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SEDIMENT INVESTIGATIONS CARRIED OUT IN THE LONGITUDINAL SECTION OF THE TISZA AND IN THE MOUTH OF ITS MAJOR TRIBUTARIES FOR ESTABLISHING THE PRESENCE OF FAECALINDICATOR BACTERIA

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Abstract

The author has carried out sediment investigations in the longitudinal section of the river Tisza from riv. km 689 till riv. km 172, as well as at 76 sampling sites in the mouth of tributairies. He has determined the Coliform, Faecal coliform and Faecal streptococcus number of samples, in MPN value, referring these to 1 g wet sediment. As this is the first sediment-bacteriological investigation in the longitudinal section of the Tisza in Hungary, thus the author gives the numerical values of the faecal bacteriological pollution of the simple sampling sites and shows them in a graph, as well.

He calls the attention to the importance of sediment investigations for the bacteriological evaluation of surface waters.

Introduction

The sediment-bacteriological investigation of the Tisza reached completion in the whole home stretch of the river at first on the occasion of the expedition, organized in August-September 1979.

The most generally accepted group of faecal pollution is that of Coliform bacteria (Standard Methods 1965). The Coliform bacterium may be of faecal origin but it can also be found in other places, thus in plants, water, silt, soil, etc. Only a part of these can develop at 44 °C. In certain opinions, all of them are considered as E.coli. But this is an error because other strains are frequently present among the colonies growing at a temperature like this (COHEN, SHUVAL 1973).

The bacteriological state of the water of the river Tisza was dealt with by more than one person (PAPP 1965, VETRÓ et al. 1966, DEÁK et al. 1975, ESTÓK et al. 1977, 1978) but silt-sediment investigations have not taken place in the longitudinal section of the Tisza, as yet. Just therefore, it seemed necessary to take up the sediment-bacteriological state of the Tisza and, within this, to clear up the quantitative conditions of the faecal indicator bacteria in the river Tisza and in the mouth of the major tributaries, as well.

The method of our investigation was founded on home experiences. This filters out the false results of the concomitant bacterial flora, which is always present in the silt (SZABÓ 1974). In the hygienic bacteriological practice, beside the demonstration of the faecal coliform number, the other reliable indicator of the faecal pollution is the presence of Faecal streptococcus (DAUBNER 1972).

Materials and Methods

The sediment samples were taken by the personnel of the research ship of the expedition, with sterile instruments, from the left- and right-side sections of the Tisza, resp. the tributaries, out of the upper 2 cm layer of the sediment. The samples taken were carried in a cooling bag, the same day, into the Water Bacteorological Laboratory of the Station of Public Hygieny and Epidemics of County Heves, where the processing of them took place.

To the investigations to be done we have not found any standardized methodical description, therefore we have worked with a method, already applied in the home practice in soil microbiology, food microbiology, and at the investigation into the silt of certain surface waters (CSATAI 1973, National Institute of Public Hygiene: Methodological Guide 1977, Hung.; OTKI Notes 1970, Hung.).

10 g of silt samples were put in physiological saline solution, in order to get a 10 p.c. suspension. These suspensions were homogenized in a shaker for 15 minutes. After shaking, 1 ml from dilutions of each sediment suspension was put in the enterobactericeae-concentrator. From every dilution, three tube-concentrations were made. Dilution was made till scale 10^7, then incubation followed at 37 °C, for 24^h. Then surface streaking followed on Endo culture medium from the tubes showing some turbidity. This was again incubated at 37 °C, for 24^h. Then we have recorded, on how many Endo plates typical Coli colonies were found. From the positive plates, we transoculated into a bouillon of lactose content and incubated at 44 °C, for 24^h. The tubes forming gas and solving lactose were regarded as pozitiv.

On the basis of the positive Endo plates the Coliform, and on the basis of the bouillon-tubes of lactone content the Faecal coliform number is given in MPN (Most probable number) value (THATCHER-CLARK 1968).

For demonstrating the faecal streptococci, we put the earlier described quantities from the dilutions into Litsky-Malman's concentrator and incubated them at 37 °C for 48^h. Here we worked till 10^4 dilution because of the prospectively lower values.

