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COMPARATIVE WATER QUALITIES STUDIES ON ARTIFICIAL WATER FLOWS IN NYÍRSÉG REGION (HUNGARY)

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ABSTRACT. We are doing biological and chemical water quality assessments for 2 drainage systems on Nagy-vájás Canal and Keleti-öv Canal as well as Canal of Máriapócs in Nyírség region (Hungary) since 2008. The main goals of the present study were to determinate macroinvertebrate taxa (bioindication for calculation of the BBI and to do comparative analytical examinations at encountered of the two canals. Because we have found flacons including chemical residua at the Nagy-vájás monitoring sampling stations, there is a possibility of a stronger pollution. In case of Canal Máriapócs, we compared the water quality of the in- and outflow section of the reservoir Levelek. We could state that in cases of Keleti-öv- and Nagy-vájás Canal the quality of the water is excellent, based on the used methods and the parameters we examined. On the basis of macroinvertebrate taxa, the water flows could be classified into the moderately polluted quality class. The most common taxa are: *Asellus* sp., *Plea* sp., *Chironomidae, Ilyochoris* sp. and *Caenis* sp. The water body of this canal is not affected by human activities appreciably although the growing rate of tourism would be unfavorable on water quality and macroinvertebrate communities.
Keywords: Belgian Biotic Index, macroninvertebrate, stream ecology, environmental science, water qualification, water chemical flavor

INTRODUCTION

As a consequence of growing antropogenous impact of the last decades, the state of our natural waters became remarkably worse. After this phenomenon was recognised, member states of the European Union worked out the Water Framework Directive (WFD) in order to establish the basis for a reasonable water management (Chave, 2001). Aim of the WFD is to rehabilitate and permanently ensure the good ecological status of natural waters by 2015 (Bácskai, 2006). Ecological approach became determinant in water qualification and as a sign of it examinations (Felföldi, 1984), which are based on biomonitoring, became gradually conspicuous. Signals of living organisms practically integrate exterior effects, thus they are unable to substitute the conventional analytical methods for water which are necessary for the examinations. Elaboration of Belgian Biotic Index (BBI) begun in 1978 and it became an official water qualifying system in 1984 (Gabriels, 2005). BBI is the most accepted and the most applied method of nowadays, which is based on the presence and frequency of differently sensitive organisms as well as on the number of identifiable taxa (De Pauw and Vanhooren, 1983).

In this paper, we introduce the first results of a survey that we are planning to continue on long-term. On the basis of water analytical parameters (MSZ 12749) and macro-invertebrate fauna, the water quality was observed in Máriapócs Main-Channel (before and after the Levelek Reservoir), in Keleti Channel as well as in Nagy-vájás Channel (Győrtelek, Hungary). We chose the water quality examination of main-channels because presently we have to effectuate more and more tasks to preserve the quality of waters. On the other hand, our aim is to point out the effects of growing water use of humans on water quality and macro-invertebrates of main-channels. Numerous wetlands are constructed worldwide, the aim of which is mainly the wastewater treatment (Verhoeven et al., 2006). In many cases, such treatments have damaging effects, such as decrease of biodiversity or emission of greenhouse-gases (Groffman et al., 1998, Machefert et al., 2002).

The most diverse and the most dangerous forms of water pollution is caused by chemical water pollutants, thus chemical properties represents the largest group of water quality properties (Oprean et al., 2009). Among these, we can find a whole range of organic and inorganic compounds, which get into the waters both natural and artificial ways (Benedek & Literáthy, 1979). Aim of chemical measurements and examinations is to determine and measure the characteristic water pollutants. Dissolved salt content of waters and wastewaters is one of the characteristic water pollutants.

Biological water quality assessment means the examination and measurement of those biological properties which are necessary for the establishment and maintenance of aquatic and periaquatic ecosystems. Species of lower and higher plant- animal- and microbial phyla are similarly used for biological experimental methods (during biological water quality assessment) (Csépai, 1976). Being conversant with the biology of certain species help us to draw a conclusion about water quality (Némedi et al., 1981). Living organisms respond differently to changes of physical-chemical factors and life conditions. Ecological water quality assessment primarily uses the results of biological method, however, it also considers the results of physical and chemical water quality assessment, and explores causal and effectual relations between changes of physical-chemical

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parameters and changes which effect living organisms. It establishes connection between indicator organism and indikandum (the phenomenon which have to be indicated).

