

ECOLOGICAL ASSESSMENT OF WATER QUALITY OF THE TISZA BY PHYSICO - CHEMICAL AND BIOLOGICAL PARAMETERS

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Abstract. Investigations during the period 1990-1992 showed disturbance of oxygen regime with evident minimum in the summer to occur in the River Tisza concurrently with a relatively high content of nutrients, mineral nitrogen particularly. Zoocenological analysis also pointed to increase in organic load. In plankton samples and bottom fauna and fish, the species being characteristic of eutrophic environment dominated. Therefore, a section of the River Tisza investigated is characterized by a rapid process of eutrophication.

Keywords: oxygen regime, nutrients, zooplankton, bottom fauna, fish, eutrophication.

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Introduction

A long-term investigation of water quality of lower River Tisza pointed out variations of values of physico-chemical and hydrobiological parameters, in particular after the dam was built, in the vicinity of Novi Becej, and stream reservoir formed (Djukić and Stanojević, 1981, 1983; Djukić and Kilibarda, 1985; Pujin, 1985, 1989, 1992; Pujin et al., 1984, 1990; Kojčić et al., 1989). Consequently, the whole body of water of the Tisza in this section, in particular in the period of its low level is slow down. In past few years, oxygen regime was found to be unbalanced evidently as well as the concentration of some nutrients. Therefore, the aim of this paper was to evaluate water quality of the lower River Tisza and to suggest certain protection measures on the basis of most recent data obtained.

Methods

In the period 1990-1992, the samples for studies of physico-chemical parameters of water and hydrobionts were collected. The analysis included oxygen regime, nutrients concentration, as well as composition and dynamics of plankton and bottom

fauna communities by using standard American methods. The ichthyofauna data are based upon the results of economic and sport catch in the form of annual values.

Results and discussion

Analysis of oxygen balance, organic load, and nutrient content pointed to the two characteristic periods as dependent on the hydrological and climatic conditions. Summer and early autumn low level of water, sedimentation and changes of oxygen regime due to stream slow down were observed. A considerable organic load and an increased content of nutrients were the basic characteristics of the River Tisza at all the profiles under investigation. The effects of the reduction of organic load along the stream owing to the deposition of organic matter with the suspended materials and nitrification were not so evident due to influence and the arrangement of pollutants. In the period 1984 - 1986, an evident increase in all the mineral forms of nitrogen, in particular ammonia, was recorded (Kojčić et al., 1989), while the period of stagnation followed after.

Nitrate form (7.62 ± 4.11 mg/l,) making up 60-80% of total nitrogen predominated. Ammonia

Table 1 Qualitative composition of zooplankton of lower River Tisza

Species	1990	1991	1992	Species	1990	1991	1992
Protozoa				<i>K.cochlearis</i> var. <i>tecta</i> (LAUTER.)	+	+	+
<i>Amoeba vulgaris</i> EHR.	+			<i>K.quadrata</i> (O.F.M.)	+	+	+
<i>Aspidisca costata</i> (DUJ.) CL.L.	+	+	+	<i>K.valga</i> f. <i>monospina</i> (KLAUS.)	+	+	+
<i>Carchesium polypinum</i> L.	+	+	+	<i>Lecane bulla</i> (GOSSE)	+		
<i>Trithigmostoma cucullulus</i> (O.F.M.)	+	+	+	<i>L.luna</i> MÜLLER	+	+	+
<i>Chilodonella uncinata</i> EHR	+			<i>L.lunaris</i> (EHR.)	+		
<i>Colpidium colpoda</i> (EHR.) STEIN	+	+	+	<i>Liliferotrocha subtilis</i> RODEW.	+	+	+
<i>Didinium nasutum</i> O.F.M.	+			<i>Mytilina mucronata</i> (EHR.)		+	
<i>Epistylis plicatilis</i> EHR.	+	+	+	<i>Notholca squamula</i> (O.F.M.)	+	+	+
<i>Paramecium aurelia</i> complex	+	+	+	<i>Polyarthra dolichoptera</i> IDELS.	+	+	+
<i>P.caudatum</i> EHR.	+	+	+	<i>P.vulgaris</i> CARLLIN	+	+	+
<i>P.putrinum</i> STOCKES	+	+	+	<i>Pompholyx complanata</i> GOSSE	+	+	+
<i>Stylonychia mytilus</i> EHR.	+			<i>Rotaria neptunia</i> EHR.	+	+	+
<i>Tintinnopsis lacustris</i> complex	+	+	+	<i>R.neptunoides</i> HARRIG	+	+	+
<i>Tokophrya quadripartita</i> Cl.L.	+	+		<i>R.rotatoria</i> (PALLAS)	+	+	+
<i>Vorticella campanula</i> EHR.	+	+	+	<i>Synchaeta oblonga</i> EHR.	+	+	+
<i>Vorticostoma</i> EHR.	+	+	+	<i>S.pectinata</i> EHR.	+	+	+
Rotatoria				<i>Trichocerca dixon-nuttalli</i> JENN.		+	
<i>Anuraeopsis fissa</i> (GOSSE)	+	+	+	<i>T.rattus</i> (MÜLLER)	+	+	+
<i>Asplanchna brightwelli</i> (GOSSE)	+	+	+	Cladocera			
<i>A.girodi</i> DE GUERNE	+			<i>Alona quadrangularis</i> (O.F.M.)		+	
<i>A.priodonta</i> GOSSE	+	+	+	<i>Bosmina longirostris</i> (O.F.M.)	+	+	+
<i>Brachionus angularis</i> GOSSE	+	+	+	<i>Ceriodaphnia quadrangula</i> (O.F.M.)		+	
<i>B.budapestinensis</i> DADAY	+	+	+	<i>Chydorus sphaericus</i> KURZ	+	+	+
<i>B.calyciflorus</i> PALLAS	+	+	+	<i>Daphnia longispina</i> O.F.M.		+	
<i>B.diversicornix</i> DADAY	+	+	+	<i>D.magna</i> STRAUSS		+	
<i>B.leydigi</i> COHN	+			<i>Diaphanosoma brachyurum</i> LIEVIN	+		
<i>B.quadridentatus</i> HERMANN	+			<i>Moina micrura</i> (KURZ) SRÁMEK-HUSEK	+	+	+
<i>B.urceolaris</i> (O.F.M.)	+			<i>M.rectirostris</i> (LEYDIG)	+	+	+
<i>B.urceolaris</i> var. <i>rubens</i> EHR	+	+	+	<i>Scapholeberis kingi</i> SARS		+	
<i>Cephalodella catellina</i> (MÜLL.)		+		Copepoda			
<i>C.gracilis</i> EHR.		+		<i>Acanthocyclops robustus</i> SARS	+	+	+
<i>Colurella dicentra</i> GOSSE	+	+		<i>A.vernalis</i> FISCHER	+	+	+
<i>Epiphanes senta</i> (MÜLL)		+		<i>Cyclops vicinus</i> (ULJANIN)	+	+	+
<i>Euchlanis dilatata</i> (EHR.)			+	<i>Eucyclops serrulatus</i> FISCHER	+	+	+
<i>Filinia longiseta</i> (EHR.)	+	+	+	<i>Mesocyclops leuacarti</i> CLAUS	+	+	+
<i>Hexarthra mira</i> (HUDSON)			+	<i>Thermocyclops crassus</i> (FISCHER)	+	+	+
<i>Keratella cochlearis</i> (GOSSE)	+	+	+				

