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INFESTATION OF TAILLESS AMPHIBIANS OF GENUS RANA BY TREMATODES IN THE VALLEY OF THE TISA RIVER (YUGOSLAVIA)

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Abstract

On a section comprising the territory of Bečej and Ečka a parasitological search has been carried out in 13 hosts of the species *Rana esculenta* and 9 individuals of the species *Rana ridibunda*. Almost the same extensity of invadedness in both species of frogs has been stated (77.8% and 76.9%), while the specimens of the species *Rana ridibunda* have shown a greater intensivity of infestation. Nine species of trematodes have been defined: *Diplodiscus subclavatus* GOETE, *Gorgodera cygnoides* ZEDER, *Haematoloechus (Pneumonoeces) variegatus* RUDOLPHI, *Haematoloechus (Pneumonoeces) schulzei* WUNDSCH, *Opisthyoglyphe ranae* FRÖLICH, *Cephalogonimus retusus* DUJARDIN, *Pleurogenoides medians* OLSSON, *Prosotocus confusus* LOOSS and *Pleurogenes claviger* RUDOLPHI.

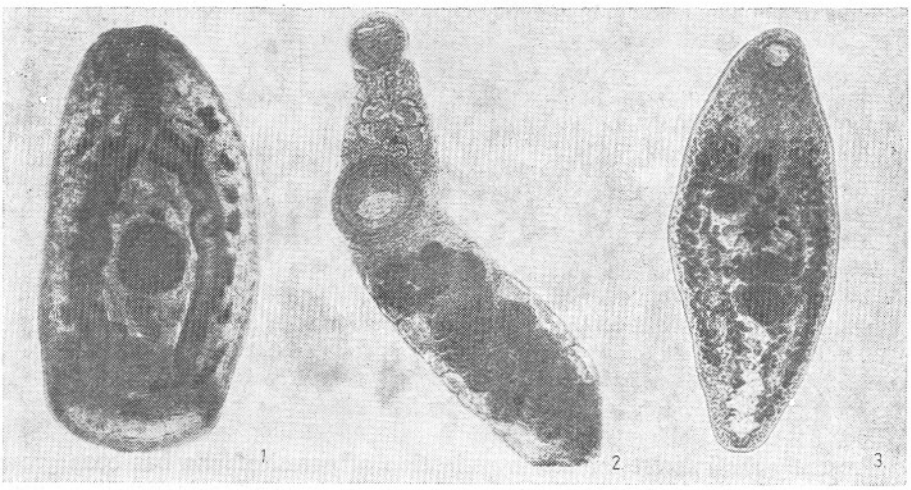

Fig. 1 — *Diplodiscus subclavatus*
Fig. 2 — *Gorgodera cygnoides*
Fig. 3 — *Opisthyoglyphe ranae*

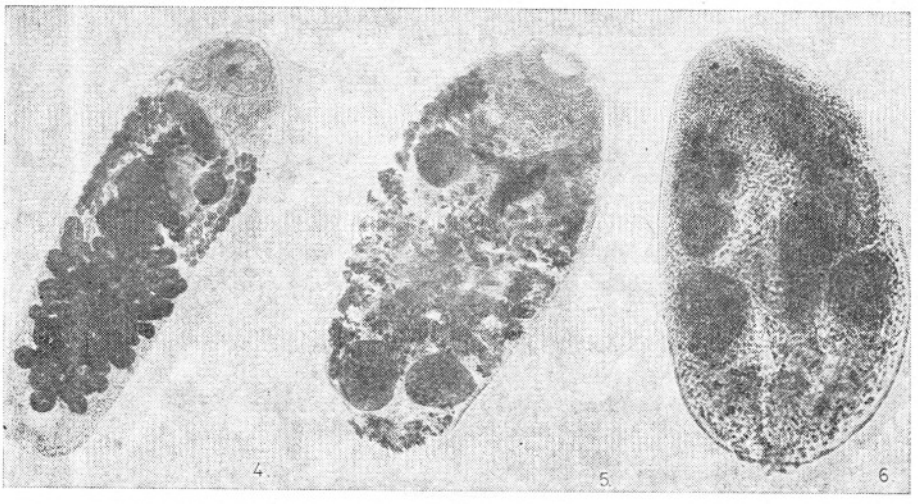

Fig. 4 — *Cephalogonimus retusus*
Fig. 5 — *Pleurogenes claviger*
Fig. 6 — *Pleurogenoides medians*

Fig. 7 — *Prosotocus confusus*

Introduction

Presently the interest for the investigation of parasitofauna has been growing constantly both with respect to their place in the systems and their spread, as well as from the ecological aspect. The basic problem in the domain of ecology is, of course, to state how the parasites develop in the interaction on the line exterior environment-parasite-host, as well as to define their role in given ecosystems, in this case, primarily in the acquatic ones. Namely due to alimentary concatenation, amphibians, particularly the hosts of endohelminths, are organically connected to a great deal with the members of marshy biocenoses, among others with many economically important species.

The investigation of helminthofauna of tetrapodes from the open air of Vojvodina (the northern part of Yugoslavia) so far has been sporadically carried out, and that of the hosts of ornitofauna (SEY et *al.* 1971; SOTI et *al.* 1972; MIKES et *al.* 1974), of terriofauna — the mouselike rodents from agrobiocenoses (MÉSZÁROS et *al.* 1983), from small mammals of the periodically inundated zone of the Tisa River (MIKES, HABIJAN, MIKES, 1986), as well as *Anura,* also from the valley of the Tisa River (MIKES, POPOVIĆ 1988). Data on helminthofauna Amphibia in Yugoslavia can be found only in works HRISTOVSKI 1968, 1974 from the territory of Macedonia, and trematodes of the small cormorant *(Phalacrocorax pygmaeus)* from the territory of the Scutari Lake have been treated by POPOVIĆ (in press).

In this paper we present the infestation of two species of hosts — the tailless amphibians from genus *Rana (R. esculenta)*-13 frogs and *R. ridibunda*-9 frogs by trematodes. Beside defining the level of the quantitative and qualitative invadedness of the hosts by certain groups of helminths, the analysis of the collected material is also concerend with the defining of the taxonomic belonging of the discovered termatodes.

Materials and Methods

The analysis of the infestation of the hosts by endohelminths has been performed on a total of 22 individuals of tailless amphibians (13 ind. *Rana esculenta* and 9 ind. *R. ridibunda*). The hosts originate from two specific localities in the valley of the Tisa River. One locality is situated in the valley of the Tisa River near Bečej. The biotope itself represents a littoral zone of the river, which is owergrown by *Amorpha fruticosa* in the frame of *Saliceto-Populetum nigrae,* a component which is situated in a narrow girdle of only 30—150 m between the protective dam and the river. The other locality comprises the periodically inundated territory of the estuary of the Begej into the Tisa River with Carska Bara and several large anthropegenous ponds. The analysed material originates from the pit of Carska bara surrounded by *Saliceto-Populetum nigrae* components, in front of which there is a very developed *Scripo-Phragmitetum* marshy community and a flotant association *Nymphaeetum albo-luteae.*

After having noted the data on localities, the data of catch, and elaborated the host (taxonomic belonging, biometric data, sex and age composition), we have submitted each individual to the parasitological examination by standard method. The search of the host with respect to the infestation by endoparasitic helminths has been performed at the level of lungs, urinary bladder and at some levels of the digestive tract (Gaster, intestinum, rectum).

The collected parasites have been elaborated macrotechnically, and conserved in 70% alcohol, in order to be eleborated and defined microtechnically later on. Permanent preparations have been stained with alaun-carmin and fixed by Canada balsam. The defining has been performed according to the EDELÉNYI key (1974).

