

RESULTS OF THE ALGOLOGICAL INVESTIGATION OF THE SAJÓ BED STRETCH BELOW MISKOLC IN 1976

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Abstract

(1) It is to be established by reason of the results of the comparative algological investigation of the Sajó bed stretch below Miskolc that:

the original Hernád-bed of small water output, owing to its rich algal population, increases the tychoplanktonical algal communities of the Sajó, while the Hernád factory canal of large water output may partially decrease it;

it is of definitive importance, at any rate, if the algae having got into the Sajó have found the favourable living conditions;

their joint effect is fundamental in the life of the Sajó and through this they may also influence the affected bed stretch of the Tisza.

(2) In the Sajó stretch below Miskolc trophity is increasing. This is the result of the increasing pollution.

(3) The algal population maximum, observed on the occasion of examining the longitudinal section on July 19—20, 1976, is of tributary origin but of a type of developing secondarily in the Sajó. Thus, apart from characterizing the tributaries, it is also showing well the water quality of the Sajó stretch before the discharge of the Sajó into the Tisza. Its correlation with the chemical "background" gives us information also of the correlation between trophity and saprobity.

(4) For the sake of protecting the quality of the Tisza water, the trophity of the Sajó is to be decreased what means a decrease also in the allochthonous materials.

Introduction

According to the investigations of the tychoplanktonical algal communities of the Sajó (VÁNCSA, 1977), the bed stretch of this river in Hungary falls into well-delimitable parts. The single stretches are characterized by the water-using, water-polluting activity of the man, as well as by the fundamental changes in water quality under the influence of tributaries.

The Sajó arrives at the area of Miskolc with a considerable pollution. The quality of its water is fundamentally changed here by the water-using, water-polluting activity of the man. The bed stretch below Miskolc is only loaded — in addition to the fundamental burden — by the sewage-waters of some minor settlements, resp. by the pollutions originating from the agricultural water-usage and the runoff from land. The double-mouth of the Hernád may casually considerably deteriorate the conditions of pollution and self-purification but it can also have a favourable effect on the water of the Sajó.

It follows from this that the conditions favourable from the point of view of self-purification can develop in the bed stretch between the inflow of the Szinva and Hernád and the realization of this process can be observed to a certain extent in the stretch free from these disturbing effects.

In this paper I render account of the results from the year 1976, emphasizing the changes to be observed in the stretch part below Miskolc, with special regard to the effect of the double Hernád-mouth on the Sajó and to the peculiarities of the algal population maximum observed at the investigation of the longitudinal section on July 19—20, 1976.

Discussion of the results of the investigation

I have examined the qualitative and quantitative composition of the tycho planktonical algal communities of the Sajó from the water samples drawn also in 1976, with a monthly frequency, marked out according to my quoted paper, in ten sections considered as characteristic. I have casually investigated it in other sections, too, as well as the tycho planktonical algal communities of the original Hernád-bed, the Hernád factory-canal, as well as the Takta canal, in their mouth sections. The aim of my work was not to study the algal taxons of rare occurrence but to observe and evaluate the algal population maxima that are suitable for being qualified. In this way, the algal taxons that may possibly have proved taxonomically new, fell, of course, into the background.

According to the investigations of the Sajó, performed in the year 1976, the change in the total algal number (Tables 1&2, as well as Fig. 1) is extreme: in three sections of the upper reaches it was also of atrophic character, while in the lower reaches on three occasions it was eu-, resp. polytrophic. (The qualification as "atrophic" does not exclude the possibility of that algae could occur in the three sections, too. Practically it means that in the microscopically examined water amount I have not found any algae; their total algal number is practically zero, and zero was also the chlorophyl *a* content!). On the basis of the total algal number, the water of the Sajó is characteristically mesotrophic.

It changes on the basis of the chlorophyl *a* content, being of atrophic or eutrophic character. In the upper reaches, the chlorophyl *a* content has never surpassed the oligo-mesotrophic grade, while in the lower reaches, in the spring-summer months, the water of the river Sajó was often found to be of mesotrophic, meso-eutrophic, and at the July maximum even of eutrophic character.

