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BACTERIOLOGICAL QUALITY OF THE FRESH WATERS IN THE REGION OF THE LOWER TISZA IN THE PERIOD 1977—1986

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Abstract

The quality of water in the rivers Tisza, Hármas-Körös and Maros was characterized on the basis of bacteriological investigations carried out by the authors in the period between 1977 and 1986. The changes of the bacteriological parameters in the course of the years are shown in the figures. Quality of water at different sampling points was evaluated by cluster and centroid analysis. On the basis of the results obtained in the bacteriological studies the following conclusions have been reached:

— The quality of water in the river Tisza has been gradually deteriorating during the last ten years in all the four sampling points. The water was particularly polluted and contaminated in the sections at Mindszent and Tiszasziget.
— The bacteriological quality of water in the Hármas-Körös was the most favourable above its influx into the Tisza, though even at this sampling point temporary deterioration of water quality was observed.
— The water quality in the tributary Maros has deteriorated significantly during the period under investigation. Since 1980 pollution and contamination have been registerd at both sampling points.

Introduction

In order to follow the quality of surface waters in the rivers of the region under survey samples have been regularly taken in the last years for bacteriological, chemical and biological analysis. In the present paper the results of the bacteriological investigations are presented. The investigations have been carried out in the Public Health Station of County Csongrád in the framework of the collaboration agreement between the two institutions.

The quality of water in the river Tisza has been investigated in the 60s by PAPP (1961, 1964, 1965). It has been found that significant pollution of the river occurs only at three points, whether at the other sampling points water has been characterized as "clean". DEÁK—SCHIEFNER (1971, 1982) in parallel studies of the longitudinal section of the Tisza and its six most important tributaries found that the pollu-

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tion in the rivers Hármas-Körös and Maros was insignificant, whether the quality of water in the Tisza dropped by one category in ten years.

In several papers HEGEDÜS et *al.* (1979, 1980, 1983, 1985) reported on the bacteriological quality of the surface waters in the County Csongrád. It has been found that the quality of water in the river Tisza gradually deteriorated in the investigated period.

Materials and Methods

In the present communication the quality of water in the rivers Tisza, Hármas-Körös and Maros is characterized on the basis of a series of bacteriological data collected in a ten years' period. Samples were taken at four sections along the Tisza: Csongrád 246 riv. km., Mindszent 216,2 riv. km., Tápé 177,5 riv. km. and Tiszasziget 162,5 riv. km. The tributaries were studied at the influx, and the river Maros in the section below the town of MAKÓ (24,3 riv. km) as well. In the period of investigation the samples were taken generally every month and 12 000 tests were carried out.

The bacteriological tests were carried out according to the "Methodological Guide to the Hygienic Bacteriological Investigations of Surface Waters", published by the National Institute of Public Hygiene (1977) and the "Bacteriological Investigation of Drinking Water" standard (1971). The evaluation of results was based on the limit values suggested in the Eü. SZ—OVHSZ 141/T "Plan of Sectorial Normalization for Classifying the Surface Water Qualification" (1972).

Results and Discussion

Close similarity was observed in the changes of the annual mean values for coliform and faecalis coliform bacteria at the four sampling points in the longitudinal section of the Tisza (Fig. 1a, b). Since 1982 their values showed an increase at all the four sampling points, the coliform number being in the order of several thousands and that of faecalis coliform — several hundreds. For both parameters the highest