Then from the tubes showing turbidity we made surface streaking on Szita's culture media E_{67}. On the culture medium, on the basis of positive tubes, showing a typical colony-morphology, we give the faecal streptococcus number similarly in MPN value.

Results

The performed investigations closed with varied results, which results can only partly be explained unambiguously. At the same time, the results of the entire longitudinal section can be evaluated only by comparing them with the other investigated bacteriological, physical, chemical, etc. parameters, and certain conclusions can only be drawn in this way.

The results are varied but the Faecal coliform No/g value is always lower than the Coliform No/g value in the whole strech of the Tisza, resp. in the sediment of tributaries.

We have got saliently high values in case of both parameters in the tributaries Bodrog, Sajó, Zagyva, and Maros, as well as in the Szeged section of the Tisza (3 km below the Maros). It exceeds the order of magnitude 10^6 in the sediment of the Sajó — what can be understood if we take into consideration that the Sajó gets 85,000 cc.m/day industrial and 71,000 cc.m/day household wastewater. Despite this, in the sediment 1 km below the Sajó, resp. in that of the 3 km Tisza section, this value is reduced by 2—3 order of magnitude — what can be explained by the strong dilution and the intensive self-purification.

In the sediment samples taken from the Kisköre Reservoir, we have got very low Coliform No/g values. From Kisköre till the mouth of the Zagyva, the investigated parameters were of $10—10^2$ order of magnitude. The following strongly salient Coliform values were determined from the sediment of the Zagyva section (2.4×10^6 Coliform number, 9.3×10^5 Faecal coliform number). This massive sediment pollution can be explained partly as a consequence of the strong wastewater load (10,000 cc.m/day industrial, 4,000 cc.m/day household, and about 2,000 cc.m/day mixed waste-

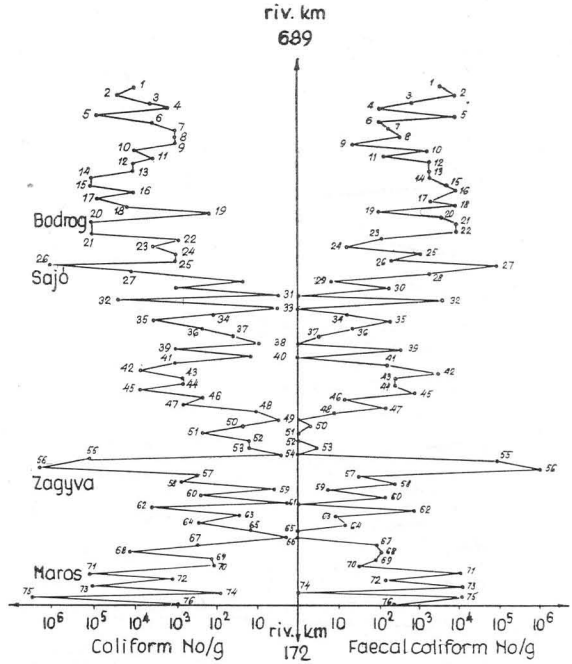

Fig. 1. Coliform, Faecal coliform number in 1 g wet sediment.

water) and partly by the extremely low water level in the time of sampling. Below the Zagyva, in the sediment of the Tisza, the Coliform and Faecal coliform/g value were only of 10^2 order of magnitude.

On the occasion of investigating into the whole longitudinal section, the highest Coliform value was measured in the 3 km Tisza-section, lying under the influence of the river Maros ($4{,}6 \times 10^6$). This may partly be explained by the settling of the Maros sediment, partly supposedly by the wastewater inflows at Szeged.

On the basis of the performed investigations, the Faecal Streptococcus number, indicating the fresh faecal pollution, was the highest in the Zagyva section, because of the facts described above. Almost 1/3 part of the samples proved to be negative. The most favourable state was registered in the Körös section and in the Tisza section below the Körös, where the Faecal streptococcus No/g value was negative in more than one sample.