The extensity and intensivity of the infestation by indigenous trematodes

The results of the analysis of infestation in general show a high degree of infestation by trematodes (about 3/4 of the examined individuals are invaded), and that almost with the same extensity in both species of hosts (Tab. 1). When analysing the

distribution of parasites according to their localization, it has been stated that trematodes occur mainly in intestinum and lungs, and that in the spacies *R. ridibunda* in a somewhat higher percentage. The extensity of infestation shows a high level of infected condition in both species of hosts — in the case of *R. esculenta* there is in the intestinum a four times greater number, and in *R. ridibunda* a two times greater number of trematodes in relation to the infestation of lungs.

The infestation of the host by trematodes with respect to the intensivity of the invadedness of organs shows a relatively low level of the infestation of lungs in relation to intestinum (Table 1). It may be noticed that the high level of invadedness

Tab. 1. *The locality of invasion of the host with Trematods*

Host	№			Organum														
				Intestinum								Pulmo				Ves. urin.		
	EXP	INF	%	№	%	1—10	11—20	36—45	51—60	71—75		%	1—5	16—10		№	%	1—5
Rana esculenta	13	10	76,9	8	80,0	2	3	2	1		2	20,0	2			1	10,0	1
Rana ridibunda	9	7	77,8	6	85,7	1	2		2	1	3	42,8	2	1				

of the intestinum makes its appearance simultaneously with an important intensivity in the category of above 50 percent trematodes per host, and that with a somewhat increased number of individuals in the species *R. ridibunda.*

Eight species of trematodes, out of nine defined species, have been stated in the host *R. esculenta,* and in *R. ridibunda.* It has to be added that liver-flukes *Haematoloechus schulzei* is absent in the species *R. esculenta,* and the liver-fluke *Gorgodera cygnoides* has not been stated in the host *R. ridibunda* (Table 2). The remaining seven

Tab. 2. *The extensity and intensity of the invasion of the host with Trematods*

Trematodes	Rana esculenta								Rana ridibunda								
	Extensity			Intensity					Extensity			Intensity					
	№								№								
	EXP	INF	%	1—5	6—10	11—15	31—35	51—55	EXP	INF	%	1—5	6—10	11—15	16—20	21—25	46—51
1. *Diplodiscus subclavatus*	10	3	30,0	2	1				7	6	85,7	6					
2. *Gorgodera cygnoides*	10	2	20,0	2					7	—							
3. *Haemotolechus variegatus*	10	1	10,0	1					7	2	28,6	2					
4. *Haematoloechus schulzei*	10								7	2	28,6	2					
5. *Opisthyoglyphe ranae*	10	7	70,0	5	1		1		7	3	42,8			1	1		1
6. *Clephalogonimus retusus*	10	6	60,0	2	1	1	1	1	7	6	85,7	3	1			1	1
7. *Pleurogenes claviger*	10	1	10,0	1					7	2	28,6	2					
8. *Pleurogenoides medians*	10	1	10,0	1					7	1	14,3	1					
9. *Prosotocus confusus*	10	1	10,0	1					7	2	28,6		2				

species of trematodes have been found in both examined species of hosts. The liver-flukes and *Opisthyoglyphe ranae* and *Cephalogonimus retusus* in both species of hosts show a high level of the extensity of infestation (from 42.8% to 85.7%), and the species *Diplodiscus subclavatus* is present in the case of *R. ridibunda*.

Faunistic and taxonomic survey of defined species of trematodes

In the two examined species of Anura, 9 species of trematodes (belonging to 5 families) have been stated. It makes the half of the already known 18 species of trematodes in frogs. The following species of trematodes have been determined:

1. *Diplodiscus subclavatus* (PALLAS, 1790), GOEZE, 1782
   Host: *Rana esculenta* L. — discovered in 3 individuals
   Rana ridibunda PALLAS — discovered in 6 individuals
   Locality: Bečej
   Localization: intestinum

2. *Gorgodera cygnoides* ZEDER
   Host: *Rana esculenta* L. — 2 infested individuals
   Locality: Ečka, Bečej
   Localization: vesica urinaria

3. *Haematoloechus variegatus* RUDOLPHI
   Host: *Rana esculenta* L. — 1 infested individual
   Rana ridibunda PALLAS — 2 infested individuals
   Locality: Bečej
   Localization: pulmo

4. *Haematoloechus schulzei* WUNDSCH
   Host: *Rana ridibunda* PALLAS — 2 infested individuals
   Locality: Bečej
   Localization: pulmo

5. *Optisthyoglyphe rane* FRÖHLICH
   Host: *Rana esculenta* L. — 7 infested hosts
   Rana ridibunda PALLAS — 3 infested hosts
   Locality: Bečej
   Localization: instestinum

6. *Cephalogonimus retusus* DUJARDIN
   Host: *Rana esculenta* L. — 6 infested hosts
   Rana ridibunda PALLAS — 6 infested hosts
   Locality: Bečej
   Localization: intestinum

7. *Pleurogenes claviger* RUDOPHI
   Host: *Rana esculenta* L. — infested individual
   Rana ridibunda PALLAS — 2 infested individuals
   Locality: Bečej
   Localization: intestinum

8. *Pleurogenoides medians* OLSSON
Host: *Rana esculenta* L. — 1 infested individual
Rana ridibunda PALLAS — 1 infested individual
Locality: Bečej
Localization: intestinum

9. *Prostocus confusus* LOOSS
Host: *Rana esculenta* L. — 1 infested individual
Rana ridubunda PALLAS — 2 infested individuals
Locality: Bečej
Localization: intestinum

Morphological features of the defined trematodes

1. *Diplodiscus subclavatus*

The lenght of the body is 1.4 mm—3.5 mm, and the width 0.58—1.27 mm. The body is pear-shaped. The abdominal sucker is terminal, very developed. In the middle part of the abdominal sucker, another sucker may be seen. The testis is a little greater than the oral sucker 316,0—647,8×276,5—474,0 μm. The overy is smaller than the testis 110.6—260.7×118.5—244.9 μm. The dimensions of the eggs 86.9—158× ×63.2—86.9 μm.

2. *Gorgodera cygnoides*

The length of the body is 1.8 mm and 5.79 mm, and the width 0.49 mm, 1.22 mm). Oral sucker has smaller dimensions (221.2 μm and 434.5 μm×244.9 μm and 505.6 μm) than the abdominal one (363.4 μm and 948.0 μm×379.2 μm and 897 μm). Testis are not clearly divided in the left and right group (126.4—395.0 μm×189.6—537.2 μm). The dimensions of the ovary are 173.8 μm and 521.4 μm×237.0 μm and 442.4 μm. The eggs are oval: 30.0—36.25×18.75—25.0 μm.

3. *Haematoloechus variegatus*

The length of the body is 5.0—9.0 mm, and the width 0.916—1.659 mm. The surface of the body does not possess any pricks. Oral sucker is subterminal (355.5—655.7×260.7—647.8 μm). The abdominal sucker has smaller dimensions (244.9—308.1×252.8—308.1 μm). The testis are elongated-oval. They are situated on the medial line, one behind the other (T_1=553.0—813.7×450.3—521.4 μm; T_2= =529.3—1.343×347.6—584.6 μm). The dimensions of the ovary: 323.9—884.8× 268.5—790.0 μm, and those of the eggs: 30.0—51.25×15.0—30.0 μm.

4. *Haematoloechus Schulzei*

The lenght of the body is 3.1—5.5 mm, and the width 1.098—1.437 mm. The surface of the body is covered with tiny pricks. The dimensions of the oral sucker: 292.3—418.7×371.3—434.5 μm, and the abdominal sucker 308.1—323.9×308.1—355.5 μm. The first testis 553,0—639.9×371.3—521 μm, and the second testis: 711.0—726.8×276.5—521.4 μm. The ovary (379.2—474.0×237.0—395.0 μm) is situated directly below the abdominal sucker. The dimensions of eggs: 30.0—52.5× 15.0—30.0 μm).

