

WATER QUALITY IN KÖRTVÉLYES BACKWATER

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Abstract

From the aspect of water chemistry, unequivocal increase resp. decrease was not found in the amounts of most components. The results suggest that the water quality has not changed essentially in the backwaters during the last three years.

Introduction

Increasingly more mention has been made recently of the importance of environmental protection and the urgent problems of nature conservancy. We speak about nature conservancy and environmental protection separately as if they were different things. This differentiation is, however, faulty. There is no nature conservation without the examination of the environmental factor (PAPP 1973, 1974).

The protection of environment does not mean only water and air protection (SEBESTYÉN 1963). The task they have in common is the protection of our still existing natural resources and the saving of our rivers and forests that are partly on the brink of perdition, partly heavily polluted. The same purpose is served by the measures of the National Authority for Environment Protection and Nature Conservation as well as the Act of Environmental Protection. Building and reconstruction of land has been carried out in increasingly more places, but land conservation is above them in importance. It is always cheaper and simpler to preserve the natural conditions of a region than to sanify a ruined land (Publications of Kiskunság Nemzeti Park 1978, 1979, 1980) not to mention in this regard the difference in value between a natural land and an artificially shaped one. In our country there are also several nature conservation areas resp. land conservation districts. The Körtvélyes backwater, the object of these studies is also such an area.

Preliminaries

The flood-plain on the left shore of the Tisza in sections ranging from 197.0 riv. km to 208.3 riv. km and from 33.0 riv. km to 46.0 riv. km were declared Land Conservation Area by decision No. 390/1971 of the National Authority for Environment Protection and Nature Conservation. In 1974, the Szeged Board of the Hungarian Academy of Sciences charged the Team of Tisza Research with the commission to work out the foundations for the social utilization of the Körtvélyes Land Conser-

vation District. In 1976, the Directorate of Water Conservation of the Lower Tisza Region joined with the Team of Tisza Research of the Hungarian Academy of Sciences in the implementation of this work.

The origin of the backwater

The history of the land

Before the regulations of the water-ways in the last century, the rivers of the Hungarian Plain dominated over an area of approx 25 000 km² during high-water periods occurring once or twice in a year. The enormous damages caused by these floodings were radically eliminated by the regulation of the Tisza (1850—1932). In the course of this large-scale enterprise the 1214 km length of the Tisza river was shortened to 960 km by means of 112 cut-offs and the flood-plain limited to the narrow shorelines was pressed within a long dam system.

Considering the fact that this system of flood-control was established by techniques used in the last century under the unfavourable conditions of old days and with the toilsome work of pick-and-shovel-men, we can take it for granted that nothing in the future will be able to surpass that effort with which our people participated in this gigantic work. In the flood-plain of the regulated Tisza, the land is indeed a large open-air museum. At the same time, however, the natural conditions here have brought about such a biota in the area of the backwaters (Mártély and Körtvélyes backwaters), navy-ponds, in the environment of meadows and gallery forests which are unique features of the Hungarian Plain and therefore their conservation is necessary. The area still bears in a lesser or greater degree the marks which characterized it before and after the regulation of the Tisza, and this is the reason for its having received the task to conserve the old and new local characteristics, the zoological and floristic values for the succeeding generations, to serve the purposes of research and education and to satisfy the increasing social demands on nature (recreation).

Hydrological conditions

In the XIXth century, man has brought about great changes in the hydrographical features of the natural Tisza region by planned anti-inundation work. As a consequence of the regulation of the Tisza, the hydrological conditions changed, the level of the flood increased by the damming of the flood-plain, at the same time, the depth of the river also increased. During these works stagnant waters (ox-bow-lakes) formed in the flood-plain and in the flood area of the Tisza, which have for the most part retained the original hydrographical characteristics. From 1856 to 1932, 112 short-cuts were made on the Tisza. The most important data in connection with these cut-offs are the following: In such river sections where the channel deteriorated and widened, it was regulated.

There are two backwaters in the nature conservation area: the Körtvélyes backwater and the Mártély one. The Mártély backwater serves for the purpose of recreation, while the Körtvélyes one is a severely protected nature conservation area, a study area for the purpose of research, observation and education.