The cause of the expressly different trophity characters below Miskolc and above Miskolc is to be looked for first of all in the rich algal vegetation of the double Hernád-mouth and the Takta canal. On the other hand, the development of the own tycho planktonical algal vegetation of the Sajó in the lower bed stretch may also be considerably supported by the slowing down of the river current, and this also takes part in the periodic increase of trophity grade.

The stock of the netted zooplankton (mostly Rotatoria) was of considerable quantity from April up to September, its maximum was observed in July what agreed well, in time, with the maximum time of the total algal number and the chlorophyl-*a* content. This could take place — in addition to the other environmental effects — as a result of the periodical abundance in nutritive materials (the considerably increased algal population). This is shown also by that it is in a good correlation with the quantitative changes in the algal population.

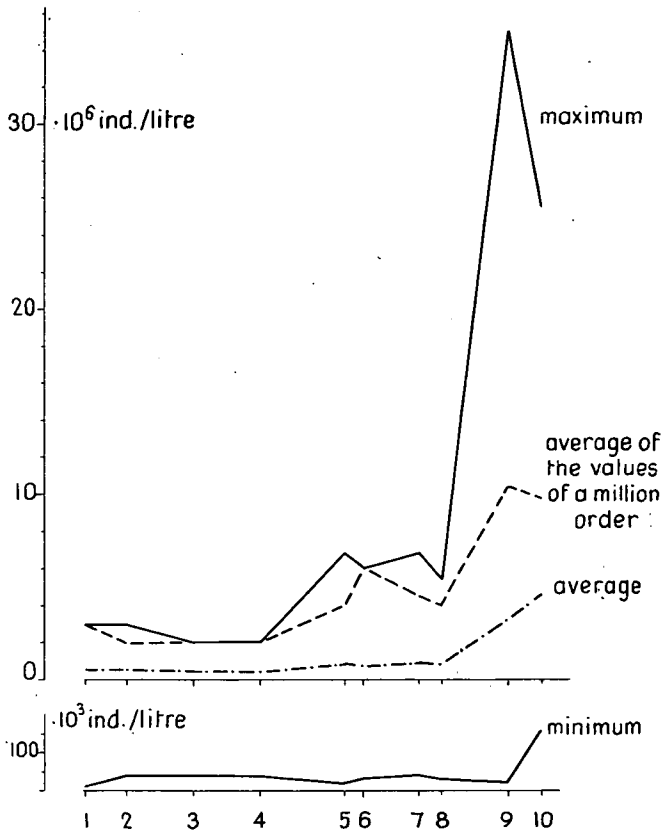


Fig. 1. Characteristic values of the total algal number of the Sajó (minimum, maximum, the average of values of a million order and of all values) in 1976.

In Figures 1 to 4, sampling sites 1 to 10 are represented in the scale of river-km, therefore the proper comparison of the distances between the single sections is possible.

On the basis of the saprobic index investigations (Fig. 2), the characteristic features of all the ten investigated sections are anyway referring with small deviations to a similar saprobic character but the most characteristic changes manifest themselves well. (At interpreting the Figure, it is to be taken into consideration that it does not show any simultaneous values but annual peculiarities observed in the ten investigated sections. The changes are, in my opinion, well shown by the Figure).

On the basis of the microscopic examinations, the saprobity of the Sajó is most unfavourable in the frontier section (Sajópüspöki) and most favourable in the mouth section (Ószederkény). At the same time, the effect of the Miskolc area, influencing the water quality presents itself well, there are appearing fundamental changes in the shorter or longer bed stretches below the mouths of the original Hernád-channel and the Hernád factory-canal, as well as the Takta canal, too.