5. *Opisthyoglyphe ranae*

The dimensions of the body are 0.853—1.532 × 0,331—0.726 mm. The surface of the body is covered by small pricks. Oral sucker is larger (110.6—181.7 × 118.5—189.0 μm) than the abdominal one (92.5—165.9 × 96.25—134.3 μm). Testis are situated in the posterior half of the body medially one behind the othher (T_1 = 79.0—158.0×115.0—284.4μm; T_2=79.0—165.9×108.75—276.5 μm). Ovary (75.0—197.5× 71.25—173.8 μm) is situated at left side of the body, near the abdominal sucker. The dimensions of the eggs: 36.25—56.25 × 22.5—35.0 μm.

6. *Cephalogonimus retusus*

The length of the liver-fluke is 1.319—3.500 mm, and the width 0.395—0.853 mm. Tiny pricks cover the surface of the body. Oral sucker (181.7—268.6× 181.7—284.4 μm) is larger than adbominal one (122.5—205.4× 133.75—229.7 μm). The dimensions of the first testis: 101.25—237.00× 112.5—308.1 μm, and the second testis: 110.6—268.6× 125.0—252.8 μm. Ovary is situated at the left side of the body (76.25—229.1 × 66.25—181.7 μm). The eggs: 31.25—65.0× 15.0—27.5 μm.

7. *Pleurogenes claviger*

The length of the body is 1.830 mm and 2.725 mm, and the width 0.774 mm, 0.963 mm. Pricks cover the surface of the body. The dimensions of the oral sucker: 205.4× 237.0 μm and 237.0× 316.0 μm), and the abdominal one: 150.1× 158.0 μm, and 189.6×237.0 μm. The size of the first testis: 244.9×276.5 μm, and 316.0×244.9 μm, and the second: 213.3×237.0 μm; 252.8×284.4 μm. The lenght of the ovary: 237.0 μm and the width 252.8 μm—268.6 μm. The dimensions of the eggs: 27.5 —31.25 × 75—17.5 μm.

8. *Pleurogenoides medians*

The length of the body: 0.671 mm, and the width 0.363 mm. The dimensions have been registerd only in one trematode. The dimensions of oral sucker: 95.0× 110.0 μm, and the abdominal one: 97.5× 96.25 μm, and 118.5× 126.4 μm. The body is covered with tiny pricks. The lenght, and the width of the first testis: 134.3× 165.9 μm and 158.0× 110.6 μm, and the second testis: 126.4× 110.6 μm and 173.8× 158.0 μm. The dimensions of the ovary: 107.5× 80.0 μm, and 158.0× 134.3 μm. The eggs: 15.0—31.25× 11.25—16.25 μm.

9. *Prosotocus confusus*

The lenght of the body: 0.813—1.350 mm, and the width 0.513—0.861 mm. Tiny pricks cover the surface of the body. Oral sucker is larger (142.2—237.0× 165.9—221.2× 112.5—237.0 μm). The dimension of the right testis: 110.6—237.0× 158.0—237.0 μm; that of the left one: 134.3—221.2× 158.0—252.8 μm. The length of the ovary: 134.3—221.2 μm and the width 158.0—237.0 μm. The dimensions of the eggs: 17.5—30.0× 10.0—15.0 μm.

Conclusion

The parasitological examination of two species of hosts of the genus Rana *(R. esculenta* and *R. ridibunda)* from the valley of the river Tisa, with respect to the infestation by trematodes, has given the following results:

— The presence of nine species of parasites, belonging to five families of trematodes has been stated, what makes the half of the already known species of trematodes in Anura. Two of them

— *Haematoloechus schulzei* is absent in the host *R. esculenta,* and the trematode *Gorgodera cygnoides* has not been stated in the species *R. ridibunda* (Table 2).

— First of all, trematodes appear in the intestinum and lungs of the host. As to their distribution in hosts, in the intestinum of *R. esculenta* a four times greater number of trematodes has been stated, while in the lungs of *R. ridibunda* a two times greater number of trematodes has been found.

— Simultaneously with the high level of infestation there appears a significant intensivity in the category above 50 percent trematiodes per host, and that with a somewhat higher number of individuals in the species *R. ridibunda* (Tab. 2).

— The extensity of invadedness of hosts by trematodes is significant. In both species of hosts about 3/4 of examined individuals are infested (Table 1). A high degree of invadedness wiht *Opisthyoglyphe ranae* (42.8%) and *Cephalogonimus retusus* has been stated in both species of hosts and with *Diplodiscus subclavatus* (85.7%) in the case of the species *R. ridibunda* (Tab. 2).

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A Tiszavölgy Rana (Amphibia) békáinak Trematoda fertőzöttsége (Yugoslavia)

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Kivonat

A Tiszavölgy Becse és Écska térségéről gyűjtött Rana nemhez tartozó 13 *Rana esculenta* és 9 *Rana ridibunda* helmintológiai vizsgálatát végezték el a szerzők. Megállapítást nyert, hogy a gazdaállatok egyedeinek fertőzöttségi extenzitása, mindkét békafaj esetében, többé-kevésbé egyenletes (77,8% és 76,9%). Ugyanakkor a tavi béka fertőzöttségi intenzitása elenyészően nagyobb. Összesen 9 Trematoda faj került elő: *Diplodiscus subclavatus* GOETE, *Haematoloechus (Pneumonoeces) variegatus* RUDOLPHI, *Hematoloechus (Pneumonoeces) schulzei* WUNDSCH, *Opisthyoglyphe ranae* FRÖLICH, *Gorgodera cygnoides* ZEDER, *Cephalogonimus retusus* DUJARDIN, *Pleurogenes claviger* RUDOLPHI, *Pleurogenoides medians* OLSSON és *Prosotocus confusus* LOOSS.

Инфестированность безхвостых земноводных рода (Amphibia: Anurat) в долине реки Тиса

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Резюме

На участке реки Тиса, в районе г. Бечей и м. эчка, выполнены паразитологические испытания 13 экземпляров породы *Rana esculenta* и 9 экземпляров породы *Rana ridibunda*. Установлена была почти идентичная экстенсивность инвадированности подвергаемых анализу примеров обоих пород лягушек (77,8%, т.е. 76,9%), в то время как у экземпляров пород *R. ridibunda* обнаружена увеличенная интенсивность зараженности. Установлено было 9 пород Trematoda: *Diplodiscus subclavatus* GOETE, *Gorgodera cygnoides* ZEDER, *Haematoloechus (Pneumonoeces) variegatus* Rudolphi *Haematoloechus (P.) schulzei* WUNDSCH, *Opisthyoglyphe ranae* FRÖLICH, *Cephalogonimus retusus* DUJARDIN, *Pleurogenoides medians* OLSSON, *Prosotocus confusus* LOOSS и *Pleurogenes claviger* RUDOLPHI.

Infestiranost bezrepih vodozemaca roda Rana (Amphibia: Anura) u dolini reke Tise

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Izvod

Na deonici reke Tise, sa područja Bečeja i Ečke, invršena je parazitološka pretraga 13 domaćina vrste *Rana esculenta* i 9 jedinki vrste *Rana ridibunda*. Ustanovljen je skoro istovetan ekstenzitet invadiranosti kod analiziranih jedinki obe vrste žabe (77,8% odnosno 76,9%), dok su primerci vrste *R. ridibunda* imala veći intenzitet zaraženosti. Determinisano je 9 vrsta *Trematoda: Diplodiscus subclavatus* GOETE, *Gorgodera cygnoides* ZEDER, *Haematoloechus (Pneumonoeces) variegatus* RUDOLPHI, *Haematoloechus (P.) schulzei* WUNDSCH, *Opisthyoglyphe ranea* FRÖLICH, *Cephalogonimus retusus* DUJARDIN, *Pleurogenoides medians* OLSSON i *Prosotocus confusus* LOOSS, i *Pleurogenes claviger* RUDOLPHI.