The location of the backwater

The Körtvélyes backwater is situated on the left bank of the Tisza in its section ranging from 201 riv. km to 203 riv. km. Its length is about 4.7 km and its water area about 60 ha. The backwater is approx 4.0 m deep and in high-water periods its

depth increases. It has connection with the Tisza river itself only in periods of flooding. Its water supply, which is provided by the Körtvélyes pump of 1.24 m³/s capacity — except in period of flooding — is solved only partly.

Pollution of the backwater

The pollution load in the Körtvélyes backwater originates from several sources, of which the following ones should be mentioned here:

- meteoric and sewage water from Orosháza, Szentetornya, Kakasszék, the Institute of Kútvolgy
- agricultural waste waters
- residues of herbicides
- run-offs from the rice-plantation of the State Farm of Hódmezővásárhely (450 ha) and drain water.

Since the backwater is a kind of impounded water, the exchange of water is little during summer, which circumstance accelerates the process of pollution. Self-purification of water decreases. The pollution with organic materials results in a luxuriant growth of aquatic plants. The enormous mass of decaying plants which sediment to the bottom of the channel promote the process of filling up. Water plants are able to accumulate in some measure great amounts of pesticide residues, thereby diminishing the concentration of these agents in the water.

Materials and Methods

In these investigations sample taking was considered essential. Good sampling is indispensable in obtaining exact experimental results and in making these results utilizable in practice. After the careful survey of the experimental area, the place of sampling was allocated by keeping in view the object of the experiment. All factors that might influence the composition of the water sample were taken into consideration. We worked with dipped samples in each case. Temperature was measured with mercury, with an accuracy of 0.1—0.2 °C.

In the measurement of coloration, the water samples were compared with known concentrations of potassium chloroplatinate and cobalt chloride. The determination of total dissolved materials was made by filtering known quantities of water samples through membrane filters of 0.45 μ pore size, and by condensing the filtrates by evaporation after which drying at 105 °C and weighing followed.

The pH of water was measured with an electric pH meter. Total hardness of water was determined with 0.5 M Komplexon III solution to be standardized. Titration was carried out at pH 10 in the presence of Erichrom-black T indicator, until it changed from red to violet. The results are given in GH° (German Hardness°). Calcium was determined by complexometry with 0.05 M standard Komplexon III solution. Titration was carried out at pH 12—13 in the presence of Murexid indicator until the lilac colour appeared. Sodium concentration was measured with flame photometer at 589 nm. Ammonia determination was made on the basis of the consideration that the ammonia mercury (II) iodide complexon produces a yellowishbrown compound with Nessler reagent in alkaline medium. Colour intensity of the solution is proportional to the ammonia content. The measurements were performed at 400 nm.

In the determination of nitrite, the nitrite ions were diazotated with sulfanilic acid, and the diazonium compound was made to react with alpha-naphthylamine. The compound produced was reddish-violet in colour and its colour intensity was proportional to the concentration of nitrite ions. Extinction was measured at 520 nm.

In nitrate determination, the solution was made to react with sodium salicylate in H₂SO₄-containing medium and the compound obtained possessed a yellow colour. Intensity of colour is proportional to nitrate content. The measurement was made at 410 nm.

In phosphorus determination a blue colour develops if the orthophosphates react with ammonium molybdate in the presence of ascorbic acid. The intensity of colour is proportional to the amount of the orthophosphate ions.

Concentration of chloride ions was measured by titration with standard 0,1 N mercury nitrate solution in the pH range 7 to 10 in the form of mercury chloride. The end point was indicated with potassium chromate solution.

In sulfate determination the water samples were allowed to flow through cation exchange resin in an alcoholic-medium. Titration was made with 0.02 N lead nitrate in water in the presence of dithizon indicator. The concentration of dissolved oxygen was determined by Winkler's method. For the measurement of chemical oxygen demand the potassium permanganate method was used. The samples were boiled in 0.01 N KMnO_4 solution in sulfuric acid-containing medium for 10 min. In this way we obtained the amount of oxygen utilized for the oxidation of the organic materials.

The water sample was boiled in 0.025 N potassium bichromate (known amount) solution acidified with sulfuric acid for 1 h. The surplus oxidizing agent was titrated with 0.025 N ferri (II) ammonium sulfate in the presence of ferroin indicator until the indicator changed from blueish-green to reddish-blue.

