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WATER QUALITY OF THE TISZA RIVER AT SZOLNOK IN THE PERIOD 1970—1988

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Abstract

A process of water purification is characteristic for the second biggest Hungarian river in the stretch between the mouth of the Sajó river and Szolnok. Because of the considerable water consumption of Szolnok for industrial purposes and drinking-water supply, the water quality and its longterm changes are of outmost importance. Our analysis is based on the evaluation of results obtained in the studies of water samples collected weekly from the Tisza reach at Szolnok (335,4 river km, Fig. 1) in the period 1970—1988. In order to obtain sufficiently detailed information on the water quality the most important 27 water quality parameters have been considered in the present study.

The changes observed in the annual maximal, minimal and mean values of several parameters in the period between 1970 and 1988 are shown in Figs 2—5. The changes in the water quality reflected by the mean values of the quality parameters were not considerable, altogether deterioration of water quality was observed (Table 1), which is proven by the increase in the average concentrations in most of the parameters.

The direction and extent of the changes were determined for the periods 1970—1978 and 1979—1988 by means of regression analysis (Table 1). It was found that a considerable deterioration of water quality took place in the 70s. Among the parameters studied 52% showed an improved or unchanged water quality, 22% indicated slight and 22% — considerable deterioration between 1979 and 1988 (Table 2).

The quality of water in the Tisza met the I. class requirements when used for industrial and irrigation purposes during the whole period studied (Table 3). From 1976 on it corresponded only to II. class in covering the needs of fishery or drinking-water supply, and in this field a further deterioration of water quality is to be expected.

Introduction

The water of the Tisza river reaching the territory of Hungary is very clean, all water quality parameters meet the requirements for I. class water quality. However, the river water is influenced unfavourably by its tributaries, in the first place by the polluting materials carried by the Szamos and Sajó rivers. A process of water purification is characteristic for the Tisza stretch from the mouth of Sajó to the reach at Szolnok, where our studies have been carried out (VIGH 1983).

Since the consumption of water for industrial purposes and drinking-water supply in Szolnok is significant, the water quality and its long-term changes are of a particular importance. The changes have been followed in our studies on the basis of data obtained for the reach at Szolnok (335,4 river km) above the mouth of the

Zagyva river (Fig. 1). Samples have been collected in this reach practically every week (52 samples/year) between 1970 and 1988. In our analysis data on 27 important, almost exclusively macro-component parameters were evaluated.

ANDERSON—ZAGORSKI (1968) studied 3 water quality parameters (dissolved O_2, BOD_5 and coliform bacteria) in a reach of the Passaic river between 1955 and 1968 assuming linearity of the trends. EDWARDS—THORNES (1973) studied the tendencies in 8 water quality parameters on the basis of weekly measurements in the Staur river during a twenty-year period (1950—1970). HORVÁTH—PANNONHALMI—VÁRDAY (1981) compared the relation between concentration and massflow in respect to four parameters (COD_k, NH_4, NO_3 and PO_4) for the whole stretch of the Danube on the territory of Hungary during two periods (1968—1972 and 1973—1978). ROTSCHEIN (1981) evaluated a series of COD_p measurements carried out on water samples from the Danube between 1950 and 1978 in a function of time. STEGMAN (1976) established trend equations for 9 parameters measured in Oker between 1965 and 1974.

HOCK (1981) determined the trends for a ten-year series of 6 water quality parameters measured in 25 incoming and 3 outgoing reaches of Hungarian border rivers. In 1983 he developed a water quality model for prediction of the trends in water quality changes, the results of which were demonstrated on the data measured between 1970 and 1979 in 11 border reaches of the Tisza river system (Tisza, Szamos, Bodrog, Sajó, Bódva, Hernád, Fehér-Körös, Fekete-Körös, Sebes-Körös, Berettyó, Maros). From 11 border reaches studied, in 9 cases for the concentration of PO_4-ion 8,0—18%, for ammonium-ion in 8 rivers 3,0—12,7%, for nitrate-ion as well in 8 border rivers 3,5—10,6%, for dissolved O_2 in 7 rivers 0,8—2,9%, for BOD_5 in 3 rivers 2,5—8,5% annual water quality deterioration was established. Among the six border rivers from the water-shed area of the Tisza above Szolnok the most significant water quality deterioration occurred in the Szamos.

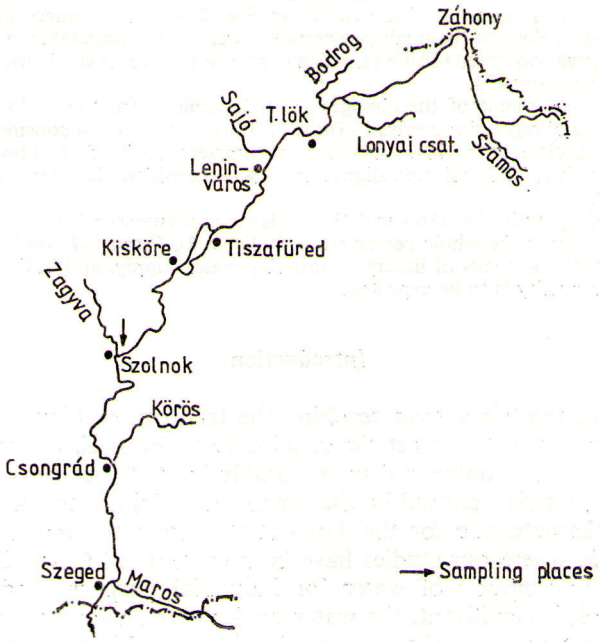

Fig. 1. The stretch of the Tisza river on the territory of Hungary

Materials and Methods

In the evaluation of the water quality of the Tisza river were used the results of measurements carried out on samples taken from the reach at Szolnok (above the influx of the Zagyva river, 335,4 river km). This reach belongs to the national basic surface water network, where the water tests are carried out weekly (number of samples: 52/year). The water quality parameters were measured in the samples in the Laboratory of KÖTI—KÖVIZIG (Directorate of Environmental and Water Conservancy of the Central Tisza Region) in Szolnok according to the effective regulations and CMEA methodology.

Results and Discussion

Concentration changes in function of time

It is important to emphasize that annual changes in water quality are influenced to a considerable extent not only by the varying pollution load but by the hydrological and meteorological factors as well.

One of the most important factors modifying the water quality — the water output, varied significantly from year to year (Fig. 2). The maxima often exceeded many times the mean value.

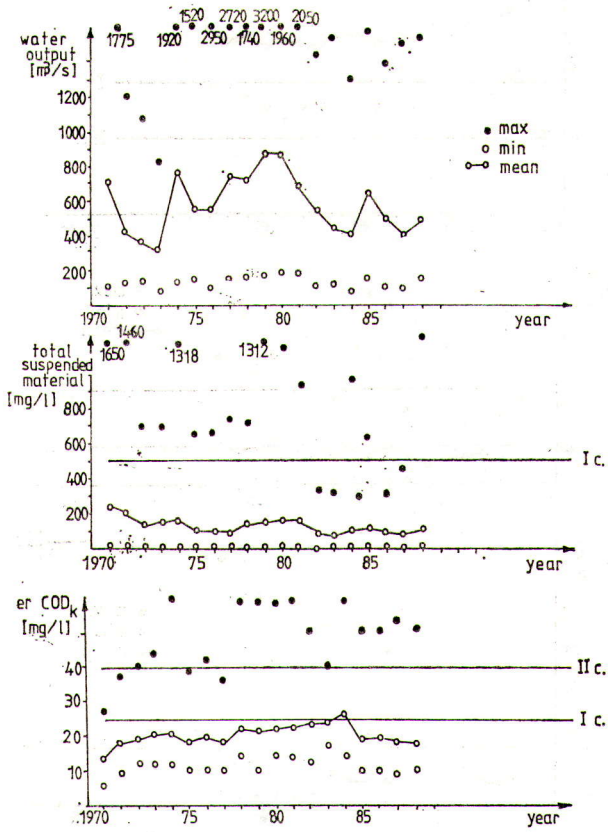

Fig. 2. Changes in water output, total suspended matter and COD_k concentrations in the Tisza (Szolnok)

The total concentration of the suspended mater depended strongly on the river flow. In all cases maximal values were measured during the periods of high water, reaching occasionally extremely high values, exceeding 1000 mg/l. Minimal values between 1 and 10 mg/l coincided with the summer periods of low water (Fig. 2).

The annual maxima of COD measured in the original samples by the chromate method, appeared together with the maxima in suspended mater concentrations (Fig. 2). The mean values were close to or even in one year exceeded the I. class limit value.

The changes in BOD_5 concentration values in different years were less pronounced than those of COD.

The concentration of dissolved O_2 (and the oxygen saturation) tended to decrease in the course of the 19 years of observation, however, since 1978 the decrease stopped (Fig. 3). The oxygen content of water was always sufficient for supporting the life functions of aquatic organisms. The minimal values fell between the limit values for

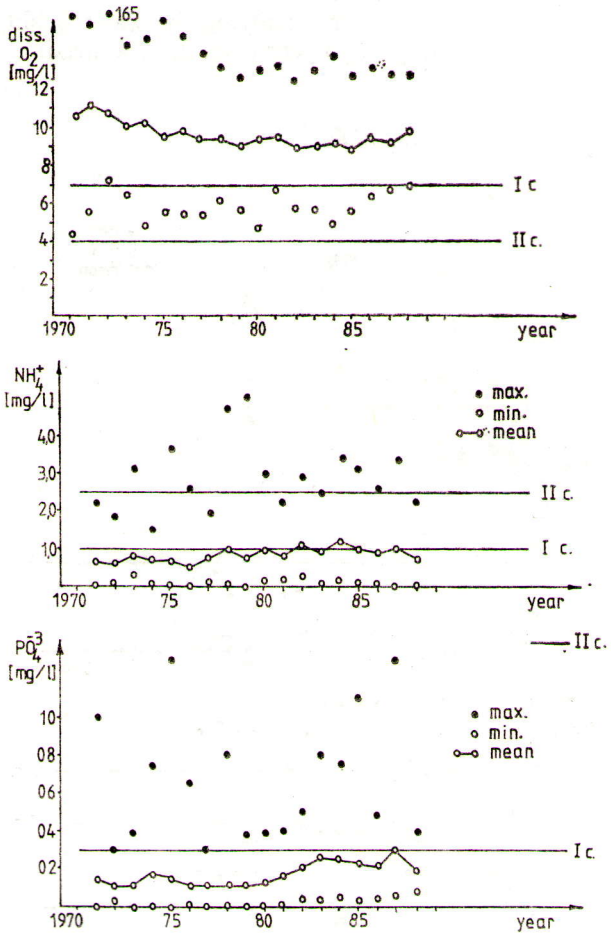

Fig. 3. Changes in concentration values of dissolved oxygen, ammonium-ion and phosphate-ion in the Tisza (Szolnok)

I. and II. class, and were observed in the summer-autumn periods of low water. The trend in the changes of this parameter is in accordance with the increase of the organic mater content in the water.

Among plant nutrients the concentration of ammonium-ion steadily increased (Fig. 3). In the last years its mean values exceeded the I. class limit value. Maximal values were observed always in winter periods characterized by low water temperature (WAIJANDT 1987). Minimal values were registered in warm summer periods. The values of this parameters varied in a relatively wide range from year to year.

The mean concentrations of nitrite-ion fell in the II. class water quality range. Till 1980 its values increased, after which they decreased to a similar extent.

The concentration of nitrate-ion hardly changed in the studied period, and its mean values never exceeded 9 mg/l. The maximal values were lower than the I. class limit values (WAIJANDT 1988).

The measurements of total nitrogen content started in 1975. The values showed a strongly decreasing tendency. The maxima coincided with the periods of the maximal concentration of suspended mater. Since 1979 the changes in the mean values showed a great similarity to the changes in the average water output.

The phosphate-ion content of the Tisza increased significantly (Fig. 3).

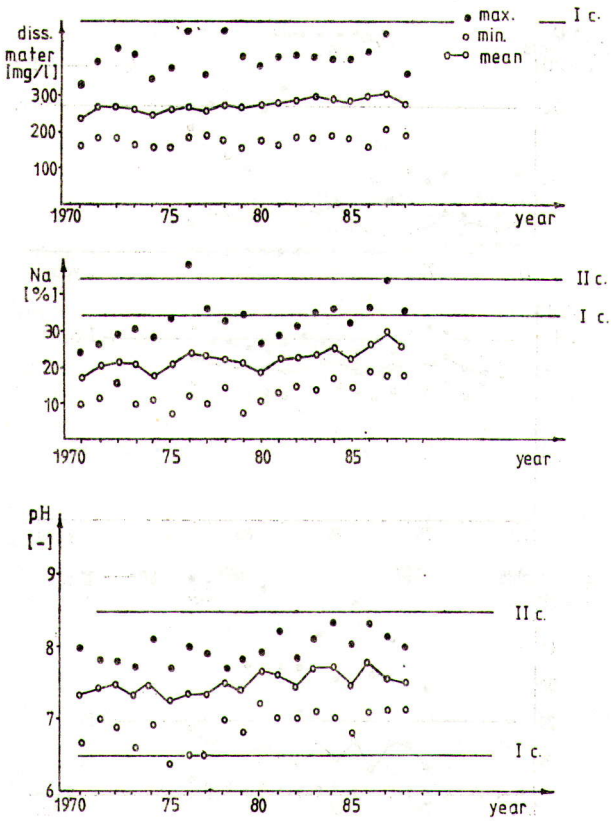

Fig. 4. Changes in the concentration of total dissolved matter, Na% and pH values in the Tisza (Szolnok)

This increase can not be attributed slowly to the application of phosphate artificial fertilizers in the agriculture, since the phosphate concentration of communal waste-waters is as well significant (WAIJANDT 1988).

The changes in the mean concentration of the total phosphorus did not follow in magnitude the increase in the phosphate-ion concentration. The maximal values are remarkably high and usually coincided in time with the suspended matter maxima.

Among the mineral components the total mineral salts are included in good approximation in the total dissolved matter. The values of this parameter are considered to be favourable since even the maximal values are within the I. class range (Fig. 4).

Considerable changes in unfavourable direction were observed in the Na% values (Fig. 4). The increase in this parameter is probably related to the raise in chloride- and sulphate-ion concentrations. In the last years during lasting periods of low water the maximal values fell already into II. class range. The source of the increased Na load is the industry and partially the thermal waters in the Tisza watershed area.

The total hardness and alkalinity of the Tisza water did not change noticably in the last 19 years.

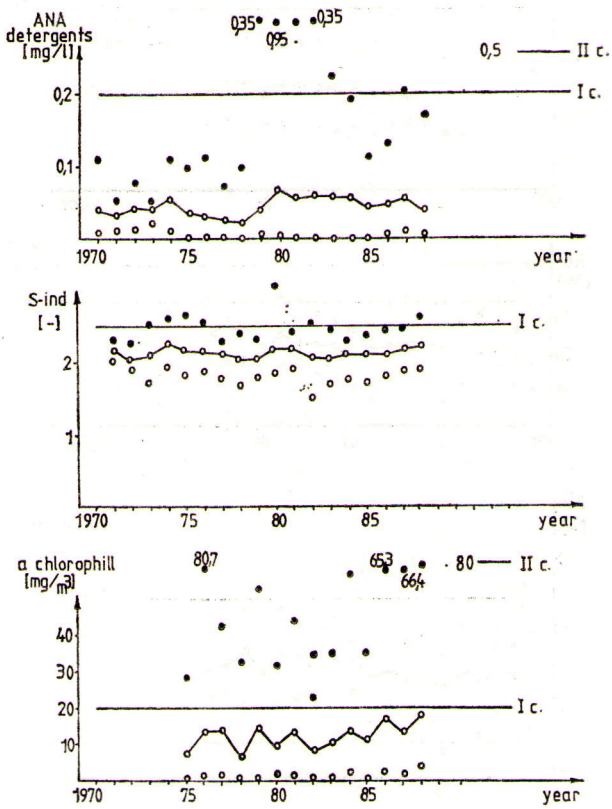

Fig. 5. Changes in the concentrations of anion active detergents, a-chlorophill and saprobity-index values in the Tisza (Szolnok)

The chloride- and sulphate-ion concentrations showed a slight increase but remained in the favourable lower half of the I. class range.

The pH values were in the I. class range of 6,5—8,5, except for one case. Both the mean and maximal values showed an increasing tendency (Fig. 4).

Phenols originating mainly from antropogen sources showed an increase in the last few years.

The concentration of anion active detergents is favourably low. The mean concentrations did not increase since 1980. However, occasionally strikingly high maxima were detected, which tended to be less pronounced in the last years (Fig. 5).

The apolar mineral oils (UV-oils) have been determined photometrically in the UV spectral region (MSZ—12750/23—76). According to some oppinions, besides the oils other organic substances absorb as well at the wave-length used in our measurements. For this reason the measured values contain certain positive error of unknown magnitude. The concentration values showed a definite increase.

Among the biological components the values of S-index (Saprobity index) practically did not change, except for insignificant variations (Fig. 5). The changes in S-index did not follow the increase in the organic matter content.

The increase in the mean value of a-chlorophill followed with considerable variations the increase in the concentrations of ammonium- and phosphate-ion, which being plant nutrients are easily taken up by the algae. The maximal values increased significantly in the last years (Fig. 5). and were measured in warm summer periods of low water.

Tendencies in water quality changes

In a series of water quality data measured during a comparatively long period components reflecting long-term trends, periodicity and randomly occurring changes can be distinguished (KÖVES—PÁRNICZKY 1986).

In the present evaluation we did not look for the causes of water quality changes and did not estimate the individual effects of different modifying factors (water output, loading, meteorological circumstances, etc.). For different consumers the resulting water quality is of a primary importance. It can be seen from the figures that the changes in the mean values are comparatively small. For this reason assuming a linear trend, the regression lines were calculated for the mean values obtained in the periods 1970—1978 and 1979—1988. With their help the annual changes were obtained and are summarized in Table 1 in percent and concentration values (because of the importance of water output, the corresponding data for this parameter are given as well).

Among the 27 parameters studied — taking into consideration the mean values obtained in the two periods — altogether in 6 cases an improvement of water quality was observed (Table 1). Thus during the whole 19-year period a deterioration of water quality occurred.

If the two periods — 1970—1978 and 1978—1988 — are considered separately, it can be seen that a considerable water quality deterioration took place in the 70s. In this period the organic mater load increased and the dissolved oxygen and oxygen saturation decreased (Because of the significant increase in COD_{sp} values in 1978—79, a decreasing tendency was obtained for both periods). The concentrations of ammonium-, nitrite- and nitrate-ions considerably increased.

In 1979—1988 period a significant increase was observed in Na% and pH values, concentrations of phosphate-ion, phenols and a-chlorophill. However, the

absolute increase of phenol concentration is negligibly small. During this period among the parameters studied 52% showed improved or unchanged water quality, 22% indicated small and 22% — a considerable deterioration (Table 2). The absolute value of the change observed for the only substantially deteriorated parameter — dissolved Mn — is insignificant (Table 1).

Changes in water quality according to the specificity of consumer

Since 1978 the biological stability of water determined on the basis of 17 frequently measured components according to the regulations (MSZ—10—172/3—85) changes steadily from I. to II. class (Table 3). The mineral components important when water is used for industrial and irrigation purposes did not change significantly, as described above. In these two fields of consumption the Tisza water was of I.

Table 1. *Measure of water quality changes in the Tisza reach at Szolnok (1970—1988)*

Component	1970—78 change %/year	1979—1988 change mg/l/year	1970—78 Mean value mg/l	1979—1988 Mean value mg/l
Water output	4,0	−7,1	−41 (m^3/s)	568	580
Total suspended mater	−8,4	−6,9	−7,5	147	108
Dissolved Fe	−3,2	−2,4	−2,4	0,22	0,10
Dissolved Mn	−8,8	9,4	0,007	0,03	0,078
Er COD_{sp}	−0,1*	−0,6	−0,04	5,97	6,68
Er COD_k	1,2*	−2,5	−0,53	19,6	21,4
BOD_5	−1,8	−2,2	−0,10	4,62	4,47
Dissolved O_2	−1,8	0,4	0,034	10,1	9,24
O_2 saturation	1,9	0,4	0,37(%)	91,4	82,9
Total alkalinity	−1,0	−0,7	−0,02	2,62	2,51
Total hardness	−1,0	−0,7	−0,68	92,5	90,5
Cl^--ion	0,3	1,5	0,5	30,5	33,4
SO_4-ion	2,5	1,3	0,7	47,6	52,2
Total dissolved matter	0,8	0,7	2,0	257	282
sp. conductivity	0,8	0,6	2,6 (uS/cm)	361	400
Na % value	2,4	3,2	0,7 (%)	20,6	23,2
pH value**	−0,8	3,4	0,007 (−)	7,38	7,57
NH_4-ion	3,7	0,6	0,006	0,74	0,95
NO_2-ion	11,5	−9,5	−0,021	0,20	0,22
NO_3-ion	4,1	−1,0	−0,08	7,2	7,6
Total N	—	−7,0	−0,31	—	4,4
PO_4-ion	−3,5*	6,0	0,012	0,13	0,21
Total P	—	−3,7	−0,011	—	0,29
Phenols	—	5,3	0,0002	—	0,004
ANA detergents	−5,6	−2,0	0,001	0,034	0,050
UV oils	—	6,5	0,018	—	0,28
S-index	−0,4	0,2	0,005 (−)	2,12	2,11
a-chlorophill	—	4,6	0,60 (mg/m^3)	—	13,0

* 1971—1978

** calculation of the measure of change: change/2,0 (the I. class range 8,5—6,5 = 2,0)

class during the whole period studied and in the near future its classification is not expected to change.

The majority of the parameters important from the point of view of fishery and drinking-water supply showed unfavourable changes. Consequently from 1976 on

Table 2. *Evaluation of water quality changes in the period 1979—1988 on the basis of MSZ 10—172/1—83*

1. Practically unchanged or improving components (n = 14, 51,9%)

total suspended matter	NO_2-ion
dissolved Fe	NO_3-ion
$erCOD_{sp}$	
$erCOD_k$	total N
	total P
BOD_5	ANA detergents
dissolved O_2	
O_2 saturation	
total alkalinity	
total hardness	

2. Slightly deteriorated components (>3%/year) (n = 6, 22,2%)

Cl^--ion	Na% value
SO_4-ion	amonium-ion
	S-index
total dissolved mater	
sp. conductivity	

3. Significantly deteriorated components (3—7%/year) (n = 6, 22,2%)

Na% value	phenols
pH value	UV oil
PO_4-ion	a-chlorophill

4. Markedly deteriorated components (>7%/year) (n = 1, 3,7%)
   dissolved Mn

Table 3. *Classification of water quality in the Tisza at Szolnok (remark: without UV oil)*

Year	Biol. stab.	Industr. water	Irrig-water	Water used in fishery	Used in drink-ingwater supply
1970.	I.	I.	I.	I.	I.
1971.	I.	I.	I.	I.	I.
1972.	I.	I.	I.	I.	I.
1973.	II.	I.	I.	I.	I.
1974.	II.	I.	I.	I.	I.
1975.	I.	I.	I.	I.	I.
1976.	II.	I.	I.	II.	II.
1977.	I.	I.	I.	I.	I.
1978.	II.	I.	I.	II.	II.
1979.	II.	I.	I.	II.	II.
1980.	II.	I.	I.	II.	II.
1981.	II.	I.	I.	II.	II.
1982.	II.	I.	I.	II.	II.
1983.	II.	I.	I.	II.	II.
1984.	II.	I.	I.	II.	II.
1985.	II.	I.	I.	II.	II.
1986.	II.	I.	I.	I.	I.
1987.	II.	I.	I.	II.	II.
1988.	II.	I.	I.	II.	II.

almost every year the quality of the Tisza water was of II. class and in these respect further deterioration is to be expected.

This is a particulary unfavourable situation, since drinkingwater supply of Szolnok and neighbouring settlements comes from the Tisza.

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A Tisza vízminőségének változása Szolnoknál 1970—1988 között

WAIJANDT J.

KÖTIKÖVIZIG Szolnok Tiszaliget

Kivonat

A Tisza folyót a Sajó torkolatától Szolnokig a tisztulás jellemzi. Szolnoknál jelentős mértékű az ipar és ivóvíz célú vízhasználat, ezért nagy jelentősége van a víz minőségének és hosszabb távú változásának. Elemzésünk során a folyó szolnoki szelvényében (335,4 fkm) heti gyakorisággal 1970—1988 közötti időszakban vett vízminták vizsgálatának eredményeit használtuk fel. A legfontosabb 27 vízminőségi komponenssel foglalkoztunk.

Bemutattuk néhány komponens évenkénti minimum-, maximum- és átlagértékeinek alakulását 1970 és 1988 között. Az átlagértékek által reprezentált vízminőség-változás mértéke nem volt nagy, összességében vízminőségromlás játszódott le. Az 1970—1978 és 1979—1988-as időszakokra vonatkozó regressziós egyenesek felhasználásával meghatároztuk a változások irányát és mértékét. Meg-

állapítható volt, hogy a nagyobb mértékű vízminőségromlás a hetvenes években játszódott le. A vizsgált komponensek 52%-a javuló vagy változatlan minőséget, 22—22%-a kismértékben, ill. nagymértékben romlott 1979 és 1988 között.

Az ipari és öntözővíz céljára a Tisza vize a vizsgálat teljes időszakában I. osztályú volt. A halgazdasági és ivóvíznyerés céljára 1976-tól általában csak II. osztályú minőséggel rendelkezett és ezen vízhasználatok szempontjából a további vízminőségromlásnak van nagyobb valószínűsége.

КАЧЕСТВО ВОДЫ РЕКИ ТИСА В РАЙОНЕ СОЛНОКА В ПЕРИОД 1970—1988

Й. Вайандт

Для отрезка Тисы между устьем Шайо и Солноком характерно улучшение качества воды. Вследствие значительного потребления воды в районе Солнока, используемой в промышленных целях и для снабжения питьевой водой, качество воды и тенденции его изменения в будущем имеют особое значение. В анализе, проведенном автором, использованы результаты измерений на пробах, бравшихся еженедельно на отрезке Тисы у Солнока (335,4 р. км.) в период 1970—1988 гг. Было исследовано 27 наиболее важных характеристик качества воды.