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THE CARABIDAE (COLEOPTERA) FAUNA ON THE SODIC SOILS OF THE TISA VALLEY (YUGOSLAVIA)

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Abstract

An investigation of the Carabid fauna present in a solonetz-type soil was conducted in the period 1984—1986. The experimental site was located on the left bank of the Tisza River, near the village of Kumane, in the western part of the region of Banat.

Fifty-five species from 22 genera were registered. According to the zoogeographical distribution, there predominated the species with a wide area of distribution (Palearctic, Euro-Siberian species). As the species whose area of distribution is located south or southeast of the examined region were present in a significant portion (33 percent), it may be concluded that the examined region is a transitive area between the typical European fauna and Oriental-Balkan, i.e. Mediterranean fauna.

A large number of the registred species (40 percent) are regular members of agrobiocoenoses of Vojvodina Province. *Harpalus aeneus* (FABRICIUS), *Harpalus pygmaeus* DEJEAN, *Poecilus puncticollis,* (DEJEAN) *Harpalus distinguendus* (DUFTSCHMID), and *Harpalus serripes* (QUENSEL) are the dominant species comprising more than two thirds of the specimens caught. The dominant and subdominant species (17 of them) comprise 86 percent of the total collected materials while the remaining 38 species take only 14 precent of the total registered specimens.

Introduction

The Carabid fauna in the dominant soil types of Vojvodina Province has been studied by SEKULIĆ (1976, 1977). However, there are scant data on the occurrence of that insect group on saline soils (ČAMPRAG & J. DJURKIĆ 1967). Saline soils take over 160.000 ha in Vojvodina Province, stretching mostly along the major rivers of the Province, the Danube and the Tisza. The most frequent soil type on these areas is solonetz which takes over 65% of the total area. The above authors merely summarized the presence of the Carabidae family without going in detail regarding the quality or quantity of their population.

Considering the trend of turning these areas into arable land, by means of modern cultivation methods, and considering the importance of Carabids in a biocoenosis, a program was started in 1981 aimed at a better knowledge of the epigeal entomofauna of these biotopes. Two-year research data of the program were analysed by ČAMPRAG & SEKULIĆ (1984) who placed emphasis on dominant Carabid species and the dynamics of their population in the course of growing season. The program then proceeded for next three years. Bearing in mind the importance of pastures on saline soils as the last refuge to a number of elements of the steppe fauna which have vanished from other sites, we decided to define the fauna of such a biotope from both faunal-zoogeographical and ecological aspect.

Experimental site and method of work

Experiments were conducted in the course of 1984, 1985, and 1986 at a spacious pasture on the left bank of the Tisza River, near the village of Kumane located in the western part of the region of Banat. *Achilleo-Festucetum pseudovinae* was the dominant association at the experimental site consisting mainly of the following plant species: *Festuca pseudovina, Achillea millefolium* ssp. *collina, Alopercurus partensis, Podospermum canum, Bromus mollis,* and *Eryngium campestre.*

The vegetative cover is luxuriant in spring, due to high soil moisture and abundant rainfall. Large or small puddles occur in depressions allowing the development of some hygrophilous species.

In summer, the intensive drought in combination with unfavourable edaphic factors and intensive grazing lead to a high degradation of the vegetative cover. Strong winds throughout the year and intensive insolation in summer months are additional unfavourable factors which should not be disregarded.

Experimental materials were collected by means of 12 Barber traps containing 4% formaline as a conserver. The traps were visited and renewed at 20-day intervals from April to November.

Results and Discussion

Over the period of the three experimental years, 861 specimens of the Carabid fauna where collected, three specimens per trap.

The presence of the following species has been established:

Cicindelinae

1. *Cicindela germanica* LINNÉ 1758, a termophilous Euro-Asian species.

Carabinae

2. *Calosoma auropunctatum* (HERBST) 1784, distributed in Europe, except in south-western parts, Asia Minor, Syria, and Egypt.
3. *Carabus coriaceus rugifer* KRAATZ a mesophilous sub-species inhabiting south eastern Europe.
4. *Carabus cancellatus tibiscinus* CSIKI 1905, a mesophilous species inhabiting southern parts of Central Europe.

Trechinae

5. *Trechus quadristriatus* (SCHRANK) 1781, an eurytopic, plaearctic species.

Ditominae

6. *Ditomus clypeatus* (ROSSI) 1790, a thermophilous Mediterranean species.

Anisodactylinea

7. *Anisodactylus signatus* (PANZER) 1797, a thermophilous species inhabiting southern and central Europe.

Harpalinae

8. *Acinopus picipes* DEJEAN, a thermophilous southern European species.
9. *Parophonus maculicornis* (DUFTSCHMIND) 1812, a thermophilous species distributed in western Asia and southern Europe.
10. *Parophonus mendax* (ROSSI) 1790, a thermophilous southern European species spreading to the southern parts of central Europe and to the Caucassus Mountain.
11. *Harpalus cephalotes* FAIRMAIRE 1854—56. a thermophilous and halophilous species inhabiting southern parts of Europe.

12. *Harpalus diffinis* DEJEAN 1829, a thermophilous species present in all parts of Europe except the northern part.
13. *Harpalus azureus* (FABRICIUS) 1775, a thermophilous and xerophilous species inhabiting Europe to western Asia.
14. *Harpalus rupicola* STURM 1818, a thermophilous species present in Europe, except in western and northern parts, and Asia Minor.
15. *Harpalus rufipes* (DE GEER) 1774, an eurytopic species distributed over the entire palearctic area.
16. *Harpalus griseus* (PANZER) 1797, an eurytropic species distributed over the entire palearctic area.
17. *Harpalus froelichi* STURM 1818, a thermophilous species inhabiting Europe except its southern part, Siberia, and the northern part of China.
18. *Harpalus zabroides* DEJEAN 1829, distributed in Europe to western Siberia.
19. *Harpalus aeneus* (FABRICIUS) 1775, an eurytopic, palearctic species.
20. *Harpalus distinguendus* (DUFTSCHMID) 1812, an eurytopic, Euro-Siberian species.
21. *Harpalus smaragdinus* (DUFTSCHMID) 1812, a thermophilous Euro-Siberian species.
22. *Harpalus saxicola* DEJEAN 1829, a thermophilous and xerophilous pontic species.
23. *Harpalus pygmaeus* DEJEAN 1829, a thermophilous species inhabiting the Mediterranean and southern parts of Europe.
24. *Harpalus rubripes* (DUFTSCHMID) 1812, a xerophilous species, distributed in Euro-Asia except far north.
25. *Harpalus albanicus* REITTER 1900, a thermophilous species inhabiting southeastern Europe.
26. *Harpalus flavicornis* DEJEAN 1829, inhabits southeastren Europe to Switzerland.
27. *Harpalus anxius* (DUFTSCHMID) 1812, a xerophilous palearctic species.
28. *Harpalus serripes* (QUENSEL) 1806, a xerophilous palearctic species.

Pterostichinae

29. *Poecilus punctulatus* (SCHALLER) 1783, inhabits Europe to western Siberia.
30. *Poecilus sericeus* FISCHER de WALDHEIM 1823 a xerophilous species, distributed from Siberia to southeastern Europe.
31. *Poecilus cupreus* (LINNÉ) 1758, a hygrophilous species of Euro-Siberian distribution.
32. *Poecilus puncticollis* (DEJEAN) 1828, a halophilous species, distributed in southern and southeastern Europe.
33. *Pterostichus macer* (MARSHAM) 1802, a thermophilous Euro-Siberian species.
34. *Pterostichus melanarius* (ILLIGER) 1798, an eurytropic Euro-Siberian species.
35. *Pterostychus cylindricus* (HERBST) 1785, distributed from southeastern parts of central Europe to Turkey
36. *Calathus ambiguus* (PAYKULL) 1790, a xerophilous species, distributed in the western part of the palearctic region.
37. *Dolichus halensis* (SCHALLER) 1783, spreads in the southern half of Europe to eastern Asia.
38. *Agonum viridicupreum* (GOEZE) 1777, a hygrophilous species, distributed in Europe.
39. *Platynus dorsalis* (PONTOPPIDIAN) 1763, an eurytopic species of Euro-Siberian distribution.