Results

The components investigated were plotted in the function of time. The water to be found under natural conditions is always a solution. The total salt concentration of the backwater was variable. In early spring its value was generally 200—260 mg/lit, in late summer even increasing to 400—500 mg/lit. The salt concentration of the backwater depended on the intensity of evaporation at the lake surface (Fig. 1).²

Not only the quantity of total dissolved inorganics is decisive but their qualitative composition, as well. Because of that the contents of dominant ions (Ca, Mg, Na, K, Cl, SO_4 , HCO_3 , CO_3) were also determined.

Körtvélyes-backwater 31. 3. 1978. (spring)

	mg liter ⁻¹	Reactive weight	mg — equivalent	Equivalent %S	a cm
K	5.5	39.102	0.140	3.577	0.24
Na	16.0	22.990	0.696	17.782	1.19
Ca	48.0	20.040	2.395	61.191	4.11
Mg	8.3	12.156	0.683	17.450	1.17
			3.914	100.000	
CO_3	0.0	30.004	0	0	
HCO_3	142	61.017	2.327	50.686	3.40
Cl	22	35.453	0.620	13.505	0.91
SO_4	79	48.031	1.644	35.809	2.40
			4.591	100.000	
			I=8.505		

Radius of the circle: $0.572 \sqrt{8.505} = 0.572 \times 2.92 = 1.67$ cm

$$\sqrt{I} = \sqrt{8.505} = 2.92$$

$$0.023 \sqrt{I} = 0.023 \times 2.92 = 0.06716$$

Total dissolved in organics = 220 mg/l

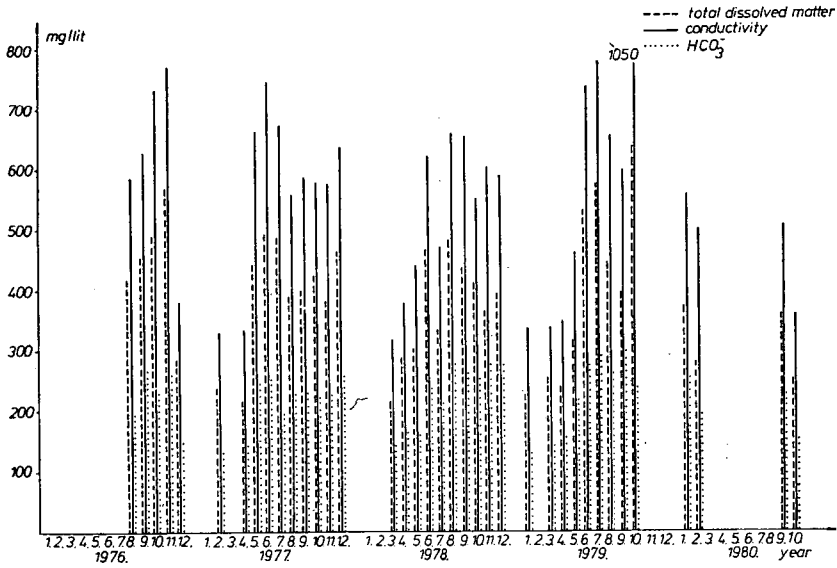


Fig. 1. Changes of total dissolved matter, conductivity and HCO_3^- content in Körtvélyes backwater.

In the backwater, calcium was the dominant ion (Fig. 2), with values ranging from 39.0 mg/lit. to 76.0 mg/lit. Magnesium exhibited similar fluctuations, though with lower values (8.0 mg/lit). The standard value of Mg was 15.0 mg/lit.

Körtvélyes-backwater 19. 6. 1978. (summer)

	mg liter ⁻¹	Reactive weight	mg — equivalent	Equivalent %S	a cm
K	7.0	39.102	0.179	2.409	0.21
Na	71.3	22.990	3.101	41.730	3.66
Ca	56.2	20.040	2.802	37.707	3.30
Mg	16.4	12.156	1.349	18.154	1.59
			7.431	100.000	
CO_3	0	30.004	0	0	0
HCO_3	235	61.017	3.851	54.057	4.737
Cl	49.6	35.453	1.399	19.638	1.721
SO_4	90.0	48.031	1.874	26.305	2.305
			7.124	100.000	
			I=14.555		