MATERIALS AND METHODS

Research area

Máriapócs Main-Channel: Most of the water which is collected by River Tisza arrives from beyond the borders. One of these streams is Máriapócs Main-Channel that flows into the Tisza in Gávavencsellő after it collects thee water of Middle-Nyírség, which was originally an area without outlet. The whole channel-system was put into operation in 1939. In order to reduce the permanent drought in Nyírség, several reservoirs were constructed between 1975 and 1980, the aim of which was primarily to ensure the possibilities for watering. Sampling places were pointed out before and after the Levelek Reservoir. The whole water surface of the reservoir is 250 hectares, while the average water depth is 2 meters. In case of maximal water-level, water-capacity is more than 4.000.000 km^3 (Konecsny, 2005). On Máriapócs Main-Channel, 1^{st} and 2^{nd} sampling places were marked out before the Reservoir, while 3^{rd} and 4^{th} sampling points were after the outflow.

Keleti Channel and Nagy-vájás Channel: The settlement of Győrtelek is intersected with these junction channels which can be found 67 km away from Nyíregyháza, on the Szatmár Plain, near to the Holt-Szamos. The village is also cut across by Number 49 and Number 491 main roads, which enable to reach the settlement from Romania and Ukraine, across Tiszabecs and Csengersima border stations. 0-10 RKM of the Keleti Channel can be found in Tunyogmatolcs, in the bed of Holt-Szamos, as it is certified by the river register as well. Between 10 and 34.56 FKM, the section of Keleti Channel can be described with an artificial status. On the area between Szamos and Kraszna, considerably large lands are covered by water in the periods of internal water. In case of high water levels of the recipient rivers (Tisza, Szamos), water control and water detentions between the inlets become greatly important. As a consequence of human activities, the original plant cover of the area has changed. Water quality is damaged by the growing vegetation cover as well as by potential and diffuse sources of pollution. Antoropogenous impacts and the contaminating effects of agricultural waters are the main factors which influence the water quality of the area (Török et al., 2009). Representative sampling points were marked out on the examined sections of the channels. Given sampling points can be found on characteristic sections of the examined area. The first sampling point (G1) can be found on an inhabited land, 200 km away from the immediate junction. The second sampling point (G2) can be found by the junction of Nagy-vájás Channel and Keleti Channel. The site is enclosed by agricultural and neglected areas. The third sampling point (G3) can be found next to a lock, on a section of Nagy-vájás Channel which comes from Nagyecsed. This section is characterised by the neighbourhood of inhabited areas and consequently, by periodical contaminations which come from urbanizational and human activities. The section is also expressly characterised by the presence of communal, hardly degradable and environmentally harmful contaminants, plastics and flacons which have been contaminated by chemicals. The fourth sampling point (G4) can be found near to a bridge of Keleti Channel, on a channel section which comes from the direction of Romania. The channel transfers its water directly from Romania. The sampling point is surrounded by agricultural sites, inhabited places and abandoned weedy areas.

Research methods

Collection of water samples was preceded by a preliminary survey of the site. The first water samples were taken after this survey. Samples were taken with ladling from the surface layers of waters at depth of 15 cm. For the determination of ion content of water, water samples were ladle to a sampling bottle, the volume of which was 250 ml. Samples were carried to the laboratory in a cooler bag. Until the preparation, samples were stored at a +4°C temperature. During our research, ammonium (NH^{4+}), nitrite (NO^{2-}), nitrate (NO^{3-}), chloride (Cl^-), ortho-phosphate (PO_4^{3-}) and iron (Fe^{2+}, Fe^{3+}) contents of the samples were determined with photometric and colorimetric method. (MSZ 12749). Nanocolor Water Analysis has been practical means for the determination of many analytical parameters for a long time. Different ions are determined by different reagents. Conductivity, pH, and water temperature were measured on site, at the time of sampling. Conductivity and pH were measured with digital pH and conductivity meters. Macroinvertebrata species were collected with a standard handnet, which meets the requirements of the water qualifying system of BBI (Belgian Biotic Index) (De Pauw & Vanhooren, 1983; De Pauw et al., 1996). The mesh size of the handnet was 0.5 mm. Identifications were carried out according to generally used handbooks (De Pauw et al., 1996; Déri, 1995; Dukai, 2000).