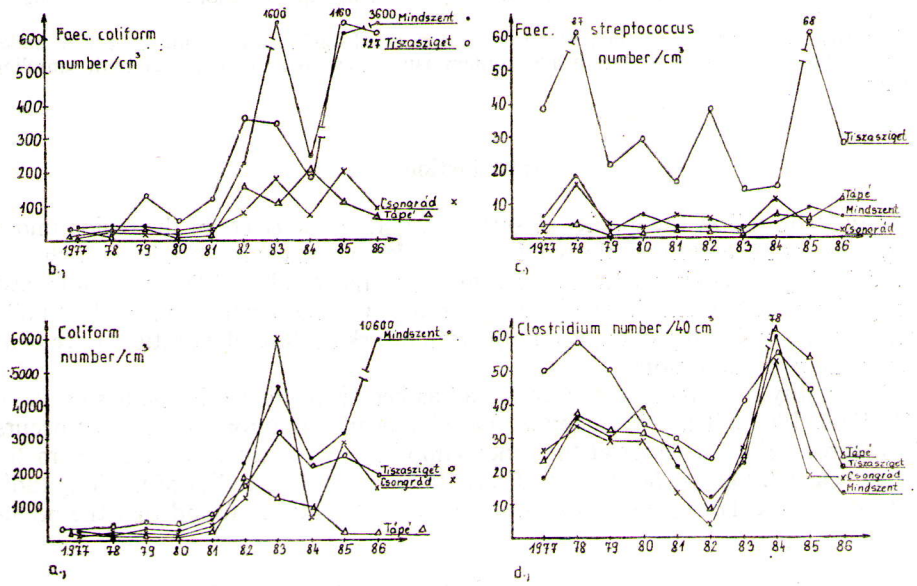

Fig. 1. Results of bacteriological investigations (meanvalues)

values were registered at sampling points Mindszent and Tiszasziget, and their values tended to be lower for the sampling points at Tápé and Csongrád. The annual mean values for faecalis streptococcus (Fig. 1c) showed similar changes at sampling points Tápé, Mindszent and Csongrád. These obligate faecal indicator bacteria were isolated in high numbers from water samples collected in the section at Tiszasziget. This is due to the influx of unpurified sewage water from the town of Szeged. The lowest mean values of anaerobic sulfite-reducing Clostridium (Fig. 1d) were registered in 1982 at all sampling points. The highest values were measured in 1984, exceeding at all the four sampling points the limit value of 50/40 cm^3.

The counts of the coloniforming bacteria at 20 °C and 37 °C (Fig. 2a, b) were determined on meatpeptonagar culture medium. The mean values obtained for these bacteria showed a significant scattering in the investigated period. It could be stated altogether that before 1980 the values were in the order of ten thousands, and subsequently values several times higher became frequent.

As far as the enteral pathogens are concerned, tests were carried out for demonstration of bacteria from Salmonella genus (Fig. 2c). Among the sampling points of the longitudinal section of the Tisza most frequently *Salmonella* positivity was observed for samples originating from Tiszasziget, followed by those from the section at Mindszent. The *Salmonella* contamination at Csongrád and Tápé sampling points was of lesser extent and became significant only in single years.

On the basis of the ten years' data series the number of objected samples was calculated and presented in percentage in Fig. 2d. From bacteriological point of view a sample is considered as objected if the value of any of its parameters exceeds the limit value for II. Category water quality. It can be seen from the figure that in 1977 25% of all the samples taken at Csongrád and 60—80% of those taken at the other three sampling points were objected.

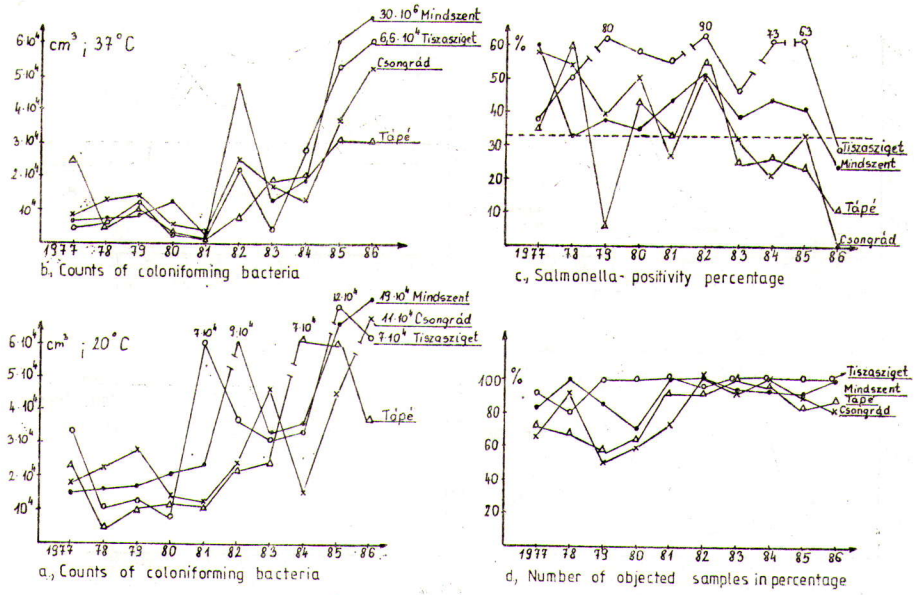

Fig. 2. Results of bacteriological investigations (meanvalues)