Seasonally no characteristic connection appears but, as compared with the earlier years, it can be ascertained that the saprobity of the Sajó water has not changed in a characteristic degree. (The importance of performing saprobic

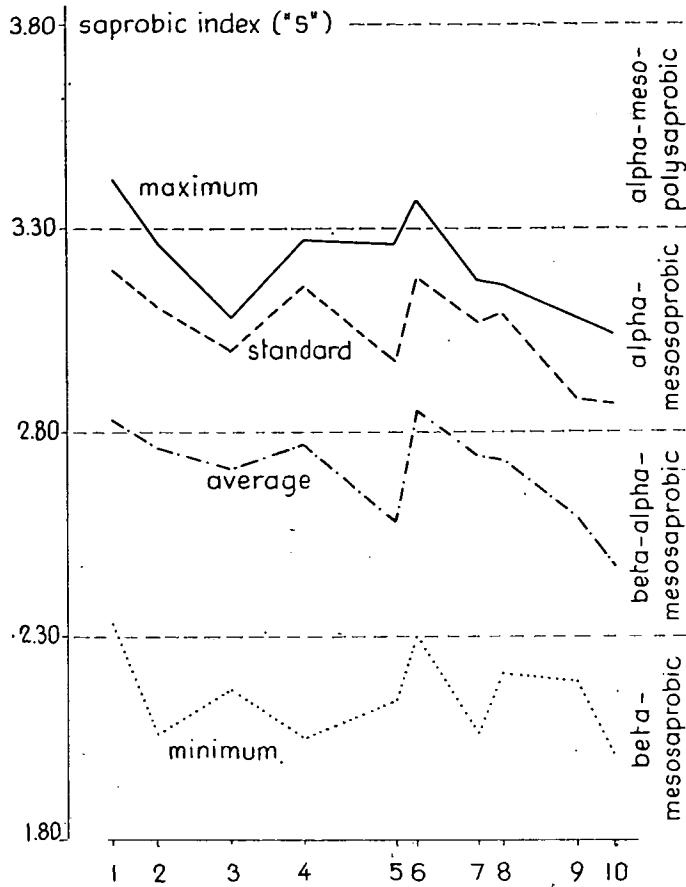


Fig. 2. The characteristic saprobic-index ("S") values of the Sajó (minimum, maximum, standard and average) in 1976.

investigations is — in spite of the several counter-arguments against the method — therein that in the course of this the microscopic living world of the water is examined in a living state — what is, of course, useful for forming an opinion of the water.)

The characteristics of the change in trophity-saprobity of the Sajó (Table 2) are of changing character in opposite direction to each other:

The *minimum values* of the *total algal number* (Fig. 1) are characteristically of *ten thousand* order of magnitude, they have only before the mouth a value of a hundred thousand. Their *maximum values* are characteristically of a *million* order of magnitude but in the bed stretch before the mouth their value is of *ten million* order of magnitude. The formation of the average values calculated on the basis of the million litre numbers *approximates the maximum value*. But it is somewhat more equalized in the stretch before the mouth. The formation of mean values calculated on the basis of a million litre numbers *approaches the maximum value*, and in the stretch before the mouth it is a little more equalized. The formation of

