years (2006-2008) about 100 Mio. young larvae were introduced by this technique in the Lippe near Lippborg and about 25 Mio. in the Odra near Hohenwutzen. There is hope now that the introduced young larvae find suitable living conditions in both rivers in order to establish stable populations in the next years. In this way, our attempt of recolonization could contribute a little bit to the conservation of biodiversity and at the same time counteract the continuous reduction of species number in Middle Europe.

References

Andrikovics S & Turcsányi I (2001): Tiszavirág. Tisza Klub Füzetek 10: 1–69, Szolnok

Clutius A (1634): De hemerobio sive Ephemero insecto et majali verme: 96–104, Amsterdam

Cornelius C (1848): Beiträge zur näheren Kenntnis der *Palingenia longicauda* (Oliv.): 1–37. Büschler'sche Verlagsbuchhandlung, Elberfeld

Russev B (1987): Ecology, life history and distribution of *Palingenia longicauda* (Olivier) (Ephemeroptera). Tijd. Ent. 130: 109–127, Amsterdam

Swammerdam J (1752): Bibel der Natur (Haft, Uferaas): 100–114. J. F. Gleditschens Buchhandlung, Leipzig

Tittizer T, Fey D, Sommerhäuser M, Málnás K & †Andrikovics S (2008): Versuche zur Wiederansiedlung der Eintagsfliegenart *Paligenia londgicauda* (Olivier) in der Lippe. Lauterbornia 63: 57–75, Dinkelscherben

Triebke F (1840): Einige Bemerkungen über *Ephemera flos-aquae* Illiger. Stettiner Entomologische Zeitschrift 1: 54–58, Stettin

Myriophyllum spicatum L. and *Hydra oligactis* (Pallas, 1766) interactions in the small Lake Gornjogradsko in Osijek

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Introduction - Educational Methodology

At the beginning of the 20th century the City of Osijek had six artificial lakes. However, strong negative anthropogenic influence several decades ago reduced this number to three. For the purpose of this investigation, the most suitable research location was Lake Gornjogradsko *(Figure 1)* with its southern shallow littoral zone overgrown by macrophyte vegetation, a depth up to 0.60 m and a quite steep shore. The aim was to elucidate the relationship of submerged macrophytes with attached periphyton and microfauna.

Figure 1. Lake Gornjogradsko in Osijek

Since this lake is located in the city itself and easily accessible, it is a favourable place for a "natural classroom" where pupils and students of the Faculty of Teacher Education can observe, investigate, study and teach science. A visit to Lake Gornjogradsko can serve as an ideal exchange of cross-curricular activities and provide a great possibility for future teachers and pupils to perform a joint creative work since they are involved together in preparation and performance of tuition in a natural environment.

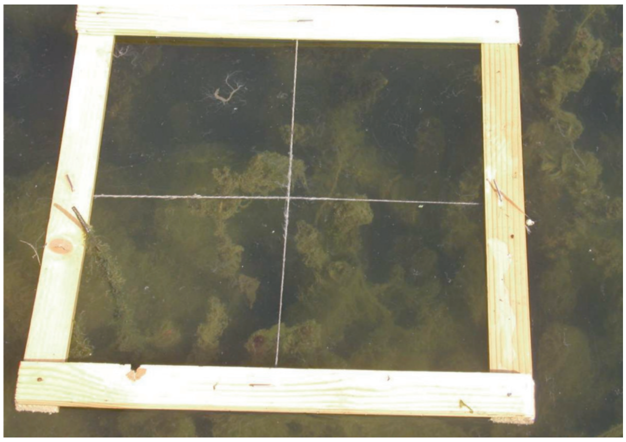
Methods

During March 2007, water milfoil *(Myriophyllum spicatum)* samples were taken every second day in 4 L plastic bags using scissors. At each sampling, five replicates were taken together with attached periphyton and microfauna *(Figure 2).* During the sampling, physical and chemical parameters of water (temperature, dissolved oxygen, pH and conductivity) were analyzed using the field lab (Multi set 340i WTW). After counting brown hydra *(Hydra oligactis)* in each sample on *M. spicatum,* the periphyton was rinsed from a plant and assembled with the rest of the filtered (60 µm pore size) sample in a bottle for later analysis. Macrophyte branches length was measured using millimetre paper and ruler and then summed up for each plant. Macrophyte and periphyton fresh weight was measured with 0.01 g accuracy. Prior to weighing, the periphyton samples were filtered through a paper filter (Whatman GF/C). Total biomass (macrophyte + periphyton) was calculated for each replicate. Correlation analysis was made for the number of brown hydras and macrophyte length, macrophyte biomass, periphyton biomass and total biomass.