Показано изменение максимальных, минимальных и средних значений нескольких компонентов в период 1970—1988 гг. В этот период не наблюдалось значительных изменений качества воды, судя по средним значениям параметров, в общем произошло ухудшение качества воды. При помощи регрессионных прямых, построенных по данным, полученным в периоды 1970—1978 гг и 1979—1988 гг, были определены степень и направление изменений качества воды. Было установлено, что значительное ухудшение качества воды произошло в 70х годах. Среди исследуемых параметров 52% указывают на улучшение или отсутствие перемен, 22% на незначительное и 22% на значительное ухудшение качества воды.

В течение всего периода наблюдений качество воды Тисы соответствовало I категории в случае использования в промышленности и орошении. Однако, при применении в рыбоводстве и для снабжения питьевой водой с 1976 г. ее качество удовлетворяло требованиям лишь II категории и в этой области ожидается дальнейшее ухудшение.

Kvaliteta vode kod Solnoka u periodu od 1970 do 1988 godine

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Rezime

Drugu najveću reku Mađarske od ušće Šajo do Solnoka očišćenje karakteriše. Kod Solnoka značajna je potrošnja vode i u industrialnom i u građanskom vidu, zato je potrebno pratiti promenu kvaliteta vode i opširne promene. Prilikom analize u odseku dužine (335,4 km, Fig. 1.) nedeljno su vadili primerke u periodu od 1970. do 1988. godine. Analizirani su 27 najvažniji komponenti.

Na 2—5. slicima je prikazan godišnji min., maks. i prosećne krive nekoliko komponenata u periodu od 1970. do 1988. Prosećne krive ne pokazuju veću promenu kvaliteta vode ali u celini kvaliteta se kvario (Tab. 1.). Ovo je dokazano i sa prosećnom koncentracijom, jer su povećali kod više komponenata. Sa metodom regresije odredili su pravac i meru promene za periode 1970—78 i 1979—1988 (Tab. 1.). Veći kvar dogodilo se sedamdesetih. Izučeni komponenti u 52%-u su pokazali poboljšenje ili stagnaciju ali komponenti u 22%-u su pokazali manje ili veće kvarenje u periodu od 1979 do 1988 god. (Tab. 2.) Prema industrijalnim i meliorizacionim kriterijumima voda Tise je bila I klasa preko celog izučenog perioda (Tab. 3.). Za dobivanje vode za ribolovarstvo i za potrošnju građana kvaliteta vode ja bila II klasa od 1976. god. I dalje se može očekivati kvarenje kvaliteta vode.

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Vertretung der erdöl- und phenolabbauenden Bakterien im Theisswasser

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Resümee

Die Belastung der oberflächlichen Gewässer mit Erdöl und Phenol stellt ein bedeutendes Problem der Gegenwart dar. Da durch die methabolische Aktivität der Mikroorganismen die Selbstreinigungsprozesse von sämtlichen organischen Belastungsstoffen stattfinden, war unsere Absicht, mit dieser Arbeit das Auftreten dieser Bakteriengruppe im Theisswasser, die bedeutend für den mikrobiellen Abbau des Erdöls und Phenols ist, darzustellen.

Die zweijährigen Untersuchungen der erdöl- und phenolabbauenden Bakterien im Theisswasser zeigten das zeitweise oder dauernde Auftreten dieser Bakteriengruppen an allen untersuchten Probeentnahmestellen.

Der Anteil dieser Bakteriengruppe an der heterotrophen Population war sehr groß (38—128% für ölabbauende und 0,8—5,6 für phenolabbauende Bakterien). Das Auftreten dieser Bakterien im Theisswasser spricht über die zeitweise oder dauernde Anwesenheit von Erdöl und Phenol als Belastungsstoffe aber auch über die methabolische Aktivität der Mikroflora, die gute Möglichkeit für Selbstreinigunsprozesse im Theis darbietet.

Einleitung

Aufgrund der Untersuchung des Auftretens und der Vertretung der Bakteriengruppe, die für den mikrobiellen Abbau der Erdöl- und Phenolbelastung im Theisswasser in der Zeit zwischen 1987 und 1988 von der Bedeutung ist, wurde ihre zeitweise oder dauernde Anwesenheit an allen untersuchten Probeentnahmestellen festgestellt.

Die Zahl dieser Bakteriengruppe in der heterotrophen Population liegt sehr hoch, insbesondere der Erdölabbauenden. Das Auftreten dieser Bakterien im Theisswasser deutet auf die zeitweise oder dauernde Anwesenheit von Erdöl und Phenol als Belastungsstoffe im Theisswasser hin aber auch darauf dass die methabolische Aktivität der autochtonen Mikroflora die gute Selbstreinigunsmöglichkeit darbietet.

Material und Methode

Die Untersuchungen erfolgten im Laufe 1987 und 1988 an den 5 Probeentnahmestellen auf dem jugoslawischen Theissabschnitt. Die Wasserproben wurden auf dem 152., 105., 66., 37. und 5. km stromaufwärts von der Theissmündung in die Donau entnommen. Die Gesamtbakterienzahl wurde mittels der bakteriologischen Filtration (RAZUMOV 1932) mit bakteriologischen Filtern „Sartorius"

No. 2 festgestellt und die Zahl der aeroben Heterotrophen und lipolitischen Bakterien mit Hilfe der üblichen Zuchtmethoden. Die Vertretung und die Zahl der phenol- und erdölabbauenden Bakterien wurden auf spezifischen Nährböden festgestellt. Die erdölabbauenden Bakterien wurden auf dem modifizierten Nährboden MSWYE mit dem Oelpulver aus Erdölparaffinbase (WALKER et *al.* 1976) untersucht. Die Zahl der Bakterien, die Phenol als Nährstoffquelle verwerten wurde auf dem Nährboden aus Phenol und Bromthymolblau als dem Indikator (RALSTON und VELA 1974) bestimmt.

Ergebnisse und Diskussion

Die mikrobiologischen Analysen zeigten, daß in den meisten Proben aus dem Theisswasser die Bakterien vorhanden waren, die Erdöl und Phenol als Kohlenwasserstoff- und Energiequelle verwerten. Die durchschnittliche Zahl der Bakterienkolonien auf dem Erdölnährboden betrug im Laufe der zweijährigen Untersuchungen meistens einige Zehntausenden und seltener einige Hunderttausenden/cm³ Wasser (Abb. 1). Auf dem Phenolnährboden wurden oft keine Kolonien festgestellt oder ihre Zahl war gering und betrug einige Tausenden oder einige Zehntausenden /cm³ Wasser.

Da in den entnommenen Wasserproben auch die Gesamtzahl des Bakterienplanktons und die Zahl der aeroben Heterotrophen untersucht wurde, war es interessant die gegenseitige Beziehung dieser Bakteriengruppen mit kohlenwasserstoffabbauenden Bakterien festzustellen. Die erdöl- und phenolabbauenden Bakterien zeigten verhältnismässig geringen Anteil an dem Gesamtplankton (Tab. 1). Die erdölabbauenden Bakterien waren mit 3,7 und 22,9 Prozent) im Durchschnitt 8,1%) vertreten während der Prozentsatz der phenolabbauenden Bakterien bedeutend niedriger lag, zwischen 0,2 und 0,5 Prozent (im Durchschnitt 0,3%). Aber der prozentuale Anteil dieser Bakteriengruppe an der Population der Heterotrophen lag wesentlich höher und betrug 0,8 bis 5,6 Prozent (im Durchschnitt 1,9%) der phenolabbauenden und 38—128 Prozent (im Durchschnitt 48%) der erdölabbauenden Bakterien. Es ist bemerkbar, daß es vorkam, daß die Zahl an Bakterienkolonien auf dem Erdölnährboden größer war als die Kolonienzahl auf dem standarden Agarnährboden. Es besteht die Meinung (SELIBER 1960, ŠLEGEL 1972, GRINBERG et *al.* 1981), daß die kohlenwasserstoffabbauenden Bakterien keine eng spezifische Gruppe darstellen, sondern daß es sich meistens um die zahlreichen einfachen Formen handelt, die ganz gut auf dem standerden Nährboden gedeihen und unter unterschiedlichen physiologischen Bakteriengruppen zu treffen sind.

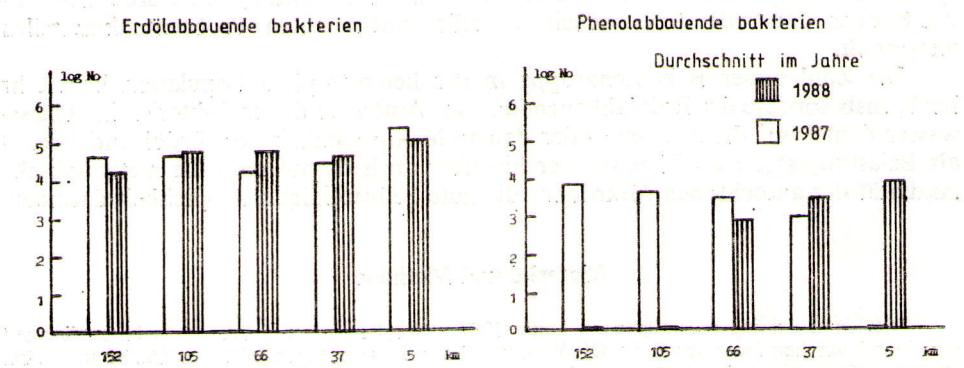

Abb. 1.

Aufgrund der Untersuchung der Mikroorganismen, der aktiven erdölabbauenden Bakterien in Gewässern von Dnjeper (KVASNIKOV et *al.* 1981) führt KVASNIKOV an, daß die Zahl der isolierten Bakterien in der direkten Abhängigkeit von der Qualität und Menge der vorhandenen erdölorganischen Stoffen im Wasser war. Nach seinen Angaben waren diese Bakterien zahlenmässig durchschnittlich mit 100—130 000/cm³ Wasser vertreten. TRŽILOVA und MIKLOŠOVIČEVA (1987) und HORSKA (1987) bewiesen experimentell die Fähigkeit der organotrophen Bakterien im Donauwasser, die Kohlenwasserstoffe zu degradieren. TRŽILOVA und MIKOŠOVIČEVA (1989) führen an, daß aus dem Donauwasser 86 Bakterienstämme isoliert wurden, die fähig sind, Erdölstoffe abzubauen.

Es ist sehr wahrscheinlich, daß die Bakterien die aus Theisswasserproben stammen und auf dem Erdölnährboden gedeihen, die Belastungsstoffe darstellen aber daß ihre Anwesenheit gleichzeitig die Selbstreinigungsprozesse ermöglicht.

Einige Autoren (BRENIL et *al.* 1978) sind der Meinung, daß eine korrelative Beziehung zwischen der Lipasebildung und dem Verbrauch des Kohlenwasserstoffes besteht, während die anderen hervorheben, daß die lipolitischen Bakterien die physiologische Gruppe darstellen, die sich aktiv an der Umwandlung der Zwischenprodukte des abbauenden Erdöls beteiligen. Sie empfehlen sie sogar als Indikatorgruppe zur Beurteilung der Wasserbelastung mit Erdöl und seinen Produkten.

Es war interessant in dieser Beziehung, in unseren Proben die durchschnittliche Vertretung der erdölabbauenden mit mit derselben der lipolitischen Bakterien zu vergleichen. Die zweijährigen Untersuchungen des Theiswassers zeigten, daß die lipolitische Bakterienflora (Abb. 2) ausgesprochen vertreten war und da der Korrelationskoeffizient zwischen diesen zwei Gruppen hoch war ($r=0{,}84$) sind wir der Ansicht, daß sie ein Zeichen für Selbstreinigungsprozesse darstellt.

Über die phenolabbauende Fähigkeit der Mikroflora des Donauwassers zeugen die Angaben einiger Autoren (JAKSCH und RYVARDEN 1980). Unsere früheren Ergebnisse (DALMACIJA et *al.* 1987) sprechen auch über die Möglichkeit der mikrobiellen Phenolbeseitigung aus dem Wasser mit Hilfe des Biosorptionsystems. Das Auftreten der phenolabbauenden Bakterien im Theisswasser an den unterschiedlichen

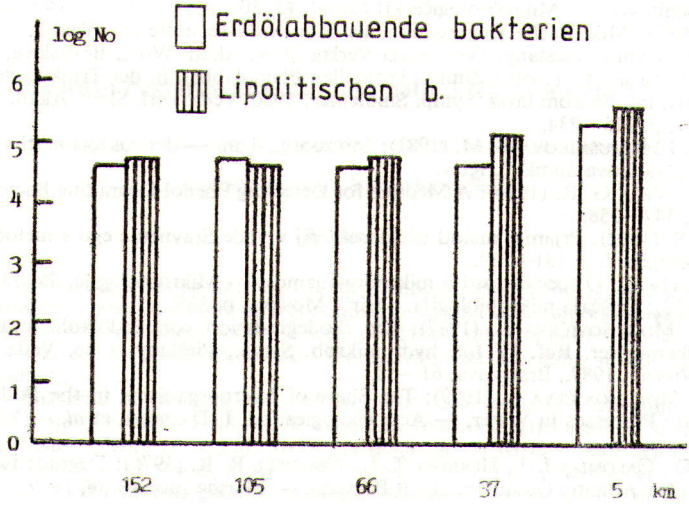

Abb. 2.

Probeentnahmestellen (Abb. 1) zeugt unserer Ansicht nach, über die Vollziehung der Selbstreinigungsprozesse.

Die zweijährige Untersuchung der erdöl- und phenolabbauenden Bakterien im Theisswasser zeigte die zeitweise oder dauernde Anwesenheit dieser Bakteriengruppe als Indikatorgruppe für Belastungsstoffe an allen Probeantnahmestellen.

Der Anteil dieser Bakteriengruppe an der Heterotrophenpopulation war sehr groß (38—128 Prozent für erdölabbauende und 0,8—5,6 Prozent für phenolabbauende Bakterien). Die Anwesenheit dieser Bakterien im Theisswasser deutet auf die zeitweise oder dauernde Anwesenheit von Erdöl und Phenol als Belastungsstoffe hin aber auch darauf, daß die methabolische Aktivität der autochtonen Mikroflora die gute Möglichkeit für Selbstreinigungsprozesse darstellt.

Table 1. *Prozentuale teilnahme der Erdöl- und Phenolabbauenden Bøakterien an der Bakterienpopulation im Theisswasser*

Bakterien-gruppen	Anteil an dem gesamten bakterien-plankton	Anteil an der popu-tation der heterot-rophen
Erdöl	8,1 (3,7—22,9)	48 (38—128)
Phenol	0,3 (0,2—0,5)	1,9 (0,8—5,6)

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A nafta és fenol oxidáló baktériumok jelenléte a Tisza vizében

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Kivonat

A naftával és fenollal szennyezett felszíni vizek jelentős problémát jelentenek az utóbbi időben. Mivel a mikroorganizmusok metabolikus aktivitása által a víz öntisztul minden szerves anyagtól, kísértük a Tisza vizében azon baktériumcsoportok jelenlétét, amelyek a naftától és a fenoltól tisztítják a vizet.

Kétéves periódus alatt a nafta- és fenolbontó baktériumok időlegesen, vagy állandóan jelen voltak a Tisza vizében, minden lokalitáson.

E baktériumcsoportok részvétele a heterotrófok populációiban nagyon nagy volt (38—128% a naftaoxidálóké és 0,8—5,6% a fenoloxidálóké) de különösen a naftaoxidálóké. E baktériumok jelenléte a Tisza vizében a nafta és a fenol időleges, vagy állandó jelenlétére mutat de arra is hogy az autohtón mikroflóra metabolikus aktivitása jó lehetőséget ad a Tisza vizének öntisztulására (autopurifikáció).

ПРИСУТСТВИЕ МИКРООРГАНИЗМОВ, ОКИСЛЯЮЩИХ НЕФТЬ И ФЕНОЛ, В ВОДЕ РЕКИ ТИСА

С. Гайни, О. Петрович, М. Матавуль, М. Гантар и Д. Раднович

В последние годы загрязнение поверхностных вод нефтью и фенолом ставит все более сериозные проблемы. Поскольку в результате процессов обмена веществ микроорганизмов происходит самоочищение воды от органических веществ, авторами было исследовано присутствие групп бактерий, очищающих воду от нефти и фенола, в реке Тиса.

В течение двухлетнего периода наблюдений временное или постоянное присутсвие бактерий, разлагающих нефть и фенол, наблюдалось в воде реки Тиса во всех точках взятия проб.

Преобладание этих групп микроорганизмов в гетеротрофной популяции было очень значительным (38—128% для нефтеокисляющих и 0,8—5,6% для фенолокисляющих). Присутствие этих микроорганизмов в воде Тисы указывает на временное или постоянное содержание в ней нефти и фенола, а также на значение метаболитной актиьности автохтонной микрофлоры для самоочищения вод Тисы.

Prisustvo bakterije koje oksidišu naftu i fenola u vodu Tise

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Rezime

Zagađene površinske vode sa naftom i fenolom dodaju nam puno problema u poslednjem vremenu. Sa metaboličnom aktivitetom mikroorganizmima svaka voda samoočišćava se od organske materije, autori su pratili one grupe bakterija, koje očišćavaju reku od nafte i fenola. Preko dvogodišnjeg perioda bakterije koje oksidišu naftu i fenola delimično ili stalno su bili prisutni u vodi Tise u svim lokalitetima.

Ove grupe bakterija su bili prisutni u većim procenama među heterotrofnim populacijama (38—128% bakt. koje oks. naftu i 0,8—5,6% koje oks. fenola) a najznačajniji su ipak one, koje oksidišu naftu. Prisustvo gore pomenutih bakterija dokazuje da nafta i fenol delimično ili stalno su prisutni u reci Tise. S druge strane, prisustvo tih bakterija ukazuje da metabolični aktivitet autohtonske mikroflore donesi dobar mogućnost za samoočišćavanje vode (autopurifikacije).

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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

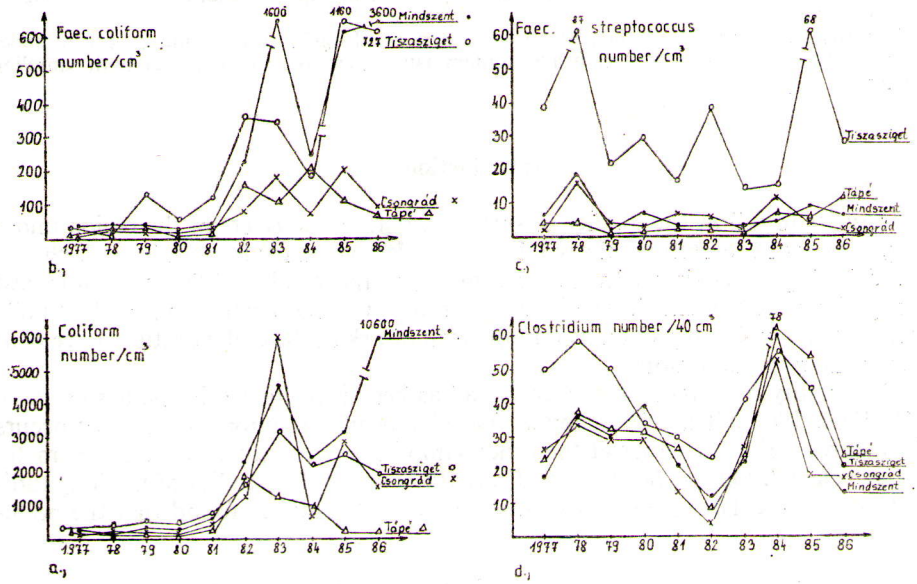

Fig. 1. Results of bacteriological investigations (meanvalues)

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.

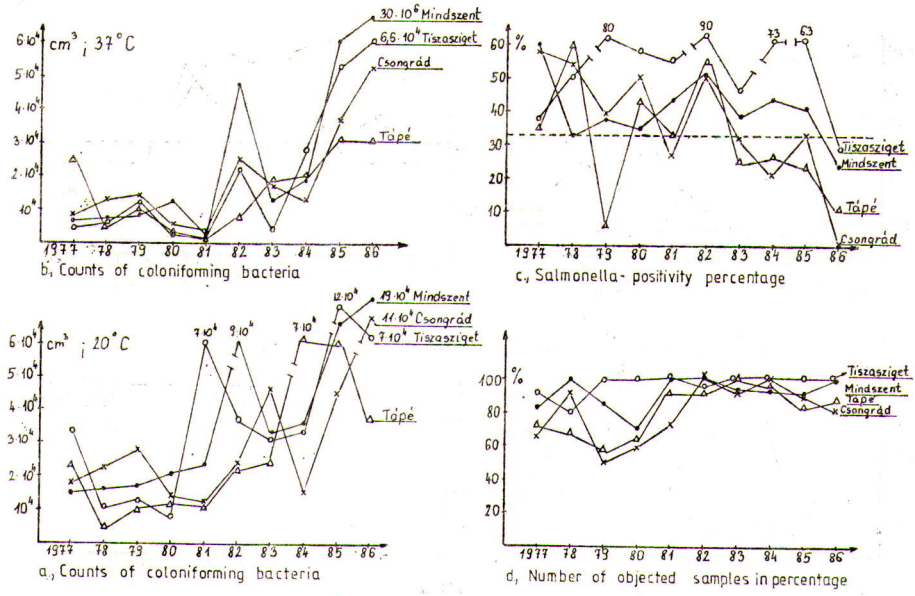

Fig. 2. Results of bacteriological investigations (meanvalues)

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,

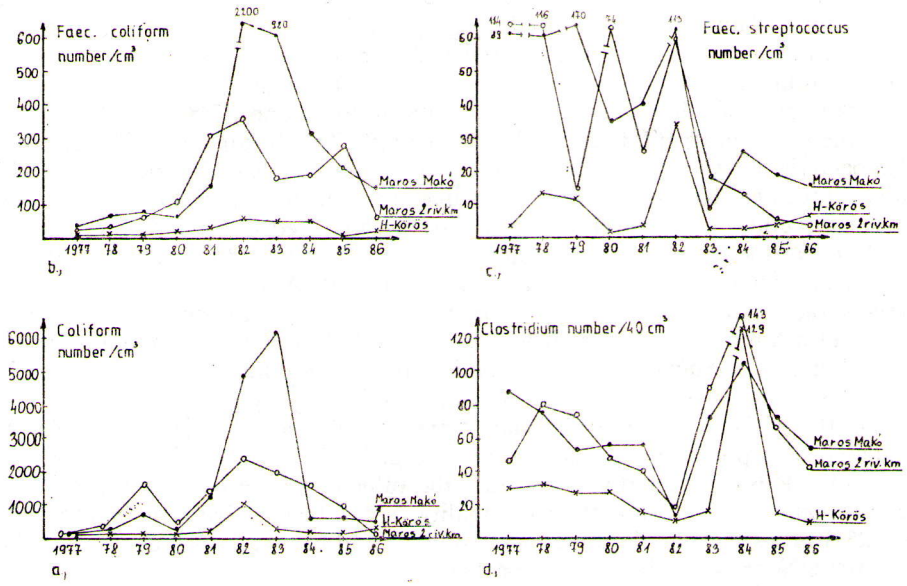

Fig. 3. Results of bacteriological investigations (meanvalues)

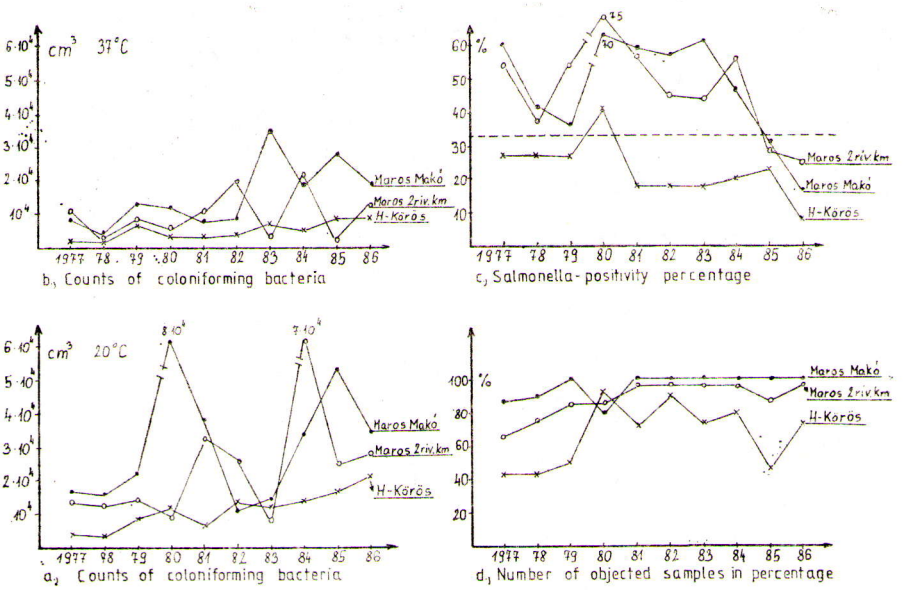

Fig. 4. Results of bacteriological investigations (meanvalues)

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

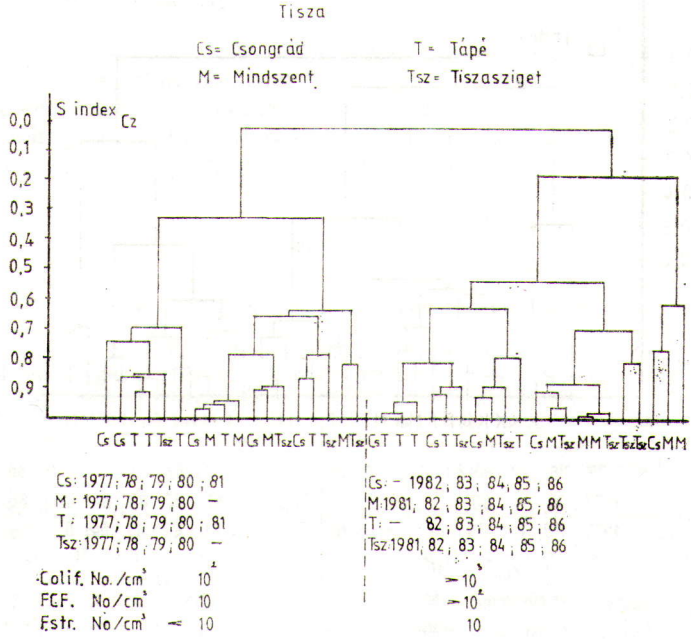

Fig. 5. Characterization of the water quality of the Tisza river by dendrogram prepared with "cluster"-analysis

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,

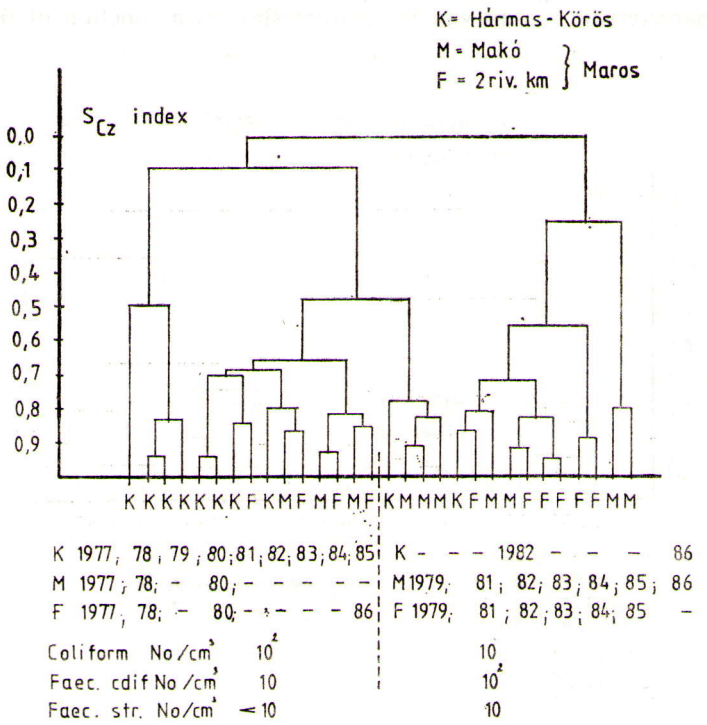

Fig. 6. Characterization of the water quality of the river Maros and Hármas-Körös by dendrogram prepared with "cluster"-analysis

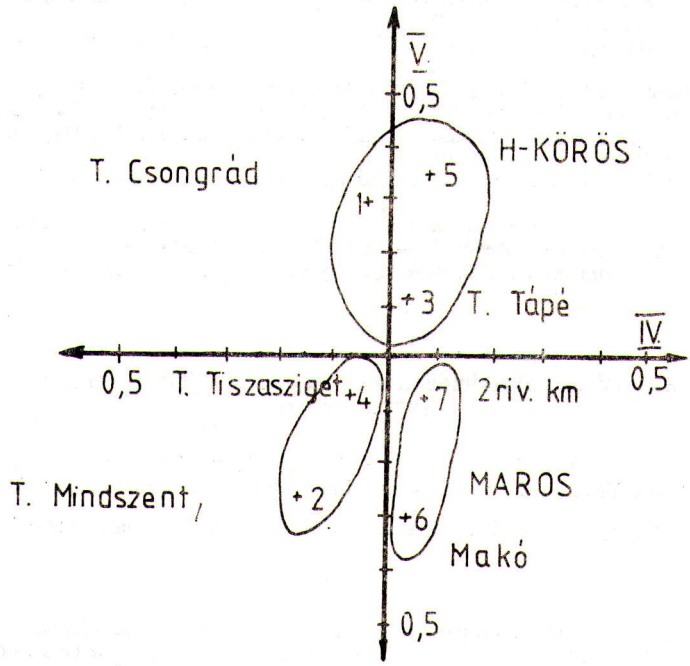

Fig. 7. The groups of related sampling points by centroid analysis

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.