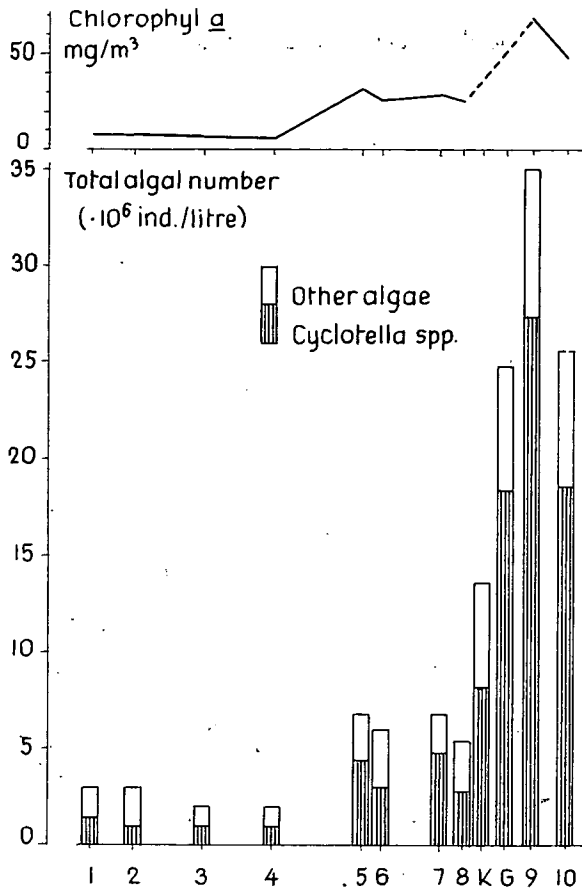


Fig. 3. The tycho planktonical algal community of the Sajó on July 19—20, 1976. In Figure 3, the sections investigated apart from sampling sites 1 to 10, between sections 8 and 9, are: K=Köröm and G=Girincs (cf. also with Table 3).

mean values calculated from the results of all the investigations approaches the minimum values but with a difference in the order of magnitude because the mean values calculated from the total result of investigations are characteristically of a hundred thousand order of magnitude. They are only in the stretch before the mouth of a million value.

The minimum values of the saprobic index (Fig. 2) are indicating *beta-mesosaprobity*, being different only in the frontier section. Its maximum values are characteristically of *alpha-mesosaprobic* character. The Sajó is only in the frontier sector and in the area of Felsőzsolca of alpha-saprobic-polysaprobic intercultural character. The standard saprobic index values, calculated on the basis of the least favourable values, being in a definite proportion to the total examination number (grouped with the exception of Spring according to seasons) approach the maxima, indicating alpha-mesosaprobity. From the mean values calculated from the results of all the investigations follows a comparatively equalized alpha-mesosaprobic — beta-mesosaprobic character, an exception being the frontier section and the area of

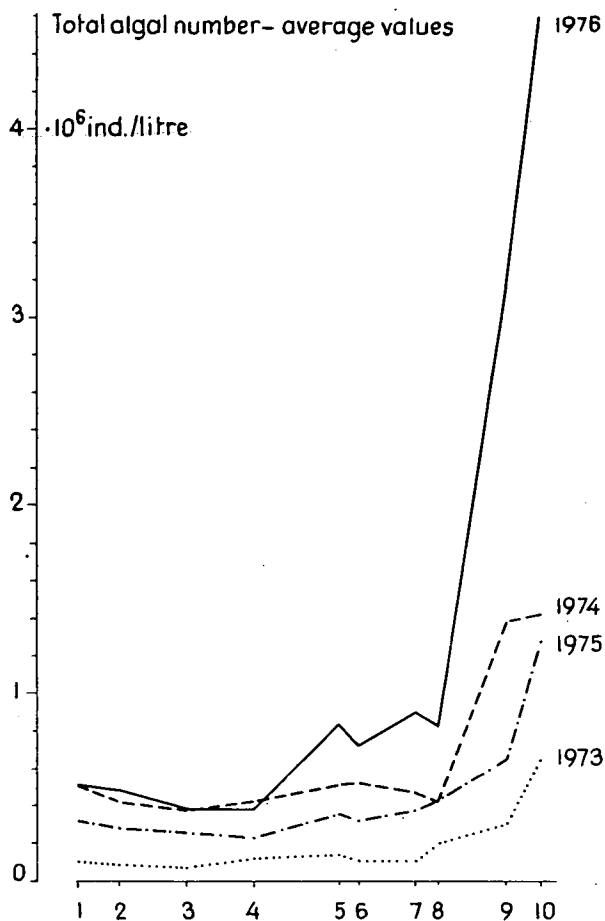


Fig. 4. Change in the trophity degree of the Sajó between 1973 and 1976, on the basis of the average values of the total algal number (10^6 indiv./litre).

Felsőzsolca where the alpha-saprobity comes through the lower limiting value of alpha-mesosaprobity, as well.