RESULTS AND DISCUSSION

Water qualification by chemical parameters

Keleti Channel and Nagy-vájás Channel (Győrtelek): According to chemical analyses, ammonium content of all water samples was less than 0.1 mg/l. This is an insignificant amount in proportion to the limit values. According to the water quality classification, the water has excellent water quality. The nitrogen form, which can be found in ammonium ions, refers to immediate pollution. This nitrogen form did not pointed out from the samples. During the examination of nitrite content, we established that nitrite ion values did not significantly differ from each other, neither on different sampling sites nor in different sampling periods (Fig. 1.). At many times, nitrite concentrations are below the limit values or approximate that. We can see a prominently high value on the third sampling point, however, according to Hungarian Standards (MSZ 12749:1994) the water can be described with excellent water quality.

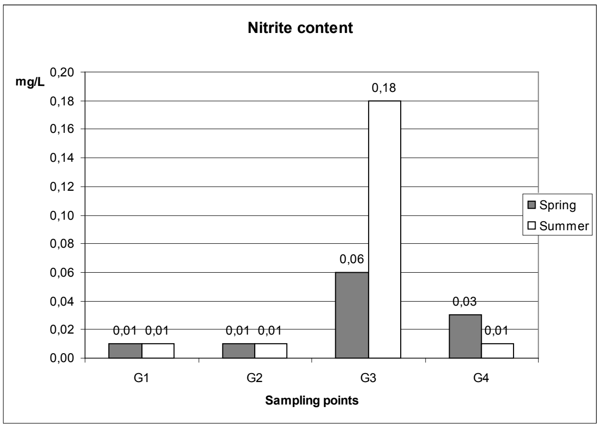

Fig. 1: Nitrite ion content of water samples at Keleti Channel and Nagy-vájás Channel's sampling points

Nitrate ion content of water (Fig. 2.) did not exceed the limit value, which had been established for our natural waters. The water has excellent water quality. The only prominently high value (9.8 mg/l) was measured in summer, in the third sampling point, on the section of Nagy-vájás. In spite of this, the water can be ranked into the good water quality category. Here, the higher nitrate content may be explained by human faecal contamination, because these sampling points can be found next to the inhabited areas.

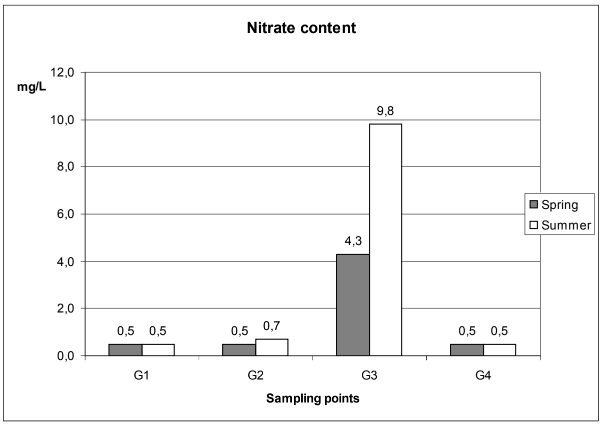

Fig. 2: Nitrate ion content of water samples at Keleti Channel and Nagy-vájás Channel's sampling points

Phosphate is the most common phosphorous form in the biosphere. In proportion to the other biological macro-elements, it can be found in considerably lower amounts in the environment. Phosphate compounds are basically important for plants as they can take up only the ortho-phosphates (PO_4^{3-}). Phosphate is the most important limiting factor in waters; because productivity of water is frequently limited by the amount of available P. Namely, high phosphorous load stops the primarily existing limitation.