Radius of the circle: $0.57 \sqrt{14.555} = 0.572 \times 3.81 = 2.18 \text{ cm}$

$\sqrt{I} = \sqrt{14.555} = 3.81$

$0.023 \sqrt{I} = 0.023 \times 3.81 = 0.08763$

Total dissolved in organics = 410 mg/l

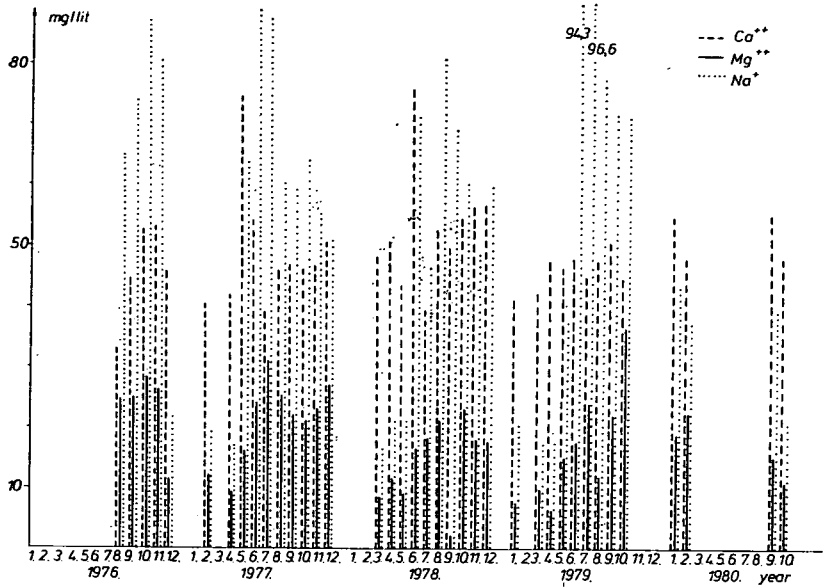


Fig. 2. Changes in Ca⁺⁺, Mg⁺⁺, and Na⁺ contents in Körtvélyes backwater.