The reciprocity of trophity-saprobity (Table 2, as well as Figures 1 & 2) is duly informing us of the dynamism of the water quality conditions. It is evident that, simultaneously with the *decrease in saprobity*, trophity, increases what may have been a natural consequence of the dissolved inorganic materials increasing together with the decrease in the amount of the solvable organic materials. (In case of the Sajó, a considerable amount of biologically resolvable allochthonous organic materials may be considerably decomposed in the food-chain of water — this is shown by the presence of a high number of heterotrophic living organisms and — as a nutritive material available to the autotrophic plants — it can considerably increase the trophity of water.)

Evaluation of the investigation of the longitudinal section on July 19—20, 1976

Corresponding to the experiences of earlier years (1965 to 1975), the effect of the double Hernád-mouth is manifesting itself in 1976, as well, in the Sajó — in the short bed stretch before its flowing into the Tisza — as demonstrated well (apart from those told previously and the above-cited examples) by the characteristics of the investigation on July 19—20, 1976 of the longitudinal section (Table 3 & Fig. 3).

At investigating into the longitudinal sector, in the stretch above Miskolc the Sajó had an equalized water output and the water output was similar to this — although somewhat smaller — up to Kesznyéten. This output was not changed by the small water quantity from the original Hernád-bed but the inflow of the Hernád factory canal was of fundamental effect. This has increased the water output of the Sajó (Q = about 5.0 cc.m/sec) to about three times as much value (Q = about 15.0 cc.m/sec) by its double water output (Q = about 10.0 cc.m/sec), in its short bed stretch before the mouth.

It turns out from the results of the investigation that the original Hernád-bed — in spite of its small water output — induces great changes owing to its rich algal vegetation but the development of the algal population maximum takes only place in the water of the Sajó. In the Sajó bed stretch below the original Hernád-bed the algal population increase continuously more and more and — as compared to the total investigations performed in the full Sajó stretch in Hungary — culminate in the maximum value reached so far ($35 \cdot 10^6$ individual/litre), at Kesznyéten. The Hernád factory canal decreases, by its considerable water output, the amount of the algal population maximum in the Sajó, and even before the inflow into the Tisza it is of considerable value.

The characteristic and dominant organisms of the observed tychoplanktonical algal community are diatom (Bacillariophyceae-Centrales) species (*Cyclotella* spp.). Besides these, they were enriched by the occurrence of several green algae (Chlorophyta), with changing individual number.

By the proliferation of *Cyclotella* spp. KÜTZ. in the Sajó, to an extent like this, the water properties which are favourable for us and may be attributed to the hydrological and ecological peculiarities of the river, are indicated unambiguously, the results being manifested, however, in the Tisza, as well.

The chemical "background" is in a good correlation with the algological changes, showing also the effect of the double Hernád-mouth; namely:

the quantity of *dissolved oxygen* (in saturation percentage!) is large in the original Hernád-bed (152 per cent), above this, in the Sajó (35 per cent) it is comparatively small but in the section of Kesznyéten (90 per cent) the oxygen-producing effect of the increasing algal population is already to be felt and it is similarly considerable in the Hernád factory canal (117 per cent), as well as in the stretch of the Sajó before its mouth (88 per cent);

the *biochemical oxygen requirement* (five days long), changing according to this, is indicating the oxygen requirement of the algal population maximum, as well; (the pH value is equalized, ecologically acceptable);

the *total dissolved material* content in the original Hernád-bed and the Hernád factory canal is approximately of the same value and smaller than in the Sajó where the amount of the dissolved material is of decreasing character;

the amount of the ammonium nitrate ions is of decreasing, resp. increasing character; indicating well the decomposition of organic materials;

the amounts of dissolved ortho-phosphates in the original Hernád-bed and the Hernád factory canal are equally of small value and of approximately identical quantity; in the Sajó, however, it is considerably larger and, in harmony with the running up of the algal population maximum, considerably decreases.

All the algal litre values of the Sajó in 1976 can characteristically be expressed with a hundred thousand order of magnitude; the minimum observed in the winter months (apart from the three atrophic values) is of ten thousand order, while the maxima are of a million — ten million value. The latter ones appear, in most part of cases, in the stretch below the double Hernád-mouth as algal population maxima, originating from tributaries but developing also in the Sajó secondarily and being observable in the Tisza, as well.