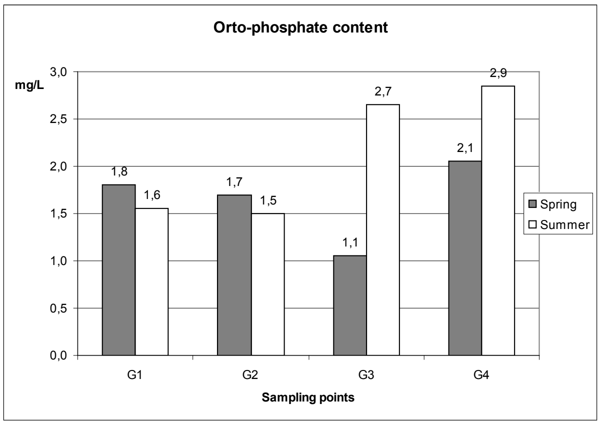

Fig. 3: Ortho-phosphates content of water samples at Keleti Channel and Nagy-vájás Channel's sampling points

In a whole, our results suggest that phosphorous supply of the samples is balanced in time and space. It does not change significantly (Fig. 3.), however, the water samples are considerably loaded with ortho-phosphate. According to the limit value of the Hungarian Standards (MSZ 12749: 1994) the water can be classified into the hardly polluted category. Thus, water of the channels is endangered by the secondary effects of eutrofication, which influences most of the human water use. Chloride ions, which can be found in most of the waters, are mostly comes from geological or antropogenous sources. Generally it can be found in a small quantity in our surface waters. Within the examined period, the determination of chloride ion content (Fig. 4.) showed insignificant changes of chloride supply on most of the sampling sites. More significant changes can be seen only in case of G1 and G2 sampling points, where chloride ion concentration of water decreased about one half of its previous level in the summer period. We explain it by the fact that chloride can be found in plants in relatively large quantities. As this ion is quite mobile, plant took up more chloride from water at the beginning of the vegetation period.

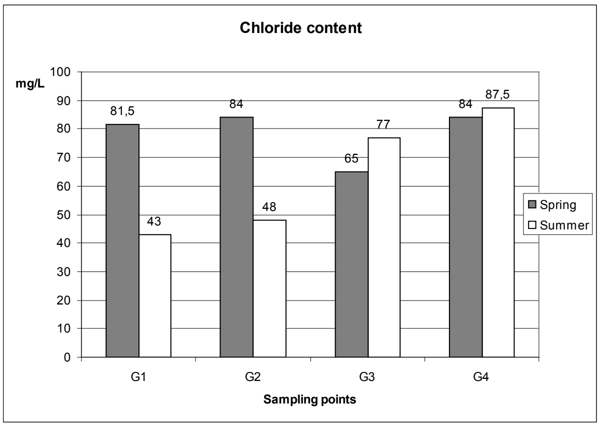

Fig. 4: Chloride ion content of water samples at Keleti Channel and Nagy-vájás Channel's sampling points

In case of sections, which are before the junctions (G3 and G4 sampling points), the measure of chloride concentration is essentially similar to the chloride concentrations of spring samples. In these sections, higher concentration values can be explained by the closeness of inhabited areas, since non-canalized areas can continuously bring fecal contamination into the water. In spite of these, we established that chloride ion concentrations did not fluctuated considerably within the examined period. Chloride ion concentrations never exceeded the limit values. On the basis of chloride ion concentration, water of the channel was ranked into the excellent water quality category.

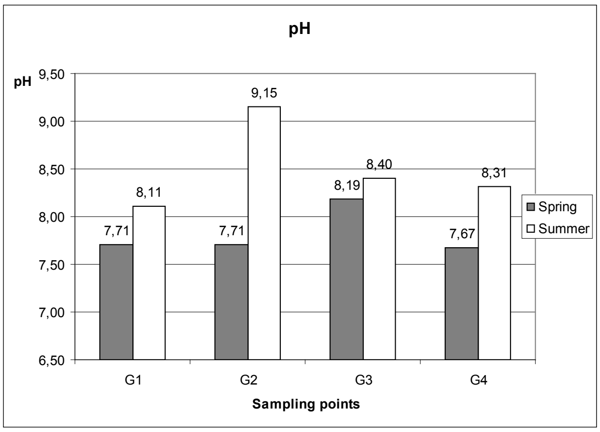

Fig. 5: pH of water samples at Keleti Channel and Nagy-vájás Channel's sampling points

The pH value of water samples was variable within the examined period (Fig. 5.). In spring, water of all sampling points can be classed into the 1st (excellent) category of Hungarian Standard (MSZ 12749), which contains the limit values of surface waters. In summer, water of sampling sites belonged to the 2nd class of water quality, with the exception of G2 sampling point. In G2 sampling point, pH value of the water became more alkaline, therefore the water belonged to the 4th category of water qualification.