In the last ten years the percentage of the objected samples changed unfavourably, its values after 1986 reaching tipically 80—100%. The water quality of the tributaries depending on their source and watershed area, differs, from that of the Tisza. On the basis of all bacteriological parameters studied during the ten years' period (Fig. 3a, b, c, d) the quality of water in the Hármas-Körös proved to be more favourable,

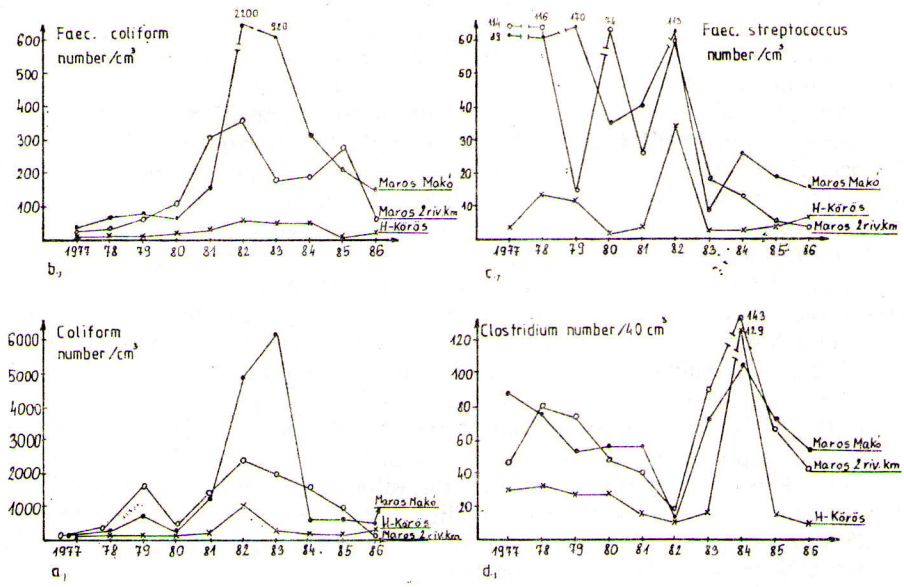

Fig. 3. Results of bacteriological investigations (meanvalues)

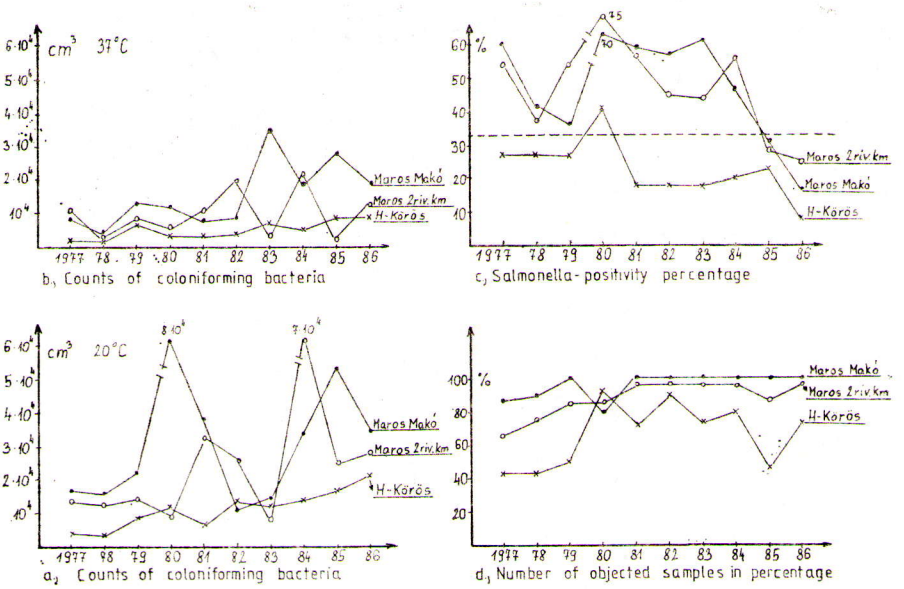

Fig. 4. Results of bacteriological investigations (meanvalues)