Zabrinae

40. *Zabrus tenebrioides* (GOEZE) 1777, inhabits south and central Europe, Asia Minor, and southern parts of western Siberia.
41. *Amara aenea* (DE GEER) 1774, a xerophilous, sometimes halophilous species, inhabits the entire palearctic region.
42. *Amara familiaris* (DUFTSCHMID) 1812, inhabits the entire palearctic region.
43. *Amara ingenua* (DUFTSCHMID) 1812, a halophilous Euro-Siberian species.
44. *Amara apricaria* (PAYKULL) 1790, an eurytropic species of Euro-Siberian distribution.
45. *Amara aulica* (PANZER) 1797, an eurytropic species of Euro-Siberian distribution.

Dallistinae

46. *Chalaenius nigricornis* (FABRICIUS) 1787, a hygrophilous species, distributed in Euro-Siberian region and Asia Minor.
47. *Chalaenius decipiens* (DUFOUR) 1820, a hygrophilous species, distributed in southern parts of central Europe, southern Europe, Marroco, and Asia Minor.
48. *Callistus lunatus* (FABRICIUS) 1775, a xerophilous species, distributed in central Europe, Mediterranean, and western Asia.

Cymindinae

49. *Cymindis variolosa* (FABRICIUS) 1794, a xerophilous species, inhabits the southern half of Europe to southeastern Siberia, and Asia Minor.

Drominae

50. *Microlestes maurus* (STRUM) 1827, a thermophilous species, distributed from western Asia over the entire Europe except far north.

Zuphiinae

51. *Polystichus connexus* (Fourcroy) 1785, a thermophilous species, inhabits northern Africa, the southern half of Europe, western Asia, and Siberia.

Brachininae

52. *Brachinus crepitans* (LINNÉ) 1758, a thermophilous species, distributed in northern Africa, Europe, western Asia, and Siberia.
53. *Brachnus ganglbaueri* APFELBECK 1904. a hygrophilous species, inhabits southeastern Europe, Asia Minor, and the Caucasus Mountain.
54. *Brachinus explodens* DUFTSCHMID 1812, a thermo-mezophilous species, distributed in southern and central Europe, western Asia, and Siberia.
55. *Brachinus bipustulatus* QUENS, a thermophilous species, inhabits the Balkan Peninsula, Asia Minor, and southern Russia.

The 55 species listed above belong to 22 genera. ČAMPRAG & SEKULIĆ (1984) found 35 species in the same area, but they classified only 23 of those as frequent species. This study confirms the presence of the previously registred species.

According to the area of distribution, the registered species may be divided as follows.

Widely distributed species (Palearctic, Euro-Asian, Euro-Siberian): *Cic. germanica, Tr. quadristriatus, H. rufipes, H. griseus, H. froelichi, J. zabroides, H. aeneus, H. distinguendus, H. smaragdinus, H. rubripes, H. anxius, H. serripes, Poe. punctuala-*

tus, Poe. cupreus, Pt. mecer, Pt. melanarius, Cal. ambiguus, Dol. halensis. Pl. dorsalis, Z. tenebrioides, A. aenea. A. familiaris, A. ingenua, A. apricaria, A. aulica, Chl. nigricornis, Mic. murus, Pol. connexus. Br. crepitans, Br. explodens.

Southern and southeastern European species for which the Panonian basin is a border area. The following species are rare north or west of this region: *Cal. auropunctatum, C. coriaceus rugifer, Dit. clypeatus, Acian. picipes, Par. maculicornis, Per. mendax, H. cephalotes, H. saxicola, H. pygmaeus, H. albanicus, H. flavicornis, Poe. sericeus, Poe. puncticollis, Pt. cylindricus, Chl. decipiens, Cym. variolosa, Br. ganglbaueri, Br. bipustulatus.*

The species *Acin. picipes* is distributed in southern Europe and it has been found in other locations in Vojvodina Province (Futog, leg. SEKULIĆ R.) These are the northernmost findings of that species.

European species characteristic for central Europe but whose area of distribution spreads eventually to the neighbouring regions: *C. cancellatus tibiscinus, Anis. signatus, H. diffinis, H. azureus, H. rupicola, Ag. viridicupreum,* and *Calis. lunatus.*

It may thus be concluded that the number of widely distributed species was 30 or 54 percent, while the number of southern and southeastern European species was 18 or 33 percent. The elements characteristic for the European entomofauna were less frequent being represented by 7 species or 13 percent. The southern part of the Pannonian basin is the site of mixing and exchange of faunal elements. The ecological conditions of pastures on saline soils in the region of Banat are suitable for thermophilous and xerophilous species with the southern area of distribution. The species *Acin. picipes, Dit. clypeatus, H. cephalotes,* and *H. saxicola* may be considered relict species in this disjunctive area (MÜLLER 1931; CSIKI 1948; FREUDE 1977).

Ecological peculiarities of the Caribid fauna

Taking into account the existing ecological conditions of the examined site, species preferring warm and sunny sites may be expected to predominate the population. The results discussed previously show that the majority of the registered species, 71 percent, were thermophilous and partially xerophilous species (According to different authors: HURKA 1960, FREUDE 1977, HIEKE 1981). On the other side, a limited number of hygrophilous species, taking 9 percent, may be found around large or small puddles at the beginning of growing season. According to the observations of HORION (1959) and FREUDE (1977), some species from our list express a high or low affinity towards saline soils: *A aenea, A. ingenua, H. cephalotes,* and *Poe. punctiollis.*

Fourty percent of the registered species are regular members of the agrobiocoenoses of Vojvodina Province and wider (SEKULIĆ & HORVATOVICH 1973, SEKULIĆ 1976). This category includes socalled eurytopic species, i.e., those with a wide ecological valency: *H. aeneus, H. distinguendus, H. rufipes, Pl. dorsalis, T. quadristriatus,* and *Poe. cupreus* (Table 1). The last species is counted among hygrophilous species by many authors. Nevertheless, it is a regular member of the Carabid fauna in agrobiocenoses, especially on chernozem soils (SEKULIĆ 1976). Considering the relationships among the species of the Carabid family (Graph 1), it may be seen that the five dominant species comprise slightly more than two thirds of the specimens caught. If the 12 subdominant species (25 percent) are added the sum figure is 86 percent of the total collected material. The remaining 38 species from receiding and subreceiding groups take 14 percent of the total collected material.