Máriapócs Main Channel: ammonium ion concentration was measured in all water samples, however, the amount of ammonium never exceeded the value of 0.1 mg/dm^3, which can be detected by the Nanocolor method (limit value of the 1st class of water quality assessment is 0.2 mg/dm^3). This refers to the aerobic status of water, since ammonium accumulation cannot be observed. Nitrate and nitrite concentrations were also determined from the samples, because these nitrogen forms are in strict connection, considering the matter circulation of nitrogen. Values of nitrate and nitrite concentrations can be seen in Figure 6. and 7. With a few exceptions, results of nitrate and nitrite concentrations meet the requirements of the 1st class of water quality assessment (limit values of the 1st class are: 1 mg/dm^3 for nitrate and 0.033 mg/dm^3 for nitrite). It is important to mention that in July, prominently high values of nitrite and nitrate was measured on the 4th sampling point. As it is a single problem, which refers to only the aforementioned sampling point, some sort of local organic pollution can be assumed.

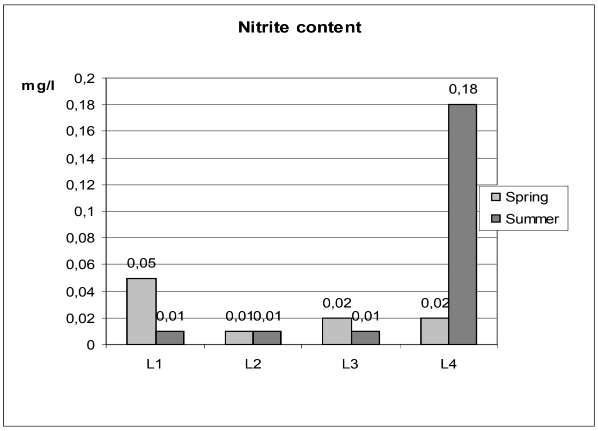

Fig. 6: Nitrite ion content of water samples at Máriapócs Main Channel's sampling points

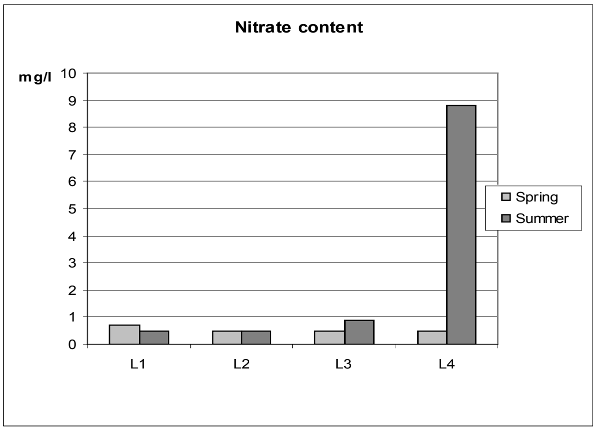

Fig. 7: Nitrate ion content of water samples at Máriapócs Main Channel's sampling points

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Ortho-phosphate concentrations of water samples are showed in Figure 8. The measured values are between 0.8 and 1.5 mg/dm^3, which considerably exceed the limit value (0.25 mg/dm^3) of the 5th class of water quality (MSZ 12749). These results refer to the highly eutrophic characteristics of the water.