The trophity degree of the Sajó the basis of the investigations in the year 1976

At evaluating the trophity degree, I consider the maximum values as characteristic although the materials getting into the Sajó and increasing trophity go on with the flood. And on the occasion of large waters, the bed can strongly be washed through. It is, at any rate, to be taken into consideration that the water mass characterized as the maximum value may be the inducer of fundamental changes in the further bed stretches — or indirectly in the water mass of the Tisza. I hold, therefore, to be advisable — similarly to the qualification of standing waters — to consider the maxima as characteristic.

By the change in the trophity degree of the Sajó, it is characteristically shown on the basis of the average values (Fig. 4) that — considering the total algal number values of 1973 as the basis of comparison — it is of increasing character of late years. From the frontier section down to the area of Miskolc it is equalizedly of similar character, from Miskolc down to the inflow of the original Hernád-bed it is likewise equalized but perceptibly larger, while in its bed stretch below the double Hernád-mouth the sudden change manifests itself in a remarkable degree. (On the basis of the mathematical average values of the whole investigation — aside from the larger or smaller changes — we may obtain similar results in respect of the changes in the trophity degree of the Sajó.)

The changes in the trophity degree can be explained with the following:

the natural (self-) purification of the Sajó is of sufficient extent, thus the amount of the dissolved nourishments is increasing. In earlier years (VÁNCSA 1975) the self-purification of the Sajó was impeded, resp. decreased by some toxic (?) effect. Of late, however, an effect like this has not been observed;

from the sewage farms functioning in the water system of the Sajó — owing to the improvement in the degree of efficiency — more dissolved nutritive material gets into the Sajó immediately or through the tributaries;

the amount of the dissolved nutritive materials, runoff from the watershed area of the Sajó and originating from the agricultural activity, is also increasing.

The results are useful in investigating the water quality of the Tisza because the pollutions of the Sajó exert their effect in the Tisza at last. The investigation into the double Hernád-mouth is therefore important.

The double Hernád-mouth can be characterized — apart from the existing similarities — with considerable qualitative and quantitative differences. The peculiarities of primarily hydrological character, coming about from the division of

Table 1. Values of the total algal number of the Sajó (.10 indiv./litre), in 1976.

Date of the investigation	Sajópuspóki	Putnok	Sajókaza	Sajószentpéter	Miskolc	Felsőszolca	Sajólad	Ónód	Kesznyéten	Ószederkény
02.09—10.	39	39	49	68	117	78	117	107	156	156
02.24—26.	204	195	88	126	146	126	146	175	175	350
03.16—17.	370	175	156	175	195	156	165	107	272	282
04.05—07.	875	1031	661	574	1021	836	486	681	282	—
05.03—04.	535	496	340	311	642	428	798	827	564	1012
05.13.	—	—	—	—	—	—	2198	2373	2821	1642
05.24—25.	603	564	817	924	584	564	691	613	1284	—
06.01—02.	389	272	311	214	389	292	195	253	564	350
07.08.	—	—	—	—	—	—	—	—	—	18479
07.19—20.	3015	2918	2042	2042	6711	5933	6808	5447	35014	25579
08.09—12.	340	282	272	350	593	661	467	515	2480	1848
09.20.	165	185	97	88	185	195	272	282	214	224
10.25—26	68	88	58	49	107	78	117	58	136	—
11.02—03.	58	58	39	39	58	49	49	68	146	321
12.14—15.	10	0	0	0	20	30	39	30	20	—
minimum	10	39	39	39	20	30	39	30	20	156
maximum	3015	2918	2042	2042	6711	5933	6808	5447	35014	25579
mean value of a million order	3015	1975	2042	2042	3866	5933	4503	3910	10399	—
average of all values	513	485	379	382	828	725	896	824	3152	4568

Table 2. Characteristics of the change in trophity-saprobity of the Sajó in 1976, the total algal number (10^3 indiv./litre) and saprobic index (‘S’) from the characteristic (minimum, maximum, standard, average) values