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HYDROECOLOGICAL RELATIONS OF LITTORAL, MARSH AND MEADOW ASSOCIATION AT BODROGZUG

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(Received october 23, 1989)

Abstract

In the flood-plain of the Hungarian Upper-Tisza stretch, at the junction of the Tisza and Bodrog, the composition of vegetation cover of Bodrogzug, formed in the Tokaj-region differs significantly from that found in other locations of the Tisza flood-plain. This can be attributed in the first place to the mountain effect, and to the diversity of soil and hydroecological conditions. The southern region of the flood-plain converted into a nature conservation area is under environmental stress effect of damming. As a consequence large areas became occupied by *Scirpo-Phragmitetum* at the expense of other cenoses. In the middle and lower stretches due to mineralogen and biogen filling up the river-beds of dead-arms have been occupied by *Sparganio-Sagittarietum, Rorippo-Oenanthetum,* at places by *Glycerietum maximae* replacing hydatophyton associations. Propagation of *Caricetum gracilis* subassociation units was observed as well.

In degraded moist habitats mud vegetation of *Eleocharito-Schoenoplectetum supini* could be found.

In the middle and upper regions of Bodrogzug vast marshy green field developed. At another places of higher moisture content *Carici melanostachyae—Alopecuretum pratensis,* on higher reliefs *Lythro virgatae-Alopecuretum* played a subordinate role as compared to other locations of the Tisza flood-plain. In drier places *Poo angustifoliae—Alopecuretum* vegetation has been plough up. In moist places used for intensive grazing *Lolio—Potentilletum anserinae,* at places *Lolio-Alopecuretum pratensis* pastures developed.

Introduction

From the point of view of its vegetation cover Bodrogzug is one of the most valuable regions of the Tisza flood-plain. Due to its geographical position, under the mountain effect (SIMON 1950, 1960) its mesoclimate is cooler, richer in precipitation. However, the Tisza barrage damming significantly affected the habitat, in the first place the hydroecological relations. The repeated inundations of the Tisza and Bodrog and the Tisza flood-plain led to formation of stable dead-water patches in low reliefs. On high-lying areas the indigenous vegetation survived, and at present, with the establishment of the nature conservation area its preservation seems guaranteed.

The studies of the region began with the phytocenological investigations of ÚJVÁROSI (1940). Synecological investigations have been carried out since 1960 with shorter or longer intermissions (BODROGKÖZY 1962, 1982, 1985). This enabled a comparative analysis of the effect of changing hydroecological conditions on meadow associations. The results obtained were useful from nature conservancy point of

view as well, contributing to establishing of Tokaj—Bodrogzug Nature Conservation Area.

The introduction of nature conservancy regulations was essential, since in the beginning of the 80s the water-supply management urged building of a storage lake in this low-lying region. At present this plan has been ultimately rejected. The nature conservancy status of the area enables continuous complex hydrobiological and biogeocenological investigations, registration of seasonal dynamics changes and analysis of existing interactions in these specific ecosystems formed at the border of the Great Hungarian Plain and Central Highlands, and parallel to this a comparative analysis of meadow associations found in other locations of the Tisza flood-plain, as well as following the long-term changes, too.

Materials and Methods

In the framwork of the programme, parallel to the preparation of littoral, marsh and meadow cenosis tables, registration of existing soil and hydroecological conditions, their changes in time, as well as the prediction of future developments are of outmost importance. For this purpose, similarly to investigations carried out in other locations, species components belonging to the most wide-spread associations and smaller subassociation units found in this region were assigned to hydroecological categories. In order to establish the differences in soil ecological relations as compared to other flood-plain locations, soil analyses have been performed for several associations as well. The interdependence of these factors has been emphasized by several authors (SIMON 1960, WESTHOFF 1969).

Determination of moisture requirements of plant species and associations has been analysed by ELLENBERG (1952), as a reflection of the Western-European, and in the first place Atlantic influence, in the Hungarian relation the assignment corresponding to the continental effect and determination of W-values has been performed by ZÓLYOMI et *al.* (1967). Soó presented F-values for several plant species (1964—1970).

The generally applied ELLENBERG system, as well as the assignment based on moisture requirements used in the Hungarian relation as suggested by Soó and ZÓLYOMI et *al.* needed further refinement. Thus, within 10 hydroecological categories 30 subgroups could be distinguished (BODROGKÖZY 1985). For easier and faster survey graphical presentation of the data was deemed suitable (See Figs. 1—16). For simplification the names of different categories are given in abbreviated form. The subgroups are indicated by numbers. In the figures subgroups 1 and 3 indicate the transition to the preceeding or following category, while subgroup 2 marks the typical plant species in the particular category.

The hydroecological charts of different cenoses can be drawn only after the hydroecological curves of their species components are constructed. They are used for assignment to different subgroups. Since in the region studied no species living in extremely dry conditions were observed, the 10th category, i.e. steno xerophyta are not present. Among the smaller units within different associations only those reflecting preceeding, present or predictable future relations of cenosis succession have been analysed.

The importance of hydrobiological investigations from the practical point of view has been emphasized by SZALAY (1957).

Results and Discussion

Permanent dead-arms

In the first place of interest were the hydatophyta associations of the extended dead-arms like Fekete-tó and Nagy-tó, i.e.

Salvinio-Spirodeletum
Hydrochari-Stratiotetum
Potamogetonetum lucentis
Nymphoidetum albo-luteae

Trapetum natantis formed a mosaic complex with the above mentioned phytocenoses. Here they are not analysed in details. Cenosystematical classification of marsh and marshmeadow associations in Bodrogzug.
(Compiled on the basis of the Soó-system)

CYPERO—PHRAGMITEA Soó 68
PHRAGMITETEA Tx. et Prsc. 42
PHRAGMITETALIA W. Koch 26

Phragmition communis W. Koch 26

Sparganio-Sagittarietum Tx. 53
— — *myriophylletosum spicatae*
— — *sparganietosum erecti* (=typicum)

Scirpo-Phragmitetum austro-orientale Soó 57
— — *oenanthetosum aquaticae*
— — *phragmitetosum* (=typicum)
— — *caricetosum gracilis*

Rorippo-Oenanthetum aquaticae (Soó 27) Lohm. 50
— — *oenanthetosum aquaticae*
— — *caricetosum gracilis*

Glycerietum maximae Hueck 31
— — *oenathetosum aquaticae*
— — *glycerietosum* (=typicum)
— — *caricetosum gracilis*

NASTURTIO-GLYCERIETALIA Br.—Bl.25

Glycerio-Sparganion Br.—Bl. et Siss. 42

Sparganio-Glycerietum fluitantis Br.—Bl.25
— — *glycerietosum fluitantis* (=typicum)
— — *agrostetosum stoloniferae*

ISOETO-NANOJUNCETEA Br.—Bl.43
NANOCYPERETALIA Klika 35

Elatini-Lindernion Soó 71

Eleocharito acicularis—Schoenoplectetum supini Soó et Ubr. 48
— — *myriophylletosum spicati*
— — *eleocharetosum acicularis*
— — *agrostetosum stoloniferae*

BOLBOSCHOENETALIA Soó 62

Bolboschoenion maritimi continentale Soó 47

Polygono-Bolboschoenetum maritimi Bodrk. 62

MAGNOCARICETALIA Pign. 53

Caricion gracilis Neuhausl. 57

Caricetum gracilis (GRABNER et HUECK 31) TX. 37
— — *glycerietosum maximae*
— — *caricetosum gracilis* (= typicum)
— — *agrostetosum stoloniferae*
Caricetum acutiformis — ripariae (SOÓ 27/30)
— — (typicum)

MOLINIO-ARRHENATHEREA SOÓ 68
MOLINIO-JUNCETEA BR.—BL. 49
MOLINIETALIA W.KOCH 26

Deschampsion caespitosae HORVATIĆ 30

Agrostio—Typhoidetum SOÓ 71

Alopecurion pratensis SOÓ 71

Carici melanostachyae—Alopecuretum pratensis SOÓ 71
— — *caricetosum gracilis* (= typicum)
— — *agrostietosum stoloniferae*
— — *alopecuretosum pratensis*

Lythro virgatae—Alopecuretum pratensis BODRK. 62
— — *alopecuretosum pratensis*
— — *lythretosum virgatae* (typicum)
— — *agropyretosum repentis*

Poo angustifoliae—Alopecuretum pratensis BODRK. 62
— — *alopecuretosum pratensis*
— — *poëtosum angustifoliae* (= typicum)
— — *trifolietosum repentis*

ARRHENATHERETEA BR.—BL. 47
ARRHENATHERETALIA PAVL. 28

Arrhenatherion elatioris BR.—BL.25
Pastinaco—Arrhenatheretum elatioris (KNAPP 54) PASS. 64

CHENOPODIO-SCLERANTHEA SOÓ 71
BIDENTETEA TRIPARTITAE BR.—BL. et TX. 43
BIDENTETALIA BR.—BL. et TX. 43

Bidention tripartitae NORDH. 50
Bidentetum tripartitae (KOCH 26) LIBBER 32

PLANTAGINETEA MAJORIS TX. et PRSG. 50
PLANTAGINETALIA TX. (47) 50

Agropyro-Rumicion crispi NORDH. 40

Lolio-Potentilletum anserinae KNAPP 46.
— — *potentilletosum anserinae*
— — *lolietosum perennis* (= typicum)

Lolio-Alopecuretum pratensis BODRK. 62

Detailed analysis of the essential associations of the Bodrogzug flood-plain.

Sparganio-Sagittarietum Tx. 53

As a consequence of mineralogen and biogen filling up the littoral vegetation of older dead-arms penetrated deeply in the river-bed. At places it was restricted to wider or narrower river-side strips of the dead-arms. Under the effect of damming at Tiszalök mainly in the southern part of Bodrogzug they occupied the regions covered with helophyta as well. Otherwise the composition of the association is very similar to that of hydatohelophyta in other locations of the Tisza flood-plain ÚJVÁROSI (1940), HEJNY (1960), BODROGKÖZY (1965, 1976, 1982), TIMÁR (1950), TIMÁR and BODROGKÖZY (1959).

At the same time upon comparison with the descriptions of the association found in other parts of Europe (WESTHOFF et *al.* 1969) it could be seen that a number of similarity markers existed.

The stands were located in the strip of the littoral zone adjasent to water, often forming mosaic complexes with Lemno-Potamogetonetea cenosis. At places a transition between them was observed. Subassociation units:

Sp.—Sa. myriophylletosum spicati

At places of increased filling up transitional cenoses developed. Their differential species are: *Myriophyllum spicatum, Ceratophyllum demersum, C. submersum, Utricularia vulgaris,* at places *Stratiotes aloides.* In some drying out river-bed stretches of the dead-arms, having, however, fresh soil even in the autumn, propagation of *Myriophyllum spicatum* forma terrestris was observed.

Soil ecology. The laboratory analysis of the soil segment of this association probed in the autumn period showed that the lake and its surroundings had taken on a marshy character. Namely, in spite of the prolonged oxydation process the content of organic mater in the *A* level of the soil segment exceeded 7%. The total content of salts was high, though even in the *A*-level it did not reach the lower limit for alkalinity of 0,1%.

Hydroecology. The covering quota of its species components was the highest in the transitory subgroup of hydato-helophyton category (hhe1), but the quota of hydatophyta (hd3) was significant, too.

Sp.—Sa. sparganietosum erecti (= typicum)

The subassociation occupied the zona stretch adjacent to the bank. Its differential species originated from Phragmitetea elements, like *Sagittaria sagittifolia, Oenanthe aquatica, Butomus umbellatus.*

Hydroecology. The two subassociation units can be clearly distinguished from hydroecological point of view as well. Namely, in the latter beside the invariably dominant hhe1 not hd3, but rather hhe3 representatives reached a significant quota-value (Fig. 1).

Scirpo-Phragmitetum austro orientale Soó 64

Phragmitetalia is widely spread all over Europe. Several authors worked on its cenosystematics (BOER 1942, WESTHOFF et *al.* 1969). In the relation of Hungary the work of Soó (1964—1980) provides an overview.

In the region studied it was found in the littoral zone of the dead-arms, at some distance from the river-beds. A high variability of its stands' appearance was observed, depending on the character of adjacent vegetation as well. It can be found often in the immediate proximity of *Sparganio-Sagittarietum* described above, or forming

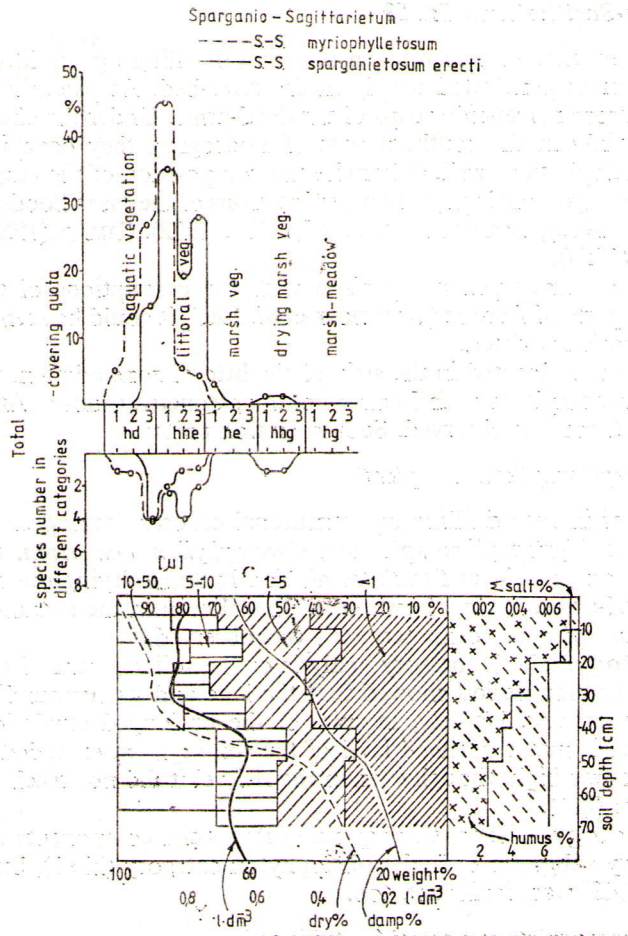

Fig. 1. Soil segment of two subassociations of *Sparganio-Sagittarietum* and *myriophylletosum*

a mosaic complex with it. It was not unfrequent that in cases of drying out due to filling up of dead-arms, or drainage, it formed complexes with *Myriophyllo-Potamogetonetum* or *Nymphaeetum albo-luteae*. From all this follows that several variants of *Scirpo-Phragmitetum* can be distinguished.

An indication for previously existing marsh habitat relations, is the fact that occasionally even species like *Ranunculus lingua, Carex vesicaria* could be observed, which are almost nonexistant in the southern region of the Tisza flood-plain. Widespread, essential variants:

Sc.—Phr. oenanthetosum aquaticae

Cenological relations. Soó (1957) assigned it to *Oenanthetum aquaticae*. In the low-lying reeds Lemno-Potamea species, like *Lemna minor, Nymphaea alba, Stratiotes aloides* were present, however, still the higher values of the covering quota

were reached by the representatives of Phragmitetea, such as the differential species *Oenanthe aquatica* and *Butomus umbellatus*.

Hydroecology. The changes caused by lengthening of inundation periods brought by damming of the barrage in the inner regions of the littoral zone are reflected in the constructed chart. It is valid in the first place for the lower region of Bodrogzug. Namely, here hydatophyta reached the total covering quota of 15%. Here the representatives of hhe category outnumbered those belonging to the transitory hel subgroup. The typical helophyta did not find yet their essential conditions.

Sc.—Phr. phragmitetosum (= typicum)

Cenological relations. It formed the second biggest zona region. Under the effect of damming, in the first place in the southern parts, the marsh-zone has been occupied by reeds. Thus, beside *Phragmites* and *Typha* species *Rorippa amphibia, Carex gracilis* were found in the lower grass level. Lately a drainage system has been built up for fast outlet of flood waters, which led to disappearance of Lemno-Potamea and Nymphaeion elements from the association.

Hydroecology. The changing hydrobiological conditions caused a significant shift as compared to the variant described above. The total covering quota of species components assigned to hidatohelophyton category (hhe2, 3) is surpassed significantly by the transitory hel subgroup.

Sc.—Phr. caricetosum gracilis

Cenological relations. This variant developed in the areas where the sedge zone was only partially occupied by reeds. Beside *Carex gracilis, Lathyrus palustris* and *Mentha arvensis* are its differential species.

Hydroecology. The transitory character of its stands from littoral vegetation zone to marsh zone is reflected in the constructed chart. It can be seen that the covering quota for the species decreased to the same extent as was the increase for the hel species (Fig. 2).

Rorippo—Oenanthetum aquaticae (Soó 27) Lohm. 50

The association has been described first by Soó (1927), its final nomenclature being published by Lohmeyer (1950). Though not very wide-spread, still it has been observed more often in the region studied as compared to other locations of the Tisza flood-plain. In general it appeared at places where reeds were missing from the littoral vegetation zone. Since its stands can tolerate without damages even prolonged inundations, some representatives of Lemno-Potamea could be found in its cenoses; in the first place *Myriophyllum spicatum, Hydrocharis morsus-ranae.* Its species composition is extremely poor. Character species are *Oenanthe aquatica, Rorippa amphibia.* Subassociation units:

R.-Oe. oenanthetosum aquaticae (= typicum)

Cenological relations. In its cenoses above the river-bed zone Lemno-Potamea species can be considered as differential elements, beside them *Oenanthe aquatica,* some Phragmitetea species like *Schoenoplectus lacustris, Iris pseudacorus* are present; *Eleocharis palustris* belongs already to Molinio-Juncetea.

Its hydroecology can be characterized by the dominant role of hydato-helophyta comprising the littoral zone. All the three subgroups (hhe1, 2, 3) are represented in its species components.

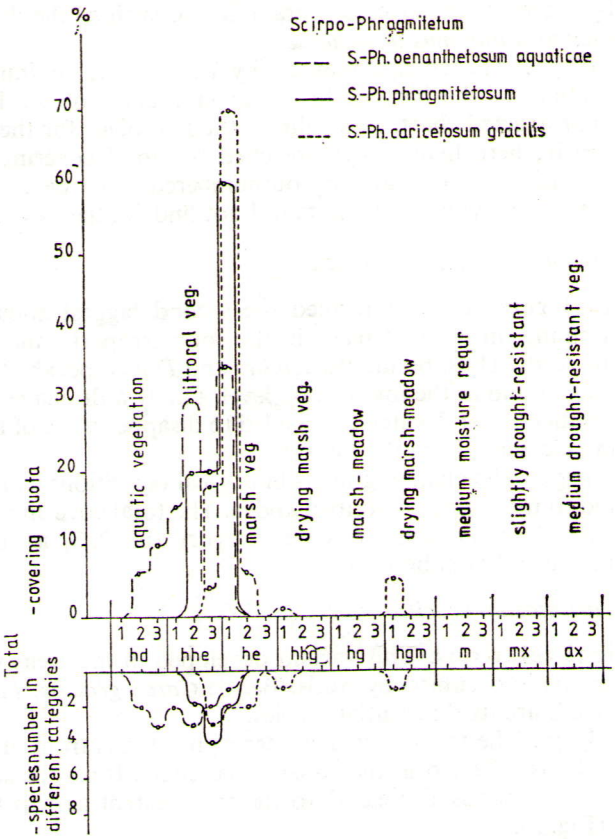

Fig. 2. Hydroecology of subassociation units of *Scirpo-Phragmitetum*

R.-Oe. caricetosum gracilis

Its differential species are: *Carex gracilis, Rorippa amphibia.* The stands forming this vegetation zone show transition towards the marsh zone.

Glycerietum maximae HUECK 31

Its cenoses are wide-spread, and are frequently found in the vegetation of the Tisza flood-plain. Thus, they are often observed in the region studied, and formed the next stretch of the littoral zone. It often replaced reeds. It formed extended stands mainly in the filled up river-beds of dead-arms. This is the explanation for the significant variations in species composition of its cenoses. Three very characteristic subassociations could be distinguished:

Gl. m. oenanthetosum aquaticae

Cenological relations. This is a relatively rare variant found in the upper regions of Bodrogzug, where the duration of the inundation effect is shorter, and it can be considered as a variant of *Glycerietum* pionir, which penetrates the river-beds of dead-arms. It often gets into contact with *Sparganio-Sagittarietum* cenoses.

Phragmitetea elements are dominant in species composition. At places it formed mosaic complexes with Scirpo-Phragmitetum.

Differential species: *Oenanthe aquatica, Schoenoplectus lacustris, Sagittaria sagittifolia.*

From hydroecological point of view it can be characterized by transitory hydatophelophyta (hdl) having covering quota above 10%. The highest quota is reached, however, by species components belonging to hhe3 subgroup. For further details see Table 3.

Gl. m. glycerietosum maximae (= typicum)

Cenological relations. This is the most wide-spread stand of the association, with a number of species somewhat higher as compared to the variant described above. Among species components beside Phragmitetea elements Caricion and Molinio—Juncetea species were found as well. Due to their tolerance characteristics, though their quota is still low, they succeeded in finding their essential conditions. In places close to reed zone *Phragmites australis* showed a significant expansion.

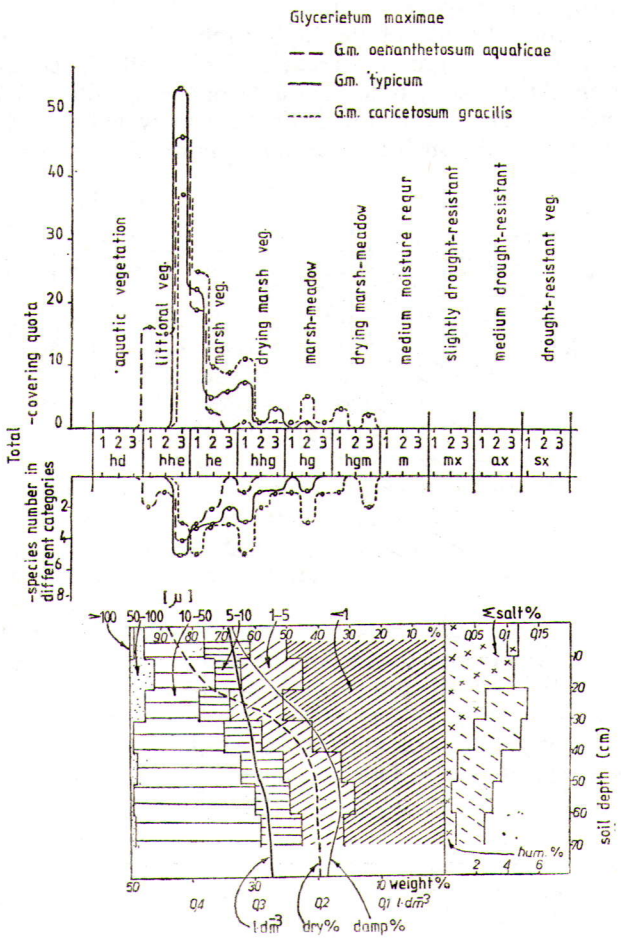

Fig. 3. Hydroecology of *Glycerietum maximae*; typicum soil segment in spring aspect

Hydroecology. Since the duration of inundation in early summer is shorter as compared to the previous variant, the effect of moisture supply on the distribution of species components is evident. This is reflected by the absence of hydatophyta. Similarly, the representatives of hhe1, 2 subgroup were missing, too. The highest covering quota in the subassociation was observed for hhe3 subgroup and reached 50%. The high values observed for he1 were caused by propagation of *Phragmites australis*. The species quota showed a steady decrease towards further hydroecological categories; *Lythrum salicaria, Veronica scutellata* and *Lycopus europaeus* belonged to hhg1 (Fig. 3).