Results and discussion

The physical and chemical parameters measured in the water (mean temperature 11.4°C, mean dissolved oxygen concentration 12.9 mg/L and conductivity 1201 µS/cm, *Table 1)* reflected typically the late winter/early spring season. Similar conditions were reported by Bogut (2005) in Kopački rit.

Figure 2. Periphyton sampling with Myriophyllum spicatum



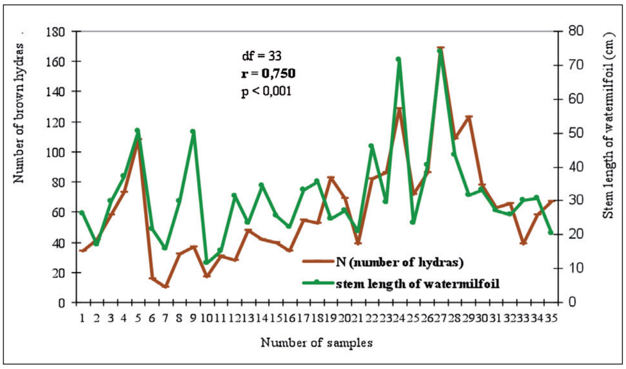


Figure 3. Correlation between the number of brown hydras (Hydra oligactis) and stem length of eurasian water milfoil (Myriophyllum spicatum)

Oxygen oversaturation and pH measurements (8.5-8.8) indicate eutrophication which is a suitable condition for the invasive *Myriophyllum spicatum* (www.wapms.org/plants/milfoil.html, 18th March 2007).

In addition to *Hydra oligactis,* the invertebrate fauna associated with *Myriophyllum spicatum* was composed of representatives of Ciliata *(Vorticella* sp., *Stentor* sp.) and Crustacea. *Daphnia* sp. was the main genus from Cladocera, and in subclass Copepoda *Cyclops* sp. was predominant. In addition to these micro- and meso-zooplankton, macrozoobenthos representatives were also registered: Chironomidae larvae and very abundant Nematodes. The stem length of *M. spicatum* varied from 11.5 to 74 cm with an average value of 31.7 cm. The mean fresh weight was 5.6 g (range 2.4 – 12.8 g). Periphyton biomass varied between 3.1 and 6.6 g (average 4.0 g). The highest value of total biomass (macrophyte + periphyton) was 17.0 g and the average was 9.6 g. The number of brown hydras counted on one water milfoil plant ranged between 10 and 169 with an average of 62 organisms.

As was expected, the highest statistical correlation was found between the number of brown hydras and stem length of water milfoil: $r = 0.750$; $p<0.001$ *(Figure 3).* Other correlations were also of statistical significance: between the number of brown hydras and total biomass: $r = 0.661$; $p<0.001$, between the number of brown hydras and water milfoil biomass: $r = 0.624$; $p<0.001$. The lowest significance in correlation was found for the relationship between the number of brown hydras and periphyton biomass: $r = 0.316$; $p = 0.05$ which is reasonable because hydras are attached to the plant surface.

Variables	MIN.	MAX.	Mean ± SD
Water temperature (°C)	9.4	13.1	11.4 ± 1.4
Dissolved oxygen (mg/L)	9.8	14.7	12.9 ± 2.1
Oxygen saturation (%)	89.0	144.0	120.0 ± 21.5
pH	8.5	8.8	8.7 ± 0.1
Conductivity (µS/cm)	1194.0	1209.0	1201 ± 5.6

Table 1: Physical and chemical parameters of water in Lake Gornjogradsko in Osijek during March 2007

Hann (1995) investigaed the invertebrate association on *Ceratophyllum demersum, Potamogeton zosteriformis* and *Chara vulgaris.* Predominant were Cladocera, Copepoda, Rotifera, Chironomidae and Ostracoda. Most Cladocera preferred *C. demersum* and *P. zosteriformis which was un*-expected because *C. demersum* and *Ch. vulgaris* are morphologically similar. Hann presumed that alelochemical characteristics were the reason for that. Hydra was mostly found on *C. demersum* and *P. zosteriformis* but it did not prefer any particular macrophyte species.