concentration (0.99 ± 0.85 mg/l) pointed to a periodically high pollution of the Tisza and during summer it made up 2-6% total nitrogen, whereas in winter even 30%. Nitrite content (0.24 ± 0.27 mg/l) did not exceed 10% total nitrogen.

Phosphate amount ($PO_4 - 0.38 \pm 0.21$ mg/l; TP - 0.22 ± 0.12 mg/l) was found to be significant at the section under consideration. Ratio of nitrogen to phosphorus pointed out the limiting role of phosphorus in eutrophication.

The changes in the oxygen regime (dissolved oxygen - 7.49 ± 2.95 mg/l; oxygen saturation - $75.2 \pm 28.58\%$) with decrease in content of dissolved oxygen were most frequently due to the stream slow down. Relatively small concentrations and saturation (rarely over 80%) showed seasonal variations. Summer and early-autumn minimum were expressively evident. At the end of August of 1992 fish killing at the upstream section nearby Novi Knezevac as a result of oxygen deficiency was recorded. Supersaturation phenomenon is not a characteristic of the Tisza and it is recorded during short intervals, namely most frequently at the end of July and at the beginning of August as the result of phytoplankton activity.

During winter and in summer chlorophyll content was low, namely below 10 mg/m^3 . At the end of May, however, at water temperature of 20°C , an increase in its concentration was recorded. Characteristic maximum values were observed in the middle of June and at the end of July-beginning of August. At luxuriant growth of plankton algae, evident fluctuations in diurnal-nocturnal oxygen cycle were observed.

During three-year investigations the phytoplankton community remained at small species number. In spring and autumn Bacillariophyta in particular the species of the genus *Stephanodiscus*, *Navicula*, *Nitzschia*, *Asterionella*, *Melosira*, and *Synedra* predominated. In summer, however, number of green algae, in particular species of genus *Pediastrum* and *Scenedesmus* increased. Cyanobacteria and Pyrrophyta occurred occasionally and were less abundant as well as Euglenophyta.

In relation to qualitative composition, number of zooplankton species was decreased when compared to previous results. In the Rotatoria group the species of the genus *Brachionus* and *Keratella* dominated while Ciliata in Protozoa namely the

species being the characteristic of water rich in organic matter (Table 1).

Quantitatively, water of the Tisza was evidently poor in zooplankton and therefore in 1992 only Protozoa dominated (Table 2).