Gl. m. caricetosum gracilis

Cenological relations. This is the most extensively spreading variant in the upper part of the region studied. This change brought by the last dry climatic period was at the expense of the typical variant of the association. The expansion of Carex variant have been going on for years.

Differential species are: *Carex gracillis, Myosotis palustris, Juncus inflexus.*

Hydroecology. The above conclusions are reflected in the chart constructed for the subassociation. Because of the higher relief the species components total covering quota in the hhe3 group decreased significantly in comparison with its typical association. At the same time the quota of the transitory he1 species of the marsh-zone increased. The decreasing moisture supply led to the appearance of hygro-mesophyta (hgm1, 3), such as *Mentha arvensis, Polygonum lapathifolium* in the stand.

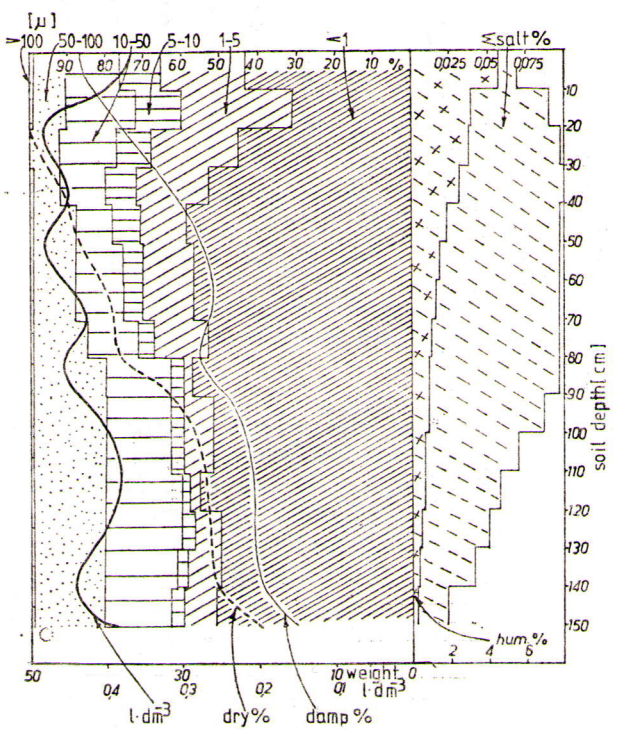

Fig. 4. Soil segment of *Oenanthe aquatica* subassociation in autumn aspect

Comparative soil ecological characteristics of the association

The laboratory analisys of soil segments probed in early summer in the habitat of different variants showed significant differences (Fig. 4).

In case of the typical variant the formation of the physical structure of the soil was related to the changes in the hydrological state. The changes in the total content of harmful salts expressed in percent here as well was an indication of the danger of later soil alkalization; though here the alkalization did not reach yet the dangerous limit of 0,10%. The diluting effect of the favourable water supply, protected the vegetation from damages, and halophyta did not appear yet in the cenoses.

The soil segment probed in the habitat of *Carex gracilis* variant was different. Binding relations were similar but the moisture content decreased, the salt content reached 0,1% and increased with depth. The concentration of the saline solution was, however, still low and could not ensure at present the appearance of less competitive halophyton elements, due to the competition effect of glycophytons.

Sparganio — Glycerietum fluitantis Br.—Bl. 25

This association is found when moving away from the littoral zone of the dead-arms and is not too frequent. Depending on the relief here as well significant differences were observed. Usually Phragmitetea elements, which could survive the dry summer periods, prevailed. In these cenoses everywhere a dominant role was played by *Glyceria fluitans*. The propagation of *Glyceria maxima* indicated the effect of the association bearing similar name. The same is valid for the propagation of *Oenanthe aquatica* observed at places. They all belonged to Phragmitetea elements. Two sub-association units could be distinguished:

Sp.-G. f. glycerietosum fluitantis (= typicum)

Cenological relations. As far as the species composition of its cenoses is concerned, as a consequence of increasing dryness they replaced *Sparganio-Sagittarietum*. Relict species like *Oenanthe aquatica, Butomus umbellatus* and *Alisma plantago-aquatica* could be considered as differential ones.

Hydroecology. The total covering quota of the relict species of the littoral zone contributed to the percentage value of hydato-helophyta. The species belonging to the three subgroups (hhe1, 2, 3) of the category taken together reached 30%. The representatives belonging to the transitory subgroup (he3) of the marsh zone had a remarkably high quota-value. However, none of the species components of its cenoses could be found in the drying marsh zone. Its cenoses were extremely poor in number of species.

Soil ecology. In order to detect the changes ocurring in the soil composition and moisture content during the vegetation period, soil segment has been probed in the autumn aspect. In the analysis of changes in moisture content, in the first place data expressed as volume weights provided reliable estimations. According to the data the vegetation cover utilized the moisture content of the soil up to depth of 30 cm. The binding relations, organic mater and salt content were similar to those observed for the previous association.

Sp.-G. f. agrostetosum stoloniferae

Cenological relations. The number of species components representing Phragmitetea decreased. Elements belonging to Molinietea and Agropyro-Rumicion came into prominence. The habitat relations manifested in the first place in a higher-

lying relief as compared to the previous variant were suitable for the propagation of *Agrostis stolonifera* and appearance of *Lythrum virgatum, Mentha arvensis* and even *Stellaria graminea* in the cenoses.

Hydroecology. It was characterized by the decrease in covering quota of the species components of both littoral and marsh zones and by increase of the values for drying marsh zone (hel, 3). At the same time single representatives of hgm and even m categories could be found.

Eleocharito acicularis — Schoenoplectetum supini Soó et Ubr. 48

It developed on the devastated patches of the filled up dead-arms of Bodrogzug, forming a wider or narrower mud vegetation zone. It had a wide range of possible occurrence from river-beds drying out in summer up to drying out marsh zone. Some of the representatives of its phytocenoses were relict species belonging to cenoses existing before the devastation, e.g. Phragmition—Phragmitetea elements. In the vegetation of diversified composition several subassociation units could be distinguished. Three of them are analysed in details:

E. a.-Sch. s. myriophylletosum spicati

Cenological relations. This mud vegetation variant penetrated in the deepest parts of the dead-arms river-beds, where Lemno-Potamea, Phragmitetea and Nanocyperion elements formed mosaic complexes. The differential species *Myriophyllum spicatum* (20%) and *Eleocharis acicularis* (30%) had a dominant role.

Hydroecology. Although it reached the highest covering quota in the transitory drying marsh zones (hhel), the total covering quota of hydatophyta (hdl, 3) was significant as well (30%). Among the latter *Myriophyllum spicatum* f. *terrestris* and *Trapa natans* f. *terrestris* were present. *Oenanthe aquatica* and *Alisma plantago-aquatica* were found among hydato-helophyta; helophyta were represented by *Lymosella aquatica, Galium palustre.* Among the representatives of mud vegetation the leading role belonged to *Eleocharis acicularis* from the hhgl subgroup (Fig. 5).

E. a.-Sch. s. eleocharietosum acicularis (= typicum)

Cenological relations. In comparison to the mud vegetation variant described above this variant is found in the devastated areas of the zone proximal to dead-arms banks and showed a significant species composition diversity. The differential species were: *Veronica beccabunga, Gnaphalium uliginosum.* The covering quota of its characteristic species increased and Lemno-Potamea and Nymphaeion elements were missing.

Hydroecology. Here the transitory helo-hygrophyta (hhgl) reached the highest total covering quota in the typical cenoses but there was a significant presence of helophyta (hel) as well.

E. a.-Sch. s. agrostetosum stoloniferae

Cenological relations. The initiation of succession towards marsh meadows is observed in the bank-side stretch of the mud vegetation zone and on the devastated patches of flat marsh meadows. The environmental hydrological conditions prevailing here are already favourable for the appearance of some Molinio—Juncete elements as well.

Its differential species are *Agrostis stolonifera, Juncus compressus* and *Gratiola officinalis.*

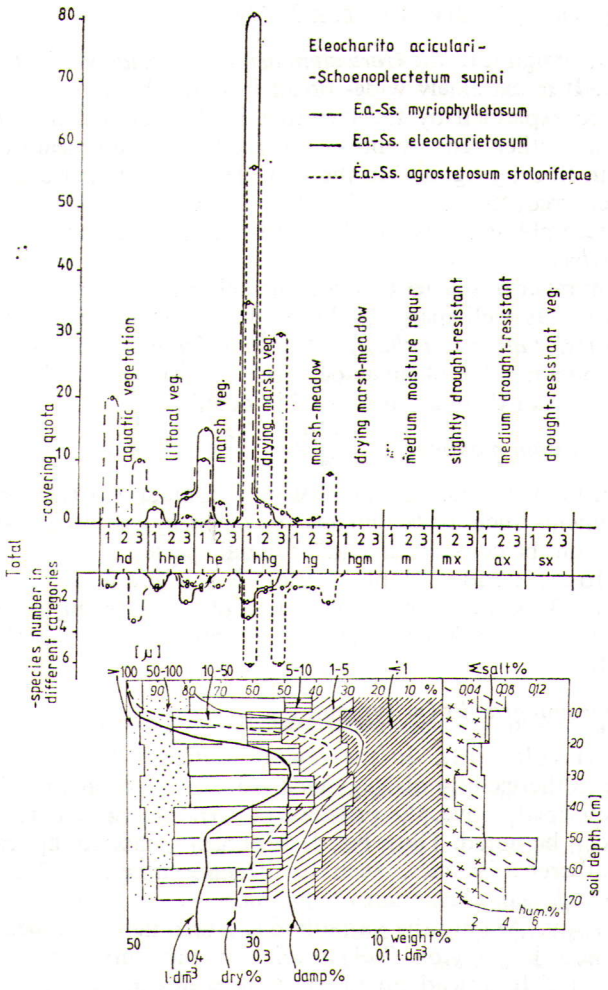

Fig. 5. Hydroecology of subassociation units of *Eleocharito-Schoenoplectetum*. Soil segment of *Myriophyllum* subassociation in spring

Hydroecology. As a consequence of reduced water supply the covering quota of its species components in respect of both species number and covering quota was distributed within hydato-helophyton category (hhg1 and hhg3), mainly through propagation of *Agrostis stolonifera, Veronica beccabunga, Rorippa armoracioides*. Within the hygrophyton category (hg1, 2, 3) propagation of *Polygonum hydropiper, P. mite* and *Ranunculus repens*.

Polygono-Bolboschoenetum maritimi BODRK. 62

It appeared partly in the dead-arm and partly in the flat marsh zones, when the content of harmful salts in the soil *A*-level exceeded 0,1%. Both from soil ecological and hydroecological point of view nearly identical results were obtained in the regions of Bodrogzug and Alpár. The detailed analysis of this association and its smaller units is presented by BODROGKÖZY (1962).

Caricetum gracilis (GRÄBER et HUECK 31) Tx. 37

Some authors assign it to the *Caricetum acuto-vesicariae* W. KOCH 26 cenosystematical category. It is extremely wide-spread in damp habitats of the Tisza flood-plain. This can be explained by the fact that in the flood-plain conditions it can tolerate better than other sedge cenoses the mud and mud-meadow soils poor in nutrients. Since in Bodrogzug, and in the first place in its upper areas drying out of sedge habitats occurred, they were replaced by *Caricetum acutiformis* cenoses. Thus, several variants resambling reeds could be distinguished. Other sedge cenoses could be traced up to *Glycerietum* zone.

Although a number of species components belonging to Phragmitetea was found in its cenoses, here as well many Molinio—Juncetea elements occurred, such as *Eleocharis palustris, Lathyrus palustris, Leucanthemum serotinum.* In the analysis of their distribution a number of subassociations and variants could be distinguished. In what follows three of them are discussed in details:

C. gr. glycerietosum maximae

Cenological relations. Its cenoses were in contact with *Glycerietum maximae.* Phragmitetea elements such as *Iris pseudacorus, Stachys palustris, Glyceria maxima* dominated and could be considered as differential species.

Hydroecology. Beside helophyta (hel) a significant quota of littoral zone representatives (hhe3) was observed. The quota of some drying marsh components (hhg1) such as *Lathyrus palustris, Lythrum salicaria* due to their broad tolerance range exceeded 10%.

C. gr. caricetosum gracilis (= typicum)

Cenological relations. In the region studied it formed extended stands, in the first place in the vicinity of Nagynádas-tó. If compared with the composition of the variant described above, the presence of species components indicating more arid conditions can be noted. Thus, beside Molinio—Juncetea, appear Molinietalia, Molinio-Arrhenatheretea species, such as *Mentha arvensis, Trifolium hybridum, Symphytum officinale* ssp. *uliginosum.*

Hydroecology. Among the variants described, here the species components reached the highest helophyton (hel) total covering quota, but within different categories they could be traced up to hygro-mesophyta. *Polygonum amphibium* f. *terrestris* appeared as a hgm1 component (Fig. 6).

C. g. agrostetosum stoloniferae

Among the variants distinguished within the association, it occupied the highest-lying relief, thus the water supply is decreased. Although the species components of the above two variants having a broad range of tolerance were present in these cenoses as well, new components were present, too, and could be considered as differential species. These were partly Molinio—Arrhenatherea representatives, such as *Trifolium hybridum,* and partly Plantaginetea elements like *Inula britannica.* The latter together with *Cirsium arvense,* belonging to Chenopodio-Scleranthea, indicated the beginning of weed overgrowth.

Hydroecology. From the constructed chart it can be seen that the total covering quota of the marsh species components further decreased and was only 40%. At the same time increased the expansion of helohygrophyta (hhg1, 3) and they could be traced on the chart up to mesophyta.

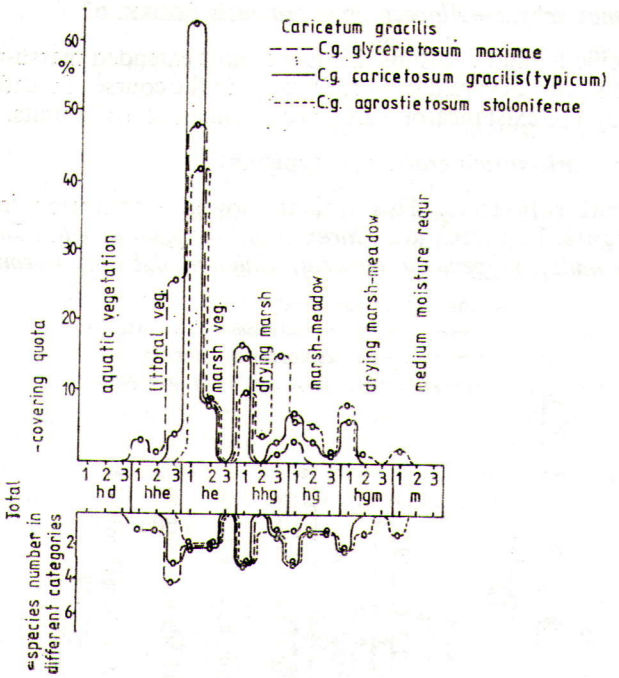

Fig. 6. Hydroecology of *Caricetum gracilis* subassociation; typicum soil segment in spring aspect.

As far as the number of species in different categories of the association is concerned, it was found that in this zone as well the number of species is extremely low. This can be explained in the first place by the fact that few species are able to tolerate the harmful effect of repeated floods.

In the Bodrogzug flood-plains dominated vast marsh-meadows. In their species composition prevailed components highly tolerant to the environmental stress effect of frequent floods. This negative effect, i.e. longer or shorter periods of inundation by stagnant water, has been compensated at places by favourable soil ecological conditions. Namely, before the construction of protective dams, in some areas of the flood-plain marshes dominated. Thus, marsh-meadows having vegetation richer than expected or than that found in other locations of the Tisza flood-plain were preserved there till to-day.

From cenosystematical point of view marsh-meadows of similar character have been introduced in the literature under the name *Alopecuretum pratensis* (REGEL 25) STETTEN 31 association (BALÁTOVÁ—TULÁCKOVÁ 1974, JEANPLONG 1960). However, in the Tisza flood-plain and adjoining tide lands *Alopecuretum pratensis hungaricum* (Soó 1952) due to differences observed both in species composition, as well as in habitat and hydroecological characteristics could be devided in several associations and subunits (BODROGKÖZY 1962). These cenoses could be clearly distinguished in the Bodrogzug region, too:

Carici melanostachyae—Alopecuretum pratensis BODRK. 62

Due to specific habitat relations this is the most extended marsh-meadow in the region studied. Its cenoses varied in a broad range in the course of meadow formation. This is proven by the existance of a number of subassociation units.

C. m.—A. p. caricetosum gracilis (= typicum)

Cenological relations. This variant showed a transition from ***Caricetum gracilis***. Differential species are: *Carex gracilis* ssp. *intermedia, Stachys palustris, Ranunculus flammula, Filipendula ulmaria, Cnidium dubium, Veronica scutellata.*

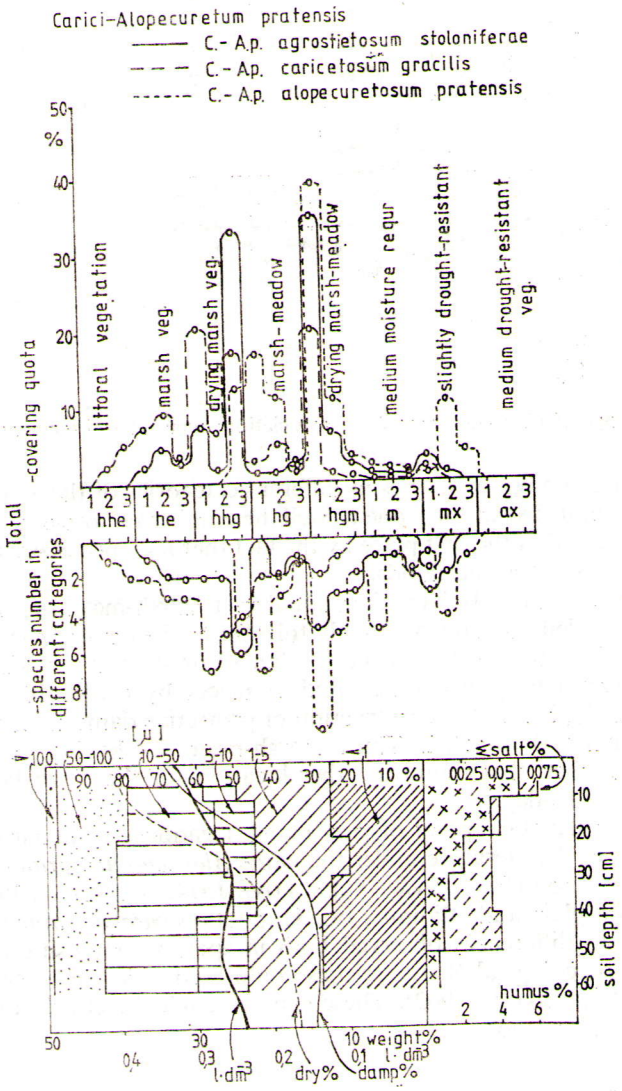

Fig. 7. Hydroecology of *Carici-Alopecuretum* subassociation; soil segment of ***Veronica scutellata*** facies in autumn

Beside Caricion gracilis elements, representatives of Phragmiteta, Molinio—Juncetea were present. The occasional occurrence of *Gentiana pneumonanthe, Serratula tinctoria, Cnidium dubium* among the species components was an indication of marsh origin.

Hydroecology. Three categories could be distinguished in this sedge-marsh-meadow: the dominant role was divided among the subgroups of the helo-hygrophyton category. The components belonging to hhg1 played the leading role. The total species number was as well the highest in this group. For further details see Fig. 7.

Soil ecology. In order to elucidate the soil relations within the variant, segments of the most important facies were probed. For the lowest-lying reliefs in case of *Eleocharis palustris—Iris pseudacorus* facies in spring aspect due to increased evaporation soil moisture expressed as volume weight decreased significantly, the content of organic matter was high and that of salts—negligible. In case of *Serratula* facies organic mater content reached 6%, which is an indication of marsh origin. For *Gentiana pneumonanthe* facies (along Füzes-tó) the moisture content decreased as compared to the facies described above, the soil was hummus, however, the salt content exceeded 0,1%. The salt content, however, did not evoke the appearance of halophyton elements in the cenoses. The occurrence of *Salix cinerea* was an indication of marsh origin as well (Fig. 8.9).

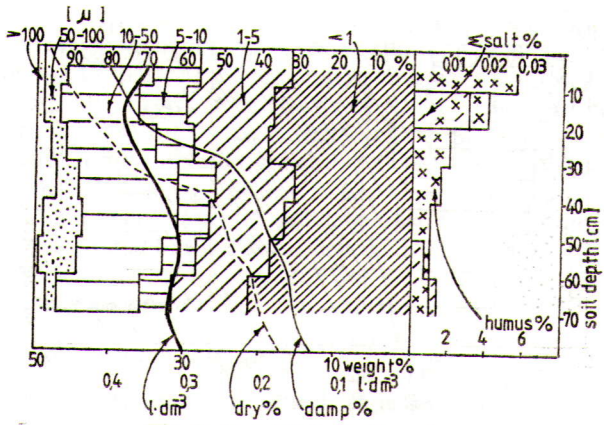

Fig. 8. *Serratula* facies in spring

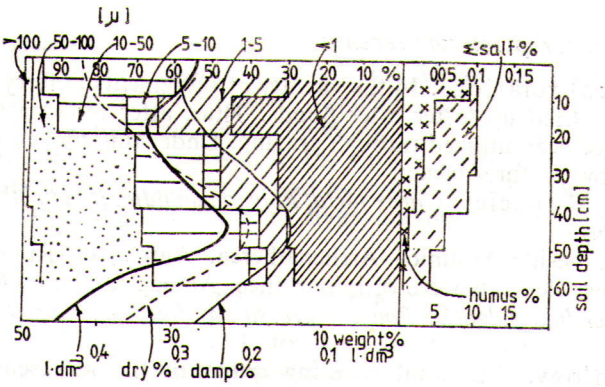

Fig. 9. *Gentiana pneumonanthe* facies in autumn aspect

C. m.—A. p. agrostetosum stoloniferae

Cenological relations. Its cenoses are often hardly distinguishable from those of the variant described above. However, in most cases the species components composition is a good basis for distintion. Its cenoses developed mostly on the highest-lying reliefs. The Phragmitetea representatives dropped out. Differential species are: *Scutellaria galericulata, Thalictrum lucidum, Ranunculus auricomus,* ssp. *binatus.* In general presence of Molinio—Arrhenatherea, Molinietalia, Calistegion elements was typical.

Hydroecology. On the constructed chart two maxima were observed: one at the transitory variant hhg3 within helohygrophyton category, the other — at the variant hgm1 of drying marsh-meadows.

Soil ecology. The results of the soil segment tests showed that the oxydation of the originally marsh soil was higher than in the previous variant and reached 3—4%. The salt content is still not significant. As far as the physical characteristics are concerned, it is less hard, which might be favourable from the point of view of eventual effect of dead-water content. The moisture content of the typical variant decreased significantly (Fig. 10).

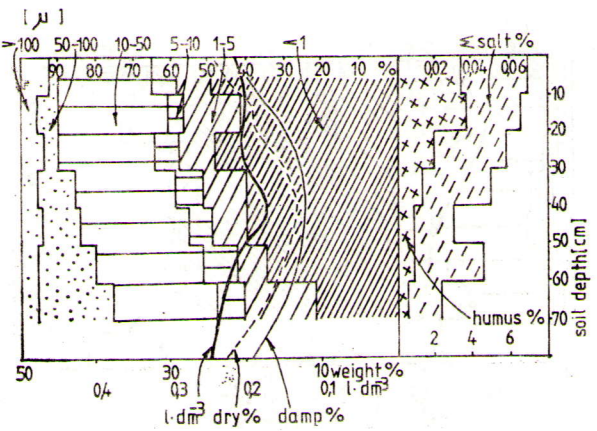

Fig. 10. Soil segment of *Agrostis stolonifera* subassociation

C. m.—A. p. agropyretosum repentis

Cenological relations. In the vicinity of settlements at ferry crossing points marsh-meadows dried up faster after floods. Thus, after mowing the stands their second yield have been utilized through grazing. Under this zoogen effect formation of marsh-meadow pastures began.

Differential species: *Carex hirta, Polygonum mite, P. amphibium* f. *terrestris, Agropyron repens.*

In general, beside Molinio—Arrhenatherea, Agropyro—Rumicion and even Festuco—Bromea elements were of importance. Among the latter *Ranunculus polyanthemos, Filipendula vulgaris, Poa compressa* ssp. *langiana, Carex praecox* should be emphasized.

Hydroecology. The total covering quota of the representatives of helohygrophyton and hygrophyton categories was of subordinate importance as compared

to that of hygro-mesophyta. The total species number was as well the highest in hgm1 subgroup. The distribution of species components could be traced up to meso-xerophyta.