i.e. less contaminated by faecal indicator bacteria than that of the Maros. In the period studied the values of all bacteriological parameters under investigation proved to be higher for the samples taken from both sampling points at the Maros, their order of magnitude being indicative for faecal contamination (Fig. 3a, b, c, d). The changes in the counts of coloniforming bacteria/cm^3 showed significant differences in water of the tributaries. In the ten years' period higher values were measured at both temperatures in the Maros water.

The water of the Hármas-Körös (Fig. 4c) is less contaminated with Salmonella bacteria at the confluence with river Tisza than that of the Maros river. The *Salmonella* positivity of the samples from the Hármas-Körös exceeded the tolerance limit value of 33% only in 1980, whether in the water of the Maros its value was under 33% only in 1985 and 1986. The annual percentage of the objected samples in the tributaries was calculated (Fig. 4d). The changing level of contamination of the Hármas-Körös, as well as the less favourable quality of water at the two sampling points of the Maros river is unequivocally proven by the percentage of the objected samples.

The results described above show that in the period studied significant changes occurred in the water quality of the rivers in the region. For more precise characterization of the process mathematical analysis was carried out. CZEKANOVSZKY (1909) similarity index was used in the cluster analysis and the relation between the sampling points was characterized by multivariable statistical analysis (Plant geography, cenology and ecology, 1981).

The dendrogram (Fig. 5) of the sampling points situated along the Tisza shows that two characteristic groups can be distinguished as a function of the years of

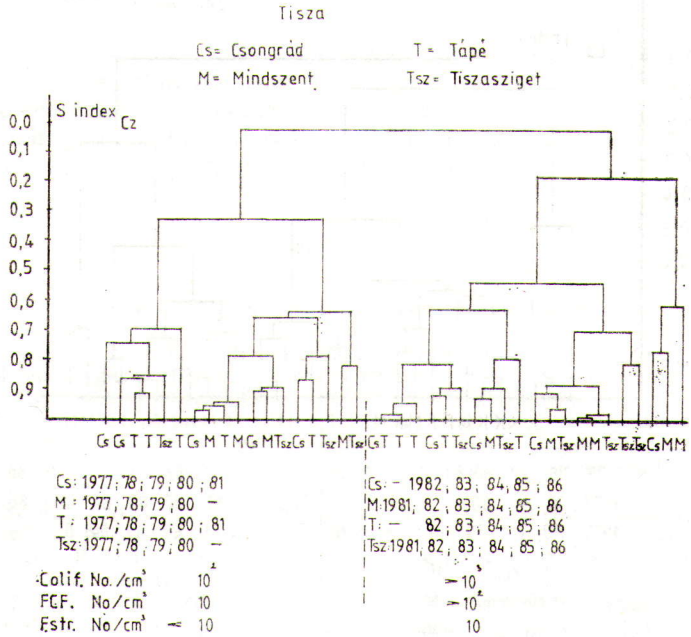

Fig. 5. Characterization of the water quality of the Tisza river by dendrogram prepared with "cluster"-analysis

investigation. The results registered at the four sampling points between 1977 and 1980, i.e. values for the number of bacteria/cm³ in the order of 100 for coliform, 10 for faecalis coliform and 10 for faecalis streptococcus, constitute the first group. Here belong as well the still favourable water quality parameters measured at Csongrád and Tápé in 1981. The second group is constituted by the results obtained between 1982 and 1986: number of bacteria/cm³ in the order of 1000 for coliform, 100 for faecalis coliform and 10 to several times this number for faecalis streptococcus. Thus significant deterioration of the water quality in the Tisza river was observed at Csongrád, and Tápé since 1982, and at Mindszent and Tiszasziget — one year earlier.