	Sajópuspóki	Putnok	Sajókaza	Sajószentpéter	Miskolc	Felsőszolca	Sajólad	Ónód	Kesznyéten	Ószederkény
Trophity										
minimum	10	39	39	39	20	30	39	30	20	é6e
maximum	3015	2918	2042	2042	6711	5933	6808	5447	35015	25579
average of the values of a million order	3015	1975	2042	2042	3866	5933	4503	3910	10399	9712
average of all values	513	485	379	382	828	725	896	824	3152	4568
Saprobity										
minimum	2,33	2,06	2,17	2,05	2,14	2,30	2,06	2,21	2,19	2,01
maximum	3,42	3,26	3,08	2,37	3,25	3,36	3,17	3,16	3,08	3,04
[[standard]]	3,20	3,11	3,00	3,16	2,97	3,18	3,07	3,09	2,88	2,87
average of all the values	2,83	2,76	2,71	2,77	2,58	2,85	2,74	2,73	2,59	2,47

Table 3. Characteristic results of the longitudinal-section investigation of the Sajó on July 19—20, 1976

	Water output (m ³ /sec)	Total algal number ($\cdot 10^3$)	Cyclotella spp. (liter)	Cyclotella (in per-centag)	Chlorophyll <i>a</i> (mg/m ³)	Saprobic index ("S")
Sajópüspöki	5,9	3 015	1 362	45	7,6	2,74
Putnok	6,3	2 918	973	33	8,3	2,68
Sajókaza	6,3	2 042	1 070	52	6,5	2,39
Sajószentpéter	5,9	2 042	1 070	52	5,6	2,93
Miskolc	4,0	6 711	4 377	65	32,2	2,18
Felsőzsolca	4,5	5 933	3 015	51	26,2	2,70
Sajólád	4,5	6 808	4 668	69	29,3	2,40
Ónod	4,5	5 447	2 723	50	25,9	2,38
original Hernád-bed	0,5	71 972	42 794	59	—	—
Köröm	5,0	13 640	8 170	60	—	—
Girincs	5,0	24 730	18 285	74	—	—
Kesznyéten	4,5	35 014	27 233	78	67,8	2,51
Hernád factory canal	0,0	40 849	29 178	71	—	—
Takta canal	0,3	9 629	973	10	—	—
Ószederkény	14,8	25 579	18 479	72	48,5	2,65

Table 4. Change in the trophity degree of the Sajó between 1973 and 1976, on the basis of the average values of the total algal number (10^3 indiv./litre)

	Sajópüspöki	Putnok	Sajókaza	Sajószentpéter	Miskolc	Felsőzsolca	Sajólád	Ónod	Kesznyéten	Ószederkény
1973	107	86	66	124	143	110	112	112	305	653
1974	500	414	366	418	507	515	468	421	1376	1412
1975	317	275	264	226	345	315	373	429	642	1266
1976	513	485	379	382	828	725	896	824	3152	4568

the bed stretch of the Hernád below the mouth, are also of fundamental consideration for the tycho planktonical algal communities.

Taking into consideration that all the algal litre-number values of the Sajó are characteristically of a hundred thousand order of magnitude, and at the same time, in case of the double Hernád-mouth this value is characteristically of a million order of magnitude, it is easy to understand that in the bed stretches of the Sajó, following the confluence of their mostly similar water amounts, the total algal litre-number of the Sajó considerably increases already from the beginning. At the same time, the algal population maximum passing in the original Hernád-bed (in spite of its low water output) may exert a considerable effect in the water of the Sajó. It is shown by this fact unambiguously that the water quality in the bed stretch before the mouth is primarily determined by the effect of tributaries and it is only casually the result of the natural biological processes in the Sajó.

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Addition to the interpretation of Tables

- (1) Sajópüspöki (frontier section)
- (2) Putnok
- (3) Sajókaza
- (4) Sajószentpéter
- (5) Miskolc
- (6) Felsőzsolca
- (7) Sajólád
- (8) Ónod
- (9) Kesznyéten
- (10) Ószederkény (before the mouth)