Lythro vitgatae—Alopecuretum pratensis BODRK. 62

In Bodrogzug region it is found less frequently than in the southern Tisza flood-plain. This is due in the first place to the effect of damming at the Tiszalök hydro-electric power station. The flood-plain mixed flowery marsh-meadows changed into *Carici-Alopecuretum.* Some of its cenoses were driven back to the protective dams along the Tisza and Bodrog.

Characteristic species: *Thalictrum flavum, Lythrum virgatum, Lychnis flos -cuculi, Galium rubioides, Senecio erraticus* ssp. *barbereifolius.* Subassociation units:

L. v.—A. p. alopecuretosum pratensis (= typicum)

Cenological relations. It showed a transition towards the association described above. Beside Molinio—Juncetea and Molinietalia elements, the dominance of Alopecurion was significant, too.

Differential species: *Lathyrus palustris, Gratiola officinalis, Leucanthemum serotinum, Veronica serpyllifolia.*

Hydroecology. At places, where its cenoses came close to the littoral zone of dead-arms, beside the significant total covering quota of helo-hygrophyta and hygrophyta (hhg3, hg2), here as well a high quota of species components characteristic for drying out marsh-meadows (hgm1) was observed. They can be followed up to meso-xerophyton category on the constructed chart. Some of them still could not, while others already could tolerate the habitat moisture conditions.

Soil ecology. Soil segments probed in two early autumn aspects were analysed. In the root zone of damp habitats of *Cnidium dubium* facies soil moisture of 2,5 l/dm^3 was detected. In the course of oxydation process taking place in the original marsh soil at present 5% organic matter content was measured. The content of harmful sodium salts due to their upward flux reached 0,10% (Fig. 11; 12).

L. v.-A. p. agropyretosum repentis

Cenological relations. This variant showing signs of weed overgrowth was found as well in the vicinity of settlements at river crossing points. It was under the continuous joint effect of more arid habitat and increased zoogen effect due to grazing Differential species: *Agropyron repens Rorippa sylvestris, Calamagrostis epigeios, Carex praecox.*

In comparison to the previous variant beside Alopecurion, Molinio—Arrhenatherea, the representatives of Agropyro—Rumicion, Chenopodio—Scleranthea and Festuco—Brometea found their essential conditions.

Hydroecology. In comparison to the variant described above, it was found that the decrease in the quota of hhg and hg species components was of the same extent as the increase in the quota of hygro-mesophyta, mesophyta and meso-xerophyta.

Poo angustifoliae—Alopecuretum pratensis BODRK. 62

It occurs at Bodrogzug, similarly to other marsh-meadows along the Tisza, at comparatively higher-lying reliefs. Uneven relief provided different life conditions, due to which within the association a number of variants could be distinguished.

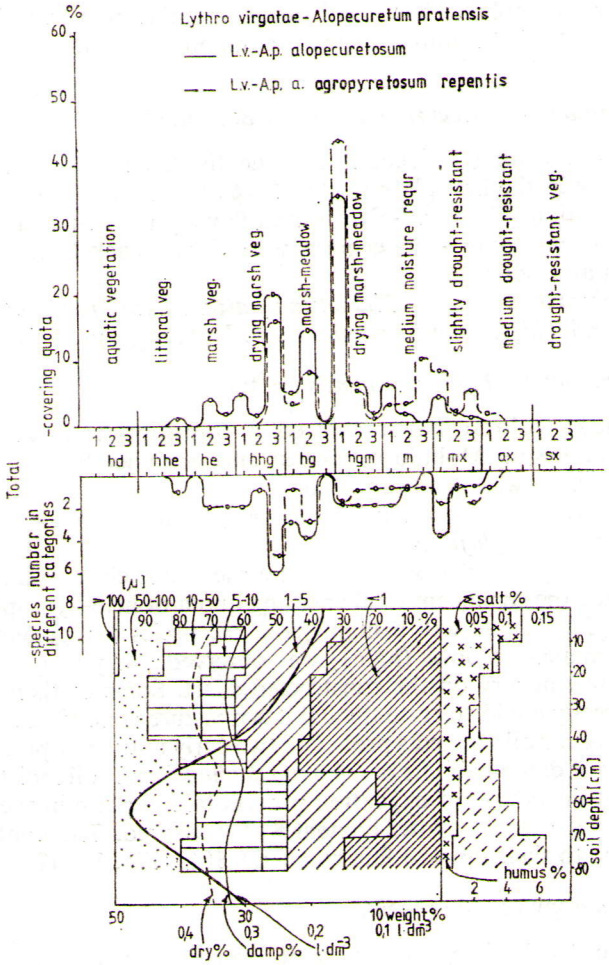

Fig. 11. Hydroecology of *Lythro virgatae—Alopecuretum*; typicum soil segment in autumn

Characteristic species: *Poa trivialis, Poa angustifolia, Stenactis annua, Rorippa austriaca.* Subassociation units:

P. a.—A. p. trifolietosum repentis

Cenological relations. Present were representatives of Molinio-Juncetea, such as *Lathyrus pratensis, L. palusrtis, Tanacetum serotinum.* Molonietalia elements were frequent as well, such as *Filipendula ulmaria, Valeriana officinalis,* which is an indication of marsh origin. *Thalictrum lucidum.* The facies forming *Ranunculus repens* belonging to Molinio—Arrhenaterea, *Agrostis stolonifera, Vicia cracca.*

Hydroecology. In comparison to the previous variant here hygrophyta propagation occurred at the expence of hhg species, this is valid for the total species number as well. Nearly equal total covering quota was reached by the drying out marsh-meadow components (hgm1), at reduced species number.

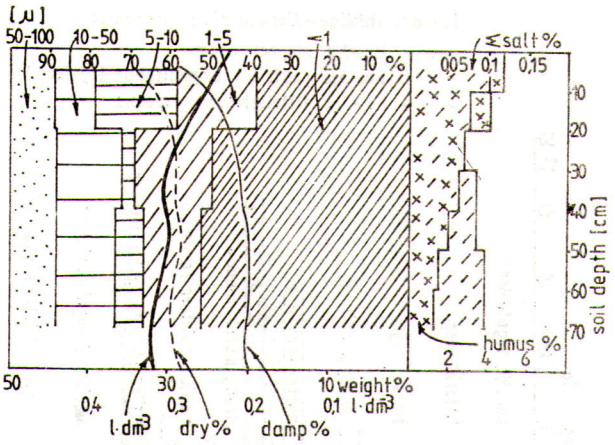

Fig. 12. Soil segment of typicum *Cnidium dubium* facies

P. a.—A. p. alopecuretosum pratensis

Cenological relations. Its cenoses were found at flood-plain locations characterized by lower moisture content, where beside *Alopecurus pratensis, Festuca rubra, Mentha arvensis, Aristolochia clematitis, Galium rubioides* were found. The extension of this marsh-meadow variant nowadays is significantly reduced, since due to increased grazing it underwent transition into different association.

Hydroecology. As compared to the variant described above in this subassociation hhg representatives entirely and overwhelming majority of hygrophyta were forced out, while the quota of hygromesophyta (hgm1) exceeded 40%, and that of the m1, 3 and mx2 representatives were above 5% (Fig. 13).

P. a.—A. p. poëtosum angustifoliae (= typicum)

Cenological relations. This association, similarly to other locations along the Tisza, is found in the highest-lying reliefs of the marsh-meadows. Since here drying occurs in shorter time after floods, in its cenoses Chenopodio-Scleranthea, Festuco—Bromea, even Festucion pseudovinae species propagation occurred. Among them the leading role is played beside *Alopecurus pratensis,* characterized by broad adaptation ability, by *Poa angustifolia* as well.

Hydroecology. In the species composition the decrease of marsh-meadow species was of the same extent as the increase in the mesophyta (m2, 3) and even more in meso-xerophyta (mx1, 2) total covering quota. The quota of dominant representatives of the drying out marsh-meadows hardly changed in comparison to the previous typical variant. In its cenoses, however, were found species characterized by such a tolerance in respect of moisture content and competitiveness that they can be considered drought-resistant (ax1, 3), e.g. *Festuca pseudovina* and *Carex praecox.*

Associations developing as a consequence of intensive grazing in the studied region:

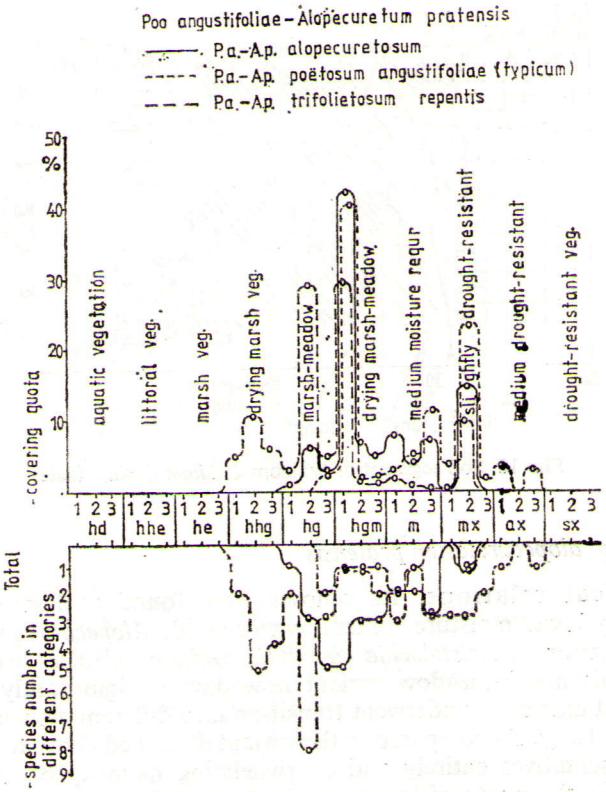

Fig. 13. Hydroecology of *Poo-Alopecuretum*

Lolio-Potentilletum anserinae KNAPP 48

In the Bodrogzug flood-plain in the vicinity of settlements marsh-meadow pastures have been marked for grazing. Under the intensive zoogen effect secondary cenoses developed depending on the relief relations. This association developed in places of higher moisture content. Two variants were analysed:

L.—P. a. potentillettosum anserinae (= typicum)

Cenological relations. Drying out marsh-meadow species dominated, such as treading tolerant *Potentilla anserina., Agrostis stolonifera, Potentilla reptans, Poa annua.* The species components belonged mainly to Agropyro-Rumicion, Plantaginetea, which were Molinio—Arrhenatherea elements.

Hydroecology. The highest covering quota was reached by helo-hygrophyta (hg2, 3). Beside the above mentioned species *Rorippa sylvestris, Potentilla supina* belonging to hg, hgm and m categories showed nearly equal quota (Fig. 14).

Lolio-Alopecuretum pratensis BODRK. 62

Lolio pastures have been studied in details by FOESTER (1968), the author determined their cenosystematical position and poor species composition.

In the territory studied, the highest-lying areas, emerging first after floods, were

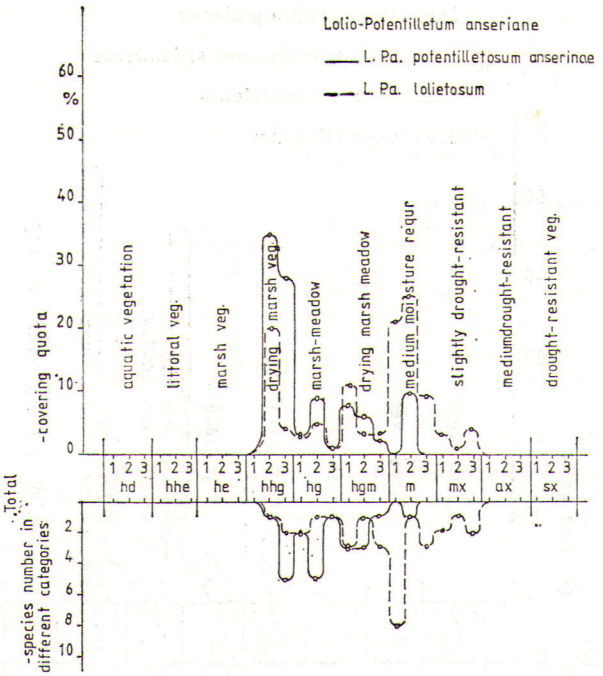

Fig. 14. Hydroecological relations of subassociation units of *Lolio-Potentilletum anserinae*

chosen as pastures. Under the influence of this harmful environmental effect, the species composition of the original marsh-meadow cenoses changed significantly. The sensitive components were replaced by more agressive ones. Depending on habitat moisture relations secondary associations developed from different original associations. Their composition is similar to that of marsh pastures in other locations of the Tisza flood-plain (BODROGKÖZY 1985).

L.—A. p. agrostetosum stoloniferae

Cenological relations. It developed in the first place from *Poo angustifoliae-Alopecuretum* under the increased zoogen effect. Its differential species are: *Euphorbia lucida, Carex vulpina, Agrostis stolonifera.* Among species components a number of Molino—Juncetea, Agropyro—Rumicion elements could be found.

Hydroecology. The total covering quota showed a steady increase from helo-hygrophyta towards hygrophyta up to mesophyta. Among helophyta *Euphorbia lucida,* in hygrophyton category *Ranunculus repens, Poa trivialis, Potentilla reptans,* and among mesophyta *Lolium perenne* presence should be emphasized.

L.—A. p. alopecuretosum pratensis

Cenological relations. Molinio—Arrhennatherea, Agropyro rumicion became dominant, Molinio—Juncetea elements dropped out. Differential species: *Rorippa austriaca, Mentha arvensis Althaea officinalis.*

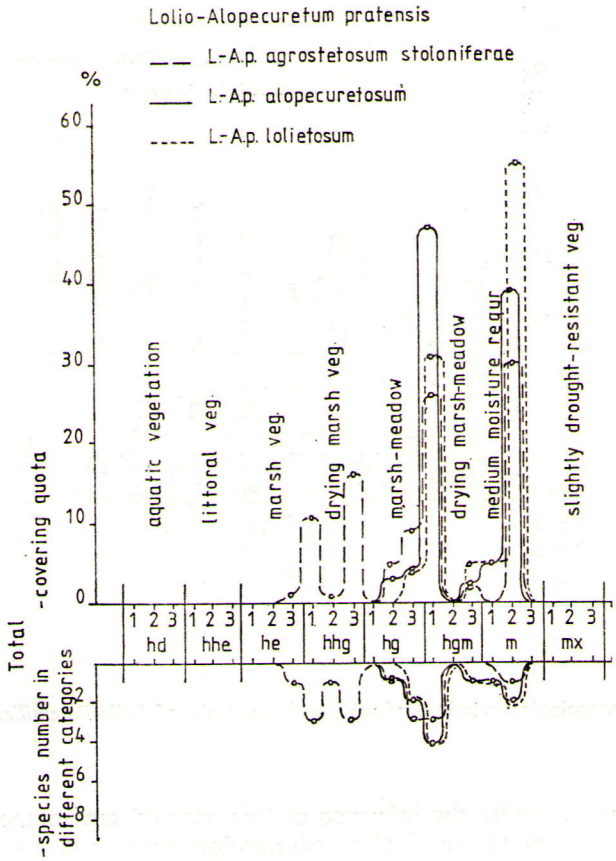

Fig. 15. *Lolio-Alopecuretum pratensis*

Hydroecology. Helo-hydrophyta dropped out, the highest covering quota was reached by hygro-mesophyta, the quota of species components belonging to mesophyton transitory subgroup increased (Fig. 15).

L.—A. p. lolietosum

Both in cenological relations and hydroecology it closely resembles the units described in other locations of the Tisza flood-plain or other more distant areas (MARKOVIĆ 1978, KÁRPÁTI et *al.* 1963, BODROGKÖZY 1985).

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Bodrogzug vízparti- mocsár és réttársulásai, hidroökológiai viszonyaik

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Kivonat

A magyarországi Felső-Tisza szakasz hullámterében a Bodrog és a Tisza összefolyásánál, Tokaj térségében kialakult Bodrogzug növénytakarójának összetétele jórészt eltér a Tiszahullámtér más vidékeinek állományaitól. Ez elsősorban a montán hatás, illetve az eltérő talaj- és hidroökológiai viszonyok következménye. A napjainkban már természetvédelmi területté nyilvánított hullámtér déli szakasza vízvisszaduzzasztás környezeti sztresszhatása alá került. Hatására a *Scirpo—Phragmitetum* más cönozisok rovására nagykiterjedésű területeket vett birtokba. A középső és alsó szakaszokon viszont a mineralogén és biogén feltöltődés következtében a holtágak medrét a hydatophyton állományok rovására *Sparganio—Sagittarietum, Rorippo—Oenanthetum,* másutt *Glycerietum maximae* foglalta el. Ugyancsak elterjedtek a *Caricetum gracilis* asszociáció alatti egységei.

A degradált nedves termőhelyeken az *Eleocharito—Schoenoplectetum supini* iszapnövényzete volt fellelhető.

Bodrogzug középső és felső szakaszán viszont végeláthatatlan mocsárrétek alakultak ki. A nedvesebb helyeken a *Carici melanostachyae—Alopecuretum pratensis,* magasabb térszínen a *Lythro virgatae—Alopecuretum* alárendeltebb szerepű mint a Tisza hullámtér más vidékein. A szárazabb szakaszokon a *Poo angustifoliae—Alopecuretum* állományait sokhelyen felszántották. — Intenzíven legeltetett helyeken nedvesebb körülmények között *Lolio—Potentilletum anserinae,* másutt *Lolio—Alopecuretum pratensis* legelők alakultak ki.

ГИДРО-ЭКОЛОГИЧЕСКИЕ ЗАВИСИМОСТИ ПРИБРЕЖНЫХ, ВОЛОТНЫХ И ЛУГОВЫХ СООВЩЕСТВ В ОБЛАСТИ БОДРОГЗУГ

Д. Бодрогкези

В поймах Верхней Тисы в районе Токая растительность области Бодрогзуг, образовавшейся при слиянии рек Бодрог и Тиса, отличается от сообществ пойм Тисы других областей. Это объясняется прежде всего холмистым характером данной области и является следствием различных почвенных и гидро-экологических условий. В настоящее время южный отрезок ноймы, объявленный заповедной областью, находится под стрессовым воздействием запруживания. Вследствие этого наблюдается значительное распространение *Scirpo-Phragmitetum* за счет других сообществ. В средней и верхней части области вследствие минералогенного и биогенного заполнения в руслах мертвых рукавов *Sparganio-Sagittarietum, Rorippo-Cenanthetum* в некоторых местах *Glycerietum maximae* вытеснили сообщества гидрофитонов. Также распространились элементы субассоциации *Caricetum gracilis.*

В низких, влажных местах произрастала ильная растительность *Eleocharito-Schoenoplectetum supini.*

В средней и верхней части Бодрогзуг образовались обширные болотные луга. Во влажных низких местах *Carici melanostachyae-Alopecuretum pratensis,* на более высоких участках *Lythro virgatae-Alopecuretum* играли второстепенную роль в сравнении с поймами других отрезков Тисы. Во многих местах на сухих участках сообщества *Poo angustifoliae-Alopecuretum* были перепаханы. В местах интензивного выгула в участках с повышенной влажностью образовались пастбища *Lolio-Potentilletum anserinae,* в других местах — *Lolio-Alopecuretum pratensis.*

Obalne i močvarne zajednice livade i hidroekološke osobine teritorije Bodrogzug

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Rezime

U gornjem otseku Tise nalazi se poplavno zemljište u ušću reke Bodrog (pored Tokaja), to je teritorija Bodrogzug, vegetacioni pokrov dosta razlikuje od biljnog pokrova ostalog poplavnog zemljišta. Ova činjenica objašnjava se prvotno sa gorskim (montan) uticajem, odnosno sa diferencijama hidroekoloških okolnosti i sa različitostima tla. Ova teritorija je prirodno zaštitna teritorija, južni otsek je ispod stresom smanjene vode. Zbog toga zajednica *Scirpo—Phragmitetum* je postao dominirajuća na račun druge zajednice. Srednji i donji otsek nasipava s mineralogenskim i biogenskim materijama, koren mrtvaje na teret hidatofiton vegetacije zauzimali su *Sparganio—Sagittarietum, Rorippo—Oenanthetum, Glycerietum maximae.* Jako su prošireni podasocijacije zajednice *Caricetum gracilis.*

Na degradiranim vlažnim mestima nađena je zajednica mulja *Eleocharito—Schoenoplectetum supini.* Na srednjem i gornjem otseku Bodrogzug dominirajuća je močvarna livada. Na vlažnijim mestima zeleni se zajednica *Carici melanostachyae—Alopecuretum pratensis,* a na višim terenima zajednica *Lythro virgatae—Alopecuretum.* Na suvim mestima zajednice *Poo angustifoliae—Alopecuretum* su nestali, napravili su oranicu od njih. Na pašnjacima među vlažnijim okolnostima rastu zajednice *Lolio—Potentilletum anserinae,* drugđe *Lolio—Alopecuretum pratensis.*

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GROWTH OF DIFFERENT FORMS OF CARP (CYPRINUS CARPIO L.) IN KISKÖRE STORAGE-LAKE

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(Received January 16, 1989)

Abstract

Carps in Kisköre storage-lake (newly called the Tisza-lake) can be classified in three groups on the basis of their profile index (P_i: ratio of body length to body hight). The most widespread form is the usual wild carp characterized by a medium hight spine arch (P_i: 2,8—3,5), but beside it the low spine arch rangy carp ($P_i > 3,5$) and the markedly high spine arch culture-carp ($P_i < 2,8$) can be found as well.

No significant differences have been found in the longitudinal growth of the three forms. However, the wild forms are lagging behind in gain of weight as compared to the culture ones. Irrespective of this in natural waters the maintenance of wild forms in the first place seems to be justified, on the one hand because of their excellent sport characteristics (when hooked they struggle vigorously and persistantly), and on the other hand because they preserve the genetic diversity of the species. Supplementing or increasing of the carp population in the storage-lake is to be solved in the future preferably by propagation of wild carps in it and not by introducing culture ones as practiced formerly.

Introduction

Carps in Kisköre storage-lake (newly called the Tisza-lake) can be classified in three groups on the basis of their profile index (P_i) defined as the ratio of body length to body hight. The most widespread form is the usual wild carp characterized by a medium hight spine arch (P_i: 2,8—3,5), but beside it the low spine arch, so-called rangy carp (*C. c. morpha hungaricus* HECKEL; $P_i > 3,5$) and the markedly high spine arch culture-carp (*C. c. morpha acuminatus* HECKEL; $P_i < 2,8$) can be found as well.

While in a previous paper (HARKA 1988) the average growth of the carp population comprising the above three forms was investigated, the present paper deals with the growth of these forms separately.

Materials and Methods

In the study the data of 65 scaly carps caught between 1985 and 1987 in the north-eastern basin of the Tisza-lake, in the vicinity of Tiszafüred and Poroszló, were used. The body length of the specimens investigated ranged between 320 and 600 mm, and their body weight between 950 and 4780 g.

The age of the specimens was determined on the basis of scalimetric analysis according to LEE (1920). Bertalaffy's matematical model (BEVERTON and HOLT 1957, GULLAND 1963) was used for description of growth as suggested by DICKIE (1971). The relation between the body length and body weight was determined according to TESCH (1971).

Results

The profile index of the specimens studied varied between 2,32 and 3,86, the average value being 3,20. The frequency showed nearly normal distribution (Fig. 1). The occurrence of the three forms was as follows: 20,00% rangy carp, 69,23% usual wild carp, 10,77% culture-carp.

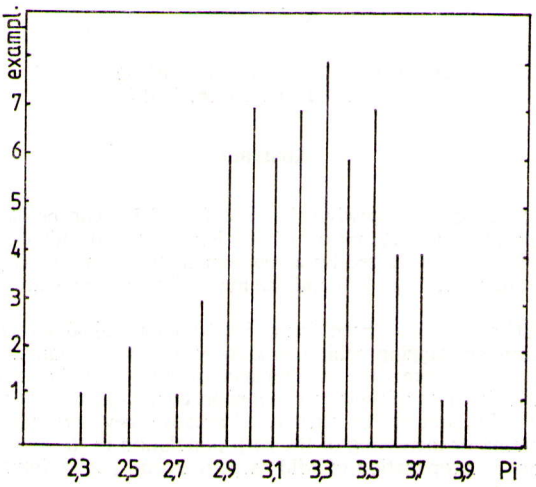

Fig. 1. Frequency distribution of profile indexes (P_i) of the specimens studied

1. Longitudinal growth

The following relations were obtained for the body length of carps at the age of "t" years (L_t: standard body length in mm):

a) rangy form $L_t = 823[1-e^{-0,1692(t-0,24)}]$

b) usual form $L_t = 886[1-e^{-0,1423(t+0,07)}]$

c) culture form $L_t = 929[1-e^{-0,1287(t+0,15)}]$ $(e = 2,718)$

To make the comparisons easier the expected body length was calculated for different ages and summarized in Table I. It can be seen that for age groups between 1 and 10 years no significant difference exists in the body length for the three forms. In this respect the three forms are of nearly equal value.

2. Relation between body length and body weight

The relation between body length (standard length: L_c) and body weight (w) is described by the lineary transformed function suggested by TESCH (1971)

$$\lg W = a + b \lg L_c$$

using the following equations:

a) rangy form $\lg W = -5{,}1188 + 3{,}1567 \lg L_c$

b) usual form $\lg W = -4{,}6095 + 2{,}9917 \lg L_c$

c) culture form $\lg W = -4{,}1351 + 2{,}8495 \lg L_c$

where body weight is given in *g* and body length — in mm.

Gradual changes are observed in the equation parameters. The value of constant "b" is the highest for rangy form, indicating the highest growth rate, however, for this form the value of constant "a" is the lowest, showing the lowest starting weight (Fig. 2). This initial drawback can not be overcome completely even at the symptotic body length (823 mm).