On the basis of the performed investigations, among the tributaries of the Tisza, the sediments of the Bodrog, Sajó and Zagyva were the most polluted. There can be demonstrated essential differences between the sections on the right and on the left. Here we should obviously take into consideration, on which side the wastewater inflows take place, as well as the flowing conditions of the rivers.

It may be established from the investigations into the sediment samples of the Tisza that the massive pollution of tributaries is considerably reduced, as a result of the intensive self-purification and the strong dilution. This is not verified only in the 3 km section below the Maros.

Comparing the water and sediment investigations of the Tisza and tributaries

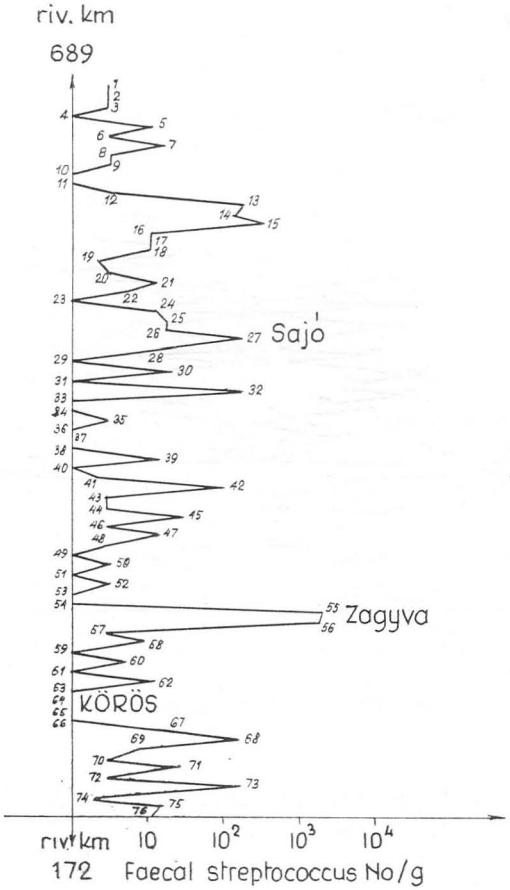

Fig. 2. Faecal streptococcus No/1 g in a wet sediment.

(though the two investigations took place with different methods), it is to be established that the most pollutions are carried by the Bodrog, Sajó, and Zagyva, which have a very high inorganic matter load. — In the settled silt the bacteria of faecal origin achieve a higher relative value than in the water.

In the silt, a larger mass of bacteria live, thus also more bacteria of faecal origin. Here the decomposition of organic matter is more intensive. At present, the Tisza is still able to reduce the bacteriological pollution of tributaries by the process of its self-purification. But if the pollution stronger increases, this may become doubtful.

It is worth considering if in river reaches, where a massive faecal pollution of the sediment is proved, bathing should be prohibited, respectively the creation of open-air baths should not be permitted.

At present, the hygienic evaluation takes only place on the basis of water investigations. In the course of our investigations, it was proved that in the bottomsediment of the surface waters loaded with wastewaters the bacteria indicating the faecal pollution are present in a much higher number than in the water itself. Consequently, the probability of the presence of the enteral pathogenic bacteria is higher, as well.

Table 1. *Sediment investigation into the Tisza and its tributaries*
28 August — September 15, 1979