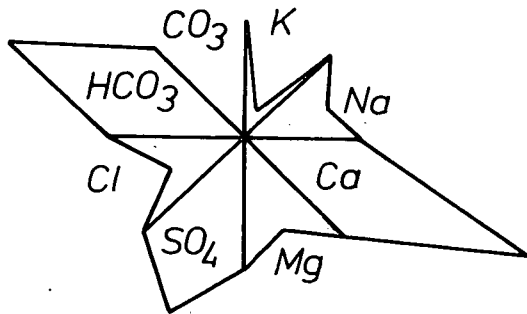


Fig. 2/a

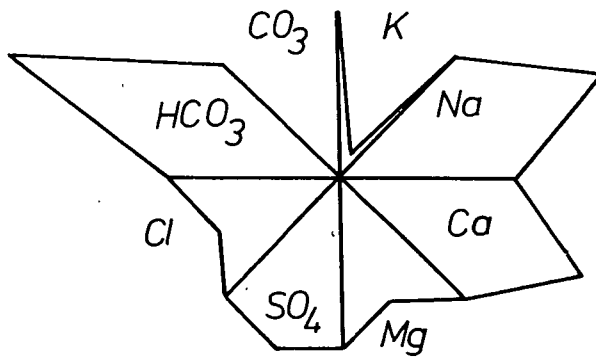


Fig. 2/b

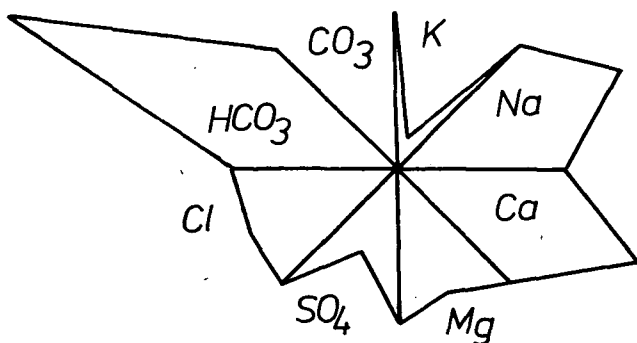


Fig. 2/c

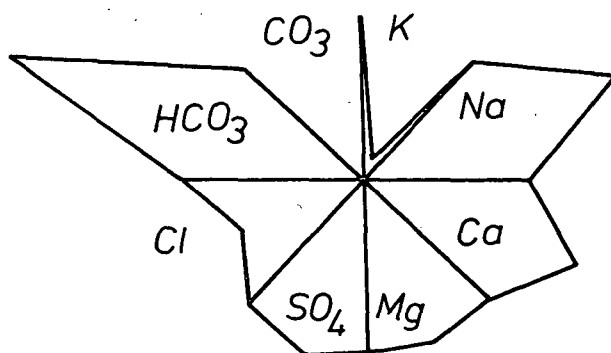


Fig. 2/d

The chemical composition of the backwater is illustrated in Maucha's diagram. Four characteristic water qualities were picked out (from spring, summer, autumn and winter). Eight dominant ions: Ca, Mg, Na, K, Cl, SO_4 , HCO_3 , CO_3 were used in the construction of Maucha's star diagram. The size of this diagram is proportional to the total ion concentration of water and indicates also the relation of ions to one another.

In regard of cations the type of the backwater was a calcium one, in the dry season a calcium-sodium one, and in periods of dilution with precipitation or after flooding with Tisza water calcium-magnesium one. In regard of anions, its type was a hydrocarbonate one. It also occurred sometimes that beside hydrocarbonate sulfate also appeared. Fig. 3 shows the seasonal changes of chloride and sulfate ions.

Values for total hardness (Fig. 4) varied between 8.1 GH° and (Fig. 4) 12.9 GH° . Apart from autumn maxima, fluctuations of the value of approx 9 GH° ($\pm 1.5 \text{ GH}^\circ$) can be accepted. Its standard value was about 11 GH° independently from the place and year of sampling. The amount of sodium ions (Na%) in the percentage of total cations was 32%. Fluctuations above this value were smaller (max. 40%) than below it (min 17%).

The use of fertilizers in increasing amounts is an inevitable consequence of developing agriculture. Hungarian and international data equally suggest that the amount of fertilizers in agriculture has increased. This also applies to the catchment

Körtvélyes-backwater 25. 9. 1978. (autumn)

	mg liter ⁻¹	Reactive weight	mg — equivalent	Equivalent %S	a cm
K	5.5	39.102	0.141	1.910	0.17
Na	69.0	22.990	3.001	40.664	3.63
Ca	49.0	20.040	2.445	33.130	2.96
Mg	21.8	12.156	1.793	24.296	2.17
			7.380	100.000	
CO ₃	0	30.004	0	0	0
HCO ₃	262	61.017	4.294	55.948	4.99
Cl	49	35.453	1.382	18.006	1.61
SO ₄	96	48.031	1.999	26.046	2.32
			7.675	100.000	
			I=15.055		

Radius of the circle: $0,572 \sqrt{15,0555} = 0,572 \times 3,88 = 2,22$ cm

$$\sqrt{I} = \sqrt{15,055} = 3,88$$

$$0,023 \sqrt{I} = 0,023 \times 3,88 = 0,08924$$

Total dissolved in organics = 436 mg/l

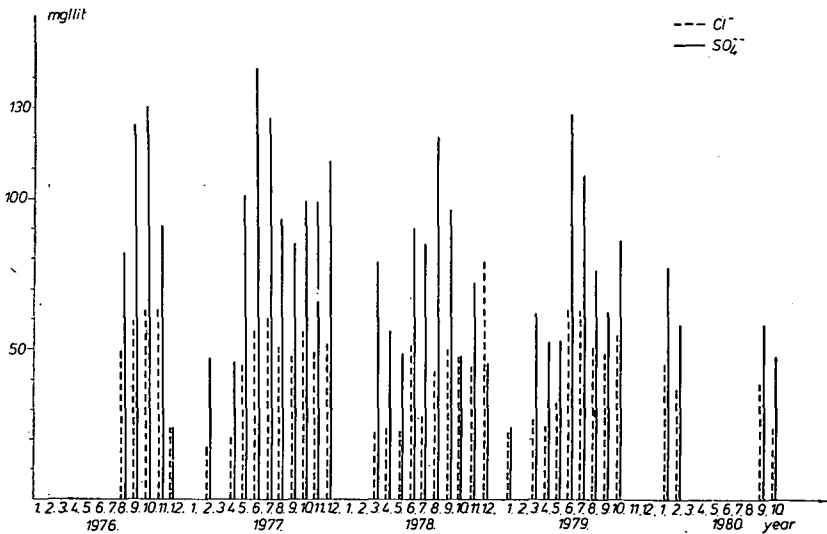


Fig. 3. Changes of Cl⁻ and SO₄⁻⁻ in Körtvélyes backwater.

basin of Körtvélyes backwater. The effective agents of fertilizers consist mainly of phosphorus and nitrate. Their changes are illustrated in Fig. 5. Nitrate concentration of the backwater exhibited a slightly increasing tendency, inspite of that, however, it may be said to have had first quality water on the basis of its NO₃ content.