3. Body weight gain

The expected body weights at different ages are calculated from the data on body length summarized in Table 1 using the relation between body length and body weight described above (Table 2). Contrary to the results obtained for body length

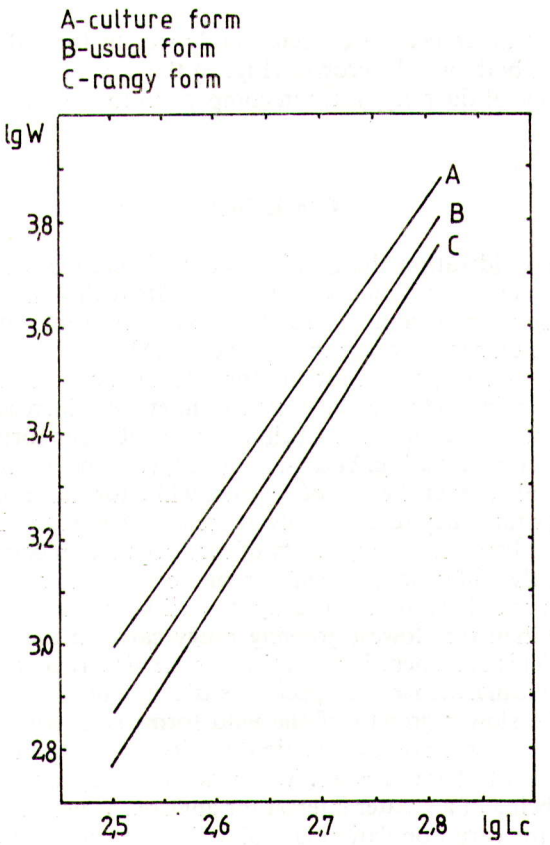

Fig. 2. Relation between body length (L_c) and body weight (W) for different forms (A: culture form, B: usual form, C: rangy form)

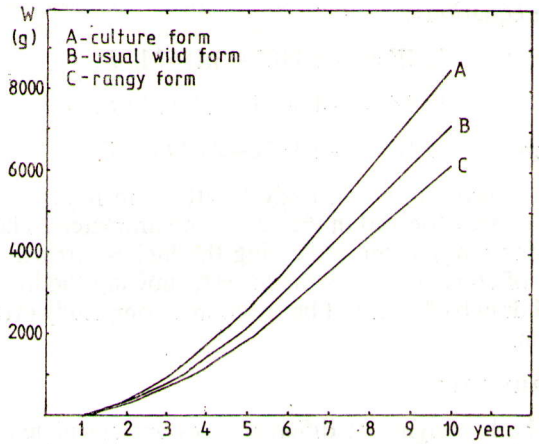

Fig. 3. Gain in body weight (W) in different forms (A: culture form, B: usual wild form, C: rangy form)

there are significant differences in expected body weight for different forms. From the curves showing body weight growth (Fig. 3) the advantage of the culture form and the disadvantage of the rangy form in comparison to the usual wild carp become obvious.

Conclusions

Taking into consideration the small number of specimens studied, the results can be considered only as preliminary information. Its reality, however, is supported by the fact that the present findings are in a good agreement with previous results involving a higher number of specimens (HARKA 1988).

Thus the body length growth for the three forms does not differ significantly, contrary to the gain in body weight showing differences increasing with age. Or, put in a different way, the specimens belonging to different forms reach the same body weight at different ages. E.g. body weight of specimens belonging to the culture form exceeds 6 kg already at the age of 8 years, while for those of the usual form it occurs at 9, and for the rangy form — only at the age of 10 years. It should be noted, however, on the one hand that the majority of carp population belongs to the younger age groups, where the differences are smaller, and on the other hand the draw-backs of the wild forms are only relative, since e.g. the wild carps in the Körös backwaters grow even slower than the slowest growing rangy carps in the Tisza-lake (TALAAT and OLÁH 1986). This statement is not valid for the first two years of life, but this fact is of no significance, since the specimens did not reach yet the catching size.

In spite of the slower growth of the wild forms still they are more valuable, not only because they preserve the genetic diversity of the species but also because of their excellent sport characteristics. When hooked they struggle vigorously and persistantly, thus being of a greater interest for anglers. At present the supplementing and increasing of the carp population is achieved by introducing culture carps from fish-farms, however, in the future it is desirable to use for the purpose wild carps propagated at the spot.

Table 1. *Longitudinal growth of different carp forms in the Tisza-lake*

Age in years	Body length in mm		
	rangy form	usual form	cultureform
1	99	125	127
2	212	226	225
3	307	314	310
4	387	390	384
5	455	455	450
6	512	512	508
7	561	562	559
8	602	605	604
9	636	642	643
10	665	675	677

Table 2. *Gain in body weight in different carp forms*

Age in years	Body weigth in g		
	rangy form	usual form	cultureform
1	15	46	72
2	168	271	369
3	540	725	921
4	1122	1387	1694
5	1870	2200	2662
6	2714	3132	3761
7	3621	4139	4939
8	4524	5160	6158
9	5381	6163	7360
10	6194	7160	8524

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A ponty (Cyprinus carpio L.) különböző formaváltozatainak növekedése a Kiskörei-tározótóban

HARKA Á.

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Kivonat

Profilindex (Pi: a standard testhossz és a testmagasság hányadosa) alapján a Kiskörei-tározótó (újabb nevén Tisza-tó) pontyai három csoportba sorolhatók. Leggyakoribb változat a mérsékelten magas hátú közönséges vadponty (Pi: 2,8—3,5), de előfordul az alacsony hátú nyurgaponty (Pi: nagyobb 5,5-nél) és a kifejezetten magas hátú nemesponty is (Pi: kisebb 2,8-nél).

Hossznövekedésben a három formaváltozat között nem mutatkozott lényeges eltérés, tömegnövekedésben azonban a vad formák elmaradnak a kultúrforma mögött. A természetes vizekben mégis indokolt a vad formák fenntartása, ugyanis ezek kiváló sporthalak (horogra akadva kitartóan és erősen küzdenek), másrészt a faj genetikai változatosságának őrzői. A tározótó pontyállományát jelenleg tógazdasági nemespontyokkal pótolják, illetve növelik, a jövőben azonban célszerű lenne ezt a vadpontyok helyben történő szaporításával megoldani.

РОСТ ОТДЕЛЬНЫХ РАЗНОВИДНОСТЕЙ КАРПА (CYPRINUS CARPIO L.) В ВОДОХРАНИЛИЩЕ КИШКЕРЕ

А. Харка

На основании значений профильного индекса (P_i: отношение стандартной длины к высоте туловища) карпы, обитающие в водохранилище Кишкере (новое название — Тисское озеро), могут быть разделены на три группы. Наиболее распространенной разновидностью является обычный карп, характеризуемый умеренно-высоким сводом спины ($P_i = 2{,}8—3{,}5$), но встречаются также сазан с низким сводом спины ($P_i > 5{,}5$) и культурный карп с подчеркнуто высоким сводом спины ($P_i < 2{,}8$).

В отношении продольного роста между этими тремя разновидностями не было существенных различий, в то время как в отношении увеличения их массы дикие формы отставали от культурных. Несмотря на это в естественных водах обосновано разведение диких форм, с одной стороны в связи с их превосходными характеристиками с точки зрения спорта (попавшись на удочку они долго и усилено сопротивляются), а с другой — для сохранения генетической вариабельности вида. Для пополнения и увеличения популяции карпов в водохранилище в настоящее время используют культурных карпов, разводимых в рыбных хозяйствах; в будущем, однако, целесообразно перейти к разведению диких карпов в водохранилище.

Prirast varijantnih oblika šarana (Cyprinus carpio L.) u rezervoaru za vodu Kisköre

Á. HARKA

Gimnazija „Kossuth Lajos", Tiszafüred

Rezime

Prema profil-indeksu (Pi: kvocijent standardne dužine tela i standardne visine tela) šarani u rezervoaru za vodu Kisköre (novije ime je: Tisa-jezero) poređaju se u tri grupe. Najčešći varijanti su divlji šarani sa umereno visokim leđima (Pi: 2,8—3,5) ali nalazi se i suvonjav šaran sa nižim leđima (Pi: >5,5) i maloljuskavi šaran sa izrazito visokim leđima (Pi: <2,8).

Prema dužinu tela nije nađen izrazita diferencija, s druge strane, divlji šarani zaostaju sa rastom težine. U prirodnim vodama ipak je potrebno održati divlje varijante, jer ove su odlične sportske ribe (prilikom ulova teško daju svoje živote), a one prenose multivarijantne genetske osobine. Sastav šarana u rezervoaru naknađuju odnosno povećavaju sa maloljuskavim šaranima. U budućnosti bilo bi celishodno ovaj proces dopuniti sa množenjem divljih šarana na licu mesta.

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SYSTEMATIC STATUS OF HUNGARIAN BULLHEAD POUT: ICTALURUS NEBULOSUS PANNONICUS ssp. n.

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Abstract

Morphological studies have been carried out by the authors on 337 specimens of bullhead pout *(Ictalurus nebulosus)* caught in Hungarian waters, and the results were compared with the data available from the literature. Taking into consideration the differences observed in the number of anal rays and in the pectorial spine, it is justified to distinguish the population of bullhead pout in Hungary and bordering regions showing the same characteristics as a separate subspecies under the name *Ictalurus nebulosus pannonicus* (ssp. n.). The formation of the new species can be attributed to the introgressive hybridization during the introduction of the species in Europe, as well as to the adaptation to the new, differrent environmental conditions.

Introduction

The acclimatization of the North-American ictalurid bullhead pout in Europe has begun at the end of the last century. The first European introduction took place in 1871 in France (VIVIER 1951). According to american data (KENDALL 1910) the regular delivery started with the first shipment to Belgium in 1884. The occurrence of this species in Germany has been observed since 1885 (SCHINDLER 1953). Its further spreading in Europe occurred on the one hand from Germany, and on the other — from further american import shipments. The provenance of the imported fish were the swamps in the Mississippi river valley, where collections have been carried out following the withdrawals of the floods. The majority of the imported bullhead pout has been identified as *Ictalurus nebulosus,* however, *I. punctatus* has been introduced as well, and, probably, *I. natalis* was present in the shipments, too (WHEELER 1978).

For a long time the bullhead pout, which became widespread in Europe has been referred to in the literature uniformly as Amiurus *(Ameiurus nebulosus),* and later as *Ictalurus nebulosus* (BERG 1949, BĂNĂRESCU 1964, LADIGES and VOGT 1965, BERINKEY 1966). For the first time the occurrence of *I. melas* species in Europe was reported by REDECKE (1941, cited in WHEELER 1978) in Holland.

In the 60s SPILLMANN (1967), TORTONESE (1967) and BĂNĂRESCU (1968) reached the conclusion that the populations found in France, Italy and Roumania belonged not to *I. nebulosus* but to *I. melas* species. Several authors attributed the earlier *I. nebulosus* data to misidentification and stated that the genus was represented in

Europe solely by *I. melas* (BĂNĂRESCU 1968, HUET 1970, BLANC et *al.* 1971). Contrary to these findings the results obtained by HOLČIK (1972) confirmed the earlier identification *(I. nebulosus)* in the population in Czechoslovakia, however, the author emphasized that the number of anal rays observed overlaps the numbers reported for these two species. After reviewing the data on bullhead pout, WHEELER (1978) contravened the findings of HUET (1970) and BLANC et *al.* (1971) concerning the exclusive occurrence of *I. melas* in Europe and accepted the occurrence of both *I. melas* and *I. nebulosus* on the continent. At the same time the author found that in Great Britain *I. melas* is the more often imported species, which he brings into connection with the fact that the provenance of bullhead pout imported for aquarium keeping or as experimental animals is usually Italy.

Among the publications dealing with this problem, particular attention is to be paid to the work of RAUNICH et. *al.* (1966), according to which the electrophoretic study of hemoglobin in the population found in the vicinity of Ferrara indicates mixing of characteristic traits of 3 species *(I. melas, I. natalis* and *I. nebulosus)*. However, the above paper does not deal with the morphological characteristics of the fish. SCOTT and CROSSMAN (1973) pointed at the occurrence of hybridization of *I. melas* and *I. nebulosus* species in natural conditions.

In the first place the results described above called for the investigation of the systematic status of bullhead pout found in Hungary. The study was justified as well by the fact that in 1980 *I. melas* has been imported to Hungary from a fish farm in the vicinity of Modena (Italy), and in the near future the appearance of its progeny is to be expected in a number of water basins.

Materials and Methods

The identification of Hungarian bullhead pout was based on live specimens caught in the Tisza river and the Hortobágy fishpond in 1983—87 ($n=200+100$ individuals), as well as on the conserved specimens in the collection of the Museum of Natural Sciences in Budapest ($n=54$ individuals). The latter originated mainly from the Danube ($n=30$ individuals) and other water basins in Hungary (for details on provenance see BERINKEY 1972).

In the work on identification the following studies have been used JORDAN and EVERMAN (1986), TRAUTMAN (1957), BLAIR et *al.* (1957), HUBBS and LAGLER (1958), SCHMITH-VANIZ (1968), SCOTT and CROSSMAN (1973), MOYLE (1976), LEE et *al.* (1980) and EDDY (1969).

For comparison we had at our disposal 10 live *I. melas* specimens belonging to the F_1 generation of the population imported in 1980 from Italy. The provenance of these specimens was Pér fishfarm (Western Hungary).

Results

As expected the question of identification has been eventually restricted to two species: *I. nebulosus* and *I. melas*. In the solution of the problem the following characteristic features have been taken into consideration:

1. The hind side of the pectoral spine in all specimens ($n=354$) without exception was markedly indented.

2. The flank colouring in every live specimen ($n=300$) was to a greater or lesser extent clouded and spotted. In the conserved specimens similar observations were made, however, those can not be considered authentical as far as the colouring is concerned.

3. The light-coloured transversal strip characteristic for *I. melas* was missing from the tail-fin base of the specimens ($n=300$). Although a lighter line was visible

in three palecoloured young specimens, it was significantly weaker and narrower than in the control *I. melas* individuals.

4. The colour of the fin-membranes was more or less identical with the colouring of the body and the rays ($n=300$), the smoky, blackish colouring characteristic for *I. melas* specimens have not been detected in any of the studied individuals.

Thus our results support earlier findings that Hungarian bullhead pout belongs to *I. nebulosus* species (LOVASSY 1927, VÁSÁRHELYI 1961, BERINKEY 1966, HARKA 1974, PINTÉR 1976).

The number of anal rays in *I. melas* and *I. nebulosus* was considered by JORDAN and EVERMANN (1896) to be an important distinguishing character as well. However, it has been shown in later studies that there is an overlapping in the number of anal rays reported for these two species (Fig. 1), and thus the ray number can not be considered as a species distinguishing character.

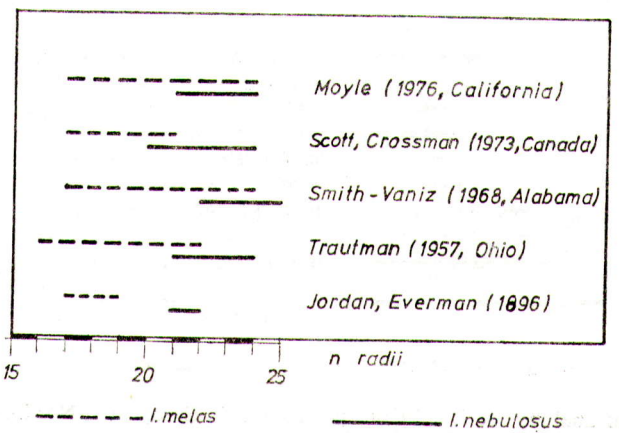

Fig. 1. Number of anal rays of *I. melas* and *I. nebulosus* according to different authors

In the Hungarian *I. nebulosus* specimens studied ($n=337$, since some of the conserved specimens were not suitable for investigation) the number of anal rays was as follows:

Number of rays	17	18	19	20	21	22	23
Number of specimens	5	19	86	131	81	13	2
Mean value:	19,92						

Discussion

Our findings are in agreement with the data obtained in the regions bordering on Hungary. In a study of 43 specimens originating from Czechoslovakia HOLČIK 1972) extreme values of 17 and 23, and a mean value of 20,09 were registered, the results obtained by MALETIN (1982) in Jugoslavia on 270 specimens were as follows: extreme values 18 and 22, mean value 19,27.

Similar results were obtained in Roumania as well, where the number of anal rays was 19—22 (BĂNĂRESCU 1964) and 17—20 (BĂNĂRESCU 1968). In the latter

work the author taking into consideration among others the number of anal rays assigned the Roumanian population to *I. melas* species, however, HOLČIK (1972) suggested a revision of this classification, based on the studies carried out on specimens from the Timis river (Roumania). The markedly indented pectoral spine of the Roumanian bullhead pout specimens found in the collection of the Museum of Natural Sciences in Budapest ($n=62$) justify the reassignment. The number of anal rays in this group varied between 17 and 23, mean value 19,15.

Comparison of the East-Middle-European and North-American data shows that the minimal number of anal rays detected in the European *I. nebulosus* populations was significantly lower, and the mean values as well did not reach the minimal numbers observed in America (Fig. 2).

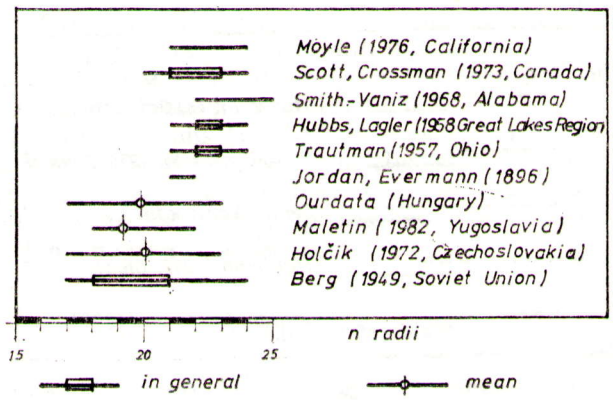

Fig. 2. Number of anal rays of *I. nebulosus* populations in Europe and North-America according to different authors

According to HOLČIK (1972) the differences observed are due possibly to adaptation, however, the possibility of hybridization should not be neglected either, since among the specimens imported to Europe besides *I. nebulosus* the occurrence of the closely related *I. melas* is highly probable, and since initially the fish were kept in artificial conditions.

The number of anal rays in the Eastern-Middle-European *I. nebulosus* (17—24) and *I. melas* (16—24) populations is nearly identical, which can be considered to result from hybridization of these two species, in the course of which some traits characteristic for *I. melas* were transferred to *I. nebulosus* (and vice versa), and since during their spreading in Europe the specimens did not encounter a pure population, the acquired properties became stabilized.

Another stabilized characteristic feature of the Hungarian bullhead pout is that the front side of the pectoral spine is not completely smooth but finely barbed, rough or occasionally indented (Fig. 3). These features resemble the characteristics of *I. natalis*, thus in our case the possibility of triple hybridization suggested by RAUNICH et *al.* (1966) can be considered as well. The roughness of the front side of pectoral spine is clearly visible in the figure based on the studies of HOLČIK (1972) in Czechoslovakia.

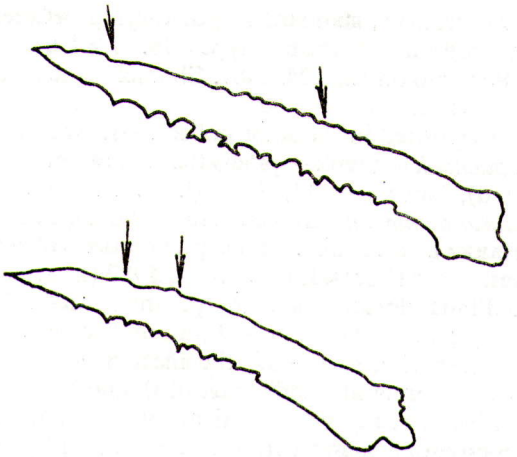

Fig. 3. Ruggedness of the pectoral spine of *Ictalurus nebulosus pannonicus ssp. n.*
Above: original pectoral spine (length 23,5 mm) of an individual caught in the Tisza river at Tiszafüred.
Below: Pectoral spine (length 21,1 mm) of an individual caught in the Danube at Sturovo (after HOLČIK, 1972)

Taking into consideration the differences in the number of anal rays and in pectoral spine, as well as the separate spreading region, it is justified to distinguish the population in Hungary and bordering regions as a separate species under the name of *I. nebulosus pannonicus* (ssp. n.).

Ictalurus nebulorus pannonicus (ssp. n.)

Holotype: female, standard length 213 mm. Deposited in the fish collection of the Museum of Natural Sciences in Budapest (No. 87. 1. 1.). Collected by Á. HARKA in the Tisza river at Poroszló, on April 14, 1987. Characteristic features — Table 1.

Table 1. *Characteristics of the holotype and paratypes of Ictalurus nebulosus pannonicus ssp. n.*

Trait	Holotype	Paratype	
		extreme values	mean value
Standard length	213	132—148	139,2
Full length	250	158—178	167,6
Body max. length	46	27—35	30,9
Tail shaft min. height	25	15—19	16,6
Predorsal distance	76	49—60	52,4
Head length	61	38—44	40,6
Interorbital distance	30	17—25	20,5
Eye diameter	8	4—5	4,6
Preorbital distance	21	11—15	13,1
Length of the anal fin	48	30—34	32,8
Hight of the anal fin	31	16—21	18,7
Number of anal rays	20	19—21	20,1

The measures are given in mm

Paratypes: 13 specimens, standard length varying between 132 and 148 mm. Deposited in the same collection as the holotype (No. 87.2.1.). Collected by Á. HARKA in the Tisza river at Poroszló on June 24, 1987. Characteristic features — summarized in Table 1.

Other materials (deposited in the same collection): No. 87.3.1. 6 bone preparations of *Ictalurus n. pannonicus* (skull+spine+the first ray of the pectoral and dorsal fin), Tisza (Tiszafüred), November 14, 1986 (l. Á. HARKA). No. 87.4.1. 10 bone preparations of *Ictalurus n. pannonicus* (see the item above), Tisza (Poroszló), November 20, 1986 (l. Á. HARKA). No. 87.5.1. 9 bone preparations of *Ictalurus n. pannonicus* (see the items above), Tisza (Poroszló), April 14, 1987 (l. Á. HARKA).

Description. Pinna dorsalis: 1/5—6; p. analis: 3—4/14-19; p. pectoralis: 1/7—8; p. ventralis: 1/7; p. caudalis: 16—19+a number of rudiments. The number of vertebra, without Weberbones 37—39, the mean value based on 27 specimens 37,6. The side line in the fore and middle part of the body is continuous, at the tail shaft often broken or incomplete, and can differ at the two flanks. The main morphometric characteristics essentially agree with the values given by SCOTT and CROSSMAN (1973) for *I. nebulosus* species (Table 2).

Table 2. *Morphometric characteristics of I. nebulosus (a) and I. n. pannonicus (b, c)*

	a	b	c
Expressed as percentage of the full length:			
Head length	22,6—26,3	21,2—26,5	23,8
Max. body hight	17,7—26,3	17,0—22,3	18,8
Tail shaft min. hight	8,1—9,9	8,6—10,6	9,8
Predorsal distance	30,4—34,3	27,6—33,2	31,3
Base of the anal fin	17,5—20,7	17,6—22,2	19,8
Expressed as percentage of the head length:			
Preorbital length	35,6—44,2	31,0—41,8	35,6
Interorbital length	45,2—53,2	45,2—63,6	52,6
Eye diameter	10,0—18,7	6,9—14,1	10,7

a: After Scott and Crossman (1973)
b and c: extreme values and mean value (based on 50 individuals)

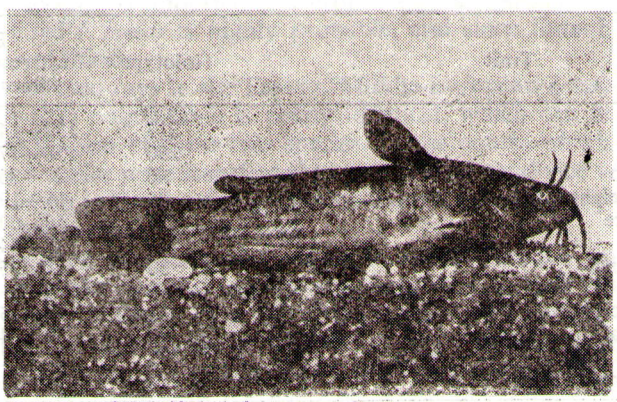

Fig. 4. *Ictalurus nebulosus pannonicus* ssp. n. from the Tisza river (photo: Á. HARKA)

Colouring. The dorsal colouring varies from yellowish-brown to blackish-brown, the flanks are of paler colour, to a greater or lesser extent cloudy, the abdomen is off-white or yellowish white. The colouring of the fins is similar to that of the body, their distal parts being often less pigmented (Fig. 4).

Ecology. The subspecies does not impose particular requirements, favours in the first place shallow waters with rich vegetation but can be found in the rivers as well.

Terra typica: Storage-lake of the Tisza river, Eastern Hungary.

Geographical distribution: At present known to occur in the Carpatian basin in the river systems of the Danube and Tisza, but according to the data of Frank (cited in HOLČIK, 1972) on the Elba region, a wider spreading could be possible, too.

Etymology. The name pannonicus refers to the presently known spreading region of the subspecies — Carpathian or Pannonian basin.

Formation. The formation of the new subspecies in the course of the species introduction in Europe is possibly due to environmental adaptation and the introgression of the various *Ictalurus*-species *(I. nebulosus, I. melas, I. natalis)*.

Distinction of *Ictalurus nebulosus* subspecies.

The distinction of the *I. nebulosus* subspecies can be based on the following key:

1. The front side of the pectoral spine is smooth, the number of anal rays is generally 22—24.

   1/a The flanks are faintly spotty, cloudy. Occurrence: South-Canada; USA
   I. n. nebulosus (LESUEUR, 1819)

   1/b The flanks are markedly spotty, cloudy. Occurrence: USA, from Indiana to Florida
   I. n. marmoratus (HOLBROOK 1855)

2. The front side of the pectoral spine is uneven, finely barbed, rough or rugged, the number of anal rays is generally 18—21. Occurrence: Eastern-Middle-Europe.
   I. n. pannonicus ssp. n.

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Magyarország törpeharcsáinak rendszertani helye: Ictalurus nebulosus pannonicus ssp. n.