Sample number	Code	Section	Coliform No/g	Faecal coliform No/g	Faecal streptococcus No/g
1	01103	Tisza, above Szamos, left	21,000	7,500	4
2	01203	Tisza, above Szamos, right	46,000	15,000	4
3	02103	Szamos, left side	7,500	1,500	4
4	02203	Szamos, right side	9,900	240	∅
5	03103	Tisza, below Szamos, 1 km left	110,000	12,000	11
6	03203	Tisza, below Szamos, 1 km right	7,500	240	4
7	04103	Tisza, below Szamos, 3 km left	1,500	390	23
8	04203	Tisza, below Szamos, 3 km right	1,500	750	4
9	05103	Tisza, above Lónyai Channel, 1 km left	1,111	43	4
10	05203	Tisza, above Lónyai channel, 1 km right	11,000	4,600	∅
11	06103	Lónyai channel, left side	4,600	240	∅
12	06203	Lónyai channel, right side	15,000	4,600	4
13	07103	Tisza, below the Lónyai channel, 1 km lef	15,000	4,600	240
14	07203	Tisza, below the Lónyai channel, 1 km right	110,000	4,600	150
15	08103	Tisza, below the Lónyai channel, 3 km left	110,000	7,500	460
16	08203	Tisza, below the Lónyai channel, 3 km right	21,000	15,000	9
17	09103	Tisza, above Bodrog, 1 km left	93,000	4,600	11
18	09203	Tisza, above Bodrog, 1 km right	21,000	12,000	9
19	10103	Bodrog, left side	240	240	3
20	10203	Bodrog, right side	110,000	7,500	4
21	11103	Tisza, below Bodrog, 1 km left	110,000	15,000	15
22	11203	Tisza, below Bodrog, 1 km right	110,000	15,000	7
23	12103	Tisza, below Bodrog, 3 km left	1,400	210	∅
24	12203	Tisza, below Bodrog, 3 km right	4,600	30	15
25	13103	Tisza, above Sajó 1 km left	1,500	2,400	23
26	13203	Tisza, above Sajó, 1 km right	1,500	460	23
27	14103	Sajó, left side	1.100,000	150,000	240
28	14203	Sajó, right side	21,000	4,600	9
29	15103	Tisza, below Sajó, 1 km left	43	9	∅
30	15203	Tisza, below Sajó, 1 km right	1,100	460	23
31	16103	Tisza, below Sajó, 3 km left	4	∅	∅
32	16203	Tisza, below Sajó, 3 km right	46,000	7,500	240
33	17103	Tisza, above Leninváros, left side	4	∅	∅
34	17203	Tisza, above Leninváros, right side	240	9	∅
35	18103	channel of thermal power station, left side	7,000	460	4
36	18203	channel of thermal power station, right side	460	43	∅
37	19103	Tisza, below Leninváros, 1 km left	75	4	∅
38	10203	Tisza, above Leninváros,1 km right	9	∅	∅
39	20103	Tisza, below Leninváros, 3 km left	2,800	750	23
40	20203	Tisza, below Leninváros, 3 km right	23	∅	∅
41	21103	Tisza at Tiszakeszi, left side	2,100	200	3
42	21203	Tisza at Tiszakeszi, right side	9,300	1,500	93
43	22103	Tisza at Tiszacsege, left side	930	430	4
44	22203	Tisza at Tiszacsege, right side	930	430	4
45	23103	Tisza at Tiszafüred, left side	9,300	930	43
46	23203	Tisza at Tiszafüred, right side	300	23	4
47	24103	Tisza at Tiszaderzs, left side	930	120	15
48	24203	Tisza at Tiszaderzs, right side	14	9	4
49	25103	Tisza at Kisköre, left side	4	∅	∅
50	25203	Tisza at Kisköre, right side	43	3	4

Sample number	Code	Section	Coliform No/g	Faecal coliform No/g	Faecal streptococcus No/g
51	26103	Tisza at Tiszabura, left side	430	∅	∅
52	26203	Tisza at Tiszabura, right side	23	∅	4
53	27103	Tisza, above Zagyva, left side	23	4	∅
54	27203	Tisza, above Zagyva, right side	4	∅	∅
55	28103	Zagyva, left side	210,000	150,000	2,400
56	28203	Zagyva, right side	2,400,000	930,000	2,300
57	29103	Tisza, below Zagyva, 1 km, left	640	43	4
58	29203	Tisza, below Zagyva, 1 km right	930	460	9
59	30103	Tisza, below Zagyva, 3 km left	7	7	∅
60	30203	Tisza, below Zagyva, 3 km right	430	230	7
61	31103	Tisza, above Csongrád, left side	3	∅	∅
62	31203	Tisza, above Csongrád, right side	7,500	930	15
63	32103	Körös, left side	43	9	∅
64	32203	Körös, right side	430	28	∅
65	33103	Tisza, below Körös, 1 km left	23	∅	∅
66	33203	Tisza, below Körös, 1 km right	3	∅	∅
67	43103	Tisza, below Körös, 3 km left	430	93	20
68	34203	Tisza, below Körös, 3 km right	23.000	150	230
69	35103	Tisza, above Maros, 1 km left	230	93	9
70	35203	Tisza, above Maros, 1 km right	150	43	4
71	36103	Maros, left side	120.000	15.000	43
72	36203	Maros, right side	1.500	240	4
73	37103	Tisza, below Maros, 1 km left	150.000	21.000	240
74	37203	Tisza, below Maros, 1 km right	93	∅	3
75	38103	Tisza, below Maros, 3 km left	4.600.000	15.000	23
76	38203	Tisza, below Maros, 3 km right	930	430	15