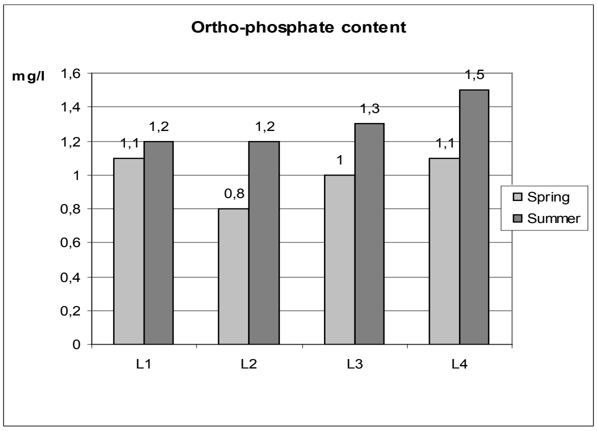

Fig. 8: Ortho-phosphates ion content of water samples at Máriapócs Main Channel's sampling points

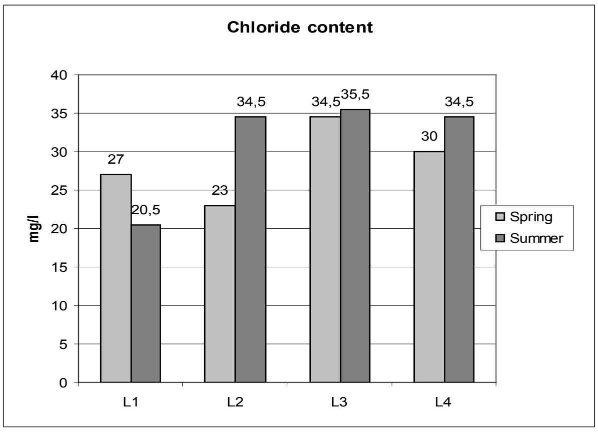

Fig. 9: Chloride ion content of water samples at Máriapócs Main Channel's sampling points

High chloride content of natural waters is considered as an indicator of fecal contamination. In our water samples, chloride concentrations were between 20 and 36 mg/dm^3 (Fig. 9.). All of the results are below the limit value (100 mg/dm^3). Figure 10 shows the pH values of water samples in two sampling dates. The values are between 7.4 and 8.6. On the basis of pH values, the 1st sample meets the requirements of the 1st class of water quality assessment, while higher pH values of the 2nd and mainly the 3rd and 4th samples (pH > 8) refer to the 2nd category (MSZ 12749).

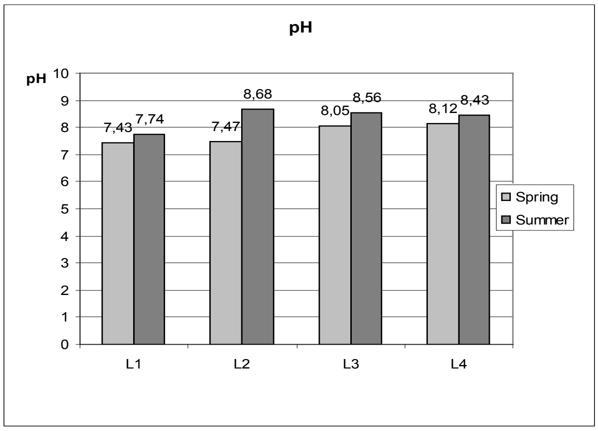

Fig. 10: pH of water samples at Máriapócs Main Channel's sampling points

Water qualification by BBI

Keleti Channel and Nagy-vájás Channel (Győrtelek): Biological water quality assessment was carried out on the basis of the identified macroinvertebrate taxa, which had been collected during the water sampling. The results indicated balanced water quality in all sampling dates, since neither strongly contaminated nor excellent water quality values were reached by the measured values. According to BBI (Belgian Biotic Index) water quality never exceeded the value of 5. In most cases, water quality belonged to the 3rd class of water quality assessment, namely the water could be placed into the moderately polluted category (Table 1.).

Table 1: Representative macroinvertebrate fauna of Keleti Channel and Nagy-vájás Channel by taxa-list of BBI (Tol: tolerance class; I: Spring sampling; II: Summer sampling)