Körtvélyes-backwater 19. 12. 1978. (winter)

	mg liter ⁻¹	Reactive weight	mg — equivalent	Equivalent %S	a cm
K	4.70	39.102	0.120	1.722	0.15
Na	59.80	22.990	2.601	37.328	3.23
Ca	56.10	20.040	2.799	40.169	3.47
Mg	17.60	12.156	1.448	20.781	1.80
			6.968	100.000	
CO ₃	0	30.004	0	0	0
HCO ₃	278	61.017	4.556	63.658	5.50
Cl	59	35.453	1.664	23.250	2.01
SO ₄	45	48.031	0.937	13.092	1.13
			7.157	100.000	
			I=14.125		

Radius of the circle: $0.572 \sqrt{14.125} = 0.572 \times 3.76 = 2.15$ cm

$$\sqrt{I} = \sqrt{14.125} = 3.76$$

$$0.023 \sqrt{I} = 0.023 \times 3.76 = 0.08648$$

Total dissolved in organics = 399 mg/l

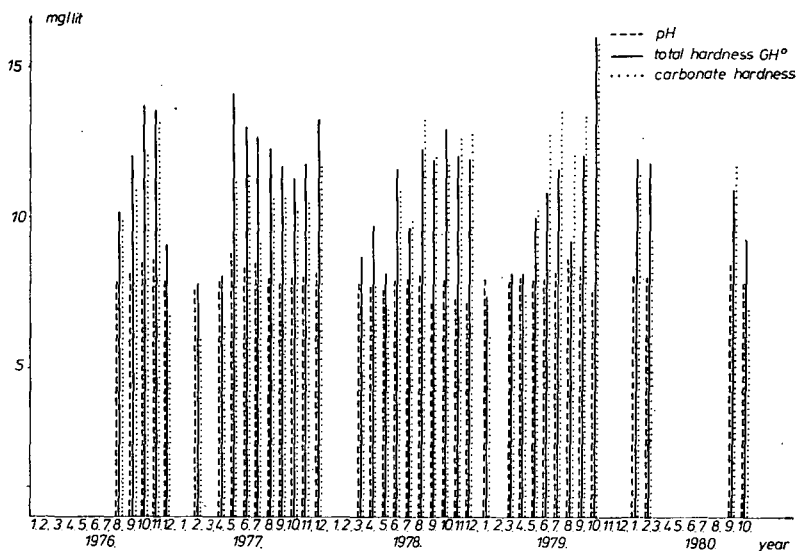


Fig. 4. Körtvélyes backwater.

Ammonium ion concentration was generally below 0.5 mg/lit. Values ranging from 0.10 mg/lit to 0.15 mg/lit or close to them were often found. The maximum was 0.73 mg/lit, not in excess of 1 mg/lit. During winter the values were naturally always higher than in other periods.

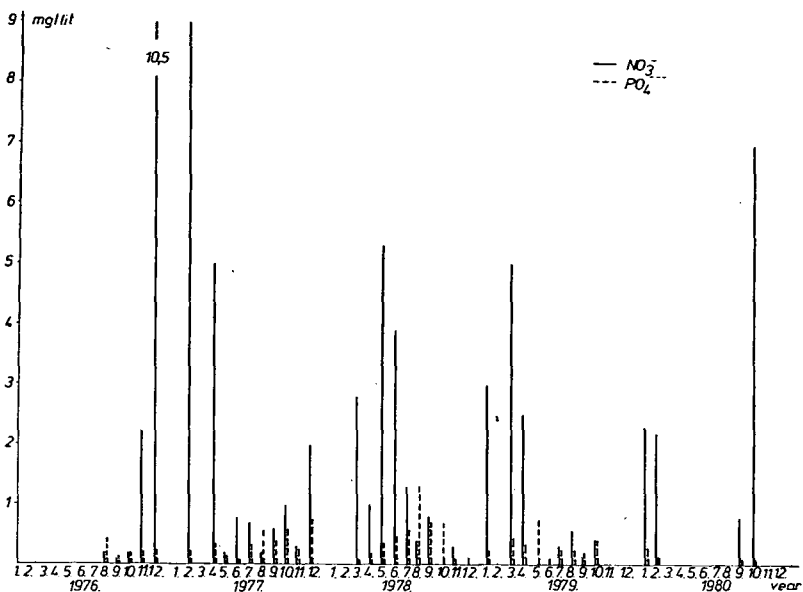


Fig. 5. Changes of NO_3^- and PO_4^{---} contents in Körtvélyes backwater.