This means a problem first of all, where the water, demarkated for bathing, is shallow and thus, at bathing, the potential infectivity of water is increased by the stirring of silt.

Thus, it seems to be advisable to investigate into the sediments of rivers, resp. lakes, loaded by organic matter and utilized for sport, and to take into consideration the results of investigation, as well, from the point of view of the hygienic evaluation.

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A Tisza hossz-szelvényében és jelentősebb mellékfolyói torkolatában végzett üledékvizsgálatok fekálindikátor baktériumok jelenlétére

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Kivonat

Szerző a Tisza folyó hossz-szelvényében a 689—172 folyó km közötti ,valamint a mellékfolyók torkolatában 76 mintavételi helyen végzett üledékvizsgálatokat. A minták Coliform, Faecal coliform és Fecal streptococcus számát határozta meg, MPN értékben, 1 g nedves üledékre vonatkoztatva Ez az első üledék bakteriologiai vizsgálat a Tisza folyó magyarországi hossz-szelvényében. Szerző megadta az egyes mintavételi helyek fekális bakteriológiai szennyezettségének számszerű értékeit. Felhívja a figyelmet a felszíni vizek bakteriológiai megítélésénél az üledékvizsgálatok jelentőségére.

ПРОВЕДЕННЫЕ НА ПРОДОЛЬНОМ ПРОФИЛЕ ТИСЫ И В УСТЬЯХ ЕЁ БОЛЕЕ ЗНАЧИТЕЛЬНЫХ ПРИТОКОВ АНАЛИЗЫ ОТЛОЖЕНИЙ НА ПРИСУТСТВИЕ ФЕКАЛ-ИНДИКАТОРНЫХ БАКТЕРИЙ

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Резюме

На участке Тисы в 689—172 п. км, а также в устьях её притоков автор провёл а нализ отложений на месте взятия 76 проб. Было проведено опеределение числа Coligorm, Faecal coliform И Fecal streptococcus, в показателе MPN.

В пересчёте на Iг влажных отложений. Это — первое бактериологическое исследоьание отложений на всём протяжении Тисы в Венгрии. Автор приводит количественные показател фекальной бактериологической загрязнённости в местах взятия проб. Обращает внимание на значение анализов отложений при бактериологической оценке поверхностных вод.

Ispitivanje prisutnosto fekalni-indikatornih bakterija u mulju uzdužnog profila Tisei na uššu njenih značajnijih pritoka

ESTÓK B.
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Abstrakt

Autor je na uzdužnom profilu reke Tise izmedju 689 i 172 rečnog Km kao i na ušćima pritoka na 76 punktova uzimao uzorke za analizu sedimenata. Uzorci su analizirani u odnosu na g vlažnog sedimenta, na broj Coliform, Fecal coliform i Fecal streptococcus u MPN vrednostima. Ova su prva sedimentno-bakteriološka ispitivanja na uzdužnom profilu reke Tise u Madjarskoj. Autor je prikazao vrednosti fekalno-bakteriološke zagadjenosti na pojedinim punktovima uzimanja uzoraka. Ukazuje se na značaj istraživanja sedimenata pri utvrdjivanju bakterioloških svojstava površinskih voda.