Ponit	List of BBI Taxa	Tol.	I.	II.
G1	*Bithynia*	4	+	+
	Asellidae	5	+	-
	Planorbis	4	+	-
	Plea	5	+	+
	Chironomidae (thummi-plumosus)	6	+	+
	Lymnea	4	+	-
	Ilyocoris cimicoides	5	+	-
	Succinea	4	+	-
	Caenis	3	+	-
	Gerris	5	-	+
	Callicorixa	5	-	+
	Unio	4	-	+
	All number of taxa:		9	6
	BBI:		5	5
	Water quality class:		III	III
G2	*Asellidae*	5	+	-
	Plea	5	+	+
	Viviparus	4	+	-
	Lymnea	4	+	+
	Planorbis	4	+	+
	Platycnemis	4	+	-
	Caenis	3	+	-
	Chironomidae (thummi-plumosus)	6	+	-
	Notonecta	5	+	-
	Unionicola		-	+
	Culicidae		-	+
	Anophelidae		-	+
	Dytiscidae		-	+
	Baetis	3	-	+
	All number of taxa:		9	8
	BBI:		5	5
	Water quality class:		III	III
G3	*Bithynia*	4	+	-
	Succinea	4	+	-
	Asellidae	5	+	-
	Plea	5	+	+
	Chironomidae (thummi-plumosus)	6	+	-
	Glossiphonia	5	+	-
	Platycnemis	4	+	-
	Ilyocoris	5	+	-
	Callicorixa	5	-	+
	Culicidae		-	+
	Planorbis		-	+
	All number of taxa:		8	4
	BBI:		5	4
	Water quality class:		III	IV
G4	*Asellidae*	5	+	-
	Plea	5	+	+
	Ilyocoris	5	+	-
	Platycnemis	4	+	-
	Chironomidae (thummi-plumosus	6	+	-
	Caenis	3	+	-
	Culicidae		-	+
	Dytiscidae		-	+
	All number of taxa:		6	3
	BBI:		5	3
	Water quality class:		III	IV

According to BBI (Belgian Biotic Index), identification of the collected macroinvertebrate taxa suggested that water quality of the two channels belonged to the moderately polluted category (3rd class), while it could be qualified as strongly polluted (4th class) on one occasion. Even the most sensitive species of the collected macroinvertebrates (*Caenis sp., Baetis sp.*) belong to the 3rd tolerance category. We also observed that most of the identified taxa were not found in all two sampling dates, except *Plea* taxa, which could be found on all four sampling points, both in spring and in summer samples. Beside this, we found *Bithynia* and *Chironomidae* taxa on 1st sampling point and *Lymnea* and *Planorbis* taxa on 2nd sampling point in all sampling dates. The latter case can be explained by the seasonal dynamics of macroinvertebrate taxa (Petri et al., 2009).

We could not find significant differences between the channel sections before and after the junction of channels, however, it is worth to mention that biotic index of Keleti Channel is lower than biotic index of the other sampling points. Considering the result of summer sampling, water quality class of Keleti Channel is also lower than that of the other sampling points.

Máriapócs Main Channel: Comparison of taxa lists, which were identified on a given sampling point in different sampling dates, shows significant differences between the sampling dates of May and July (Table 2.). On 1st and 4th sampling points only one taxon could be identified (*Chironomidae* in the first case and *Asellidae* in the second case) in all two sampling dates. On 2nd and 3rd sampling points more taxa (5 taxa in the first case and 3 taxa in the second case) were identified in all two sampling dates. Different taxa composition of summer and spring samples refers to the significantly changing micro-ecological circumstances, which results in appearance of new taxa as well as in surpassing or overshadowing of former taxa. It is probably connected to the seasonal dynamics of macroinvertebrate communities. (Petri et al., 2009). Besides changing of taxa, the results of all sampling points show increased number of taxa for the middle of July. In case of 1st and 3rd sampling points, the number of taxa increased with only two taxa, however, on 2nd and 4th sampling points the number of taxa increased with 4 and 6 taxa, respectively.

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Table 2: Representative macroinvertebrate fauna of Máriapócs Main Channel by taxa-list of BBI (Tol: tolerance class; I: Spring sampling; II: Summer sampling)