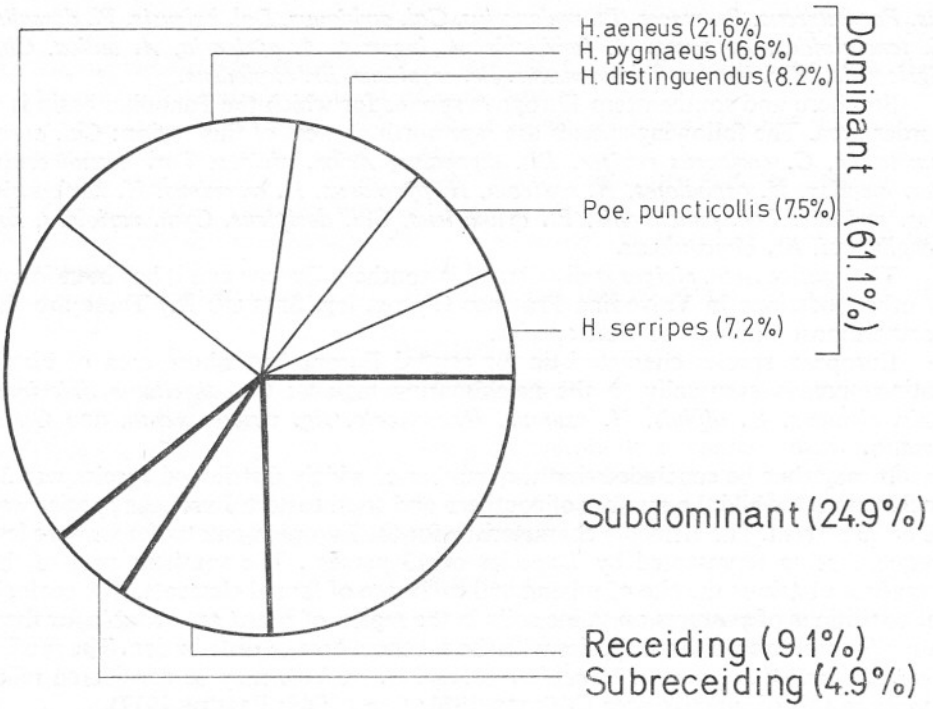

Fig. 1. Inhabiting structure of the Carabid family at a pasture established on a solonetz-type saline soil on th ᵉ bank of the Tisza River in the western part of the region of Banat (1984—1986)

Table 1. *Composition of the Carabid fauna at a pasture established on a solonetz-type saline soil on the bank of the Tisza River in the western part of region of Banat (1984—1986)*

Species	No. of specimens	Dominance (%)
Dominant		
Harpalus aeneus	186	21.6
Harpalus pygmaeus	143	16.6
Harpalus distinguendus	71	8.2
Poecilus punctiollis	65	7.5
Harpalus serripes	62	7.2
Subdominant		
Amara aenea	35	4.2
Poecilus cupreus	33	3.8
Harpalus rufipes	21	2.4
Harpalus saxicola	18	2.1
Amara apricaria	18	2.1
Poecilus punctulatus	17	1.9
Pterostichus macer	17	1.9
Brachinus ganglbaueri	14	1.6
Calathus ambiguus	13	1.5
Harpalus rubripes	11	1.3
Acinopus picipes	9	1.1
Brachinus crepitans	9	1.1

Species	No. of specimens	Dominance (%)
Receiding		
Anisodactylus signatus	7	0.8
Ditomus clypeatus	7	0.8
Calosoma auropunctatum	6	0.7
Harpalus anxius	6	0.7
Brachinus bipustulatus	6	0.7
Harpalus froelichi	5	0.6
Harpalus cephalotes	5	0.6
Amara ingenua	5	0.6
Poecilus sericeus	5	0.6
Chlaenius decipiens	5	0.6
Dolichus halensis	5	0.6
Cymindis variolosa	5	0.6
Brachinus explodens	5	0.6
Cicindela germanica	5	0.6
Subreceiding		
2 4 species	42	4.9
Total	861	100.0

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A Tiszavölgyi szikesek futóbogár faunája (Coleoptera: Carabidea) (Jugoslávia)

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Kivonat

A szerzők 1984 és 1986 között Nyugat-Bánát futóbogár-faunáját vizsgálták, a Tisza bal partján elterülő szikeseken, Kumán (Kumane) község határában. Kutatásaik során 22 nemet és 55 fajt mutattak ki.

Túlsúlyban vannak a messze elterjedt fajok (palearktikus, eurázsiai, euroszibériai, melyek a talált fajok 54 százalékát képezik. Jelentős számmal vannak képviselve a dél- és délkelet-európai fajok is (33%). Állatföldrajzi szempontból e térséget átmenetinek tekinthetjük a tipikusan európai és az orientális-balkáni, illetve a mediterrán régió között. Ezt bizonyítja néhány tipikusan déli elterjedésű faj jelenléte is. A balkán-mediterrán elem, *Acinopus picipes* Dejean esetében ezek a legészakibb lelőhelyadatok. Az előbbi, valamint a mediterrán-balkáni *Ditomus clypeatus* (Rossi), a pontikus *Harpalus saxicola* Dejean és a *Harpalus cephalotes* Fairmaire faj ezen a területen reliktumnak tekinthetők. A jellemzően európai fajok mindössze a futóbogárfauna 13 százalékát alkotják.

A fajok 71 százaléka termofil, és ezeknek nagyobb hányada xerofil is. Tavasszal a nagyobb nedvesség következtében jelentkezik néhány kifejezetten higrofil faj is. A halofil fajok karakterfajoknak tekinthetők, ezek a következők: *Amara aenea* (DEGEER), *Amara ingenua* (DUFTSCHMID), *H. cephalotes* és *Poecilus puncticollis* (DEJEAN). Jelentős azoknak a fajoknak a száma, amelyek a vajdasági szántóföldek megszokott lakói.

A domináns fajok: *Harpalus aeneus* (FABRICIUS), *Harpalus pygmaeus* (DEJEAN), *Poe. puncticollis*, *Harpulus distinguendus* (DUFTSCHMID) és *Harpalus serripes* (QUENSEL); ezek a begyűjtött példányok 2/3-át képezik. A domináns és a szubdomináns fajok együtt (17 faj) az összpéldányok több mint 86 százalékát teszik ki. A maradék 38 faj csupán 14 százalékkal vesz részt a begyűjtött anyagban.

Фауна жужелиц (Coleoptera: Carabidea) на почве в долине реки Тиса (Югославия)

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Резюме

В периоде с 1984 по 1986 г.г., в результате исследований фауны сем. Carabidae на почве типа «солонец» в районе западного Баната, на левом берегу р. Тиса, недалеко от места Кумане, обнаружено 55 видов из 22 родов.

По зоогеографической принадлежности выделяются виды с широкой областью распространения палеарктические, европейскоазиатские и европейскосибирские, составляющие 54% зарегистрированных видов. Существует значительное количество пород распространяющихся в более южных или юговосточных районах (33%), так, что эти края мы можем считать переходными между типичной европейской и восточно-балканской, т.е. средиземноморской фаунами. Эта область также является самым северным местом нахождения балканско-средиземноморского вида *Acibopus picipes* DEJEAN. Вышеуказанный вид, а также и вид *Harpalus cephalotes* FAIRMAIRE, средиземноморско-балканский вид *Ditomus clypeatus* Росси и понтский вид *Harpalus saxicola* DEJEAN наблюдаются в пределах остаточных видов. Характерные европейские виды обнаружены в гораздо меньшем количестве и составляют всего 13% фауны.

Самое большое количество видов — термофильные (71%), а частично и ксерофильные. Весной появляются и некоторые гигрофильные виды, благодаря повышенной влажности. Галофильные виды *Amara aenea* (DEGEER), *Amara ingenua* (DUFTSCHMID), *H. cephalotes* и *Poecilus puncticollis* (DEJEAN) можем считать характерными для испытываемого биотипа. Существует и большой процент (40%) видов постоянных членов агробиоценоза в Воеводине.

Доминирующими видами являются: *Harpalus aeneus* (FABRICIUS), *Harpalus pygmaeus* DEJEAN, *P. puncticollis, Harpalus distinguendus* (DUFTSCHMID) и *Harpalus serripes* (QUENSEL).

Доминирующие и субдоминирующие виды 17 составляют больше чем 86,1% приобретенного материала, а остальные 38 видов представляют 14% из многочисленных экземпляров.

Fauna trčuljaka (Coleoptera: Carabidae) na slatinama u dolini reke Tise (Jugoslavija)

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Izvod

U periodu od 1984. do 1986. godine istraživanjem faune fam. Carabidae na zemljištu tipa solonjec u zapadnom Banatu, na levoj obali reke Tise, u blizini mesta Kumane, registrovano je 55 vrsta iz 22 roda.