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Kivonat

A szerzők 337 db, magyarországi vizekből származó törpeharcsa *(Ictalurus nebulosus)* morfológiai vizsgálatát végezték el és eredményeiket összevetették a rendelkezésre álló irodalmi anyaggal. A farokalatti úszó sugarainak (anal rays) száma és a mellúszó tüske (pectoral spine) eltérései alapján indokolt a magyarországi valamint a környező területek hasonló jellegzetességekkel bíró törpeharcsa populációinak önálló alfaji megkülönböztetése *Ictalurus nebulosus pannonicus* (ssp. n.) néven. Az új alfaj kialakulása az európai betelepítéskor bekövetkezett introgresszív hibridizációval valamint az új, eltérő környezeti viszonyokhoz való adaptációval magyarázható.

СИСТЕМАТИЧЕСКАЯ КЛАССИФИКАЦИЯ ВЕНГЕРСКОГО СОМА: ICTALURUS NEBULOSUS PANNONICUS ssp. n.

А. Харка и К. Пинтер

Авторами проведены морфологические исследования 337 особей *Ictalurus nebulosus*, пойманных в венгерских водах, и результаты сравнены с литературными данными. Принимая во внимание различия, наблюдаемые в числе лучей анального плавника и в пекторальной ости, обосновано обособление популяции сома, распространенной в Венгрии и примыкающих областях, в отдельный подвид под названием *Ictalurus nebulosus pannonicus* (ssp. n). Возникновение новой популяции может быть объяснено интрогрессивной гибридизацией во время введения этого вида в Европе, а также адаптацией к условиям новой окружающей среды.

Mesto patuljastih somića (Ictalurus nebulosus pannonicus ssp. n.) u zootaksonomiji nađene u Mađarskoj

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Rezime

Autori su izvršili morfološku analizu 337 primeraka patuljastih somića *(Ictalurus nebulosus)* poticane iz mađarskih voda, dobiveni rezultati su bili upoređeni sa literaturnim podacima. Na temelju broj zraka analnog peraja (anal rays) i diferencijama bodljama prsnog peraja (pectoral spine) potrebno je odvajati podvrste patuljastog somića nađene u mađarskim i u okolnim regijama na imenu *Ictalurus nebulosus pannonicus* ssp. n. Razvoj novog podvrsta može se objasniti introgresivnom hibridizacijom, koji se dogodilo poslije nasele u Evropu i sa adaptacijom prema novim ekološkim okolnostima.

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ON FOOD COMPOSITION OF FOUR HERON SPECIES

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Abstract

The wet weight and the maximum length of the aliment animal organisms found in the food samples obtained by the neck collar method in nestlings of Purple Heron *(Ardea purpurea)*. Night Heron *(Nycticorax nycticorax)*, Little Egret *(Egretta garzetta)* and Squacco Heron *(Ardeola ralloides)* have been studied by the author between 1985 and 1989. In all of the four heron species a significant consumption of fish and frogs was observed. Night Heron and Purple Heron tended to capture big fish in smaller numbers. The proportion of insects, fish and frogs was found to be best balanced in the food of Squacco Heron. The overlap inrespect to the body weight of the aliment animal organisms was strikingly high between Little Egret and Squacco Heron. The overlap in size exceeded 50% between Night Heron, Little Egret and Squacco Heron.

The food composition of Purple Heron and Night Heron shows the highest diversity. Consumption of small mammals was observed only in Purple Heron and Night Heron in 1989, when a definite mouse gradation occurred. On the basis of the obtained data the biomass consumption of the nestlings of an average heron colony can be calculated.

Introduction

The analysis of alimentation of heron species breeding in colonies is incomplete according to the literature. The methods used are far from being precise, especially in respect to the quantity and size of food. For these reasons a study the food composition of nestlings of four heron species breeding in the Nagy-tó heron colony (near Tiszaalpári) has been carried out by the author by the means of neck-ligation method. Besides the study of food composition, the aim of the present study was to establish the weight and size of the prey animal organisms fed to the nestlings by different heron species, as well as the biomass consumed during the growth of nestlings. From the data conclusions can be drawn concerning the relation of niche-overlap and niche-width of the four heron species.

The food composition of the four heron species has been studied in details by VASVÁRI (1931, 1939, 1954) and STERBETZ (1954, 1961) in the Carpathian basin. They were basically interested in stomach content, pellets and regurgitated food. Further data are based on studies of regurgitated food (SODHI 1985, SZLIVKA 1986), as well as onfield observations (FASOLA 1986, HAFNER et *al.* 1986).

Materials and Methods

The neck ligation method has been applied for the first time in singing birds by KLUIJVER (1933). Since then this very succesful method has been applied only rarely in big birds, and never in herons. In our investigation a modification of the above method was used: the base of the neck above the fourchette (furcula) was ligated by a suitable string in such a way that it did not obstruct the nestling's breathing but did not allow the nutriment to be swallowed. The nutriment was recovered from the pharynx by means of tweegers after massaging the food towards the beak.

Samples were collected altogether from 61 nestlings in 33 nests of Purple Heron *(Ardea purpurea)*, Night Heron *(Nycticorax nycticorax)*, Little Egret *(Egretta garzetta)* and Squacco Heron *(Ardeola ralloides)* (Table 1). Altogether 165 animal organisms were identified. Samples were taken only twice from the same nest to avoid the disturbance during feeding. The samples were kept in formalin solution. During the sampling procedure no nestling was founded or died.

The elaboration and identification has been carried out in laboratory by means of binocular microscope, based on PAPP (1943), MÓCZÁR (1969) and PINTÉR (1989, 1989).

The wet body weight and the maximum length of prey animal organisms were measured. In the data procening the extent of overlap was calculated on the basis of Schoener equation

$$c_{i_n} = 1 - \frac{1}{2} \Sigma |P_{1_i} - P_{1_i}|$$

The nutriment diversity (width) was calculated by equation

$$H/S/ = -\Sigma P_i \ln P_i$$

and the evenness — on the basis of the formula

$$J = \frac{H}{H_{max}}$$

Results and Discussion

In the food of the four heron species studied Insecta, Pisces, Amphibia and Mammalia were found (Table 2). Besides these consumption of lizards, newts,snails and small mammals (mouse, shrew) is described in the literature (VASVÁRI 1931, 1939, 1954, STERBETZ 1954, 1961), and also SODHI (1985) and SZLIVKA (1986) detected annelids, shell-fish, ringed snake and bird nestlings. However, the percentage of those is negligable. All authors agree that the majority of prey animal organisms come from the following four groups: Insecta, Pisces, Amphibia and Mammalia. The nutriment of heron species is composed mainly from species belonging to the first three groups, regular consumption of mammals is observed only in Purple Heron and Night Heron, while in Little Egrets and Squacco Heron do not feed at all on these preys or only sporadicly.

Table 1. *Number of studied nests and nestlings of different heron species*

	Number of nests	Total number of nestlings
Purple Heron *(Ardea purpurea)*	3	6
Night Heron *(Nycticorax nycticorax)*	18	34
Little Egret *(Egretta garzetta)*	6	9
Squacco Heron *(Ardeola ralloides)*	6	12

Table 2. *Food composition of the four heron species studied*

	A. purpurea		*N. nycticorax*		*E. garzetta*		*A. ralloides*	
	n	w	n	w	n	w	n	w
INSECTA								
Ephemeridae larva							1	0,09
Anizoptera larva							1	0,88
Zygoptera larva					2	0,11		
Coenagrion puella							1	0,005
C. puella larva							3	0,037
Odonata spp.					2	0,4		
Diptera larva							1	—
Naucoris cimicoides							1	0,05
Notonecta glauca							2	0,24
Hidrous piceus larva			1	1,33				
Dytiscus sp.	1	0,9	1	0,1				
Acilius sulcatus					1	0,1		
Coleoptera sp.			1	—				
Dermatoptera					1	0,05		
Indet. Insecta							2	—
	1	0,9	3	1,43	6	0,66	12	1,302
PISCES								
Rutilus rutilus			1	8,4				
Scardinius eritrophtalmus			4	26,6				
Alburnus alburnus			1	6,8	11	2,74	1	0,09
Abramis brama			2	17,7	11	3,94		
Vimba vimba					1	0,13		
Tinca tinca			1	34,79				
Rhodeus sericeus amarus					10	22,32	10	1,32
Carassius carassius							1	8,2
Carassius auratus	5	108,6						
Cyprinus carpio					9	13,81	1	1,35
Misgurnus fossilis	1	7,4	1	5,8				
Ictalurus nebulosus			2	12,5	1	4,34		
Perca fluviatilis							6	2,46
Indet. Pisces	1	1,0	1	1,32				
	7	117,0	13	113,91	43	47,28	19	13,42
AMPHIBIA								
Anura tadpole	1	1,6	27	64,5	8	5,25	15	24,12
Rana ridibunda	1	20,3	2	25,8				
	2	21,9	29	90,3	8	5,25	15	24,12
MAMMALIA								
Microtus arvalis	2	20,4	3	20,45				

n = number of prey animal organisms; w = body weight/gr

The main nutriment of heron species are fish and frogs of different ages. The food composition significantly differs in different heron species. According to VASVÁRI (1931, 1954) Purple Heron and Little Egret are mainly piscivorous. This is proven by the distribution of prey animals according to the body weight shown in Fig. 1, but the fish consumption by Night Heron is also significant. If these results are compared with the distribution according to the number of individuals (Fig. 2), it can be seen that Purple Heron and Night Heron consume big fish in smaller numbers.

It should be taken into consideration that the collected samples originate from medium aged nestlings, since it was physically to apply ligation in very small nestlings,

while older nestlings left the nests if disturbed. Thus the nutriment of adult birds showed differ from those of nestlings probably in size and body weight. Besides this the difficulties in field did not allow, the collection of a significant number of samples, especially in the case of Purple Heron, thus making the comparison less accurate.

It can be seen from Fig. 1. and Fig. 2., that Little Egrets feed the nestlings with many small fish, while in the case of Night Heron frogs prevail in the prey. In both cases fish progenies and tadpoles, are the most common food, and these animals occur in high densities in that places. This suggests that the time of raising nestlings has developed to coincide with the periods of fish and frog swarming during the evolution.

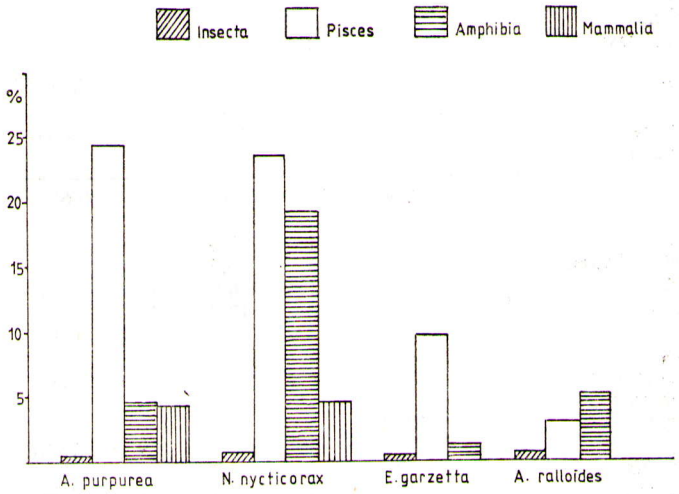

Fig. 1. Distribution of prey weight as percent of total weight

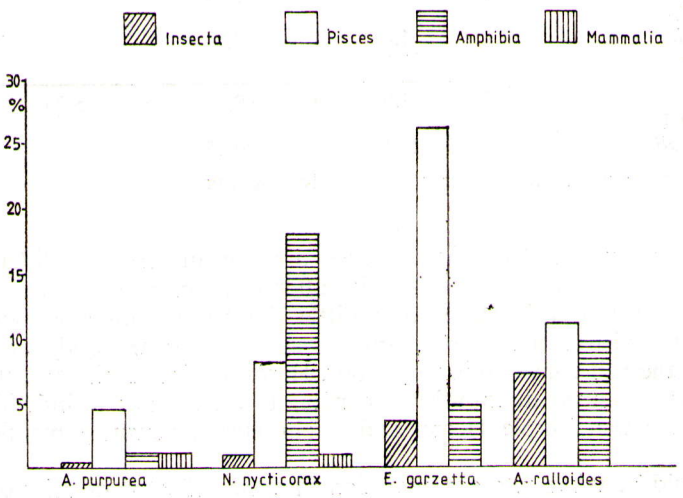

Fig. 2. Distribution of number of as percent of total number of individuals

Among the four heron species the balance of nutriment composition is the best in Squacco Heron, particularly in respect to the distribution according to the number of individuals. Fish species found in the samples agree well both with species composition and frequency of the results of investigations carried out by FARKAS (1989) in the Oxbov-lake of Lakitelek. This back-water is one of the main feeding area of herons. *Alburnus alburnus, Abramis brama, Carassius auratus* and *Cyprinus carpio* occur frequently in that back-water, and these species are often found in the nutriment of herons as well. From 26 fish species described by FARKAS (1989) 11 are found as prey of herons.

The overlap between the species was calculated from the distributions of aliment animal organisms according to both body weight (Table 3) and length (Table 4).

Table 3. *Overlap (C_{i_n}) of prey weight in the four heron species*

	A. purpurea	*N. nycticorax*	*E. garzetta*	*A. ralloides*
A. purpurea	—			
N. nycticorax	0,33	—		
E. garzetta	0,15	0,37	—	
A. ralloides	0,14	0,34	0,94	—

Table 4. *Overlap (C_{i_n}) of prey size in the four heron species*

	A. purpurea	*N. nycticorax*	*E. garzetta*	*A. ralloides*
A. purpurea	—			
N. nycticorax	0,26	—		
E. garzetta	0,08	0,65	—	
A. ralloides	0,002	0,55	0,67	—

The overlap between Purple Heron and Little Egret, and Purple Heron and Squacco Heron is not significant, it is generally about 0,3, while it is substantial between Little Egret and Squacco Heron. So these two species feed their nestlings with prey animals of similar body weight.

The data presented in Table 4 support the above findings, with the difference that there is a significant overlaps between Night Heron, Little Egret and Squacco Heron, which is most probably due to beak size and structure in the first place and also to body size (VASVÁRI 1939).

The diversity of aliment animal organisms in respect to body weight and size probably changes in relation to the body size of various heron species (Table 5), which is reflected by the value of evenness as well. However the use of different of samplesize it can cause distortion in diversity estimations. The values obtained for

Table 5. *Diversity of prey [H/S] according to weight and size, and evenness values of the four heron species*

	Weight H(S)	Evenness J	Size H(S)	Evenness J
A. purpurea	1,96	0,74	1,9	0,7
N. nycticorax	1,94	0,73	2,336	0,86
E. garzetta	1,02	0,46	1,522	0,73
A. ralloides	0,97	0,44	1,496	0,72

Night Heron are strikingly high, which are irrespective to distortions and it might be in causal relation with the frequency as well.

Naturally, the hunting habits can be decisive too, as well as the fact that during nestling raising Night Heron searches for food both day and night. The mainly diurnal Purple Heron hunts at night in this period as well, while the two other species—do not. Further difference in behaviour is that Night Heron flys long distances in serching for food while Purple Heron does not move far away, and Squacco Heron covers the smallest area (VASVÁRI 1931, 1939). The division of feeding area also influences prey capturing. FASOLA (1986) showed that in close to natural habitats Night Heron segregates from Little Egret in feeding areas, probably due to competitive interference.

The samples taken from the same nest showed that in majority of the cases the nestlings were feed with prey animal organisms belonging to the same species, being of nearly identical size in length. This supports the fact that once an adult bird is find a food patch e.g. fish progeny school, todpole groups, it try to make the maximal use of it.

Plant mass was found only in several samples of Night Heron. Most probably they were grasped together with the prey in case of less precise hits. VASVÁRI (1931) describes occurrence of plant remnants in Purple Heron too.

Mammals were not detected in samples collected between 1985 and 1988 but in field mice *(Microtus arvalis)* were found in the food composition of Purple Heron and Night Heron. Although a few were detected in our samples, the inspection of the nests of these two species resulted in finding both fur in pellets and mice in regurgitated food. This phenomenon was observed by us in June, 1989 in the heron colony situated in Pacsmag Lake, Tamási, (Transdanubia), where both fur and remnants of field mice were found not only in nests of Purple Heron and Night Heron, but also in that of Great White Egret *(Casmerodius albus)* and Grey Heron *(Ardea cinerea)*. This is most probably due to a strong gradation of field mice, which led to change in alimentation of the above heron species. Mammals were not found in nutriment of Little Egret and Squacco Heron. The significance of this finding has been emphasized in the literature too. VASVÁRI (1931, 1939) and STERBETZ (1954) found mammals in food composition of Purple Heron and Night Heron in every studied case, while in Little Egret and Squacco Heron it was observed only in few cases. The latter two species seem irrespective to the abundance of field mice, and no change occurred in the food composition so fish and frogs remained their chief food.

The number of breeding heron pairs was registered between 1985 and 1989 in the colony as well. During this period on average 160 pairs of Night Heron, 22 pairs of Little Egret, 14 pairs of Squacco Heron and 14 pairs of Purple Heron bred in the colony. From the average number of nestlungs raised by the herons and the weight of prey fed to one nestling, the amount of biomass exploited from the environment during 28 days of feeding can be calculated. Assuming three food hoarding trips per day the amount is 428.649 g, leaving the food consumed by the adult birds out of consideration.

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Négy gémfaj táplálék-összetételének vizsgálata Tiszaalpár térségében

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Kivonat

Szerző 1985—1989 között vörös gém *(Ardea purpurea)*, bakcsó *(Nycticorax nycticorax)*, kis kócsag *(Egretta garzetta)* és üstökösgém *(Ardeola ralloides)* fiókák nyakelkötéssel kapott táplálékmintáiból a táplálékállatok nedves tömegét és legnagyobb hosszát mérte. Mind a négy gémfaj hal- és békafogyasztása jelentős. A bakcsó és a vörös gém kisebb számú, de nagyobb méretű halakat zsákmányolt. A rovar, hal, béka aránya az üstökösgémnél a legkiegyenlítettebb. A táplálékállatok testtömeg szerinti átfedése a kis kócsag és az üstökösgém közt feltűnően nagy. A hosszméretátfedések a bakcsó, kiskócsag és üstökösgém közt 50% felettiek.

A vörösgém és a bakcsó táplálékösszetétele a leginkább diverz. Kisemlősök fogyasztása csak a vörös gémnél és a bakcsónál fordult elő 1989-ben, mely évben erős pocokgradáció volt. Az adatok alapján kiszámítható egy átlagos gémtelep fiókáinak biomassza-fogyasztása.

ИССЛЕДОВАНИЕ СОСТАВА ПИЩИ ЧЕТЫРЕХ ВИДОВ ЦАПЛИ В ОБЛАСТИ ТИСААЛПАР

Д. Молнар

В период 1985—1989 гг. автором исследован состав пищи птенцов четырех видов цапли: *Ardea purpurea, Nycticorax nycticorax, Egretta garzetta* и *Ardeola ralloides*, методом перевязывания шеи и измерением влажного веса и максимальной длины организмов, встречающихся в образцах пищи. У всех четырех видов значительно потребление рыбы и лягушек. Для *Nycticorax nycticorax* характерно потребление меньшего числа относительно более крупных рыб. Соотношение насекомых, рыб и лягушек является наиболее уравновешенным в пище *Ardeola ralloides*. Для *Egretta garzetta* и *Ardeola ralloides* наблюдалось подчеркнутое перекрытие по весу организмов, встречающихся в пище. Перекрытие организмов по длине тела превосходило 50% для *Nycticorax nycticorax, Egretta garzetta* и *Ardeola ralloides*.

Наиболее разнообразным является состав пищи *Ardea purpurea* и *Nycticorax nycticorax*. Потребление мелких млекопитающих наблюдалось только у *Ardea purpurea* и *Nycticorax nycticorax* в 1989 г. в связи со значительной градацией полевки. На основании полученных данных вычислено потребление биомассы птенцами средней колокии цапли.

Proučavanje sastav hrane kod 4 vrsta čaplja u okolišu Tiszaalpár

GY. MOLNÁR

Rezime

Autor je analizirao sastav hrane, vezivao je vrat čapljićima i merio je vlažnu masu i najveću dužinu grabljene životinje. Proučavao je sledeće vrste čaplja: srebrnasta čaplja *(Egretta garzetta)*, crvena čaplja *(Ardea purpurea)*, gak kvakavac *(Nycticorax nycticorax)* i žuta čaplja *(Ardeola, ralloides)*. Potrošnja ribe i žabe u svim slučajevima je značajna. Gak kvakavac i crvena čaplja su lovili veće ribe ali u manjem broju. Kod žutih čaplja je najuravnoteženija potrošnja bube, ribe i žabe. Težina grabljene životinje je skoro jednak kod ove dve vrste: gak kvakavac i žuta čaplja. Dužina grabljene životinje je isti više nego u 50% slučajevima kod gak kvakavca i srebrnaste žaplje. Sastav hrane crvene čaplje i gak kvakavca je najkolebljiva.

Potrošnja male sisavce je bio značajna samo 1989. godine to jest kod crvene čaplje i gak kvakavca, ali te godine gradacija pacova bila je jaka. Prema dobivenim podacima može se izračunati biomasu potrošene hrane čapljićima u slučaju jednog prosečnog skladište čaplja.

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FROM THE LIFE OF TISZA-RESEARCH WORKING COMMITTEE, WHICH HAS BECOME INTERNATIONAL

DR. ISTVÁN KISS

1910—1990

Dr. István Kiss was born in 1910 in Pusztaföldvár, County Békés. He graduated from the secondary school in Orosháza, and continued his studies in the State Teachers' Training School in Szeged. Already in his student years he was remarkable for his broad interests and erudition; in 1932 he worked in the Hungarian Biological Research Institute in Tihany under the supervision of Prof. GÉZA ENTZ and Prof. ALADÁR SCHERFFER. On several occasions he was awarded prizes for his scientific publications. In 1933 he graduated as teacher in biology-chemistry-geography and in handwork-technique.

He continued his studies at the Szeged University choosing botany as his main subject which played a decisive role in his whole life.

During his long and successful teaching career he worked in Kőszeg, Léva and Pápa training teachers, then in the stormy historic times he was a prisoner of war, and finally, from 1949 till his retirement in 1977 he was the professor and head of the Department of Botany of the Teachers' Training School in Szeged.

His scientific work has been carried out from the beginning of the 30s in the first place in the sodic soil regions of the Great Hungarian Plain. His main fields of research have been taxonomic, cytological and biosynoptical mass production studies of plant microorganisms. He carried out thorough and systematic studies of the algology and hydrological relations of the most typical Hungarian sodic soils. In the course of his investigations 86 new algae, mainly intraspecific variations, have been found in the sodic biotops studied. He made a significant contribution to the algological studies of the dead arms along the Tisza river.

In the center of his interest were again the development of algae mass production and studies of saprobiological and trophic relations in water-basins. His scientific work has not been interrupted even in the years of captivity. He made many interesting observations and returned home with numerous samples collected in the Caucasus mountains.

DR. ISTVÁN KISS defended his PhD thesis in 1939 and his candidate dissertation — in 1959.

The results of his fruitful scientific work have been presented in 183 scientific publications, including the university lecture notes.

His outstanding scientific and teaching activity has been honoured with a number of awards. In 1951 he received the Award of the Hungarian Academy of Sciences, and in 1962 — the title of Eminent Pedagogue.

In 1973 he was awarded the Silver Order of Labour and pedagogic award Pro. Juventure, and in 1987 for his life work — the Homo pro meritis award. In 1983 he received the golden diploma of the state school, and in 1986 — that of the Teachers' Training School.

In 1989 he was elected an honorary member of the Hungarian Hydrological Society.

Several scientific committees, in the first place the Tisza Research Work-Group, as well as the nature conservation area of the Southern Great Hungarian Plain were under his supervision.

Upon his proposition four regions were given a status of nature conservation area.

He succeeded to impress his committment and interest in nature conservancy in his pupils, who are carrying on this important work, keeping the remembrance and deep respect for their professor.

DR. J. DÓZSA

Important scientific publications of dr. ISTVÁN KISS:

1939: Békés vármegye szikes vizeinek mikrovegetációja. I. Orosháza és környéke. (Die Mikrovegetation der Natrongewässer des Comit. Békés. I. Orosháza und dessen Umgebung) — Fol. Crypt. *48*, 216—266.

1942: Bioklimatológiai megfigyelése az *Eudorina elegans* vízvirágzásában. (Bioklimatologische Beobachtungen bei der Wasserblüte der *Eudorina elegans*) — Acta Bot. Szeged, *1*, 81—94.

1957: A *Spirulina platensis planococcus* halmazairól és *Microcystic*-jellegű állapota kérdéséről. (Über Planococcus-Haufen der *Spirulina platensis* und die Frage des *Microcystis*-ähnlichen Zustandes) — Szegedi Ped. Főisk. Évk. *2*, 35—65.

1958: A vízvirágzásról. (Über das Wasserblüte) — Hidrol. Közl. *38*, 381—388.
A növényi mikroszervezetek vízvirágzásos tömegprodukciójának összefoglaló vizsgálata. (Zusammenfassende Untersuchung der Wasserblüte hervorrufenden Massenproduktion pflanzlichen Mikroorganismen) — Szegedi Ped. Főisk. Évk. *3/2*, 23—56.
A növényi mikroszervezetek tömeges felszaporodásának meteorológiai vizsgálata 1930—1957. — TMB, 3—7.
Néhány növényi mikroszervezet tömegprodukciójának meteorológiai elemzése (Meteorologische Analise der Massenproduktion einiger pflanzlicher Mikroorganismen) — Szegedi Ped. Főisk. Évk. *3/2*, 57—72.

1959: A növényi mikroszervezetek tömeges felszaporodása (tömegprodukciója) mint bioindikátorjelenség. (Die Vermehrung (Massenproduktion) der pflanzlichen Mikroorganismen als Bioindikator-Erscheinung) — Biol. Közl. *6*, 111—118.
Adatok a Szeghalom környéki szikes vizek mikrovegetációjához. (Daten zur Mikrovegetation der Natrongewässer in der Umgebung von Szeghalom) — Acta Acad. Ped. Szeged. 39—66.
Synoptische meteorobiologische Analyse der Massenproduktion einiger pflanzlichen Mikroorganismen. — Acta Biol. Acad. Sci. Hung. *9*, 317—342.
Az Orosházakörnyéki szikes vizek mikrovegetációjának vizsgálata. (Untersuchung der Mikrovegetation der Alkaliwasser in der Umgebung von Orosháza) — Szántó-Kovács Muz. Évk. 225—256.