Point	List of BBI Taxa	Tol.	I.	II.
L1	Asellidae		+	-
	Chironomidae (thummi-plumosus)		+	+
	Plea		+	-
	Leptophlebia		+	-
	Ilyocoris		+	-
	Planorbarius		-	+
	Haliplidae		-	+
	Baetis		-	+
	Succinea		-	+
	Physa		-	+
	Platycnemis		-	+
	All number of taxa:		5	7
	BBI:		4	5
	Water quality class:		IV	III
L2	Planorbis		+	+
	Lymnea		+	+
	Plea		+	-
	Leptophlebia		+	-
	Ilyocoris		+	+
	Asellidae		+	+
	Polycentropidae		+	+
	Platicnemis		+	+
	Succinea		-	+
	Argironeta		-	+
	Planorbarius		-	+
	Chironomidae (thummi-plumosus)		-	+
	Cystobranchus		-	+
	Glossiphoni		-	+
	Baetis		-	+
	All number of taxa:		8	12
	BBI:		6	6
	Water quality class:		III	III
L3	Asellidae		+	+
	Succinea		+	-
	Bithynia		+	+
	Haemopis		+	+
	Erpobdella		+	-
	Planorbarius		-	+
	Nepa		-	+
	Lymnea		-	+
	Hemiclepsis		-	+
	All number of taxa:		5	7
	BBI:		4	5
	Water quality class:		IV	III
L4	Asellidae		+	+
	Succinea		+	-
	Erpobdella		+	-
	Phryganeidae		+	-
	Nepa		-	+
	Platicnemis		-	+
	Ilyocoris		-	+
	Planorbarius		-	+
	Bithynia		-	+
	Sigara		-	+
	Notonecta		-	+
	Baetis		-	+
	Lymnephilidae		-	+
	All number of taxa:		4	10
	BBI:		5	6
	Water quality class:		III	III

1st and 2nd sampling points of Máriapócs Main Channel can be found before the junction of Levelek Reservoir, while 3rd and 4th sampling points are after the junction. Comparison of taxa list of the 1st and 2nd sampling points (Table 1. and 2.) with taxa list of the 3rd and 4th sampling points (Table 3. and 4.) shows significant similarity in case of taxa, which were collected in the same sampling date, however, this similarity is not complete. On 1st sampling point, 5 taxa were identified from which 4 could be found on the 2nd sampling point as well. In summer, 7 taxa were identified on the 1st sampling point from which 4 taxa could be found also on the 2nd sampling point. Considering 3rd and 4th sampling points, in May 5 taxa were identified on the 3rd sampling point from which 3 could be found on the 4th sampling point, while in summer 7 taxa were identified on the 3rd sampling point from which 4 taxa could be found on the 4th sampling point. As the distance between 1st and 2nd or 3rd and 4th sampling points is only 25m, strongly fluctuating water-level, low water output and the consequently low flow rate of the main channel can supposedly lead to different ecological conditions, which maintain significantly different communities even if they are within a short distance.

Water quality was determined on the basis of the number and tolerance level of taxa. On 1st and 3rd sampling points, BBI value is only 4 on the basis of tolerance levels and the low number of taxa. According to the conventional water quality assessment, it meets the requirements of the 4th class of water quality. BBI values were 5 or 6 in all other cases that refers to the 3rd class of water quality assessment.

CONCLUSIONS

Besides examining the water quality of Nagy-vájás Channel and Keleti Channel (2+3 sampling points), which can be found in Szabolcs-Szatmár-Bereg County, near to the settlement of Győrtelek, during our examinations, we also observed the water quality of Máriapócs Main Channel on 2-2 sampling points, which were marked out before and after the junction of Levelek Reservoir. Water quality assessment was carried out on the basis of water analytical parameters and the composition of macroinvertebrate fauna. Our aim was the biological and chemical water quality assessment of the channels. On the basis of our results, we can establish that Nagy-vájás Channel and Keleti Channel can be described by balanced water quality, on the basis of both biological and chemical water quality assessment. Only the phosphate content of the water was presumably high in proportion to other parameters, which referred to the strongly polluted status i.e. the 5th class of water quality assessment. On the basis of biotic indices, which were determined by the help of macroinvertebrate taxa, the worst water quality (4th class) was measured in the channel section, which comes from Romania. In the whole examined period, the biotic index of the water was 5, while the water quality was described by the 3rd class of water quality assessment. In case of Máriapócs Main Channel, we established that water of the main channel can be described with good water quality (1st and 2nd class of water quality assessment) on the basis of chemical parameters, with the exception of ortho-phosphate which reflects highly eutrophic character of the water. On the basis of occurrence, number and tolerance value of macroinvertebrate taxa, BBI values were between 4 and 6, which referred to the 3rd and 4th class of conventional water quality assessment.

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