Table 2 Quantitative composition of zooplankton (ind/ dm³) of lower River Tisza (mean values)

Groups	1990				1991				1992			
	W	S	S	A	W	S	S	A	W	S	S	A
Protozoa	12	8	32	16	21	18	40	20	60	20	30	40
Rotatoria	3	17	74	20	6	40	115	15	5	23	60	15
Cladocera	2	8	3	5	5	2	3	5	3			
Copepoda	3	25	16	2	32	12	5	5	10	22		
Total	15	30	139	55	29	95	172	42	65	51	105	80

The Oligochaeta species dominated in bottom fauna of littoral zone of the river. The specific physico-chemical conditions of the river reduced species number in 1992. Qualitatively, only six species of the four genera and the family Tubificidae - *Limnodrilus hoffmeisteri*, *L. claparedeanus*, *L. udekemianus*, *Branchiura sowerbyi*, *Potamothrix hammoniensis* and *Psamoryctides barbatus* were found. The species of the genus *Limnodrilus* being a characteristic of still and eutrophic waters evidently dominated. This is in close connection with oxygen reduction and increase in nutrients.

The quantitative analysis of bottom fauna showed variations of numbers of the Oligochaeta individuals in two decades with an evident increase in 1991 when average annual number was 1,435 ind/m² (Djukic and Kilibarda, 1985; Djukic et al. 1993). In 1992, however, mean annual number of Oligochaeta decreased significantly and it was even six times as low as numbers in previous year (227 ind/m²). Drastic reduction of individual and species numbers respectively of Oligochaeta was probably due to the influence of unfavorable physico-chemical and hydrobiological parameters upon sediment concurrently affecting the disturbance of the biological balance.

Investigation of fish community has been aimed to different habitats and involves species being the indicators of water quality (with the exception of *Acipenser ruthenus*). Trend of total catch at fishing sectors of the Tisza I (Hungarian - Yugoslav border - dike nearby Novi Becej) and the Tisza II (dike nearby Novi Becej - river mouth) was analyzed. The share of characteristic species inhabiting river bed (*A. ruthenus*), littoral zone (*Stizostedion lucioperca*), and flood zone (*Esox lucius*) were also studied. Particular attention was paid to the participation of *Carassius auratus* which in total catch of noncommercial species ("other fish

species") had individual share over 20% while its dominance was 60-70%.

Total catch at Yugoslav section of the river stream was mostly constant in the period under consideration with values ranging from 100 to 111 t per year (Table 3).

Table 3 Fish catch analysis of lower River Tisza in kg (whole section)

Year	Total catch	<i>A. ruthenus</i>	<i>S. lucioperca</i>	<i>E. lucius</i>	Other fish
1990	100427	7811	7115	1994	83507
1991	111628	2167	3032	1967	104462
1992	108909	1828	1546	504	105031
Total	320964	11806	11692	4465	293000

When the part of individual species in total catch was analyzed, however, drastic decrease in *A. ruthenus* as well as the indicator species *S. lucioperca* ($S = 1.50$) and *E. lucius* ($S = 1.75$) was recorded. At the same time, the participation of *C. auratus* ($S = 2.50$) was unchanged and remained at a remarkable level tending to increase slowly.

Table 4. Fish catch analysis of Tisza I sector (in kg)

Year	Total catch	<i>A. ruthenus</i>	<i>S. lucioperca</i>	<i>E. lucius</i>	Other fish
1990	56713	3813	3863	790	48247
1991	65315	387	796	103	64029
1992	67772	739	614	178	66242
Total	189801	4939	5273	1071	178518

Additional analysis of catch by sectors showed certain differences between the fishing areas. Total catch in the Tisza I maintained similar annual values, but in the amounts of caught *A. ruthenus*, *S. lucioperca* and *E. lucius* (Table 4) were evidently reduced. Trend of reduction of catch of the investigated species in the Tisza II sector was somewhat less expressed in the first two years, whereas it was evident in *S. lucioperca* and *E. lucius* in 1992 (Table 5). The catch of *C. auratus* expressed by sectors analyzed, remained the same (unchanged), in particular in the downstream sector.

Table 5. Fish catch analysis of Tisza II sector (in kg)

Year	Total catch	<i>A. ruthenus</i>	<i>S. lucioperca</i>	<i>E. lucius</i>	Other fish
1990	43714	3998	3252	1204	35260
1991	46313	1780	2236	1864	40433
1992	66242	1089	932	326	38789
Total	131163	6867	6420	3394	114482

A significantly smaller catch, in particular when fishes of prey were analyzed, than that at beginning

of previous decade may be noted at the same area (Budakov et al., 1985). Trend of reduction in numbers of these fish species continued in past decade (Maletin et al., 1990) and in the period under consideration the catch of *S. lucioperca* and *E. lucius* reached the lowest values.

The ichthyological results obtained show that the water quality of lower River Tisza was getting worse during the last two decades. The finding is in agreement with the data on a slower growth rate of *Blicca bjoerkna* (Budakov and Maletin, 1981), and *S. lucioperca* when compared with that reported from other rivers or water bodies in this part of the Pannonian basin (Maletin and Budakov, 1984) as well as central part of the Tisza (Harka, 1992).

The changes reported for the hydrobiont communities under consideration are a signal for a need of more detailed investigations, in particular sediments, and for a positive action in controlling and protecting this section of the River Tisza.

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