1960: A „tályoggyökér" előfordulása Orosháza határában. (Vorkommen des *Adonis volgensis* STAR. in der Markung von Orosháza) — Szántó-Kovács Múz. Évk. 307—324.

1963: Szinoptikus meteorobiológiai vizsgálatok mikroszervezetek tömegprodukciójában Orosháza környékén. (Synoptische meteorobiologische Untersuchungen an Massenproduktion von pflanzlichen Mikroorganismen in der Umgebung von Orosháza) — Szántó-Kovács Múz. Évk. 80—108.
Vízfeltörések vizsgálata az Orosháza környéki szikes területeken, különös tekintettel a talajállapot és a növényzet változására. (Untersuchungen über Wasserbrüche auf den Sodaböden

in der Umgebung von Orosháza, mit besonderer Rücksicht auf die Änderung des Bodenzustandes und der Pflanzenwelt) — Szegedi Tanárk. Főisk. Tud. Közl. 43—82.
1964: Volvocales- és Euglena-félék tömegprodukcióinak halmozódásos megjelenése „síkvidéki főhn" és „sirokkóhelyzet" időszakában a Duna—Tisza-közén. (Angehäufte Erscheinung der Massenproduktionen der Volvocales und Euglena Arten zwischen des Duna und des Tisza in einer Periode des „Freien Föhns" und der „Schirokko-Lage") — Szegedi Tanárk. Főisk. Tud. Közl. 3—23.
Az *Adonis volgensis* lelőhelyei és népies gyógyászati vonatkozásai Magyarországon. — Szegedi Tanárk. Főisk. Tud. Közl. 25—54.
1965: Néhány dél-alföldi szikes tó dinamikus egyensúlyának eltolódása az elsődleges termelés irányába. (Hochgradiga Verschiebung des dynamischen Gleichgewichtes einiger Natrongewässer der südlichen Ungarischen Tiefebene in Richtung des primären Produktion) — Szegedi Tanárk. Főisk. Tud. Közl. 25—58.
Növényvilág. (Orosháza növényzete) In: Orosháza története és néprajza. I. Szerk.: Nagy Gy. — 60—80.
1966: *Trachelomonas*-félék a Dél-Alföldről. (Trachelomonas-Funde aus der Südlichen Tiefebene Ungarns) — Szegedi Tanárk. Főisk. Tud. Közl. 3—43.
1968: Talajalga-tömegprodukciók néhány dél-alföldi szikes terület vízfeltöréses foltjain. — Hidrobiol. Napok, Tihany 5—7.
Ősgyepmaradvány az orosházi Nagytatársáncon. — Szegedi Tanárk. Főisk. Tud. Közl. 39—61.
A *Botrydiopsis* tömegprodukciós előfordulása a Dél-Alföldön. (*Botrydiopsis*-Massenproduktionen in der Südlichen Tiefebene Ungarns) — Szegedi Tanárk. Főisk. Tud. Közl. 63—76.
1969: Die algologische Erforschung des Natrongewässer in Ungarn, mit besonderer Rücksicht auf die ökologischen und produktionsbiologischen Verhältnisse. — Tihany, 1—3.
Trachelomonas és *Strombomonas* fajok a Dél-Alföld szikes területeiről. (Trachelomonas und Strombomonas Arten aus dem natronhaltigen Gebieten des Alföld) — Szegedi Tanárk. Főisk. Tud. Közl. 3—12.
Tömegprodukciókat alkotó új *Gongrosira*-változat az alföldi szikes talajok vízfeltöréses felületeiről. (Eine Massenproduktion-verursachende neue *Gongrosira*-Variante von den nässenden Flächen der Natronböden des Alföld) — Szegedi Tanárk. Főisk. Tud. Közl. 13—29.
1970: Újabb adatok a Kardoskút-pusztaközponti Fehér-tó algavegetációjához. (Neuere Beiträge zur Algenvegetation des Fehér-tó (Weissen See) bei Kardoskút Pusztaközpont) — Szegedi Tanárk. Főisk. Tud. Közl. 9—43.
Egy bugaci szikes tó vegetációs színeződést előidéző alga-tömegprodukciójáról. (Über die eine Vegetationsfärbung hervorrufende Algen-Massenproduktion einem bugacer Natrongewässer) — Szegedi Tanárk. Főisk. Tud. Közl. 45—53.
A kakasszéki szikes tó mikrovegetációja (Die Mikrovegetation des Natronsees bei Kakasszék) — Szegedi Tanárk. Főisk. Tud. Közl. 55—94.
1972: Ökológiai vizsgálatok a dél-alföldi szikesek mikrovegetációjában. — X. Biol. Vándorgy. Szeged, 72.
1973: Botanikai kutatások a hazai szikesek hasznosítása terén. — Agrobot. Tanácsk. Debrecen, 28.
A hazai szikes vizek további feltárásának néhány kérdése a makro- és mikrovegetáció kutatása szempontjából. (Einige Fragen bezüglich der weiteren Erschließung und Nutzbarmachung der ungarischen Natrongewässer vom Gesichtspunkte der Makro- und Mikrovegetationsforschung) — Szegedi Tanárk. Főisk. Tud. Közl. 3—18.
1974: Néhány természetvédelmi terület botanikai jelentősége a tiszántúli Dél-Alföldön. — XI. Biol. Vándorgy. 14—15.
1975: Mass-production occurrence of the Botrydium species in the inundation areas of the Tisza and Maros in the environs of Szeged. — T. (Sz) *10*, 39—44.
1976: Néhány Duna—Tisza-közi szikes tó algaflórájának ökológiai vizsgálata. — Magyar Biol. Társ. XII. Vándorgy. Debrecen, 114—115.
A pusztaföldvári Nagytatársánc és a rajta levő ősgyep természetvédelmi, tudományos és közművelődési jelentősége. — Békés Megyei Term. véd. Évk. Békéscsaba, 35—59.
1977: Investigation of the water blooms of *Eudorina elegans* in the dead-arm of the river Tisza at the community Mártély. — T. (Sz) *12*, 37—47.
Variability of *Scenedesmus ecornis* (Ralfs) Chod. in the dead-arm of the river Tisza at Körtvélyes. — T. (Sz) *12*, 49—55.
1978: (Kiss, I.—Marián, M.—Horváth, I.) Effect on the antropogeneous pollution on the Tisza and its tributaries. — T. (Sz) *13*, 163—168.
Algological investigation in the dead-Tisza at Lakitelek-Tőserdő. — T. (Sz) *12*, 27—47.
Occurrence of *Synura uvella* Ehr. var. *tiszaensis n.* var. in the dead arm of the river Tisza near Lakitelek. — T. (Sz) *13*, 49—54.

Eutrophication of the dead arms at Cibakháza, Csongrád, Tiszaug and Alpár in the mirror of the algal flora and algal vegetation. — T. (Sz) *13*, 203—204.
1979: Problems of the environmental and nature conversation of dead-arms and tributaries in the Upper-Tisza Region. — T. (Sz) *14*, 242—248.
Algological investigations in the dead arm of the river Tisza and Tiszaug. — T. (Sz) *14*, 41—61.
Seltene *Strombomonas*-Arten aus den toten Armen der Tisza (Theiss) am mittleren und oberen Flusslauf. — T. (Sz) *14*, 63—70.
1982: The algal flora and its seasonal aspects in the Körtvélyes and Mártély backwater of the Tisza. — T. (Sz) *17*, 51—65.
1983: Szikes vizek, szikes talajok algológiai vizsgálata a Nyírség és a Hajdúság területén. (Algologische Untersuchung von Natrongewässer im Gebiete der Nyírség und Hajdúság (Ungarn) — Acta Acad. Ped. Szeged., Ser. Biol-Geogr. 3—26.
Microcystis type planococcus state of *Anabaena* in the transitorily alkalinized Tisza river. — T. (Sz) *18*, 23—31.
The role of seasonal, edaphic and biotic factors in the development of phytoplancton communities in the Cibakháza backwater of the Tisza. — T. (Sz) *18*, 33—46.
1984: Algological investigations in the waters of the Tisza Basin at Alpár. — T. (Sz) *19*, 49—58.
1985: The development of starking algal mass productions at the Alpár-basin region on the Tisza-valley. — T. (Sz) *20*, 13—28.
A légköri ionizáció szerepe az alga-tömegprodukciók kialakulásában. (Die Rolle der atmosphaerischen ionisation in der Entstehung von Algenmassenproduktionen) — Acta Acad. Ped. Szeged. Ser. Biol-Geogr. 3—22.
1986: Az Alpári-medence algáinak tanulmányozása a környezetvédelem érdekében. — Kézirat, megjelenés alatt. Acta Acad. Paed. Szeged.
1986: Problems of the environmental protection of waters in the Alpár basin. — XVII. Congr. Hung. Biol. Soc. 52—53.
1987: Soil algae from the Alpár basin. — T. (Sz) *22*, 131.
1988: Az Alpári-medence algáinak tanulmányozása a környezetvédelem érdekében. (Untersuchung der Algen im Alpár-Becken im Interesse des Umgebungschutzes) — Acta Acad. Ped. Szeged, 23—45.
1989: Magyarország szikes területein végzett algológiai vizsgálataim áttekintése. — XXXI. Hidrobiol. Napok, Tihany. 9.

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TISZA-RESEARCH CONFERENCE XX (1989)

Compiled by

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I. Lecture on studies from the Tisza research in the Soviet Union

KOMENDÁR, L.:

On the scientific work carried out in 1989 by the Tisza Research Group in Uzgorod and its future trends

Complex botanical investigations of the Ukranian stretch of the Tisza river have been carried out by the Department of Botany, University of Uzgorod.

In the syntaxonomic studies participated V. I. KOMENDÁR, V. V. KRICSFALUSI, from the Academy of Sciences in Lvov K. A. MALINOVSKI, from the University in Ufa B. M. MIRKIN and AJRAT IZSBRIDIN, I. FODOR. Research continued in the nature conservation area, in the first place on the monographic description of rare epheneroid plants: V. I. SZALUDOS defended his candidate thesis on *Leucojum aestivum* species and G. MEZŐ—KRICSFALUSI — on *Ornithogallum umbellatum*.

Successful work has been carried out by N. V. SUMCSKAJA (*Leucojum vernum* L.), K. S. PAVLINA (*Rosa canina* L.), S. P. LISCSUK (*Rumex alpinus* L.) in the preparation of their candidate dissertations. V. V. KRICSFALUSI and V. I. KOMENDÁR completed their book on rare plants (Carpathian flora), which is at present in press in Lvov.

BEATA MOLNÁR completed her diploma work on aquatic plants under the supervision of V. I. KOMENDÁR and E. SZALMA (Szeged).

Interesting joint research has been initiated on *Iris sibirica* species on the territory of the Soviet Union and Hungary (V. I. KOMENDÁR, S. GULYÁS (Szeged) and GY. CSIZMAZIA (Szeged)).

The phytocenological, phytogeographical, ecological and zoocenological aspects of this species have been investigated.

In the field of zoologic research further studies of vertebrate fauna are envisaged. A plan for joint research in the Sub-Carpathian Nature Conservation Area has been worked out in the field of dynamics of bird populations along different stretches of the Tisza.

Further results were obtained on the influence of micromammalia on the Tisza dam (endangering the flood protection).

The manuscript of a joint Ukranian—Hungarian—Jugoslavian educational book on the Tisza river has been completed (KOMENDÁR—CSIZMAZIA—MIKES).

II. Reports on the Hungarian Tisza reach

HEGEDŰS, MÁRIA and DOBLER, ENIKŐ:

Comparative studies of the Dead-Tisza arms

In 1989 investigations have been carried out in six dead-arms in the southern stretch of the Tisza. Samples have been collected monthly during the vegetation periods, and one sample was taken every season as well.

Chemical parameters tested routinely in the practice of water-supply management have been measured; in the course of the biological studies quantitative analysis of chlorophill forms, saprobiological evaluation, as well as algae-count and biomass determination in two dead-arms have been carried out.

The following results were obtained:

— Saprobiological evaluation carried out by ecological methods showed that the water in the dead-arms at Atka, Mártély and Serházzug was typically beta-mesosaprobic.

The water in the dead-arms at Körtvélyes, Gyála and Nagyfa differed significantly from that of the previous group and was of alpha-beta mesosaprobic quality.

— The level of trophicity estimated on the basis of a-chlorophill content showed significant variations. The lowest (mesotrophic) level of trophicity was registered in the dead-arms at Mártély and Atka, and the highest — poli- or hypertrophic — in the dead-arm at Nagyfa. The rest of the dead-arms were characterized by alternate changes of eutrophic and eupolitrophic states.

— Algae-count and biomass determinations were carried out in the water samples collected in the dead-arms at Mártély and Atka. It was found that the annual biomass content differred significantly in the two dead-arms, which can be explained by the differences in their species compositions.

BANCSI, I.:

Rotatoria fauna in the reed-grass and marsh vegetation of the Kisköre storage-lake

On the territory of the Kisköre storage-lake, along the dead-arms and mortlakes rich reed-grass vegetation developed. In the shallow waters and island-like emergences rich marsh vegetation can be found. A cross-stretch of the arm at Csapó and an old dead-arm of the Tisza with well-developed reed-grass were chosen for the present study. The following plant populations were investigated:

— *Scirpo-Phragmitetum-phragmitetosum*
— *Typhetum angustifoliae*
— *Nymphoidetum peltatae*
— *Trapetum natantis*
— *Nymphaeetum albo-luteae.*

In the course of the studies water samples were collected from free-water and plant-covered areas and from the coating of leaves and stems of various plant species.

81 Rotatoria species were identified in the samples. The fauna of water-chestnut proved to be the richest. 30 Rotatoria taxons were found in water-chestnuts of both the Csapó and Nagy-Morotva-arms. In the live-coating of water-chestnut 23 taxons were identified.

The areas covered by *Nymphoidetum peltatae* and its live-coating were comparatively poor in Rotatoria.

Most of the Rotatoria taxons were found only in a few samples. From 81 taxons 29 were detected only once, 18 — twice and 10 — three times. The rest of them were found in 4—11 samples.

The characteristic Rotatoria species of the metaphyton were as follows: *Anuraeopsis fissa, Brachionus quadridentatus, Euchlanis dilatata, Lecane bulla, Mythilina ventralis* var. *macracantha, Synchaeta stylata, Testudinella patina, Trichocerca pusilla.* Among rarely found species *Colurella obtusa, Conochilus dossuarius, Eosphora najas, Lacinularia flosculosa, Lecane myriofilli* and *Trichocerca scipio* should be mentioned.

WAIJANDT, J.:

Changes of water quality of the Tisza river between 1970 and 1987

A process of water purification is characteristic for the second biggest Hungarian river in the stretch between the mouth of the Sajó river and Szolnok. Because of the considerable water consumption of Szolnok for industrial purposes and drinkingwater supply, the water quality and its long-term changes are of outmost importance. The analysis is based on the evaluation of the results obtained in the studies of water samples collected weekly from the Tisza reach at Szolnok (335,4 river km) in the period 1970—1988. In order to obtain sufficiently detailed information on the water quality the most important 27 water quality parameters have been considered in the present study.

The changes observed in the annual maximal, minimal and mean values of several parameters in the period between 1970 and 1988 were presented. The changes in the water quality reflected by the mean values of the quality parameters were not considerable, altogether deterioration of water quality was observed. The direction and extent of the changes were determined for the periods 1970—1978 and 1979—1988 by means of regression analysis. It was found that a considerable deterioration of water quality took place in the 70s. Among the parameters studied 52% showed an improved or unchanged water quality, 22% indicated a slight and 22% — considerable deterioration between 1979 and 1988.

The quality of water in the Tisza met the I. class requirements when used for industrial and irrigation purposes during the whole period studied. From 1976 on it corresponded only to II. class in covering the needs of fishery or drinking-water supply, and in this field a further deterioration of water quality is to be expected.

SZITÓ, A.:

Seasonal changes in mosquito (Culicidae) fauna in the Kisköre storage-lake

Several high water periods affected unfavourably the development of mosquito fauna, thus till the end of May the individual density was low and the number of bites/hour hardly reached 50—60. From mid-June the number of individuals increased drastically and e.g. at Tiszafüred 3888 bites/hour were measured, while at Kisköre only (!) 120.

This year anopheles species were of a secondary importance, however, *Aedes rossicus* and *Aedes nigrinus* were observed in large numbers. The following species were detected in trace numbers: *Ae. cataphilla, Ae. sticticus, Ae. cinereus*. In comparison to the previous years a decrease was observed in the number of *Aedes vexans*. In July the number of bites was unbearable in all basins of the storage-lake.

The composition of mosquito fauna changed in summer and autumn, but the number of individuals, which belonged to the summer dominant species, was the highest in autumn as well.

SZITÓ, A. and SZABÓ, T.:

The sediment-fauna of the Tisza river based on the longitudinal segment studies in 1989

The three longitudinal segments described in our previuos studies have been investigated in a low-water period, after summer drought. The present study was carried out immediately after the withdrawal of the high water and the following observations were made:

— The upper Tisza-stretch, approximately till Tuzsér, is poor in Oligochaeta and Chironomida, regarding both the species and individual numbers, mollusks similarly to the previous results were absent, later, however, an increase in Oligochaeta and Chrionomida species and individual numbers was observed. This was experienced not only in the shore region, but as well in the current.

Mollusks can be found in the Tisza-stretch above the mouth of Bodrog, in accordance with previous results their appearance can be detected from here on in varying number of individuals, mainly in the shore-band. Phryganea and water-flea occur in the places characterized by rapid-flow and stony, gravel riverbed.

Contrary to the previous observations some representatives of the sedimental fauna groups could be found in all tributaries. 1 km above the mouth of the Maros a high individual density of Oligochaeta, characteristic for waste-waters was detected in the sandy sediment of the left-hand shore (5000—8000 ind./m^2).

BOTOS, MARGIT:

Studies of Oligochaeta in the Hungarian stretch of the Tisza

Aquatic annelids (Oligochaeta) are important participants in mater and energy turnover in dead- and fresh water ecosystems. They play an important role in the degradation of organic matter in the sediment, contribute to water selfpurification and are valuable fish nutriment.

Oligochaeta are dominant fauna elements in the macrozoobenthos of freshwaters, in the first place in the shore regions (FERENCZ 1979), thus their quantitative and qualitative investigations provide information on the quality of aquatic environment as well.

In the presentation the author reports on the newest results obtained in 1989. The results accumulated in the course of the Tisza research carried out systematically for several years enable the analysis of recent changes.

BÁBA, K.:

Seasonal malacocenological studies in the region of Tisza-alpár

A study of snail populations of *Fraxino-Alnetum, Molinetum coeruleae, Alopecuretum pratensis* plant associations based on 204 live and 384 dead individuals belonging to 13 species was carried out in 1988—89.

The collected data were analysed by means of mathematical methods.

Seasonally spring and summer-autumn aspects can be distinguished in *Fraxino-Alnetum* and *Molinetum*. In dry *Alopecuretum* spring, summer and autumn aspects can be distinguished. The aspect-formation is influenced by changes in the characterspecies populations. In different biotops the propagation of identical species occur in different months. In biotops differring in humidity the variability of ecological species groups decreases with drying. The herbivor and saprophage elements are complementary, and with drying the latter types become dominant. From zoogeographical point of view drying leads to prevalence of holoarctic elements having a broad range of endurance.

GYOVAI, F.:

Dynamics (density, reproduction, mortality) of moor frog (RANA ARVALIS WOLTERSTORFFI) population in the Tisza flood-plain forest-biocenosis

A 70% decrease in the population density and biomass of R. arvalis population in Tiszaalpár has been observed in 1989 in comparison to the previous year. Here, in alder forest the autumn biomass was 9,2 kg/ha. In the same period in the Tisza Körtvélyes—Barci rét flood-plain the biomass measured in the plant associations was as follows: *Caricetum gracilis:* 1,7 kg/ha, dry cutting area 4,2 kg/ha, wet cutting area 7,6 kg/ha, *Ulmo-Fraxinetum Populus canescens facies:* 13,2 kg/ha.

In Tiszaalpár the average number of eggs found in March for two-year old small size females was 489 and for three-year old bigger size females — 1104. In spring an enormous number of eggs started to develop in 14—45 cm deep oligotrophic marshes. However, the larval development has been hampered by later drainages.

The above data and unfavourable developments observed clearly show that drainages caused the most heavy damages. It is by all means justified to preserve the fringing forests and marshes in a close to natural state.

KOVÁCS, P.:

Ichthyofaunistic evaluation of catches of fishers and anglers in the Kisköre storage-lake (1975—1988)

General environmental and ichthyobiological conditions before the building of the storage- lake.

Characteristics of the new living-space, its influence on fish population.

Evaluation of species composition on the basis of earlier literary data.

Fish species occurrence judged by catching results: (barbel, tench, bullhead pout, amur, silver carp, bighead carp, pike, pike-perch, bream, silur, eel, sturgeon, carp, crucian, carp-bream, new species in the storache-lake).

General statements, conclusions:

— composition of fish population,
— influence of artificial fish introduction
— migration,

— fish nutriment supply,
— fish protection,
— recapture
— ecological and water-management aspects of fishery and angling.

FARKAS, Á.:

Age determination, distribution and frequency of occurrence of carp-bream (*Acipenser ruthenus* L.) in the lower stretch of the Tisza river

Carp-bream is the most valuable representative of the indigenous ichthyofauna in the Tisza. It occurs frequently in the lower Tisza between 202 and 214 river km. Such stretches are found in the Maros—Tisza influx and in the vicinity of the Algyő bridge. If marl, steep shore is combined with deep water and hard-set river bed, the occurrence of carp-bream is to be expected with high probability.

Age determination was carried out on the basis of pectoralray sections.

SZALMA, E.:

Vegetation mapping of reed-grass population of the Kisköre storage-lake

The water-basins found on the territory of Kisköre storage-lake can not be considered homogenous. At least four different area can be distinguished in the storage lake. This finding is based not only on the results of chemical analysis but as well on the results of plant, faunistic and cenological investigations.

The gradual filling up of the area facilitates fast and continuous spreading of the plant associations found in the storage-lake. In several exposed locations of the storage-lake a process of marsh formation and parallel to this an increased eutrophization were observed.

III. Reports on research in the Jugoslavian stretch of the river Tisza

GAJIN, S., PETROVIĆ, O., MATAVULJ, M., GANTAR, M. and RADNOVIĆ, D.:

Presence of naphtha and phenol oxidizing bacteria in the water of the Jugoslavian stretch of the river Tisza

Lately the pollution of surface waters by naphtha and phenol imposes ever growing problems. Since the matabolic activity of the microorganisms determines the water selfpurification from organic matter, the authors followed the presence of microbial groups in the water of the Jugoslavian stretch of the Tisza, which are capable to purify it from naphtha and phenol.

In the tow-year period studied naphtha and phenol degrading bacteria were temporarily or permanently present in the water of the Tisza in all locations.

The proportion of both bacterial groups, but in the first place that of the naphtha-oxidizing ones in the heterotrophic populations was very high (naphtha-oxidizing — 38—128%, phenol-oxidizing — 0,8—5,6%). The presence of these bacteria in the Tisza points at a temporary or permanent pollution by naphtha and phenol, but at the same time indicates that the metabolic activity of the autochthon microorganisms contribute to the selfpurification (autopurification) of the Tisza water.

BUDAKOV, LJILJANA:

Growth of *Rutilus rutilis*L. 1758) in the Tisza and its tributaries

On the basis of material collected in the lower course of the Tisza, in the Dead-Tisza and within the Ó-Bega park region in 1987, the author reconstructed the longitudinal and mass growth, longitudinal and mass growth rate, and studied with the help of theoretical calculations the growth rate and growth constant. It was found that the longitudinal and mass growth showed an increase with species age, while the growth rate was the highest in the first and second year of life. The mass growth rate showed an increasing tendency and was the highest in 4^+-developmental group. The highest longitudinal and mass growth was observed in the population found in the Tisza, and the lowest — in Ó-Bega. The differences in the growth rate can be related to environmental factors. As far as the growth rate and growth constant are concerned, two periods can be distinguished — before and after the third year of life.

TÓTH, MÁRTA and PUJIN, VLASTA:

Combined effect of the Bega and Tisza on zooplankton composition

The lecture deals with the results of chemical and physical analysis carried out in 1988—89, as well as with the composition of the zooplankton of the lower Tisza and its left-hand tributary — Bega. The determination of physical and chemical characteristics showed that both rivers had a slightly alkaline pH, corresponding to average values 0,82 in the Tisza and 0,98 mg O_2/l in the Bega. The mean concentration of ammonium ion was 4,83 in the Tisza and 3,85 mg/l in the Bega.

In the two rivers altogether 36 zooplankton taxons were identified — 32 in the Tisza and 34 in the Bega, i.e. 3 Protozoa in both rivers, 27 Rotatoria — 24 in the Tisza and 25 in the Bega, 4 Cladocera in both rivers and 2 Copepoda — 1 in the Tisza and 2 in the Bega. The number of species varied significantly in different years and seasons. In the Tisza the lowest number of species was observed in the spring of 1988 and the highest — in the summer of 1989. In the Bega the lowest number of species was registerd in the spring of 1989 and the highest one — in the summer of 1988.

The results of the studies prove that there is a marked combined effect of the Tisza and the Bega on the composition of zooplankton, since 78 samples, representing more than 50%, had identical species composition.

RATAJAC, RUŽICA:

Composition and dynamics of Cladocera in the Tisza

Between 1981 and 1988 samples have been collected seasonally, at times even more frequently at five locations along the Tisza. Altogether 22 Cladocera species have been identified. Quantitative composition and number of species differed from year to year and from season to season. As far as the seasonal variations are concerned, it can be started that in winter the number of species is the lowest, it increases in spring and summer and reaches the maximum in autumn. Only in 1982 and 1988 the number of species was the highest in summer. In every season *Alona quadrangularis, Bosmina longirostris* and *Chydorus sphaericus* were present. Other species occurred more rarely. *Diaphonosoma brachyurum* was more frequently observed in the warm periods of the year.

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