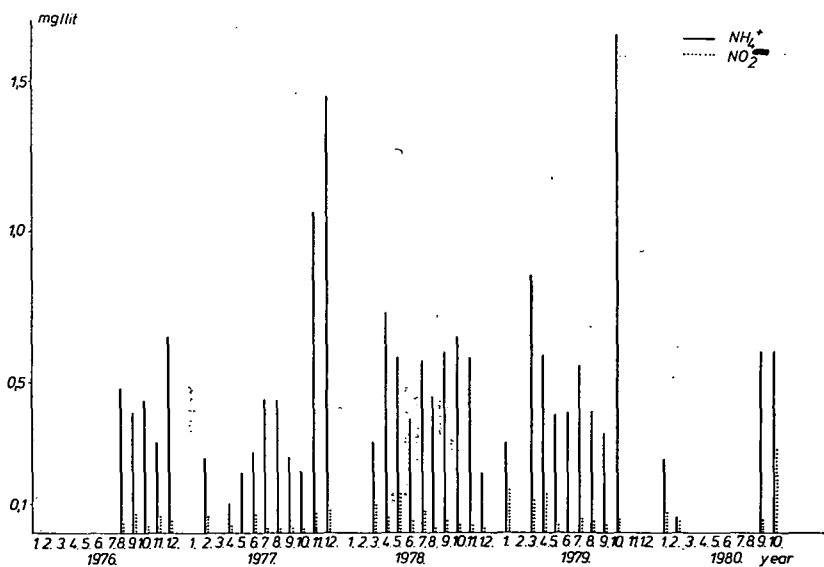


Fig. 6. Changes of NH_4^+ and NO_2^- contents in Körtvélyes backwater.

The concentration of nitrite ions was low. It may be characterized at the most by the value in the third place of decimals (Fig. 6).

In the analysis of surface waters the organic matter content is one of the most important qualitative characteristics. The changes in the organic matter content

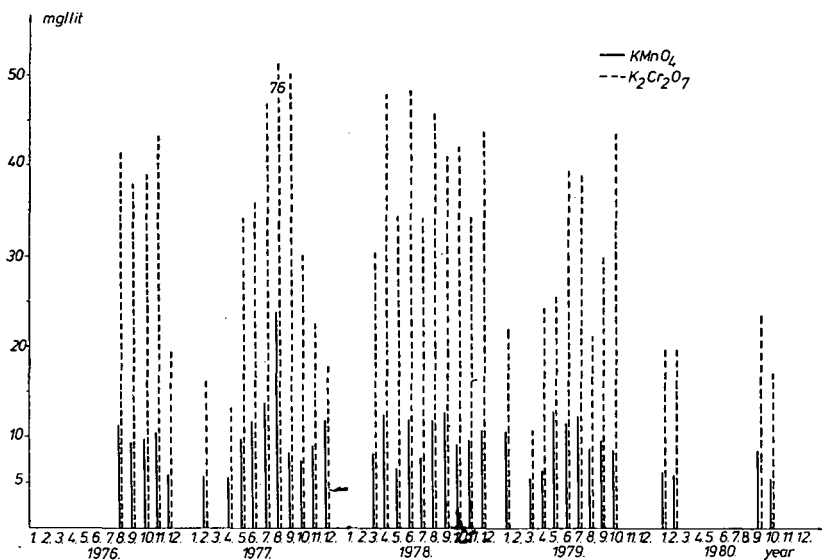


Fig. 7. Changes of organic matter content in Körtvélyes backwater.