The relation between the quality of water at different sampling points in the tributaries is shown by a dendrogram in Fig. 6. The first group is formed by the favourable results measured for the Hármas-Körös during eight years and by those for the Maros at Makó and the mouth sampling points in 1977, 1978 and 1980. The second group is constituted by the contaminated samples, collected at the two sampling points of the Maros and those taken from the Hármas-Körös in 1982 and 1986.

Finally, Fig. 7 shows the ordination of the sampling points based on the centroid analysis carried out for the ten years' period. In the analysis the number/cm³ values for coliform, faecalis coliform and faecalis streptococcus were taken into consideration. It can be seen that sampling points at the Hármas-Körös and Csongrád and Tápé on the Tisza belong to the same group, situated close to the axis of ordinates,

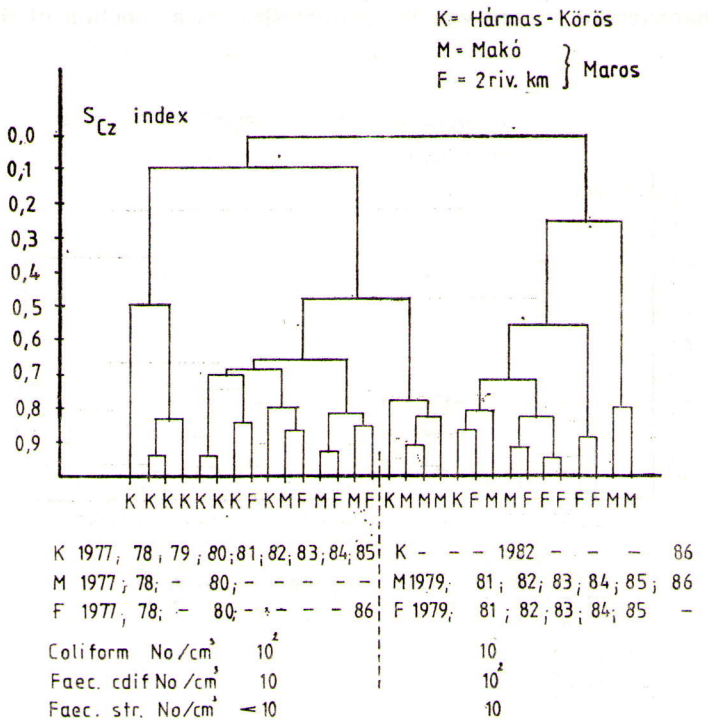

Fig. 6. Characterization of the water quality of the river Maros and Hármas-Körös by dendrogram prepared with "cluster"-analysis

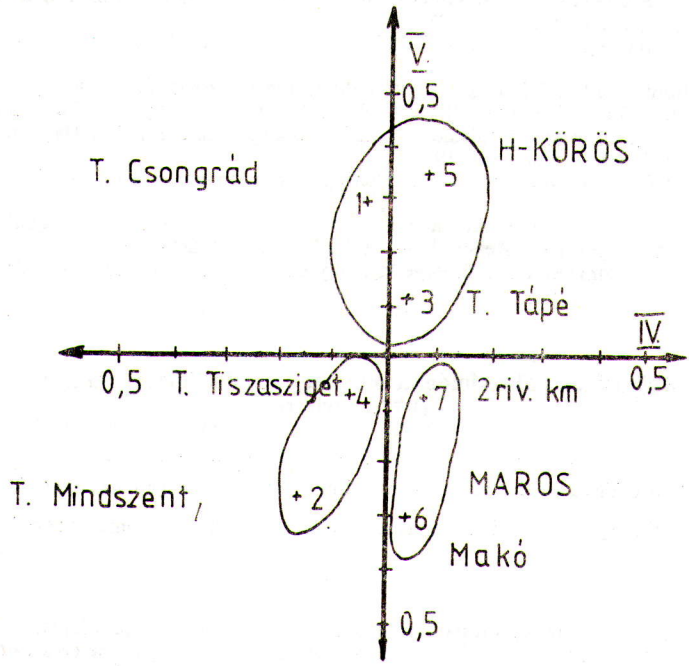

Fig. 7. The groups of related sampling points by centroid analysis

characterized by lower values, thus representing a group of sampling points with cleaner water. The sampling points at Tiszasziget and Mindszent on the Tisza belong to the group characterized by contaminated water.