Prema zoogeografskoj pripadnosti ističu se vrste sa širokim arealom rasprostranjenja (palearktičke, evroazijske i evrosibirske) koje čine 54% registrovanih vrsta. U značajnom broju su prisutne i vrste čiji areal leži južno ili jugoistočno (33%), te ovo područje možemo smatrati prelaznim izmedju tipične evropske i orijentalno-balkanske odn. mediterranske faune. Takodje je ovo stanište najseverniji nalaz balkansko-mediteranske vrste *Acinopus picipes* DEJEAN. Predhodna vrsta kao i vrsta *Harpalus cephalotes,* FAIRMAIRE, mediteransko-balkanska vrsta *Ditomus clypeatus* (ROSSI) i pontska vrsta *Harpalus saxicole* DEJEAN su prisutne u okviru reliktnog areala. Karakterstične evropske vrste su konstatovane u znatno manjem broju i čine svega 13% faune.

Najveći broj vrsta je termofilan (71%), a delom i kserofilan. U proleće se javljaju i neke higrofilne vrste, zahvaljujući većoj vlažnosti. Halofilne vrste *Amara aenea* (DEGEER), *Amara ingenua* (DUFTSCHMID), *H. cephalotes Poecilus puncticollis* (DEJEAN) možemo smatrati karakterističnim za istraživani biotop. U velikom postotku (40%) su prisutne vrste koje su redovni članovi agrobiocenoza u Vojvodini.

Dominantne vrste su *Harpalus aeneus* (FABRICIUS), *Harpalus pygmaeus* DEJEAN, *P. puncticollis, Harpalus distinguendus* (DUFTSCHMID) i *Harpalus serripes* (QUENSEL). One čine više od 2/3 registrovanih primeraka. Dominantne i subdominantne vrste (17) čine više od 86,1% sakupljenog materijala, dok preostalih 38 vrsta učesvtuje sa svega 14% u sumi registrovanih primeraka.

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HEAVY METAL CONTENT IN THE BRANCHIAE OF SOME TISZA-RIVER FISH

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Abstract

The authors studied the Zn, Cu, Pb, Cd and Hg content in the branchiae of 132 fish from 18 species with atomic absorption and microscopic histology method. Random caught fish were divided into five groups according to thier alimentation habits. In the result of examinations the Zn, Cu, Pb, Cd and Hg concentration in the branchiae exhibited a decreasing order from Zn to Hg.

It was established by the authors that the examined metals, harmful for the environment, were not contained in the branchiae in a concentration warning of an acute danger, likewise the metal concentration of the Tisza river is relatively low: it does not reach neither the Hungarian, nor the international limit values. Knowing the metal content in the branchiae and on the basis of data in literature deductions could be made on the present quality of fish, which, as it could be stated, corresponds to the reguirements of alimentation hygiene from the point of view of the amount of metal ion concentration.

Introduction

The heavy metal content detectable in the body of fresh water fish mostly comes from two sources: it is taken directly from water and from food. Depending on the metal concentration of the water environment these metals — together with other harmful materials — accumulate in the body of the fish. (Badsha—Goldspink 1982, Förstner—Prosi 1979, Hannerz 1968, May—McKinney 1981). In surface waters free from toxic heavy metals the heavy metal concentration in the fish basically depends on the geochemical conditions prevailing in the river. A metal content larger than a given value exerts harmful effect on the physiological activity of plant and animal organizations which take part in the nutrition chain. In our country water biology methods studying long term effects (Csépai—Mrs. B. Sárkány) (Fig. 1) as well as parallel chemical analytical measurements are less known in spite of the fact that their importance is at least as great as that of methods revealing acute effects, since with these an early recognition and thus prevention becomes possible.

The metal content in the sediment of the Tisza river bed was first studied in the middle region of the river (Waijandt—Mrs. Szabó 1980) and in a whole longitudinal section (László—Berta 1981) in 1979. As regards the metal content of water there was published only one publication on its Hg concentration (Mrs. M. Szabó—Waijandt 1983). We have no data in the literature on the heavy metal accumulation of Tisza water fish.

The aim of the present work was to obtain basic data by microscopic histologi-

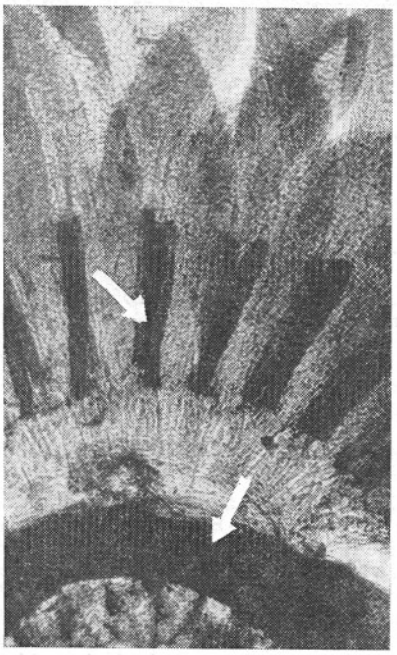


Figure 1. Details of the branchiae of *Xiphophorus helleri* toxidized by lead in an aquarium (CSÉPAI—Mrs. SÁRKÁNY 1983). In corresponding reaction media the darkening of the cartilage membrane around the arch and radii of the branchiae indicates the place of accumulation of lead. (Method: HAIDER's (1964); 60*)

cal and chemical analytical methods of the branchiae of some fish caught from the river Tisza near Szolnok reacting relatively sensitively to environmental harms (MRS. KOVÁCS—GAYER 1975, 1977, MATELEV—OSZETROV 1968, SCHULZ 1970). As a further aim we had a trial of the applicability of the two methods in our area.

Materials and Methods

Branchiae of 132 fish randomly caught from Tisza River near Szolnok, belonging to 18 species, of different age and sex were stored at −20 °C before the start of the investigations.

Microscopic histological study of the branchiae was carried out with a slightly modified Haider method (HAIDER 1964). It was experimentally stated that the heavy metal accumulation happens even in the hemibranchiae playing anatomically important part with the body of branchiae (Mrs. KOVÁCS-GAYER 1975, 1977) and the Haider method can be applied to detect this by microscopy. Taking into consideration the possibilities rendered by the method, because of their strong toxicity we preferred to detect Pb + Cd taken together and Hg selectively. The method is the following: a part of the hemibranchiae skeleton cleared of cells under a stereomicroscope, after repeated "washing" and separating steps corresponding to the detection of Pb + Cd, another part after preparations for detecting Hg were transformed by a chemical reaction into metal sulfide and then examined by light microscopy. The presence of the metal in question is indicated by the darkening of the longitudinal middle part of the skeleton. The intensity of the shade depends on the amount of the accumulated metal. Thus, it becomes possible to detect negative cases as well as the presence of the examined metal(s).

The bulk of samples dried for the chemical analysis was between 0.3 and 0.5 g, prepared according to the method described by KRISHNAMURTY (1976). Starting the studies comparative examinations were carried out with two fish species from 3—3 parallel samples, from an original sample in a teflon-

padded bomb and from a dried sample with a reflux cooler, in order to control the possible Hg loss during drying and clearing. Values obtained by the latter method in the case of *Esox l.* were a mean 96.2%, in case of *Hypophtalamichthys m.* 93.4% for the value measured with the bomb. These results agree with those measured by PAUS (1972). In view of the above mentioned we disregarded a detailed exposure of the samples in order to detect mercury. The zinc, copper and cadmium concentration of the exposed samples was measured by flame atomization method, lead was measured with an electrothermal atomizator by an AAS—3 atomic absortpion apparatus (Zeiss product, field correction). Hg content was determined by a Spektromom 190A apparatus with the so-called colsdteam method (HATCH-OTT 1968, PUNGOR Mrs. GROF 1973).