Macrophyte morphology can have a certain influence on invertebrate colonization (Dvořak 1996; Cheruvelil et al. 2000, 2002). Abundance of invertebrates is higher on plants with dissected leaves (Rooke 1984). These plants have a higher surface/biomass ratio and at the same time, they provide better shelter to invertebrates against predators and periphyton as available food resource. Hence, *Myriophyllum spicatum* L. is a suitable environment for brown hydra as proven by the maximum of 169 organisms on just one plant.

Elliott et al. (1997) investigated the predation of hydra to juvenile fishes in Opinicon Lake in Canada. Hydras were collected from *M. spicatum* where an average number of 63 organisms were found on about 20 cm long stems, which corresponds to our results. The authors concluded that as *M. spicatum* are more spread, the population of hydra is more numerous and the number of juvenile fishes is decreasing. They evidenced 26 % of larval mortality as many larvae died by the poison of hydras although they could escape from their stinging tentacles.

Hydras are certainly causing fish death especially of those which spawn in littoral lake zones (Elliott et al. 1997). The question how *Hydra oligactis* influences the fish population in Lake Gornjogradsko in Osijek is open for future investigation.

References

Bogut I (2005): Funkcionalna struktura makrofaune i meiofaune u makrofitskim zajednicama Kopačkog rita. Disertacija. Sveučilište u Zagrebu, Prirodslovno-matematički fakultet.136 pp. *[in Croatian]*

Cheruvelil KS, Soranno PA, Serbin RD (2000): Macroinvertebrates associated with submerged macrophytes: sample size and power to detect effects. Hydrobiol. 441, 133–139

Cheruvelil KS, Soranno PA, Madsen JD, Roberson MJ (2002): Plant architecture and epiphytic macroinvertebrate communities: the role of an exotic dissected macrophyte. N. Am. Benthol. Soc. 21(2), 261–277

Dvořak J (1996): An example of relationship between macrophytes, macroinvertebrates and other food resources in a shallow eutrophic lake. Hydrobiol. 339, 27–36.

Elliott JK, Elliott JM, Leggett WC (1997): Predation by Hydra on larval fish: Field and laboratory experiments with bluegill *(Lepomis macrochirus)*. Limnol. Oceanogr. 42(6), 1416–1423

Hann BJ (1995): Invertebrate associations with submersed aquatic plants in a prairie wetland. UFS (Delta Marsh) Annual Report, 30, 78–84

Rooke JB (1984): The invertebrate fauna of four macrophytes in a lotic system. Freshwat. Biol. 14, 507–513

Microphytobenthos in large rivers – living on the edge

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Introduction

Rivers, especially their near bank zones and backwaters, are hot spots for biogeochemical processes (McClain et al. 2003) and represent functional retention areas, which are important for the control and maintenance of river water quality. Especially during low flow periods the importance of zones along banks for the aquatic productivity and therefore for the carbon supply increases along regulated rivers such as the Danube downstream of Vienna. These zones along banks provide essential flow reduced and shallow areas, important for zooplankton, juvenile fish and also the development of phytoplankton and microphytobenthos (Hein et al. 2005, Schiemer et al. 2007), which provide the basis for higher trophic levels. Studies from the Elbe show for example that the conditions in groin fields for planktonic primary production are much better than in the main channel. These boundary areas provide the main source for oxygen, organic matter and algal biomass for the whole river ecosystem (Böhme 2006). In the Danube River downstream of Vienna the formation of gravel structures along the riverbank allow the occurrence of microphytobenthos and support an increased emergence, although stabilisation measures and steep embankments have reduced these optimal growth zones *(Figure 1).* Bank restoration and embankment removal will improve the environmental conditions for microphytobenthos and therefore the basic supply for the riverine food web. Anthropogenic changes in bank morphology are therefore reflected in the production potential and biomass development of benthic algae and can be used as an indicator for the quality of bank structures. Beside this indicative value, they have been identified together with macrophytes as one of four biological quality elements for the assessment of the ecological status of surface waters.