The sampling points at the Maros are as well close to each other due to the higher values of the parameters, i.e. higher level of contamination.

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Folyóvizek bakteriológiai minősége az alsó Tisza vidékén 1977—1986-ig

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Kivonat

A szerzők az 1977—86-ig végzett bakteriológiai vizsgálatok eredményei alapján a Tisza, a Hármas Körös és a Maros folyók vízminőségét elemzik. A bakteriológiai paraméterek változását a vizsgálati évek függvényében ábrákon mutatják be. A mintavételi helyek vízminőségének jellemzésére cluster és centroid analízist alkalmaztak. A vízbakteriológiai vizsgálatok eredményei alapján a következőket állapították meg:

— A Tisza vízminősége az elmúlt tíz év alatt fokozatosan romlott mind a négy mintavételi helyen. Különösen szennyezett és fertőzött a vízminőség a folyó mindszenti és tiszaszigeti szelvényében.
— A Hármas-Körös bakteriológiai vízminősége a Tiszába ömlés felett a legkedvezőbb, bár egy-egy évet tekintve e mintavételi helyen is tapasztaltak időszakos romlást.
— A Maros mellékfolyó vízminősége jelentősen romlott a vizsgálati időszak alatt. Mindkét mintavételi helyen szennyezett és fertőzött vízminőséget regisztráltak az 1980-as évektől.

БАКТЕРИОЛОГИЧЕСКИЕ ХАРАКТЕРИСТИКИ ПРОТОЧНЫХ ВОД НИЖНЕГО ТЕЧЕНИЯ ТИСЫ В ПЕРИОД 1979—1986

Мария Хегедюш, Жофия Фодре, Энике Доблер

Авторы анализируют качество воды рек Тиса, Хармаш-Кереш и Марош на основании результатов бактериологических тестов, проводимых в период 1977—1986 гг. Изменения бактериологических параметров представлены графически в зависимости от года проведения измерений. Для охарактеризования качества воды в местах взятия проб применяли кластерный и центроидный анализ. На основании результатов бактериологических исследований воды сделаны следующие заключения:

— За последние десять лет наблюдалось постепенное ухудшение качества воды Тисы во всех четырех местах взятия проб. Особенно высокая степень загрязнения и зараженности наблюдалась для отрезков реки у Миндсент и Тисасигет.

— Бактериологические характеристики воды реки Хармаш-Кереш над местом ее впадения в Тису были наиболее благоприятными, хотя в отдельные годы и здесь наблюдалось временное ухудшение качества воды.

— Качество воды притока Марош значительно ухудшилось за исследуемый период. С 1980 г. в обеих местах взятия проб регистрировали загрязнение и заражение воды.

Bakteriološka kvaliteta reke u donjim regijama Tise u periodu od 1977 do 1986 godine

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Rezime

Autori su proučavali kvalitetu vodama reke Tise, Hármas-Körös i Maroš prema rezultatima bakterioloških analize u periodu od 1977 do 1986. Promene bakterioloških parametara je pokazana na slicima u pratnju godine. Za analizu izvadene uzorke voda upotrebljeni su clusterna i centroidna analiza. Prema dobivenim rezultatima utvrđene su sledeće:

— Kvantiteta vode reke Tise kvario se preko celog izučenog perioda na svih četiri mesta vadene uzorke. Reka je najviše zagađena u odseku Mindszent i Tiszasziget.
— Iznad ušća reke Hármas-Körös najbolja je bakteriološka kvaliteta vode bez obzira za 1—2 godine, kad je bila vidna kvarenja kvaliteta.
— Kvaliteta vode Maroš je pokazal najveći kvar u izučenom periodu. Na oba dva mesta su registrovali prljavštinu i kontaminiranu vodu od osamdesetih godina.