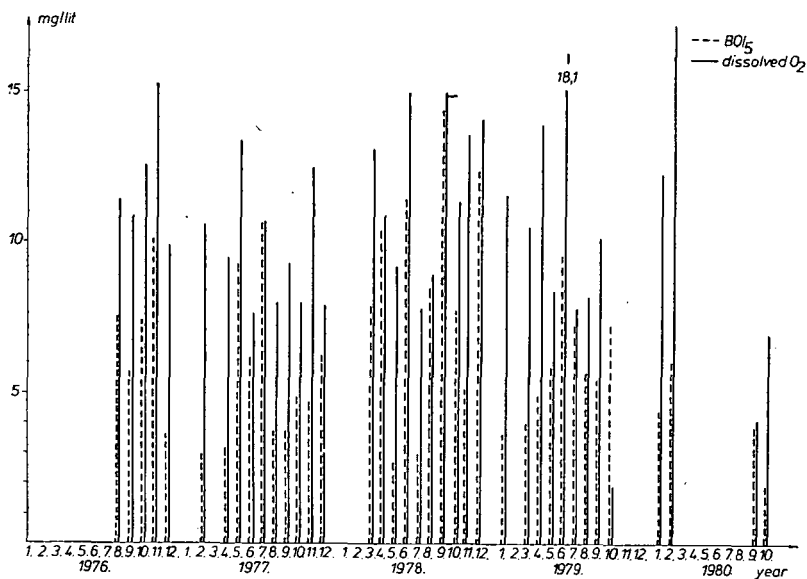


Fig. 8. Changes of dissolved O_2 and BOR_5 in Körtvélyes backwater.

of surface waters are partly the results of natural processes, partly those of human activity — depending on the circumstances. Because of that, the knowledge of this parameter may furnish us with valuable information concerning organic load and self-purification capacity. Fig. 7 shows the periodic changes of organic matter content. Character of oxidizable organic matter exhibited only small changes. The rela-

tive amount of easily oxidizable organic matter generally also diminished slightly, the ratio $\text{COD}_{\text{K}_2\text{Cr}_2\text{O}_7}/\text{COD}_{\text{KMnO}_4}$ slightly increased.

Oxygen and carbon dioxide are the two basic materials in the metabolic process between organism and its environment. Nearly every organism needs oxygen for the liberation of the energy content of organic nutrients.

The oxygen content of water depends not only from the physical factors (temperature being the most important among them) but also from the amount of organic materials present in it as well as the rate of oxygen production and consumption of the organisms.

Dissolved oxygen content proved to be always in excess of 7.0 mg/lit, and the least oxygen saturation 89%, which according to COMECON standards corresponds to first grade water quality. In Fig. 8 the changes of dissolved oxygen content and 5-day biochemical oxygen demand are illustrated.

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A körtvélyesi holt ág vízminősége

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Kivonat

1976—1980-ig vizsgáltuk a körtvélyesi holt ág vízminőségét. Részletesen foglalkoztunk a holt ág oxigénháztartásával, sóháztartásával, illetve a mezőgazdaságból származó szennyezéssel. Megállapíthattuk vízkémiai szempontból a holtág szezonális változásait és a tápanyag feldúsulását. Megfigyelhettük a Tisza áradásakor bekövetkező öblítő hatását is. Az 5 éves időszakban kapott eredményeink arra a következtetésre juttattak, hogy a körtvélyesi holt ág vízminőségében lényeges változás nem következett be.

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Abstrakt

Ispitivanje kvalitata vode mrtvaje Körtevényes vršeno je u periodu 1976—1980. godine. Detaljnije je proučavan režim O_2 i saliniteta kao i zagadjivanje preko poljoprivrede. Utvrđena je sezonska promena hemizma mrtvaje kao i povećavanje organskih materija. Takođe je zapažena i ispirajuća uloga Tise pri visokim vodostajima. Rezultati petogodišnjih istraživanja ukazuju na činjenicu da u kvalitetu vode mrtvaje Körtevényes nisu nastale značajne promene.

КАЧЕСТВО ВОДЫ СТАРИЦЫ КЕРТВЕЛЬЕШ

К. Фюгеди (Кемнешне)

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М. М. Хорват

Университет им. Йожефа Атилы, Сегед

Резюме

1976—1980 гг. изучили качество воды старицы Кертвельеш. Занялись изучением ее кислородного и солевого состава, а также засоренности ее сельскохозяйственными отходами. С помощью гидрохимии удалось определить сезонные изменения, а также накопление питательных веществ в водоемах и старицах. Ознакомились также с наступающим промывательным влиянием воды после наводнения Тисы. Полученные пятилетние результаты показали, что в старице Кертвельеш значительных изменений в составе воды не наблюдалось.