Results and Evaluation

The intake and bioaccumulation of heavy metals is influenced by several factors. In case of fish water and food are decisive for the metal intake. Water as living space and carrier for a long exposition time carries metals into the organism first of all through the branchiae and through the skin. Food of plant and animal origin can contain metal ions to various extent. Absorption largely depends on the composition of food, the degree of oxidation of the contained metals, the acidity of gastric juices and the metal content of the organism.

The same way of respiration of the fish does not yield a corresponding basis for classification. Different forms of alimentation characterizing the particular species give a reasonable basis for grouping according to alimentation habits. Accordingly the examined fish species were divided into five groups (Table 1).

Zinc

Of the five examined metals zinc showed the greatest concentration, in harmony with the concentration of this metal in water and sediments. For most species the bulk of values was around 100 µg/l (Figure 1a. Names of the fish are given in Table 1). With the exception of three species *(Cyprinus c., Carassius a.g., Esox l.)* there is no remarkable difference in the results. The Zn content in the branchiae of Balaton *Abramis b.* and *Stizostedion* l. (SALÁNKI 1981, V. BALOCH—SALÁNKI 1986) shows a good agreement with that found by us in the Tisza species (Table 2).

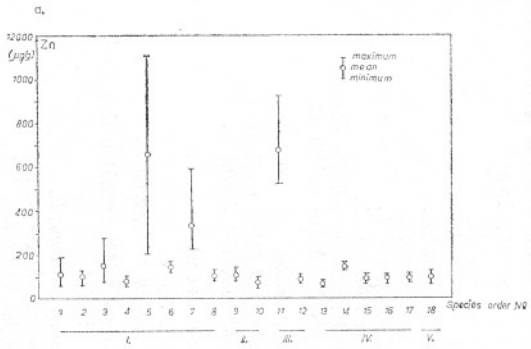


Fig. 1. Metal content in the branchiae of the examined species in the Tisza river (µg metal/g dry branchiae)
a) Zn

Table 1. *Heavy metal content in the branchiae of fish species from the Tisza river and results of microscopic histological investigation (μg metal/g dry branchiae; C_v = relative scattering)*

No. of spec.	Fish species	n/ piece	Total body weight (g)	Zn Mean	Zn C_v	Cu Mean	Cu C_v	Pb Mean	Pb C_v	Cd Mean	Cd C_v	Pd+Cd tissue biolog. invest.	Hg Mean	Hg C_v	Hg. tissue biolog. invest.
I.	Mixed alimentation	63													
1.	*Abramis brama L.*	5	350—1500	104	0.49	3.5	0.35	3.0	0.28	0.85	0.68	$+_5$	0.42	0.62	$+_2$
2.	*Leuciscus idus L.*	4	400—1200	97	0.32	5.7	0.31	3.3	0.35	0.57	0.33	$+_4$	0.28	0.41	−
3.	*Blicca bjoerkna L.*	6	130—300	149	0.49	7.2	0.41	3.8	0.30	2.67	0.52	$+_6$	0.62	0.73	$+_3$
4.	*Barbus barbus L.*	12	500—2300	74	0.19	3.4	0.24	4.4	0.58	0.66	0.34	$+_{12}$	0.30	0.31	−
5.	*Cyprinus carpio L.*	12	800—5000	654	0.47	6.6	0.51	3.5	0.34	1.04	0.57	$+_{12}$	0.29	0.49	$+_2$
6.	*Pelecus cultratus L.*	3	200—350	138	0.14	9.1	0.27	2.9	0.40	1.49	0.42	$+_3$	1.29	0.37	$+_3$
7.	*Carassius auratus gibelio* BLOCH	12	150—750	324	0.33	4.1	0.33	4.3	0.32	1.25	0.85	$+_{12}$	0.44	0.38	$+_4$
8.	*Hypophtalmichthys nobilis R.*	9	550—15 800	97	0.19	5.1	0.56	5.3	0.43	0.53	0.54	$+^9$	0.35	0.46	$+_1$
II.	Plantivorous	19													
9.	*Hypophtalmichthys molitrix V.*	11	700—11 000	98	0.23	5.6	0.27	2.6	0.34	0.48	0.73	$+_{11}$	0.21	0.34	−
10.	*Ctenopharingodon idella V.*	8	1000—10 000	68	0.28	3.2	0.27	2.8	0.56	0.48	0.92	$+^8$	0.14	0.91	
III.	Carnivorous	19													
11.	*Esox lucius L.*	10	500—2400	670	0.24	2.8	0.20	3.6	0.74	0.51	0.47	$+_{10}$	0.52	0.23	$+_6$
12.	*Stizostedion lucioperca L.*	9	800—6000	80	0.20	2.4	0.23	4.2	0.49	0.35	0.46	$+^9$	0.55	0.44	$+_4$
IV.	Feeding with small animals and fish	28													
13.	*Acipenser ruthenus L.*	7	380—810	62	0.18	3.8	0.23	6.7	0.41	0.79	0.41	$+_7$	0.43	0.24	$+_2$
14.	*Ictalurus nebulesus L.*	3	70—120	141	0.13	8.3	0.07	3.1	0.41	3.80	0.46	$+_3$	4.26	1.51	$+_2$
15.	*Perca fluviatilis L.*	3	130—250	87	0.25	3.2	0.22	5.9	0.28	0.83	0.36	$+_3$	0.64	0.37	$+_2$
16.	*Silurus glanis L.*	10	800—18 000	76	0.19	2.3	0.45	4.6	0.40	0.28	0.27	$+_{10}$	0.26	0.20	−
17.	*Aspius aspius L.*	5	550—1850	95	0.16	5.3	0.36	3.0	0.23	1.04	0.25	$+_5$	0.64	0.40	$+_2$
V.	Feeding with small animals	3													
18.	*Tinca tinca L.*	3	100—500	94	0.33	4.0	0.11	6.7	0.61	0.69	0.24	$+_3$	0.86	0.69	$+_2$

* = Designation according to (MSZ 1977)
** + positive number of cases
− negative result

Table 2. *Comparison of results of studies of the Tisza river with data in literature (μg metal/g dry branchiae)*

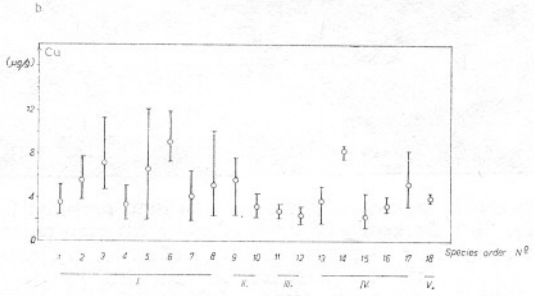
Place of Origin	*Abramis brama* L.					*Esox lucius* L.		
	Zn	Cu	Pb	Cd	Hg	Zn	Pb	Cd
Ellesmere (BADSHA-GOLDSPINK 1977)	367	—	5.2	7.8	—	—	—	—
Compstall (BADSHA-GOLDSPINK 1977)	147	—	17.5	11.2	—	245	4.0	1.8
Balaton (SALÁNKI et al. 1981)	155	8.0	13	1.4	0.42	—	—	—
Tisza	104	3.5	3.0	0.85	0.42	670	3.6	0.51

	Perca fluviatilis L.		
	Zn	Pb	Cd
Ellesmere (BADSHA—GOLDSPINK 1977)	158	19.5	20.8
Tatton (BADSHA—GOLDSPINK 1977)	125	15.1	1.6
Tisza	87	5.9	0.83

	Stizostedion luciuperca L.				
	Zn	Cu	Pd	Cd	Hg
Balaton (SALÁNKI et al. 1981)	95	4.9	5.4	0.80	0.31
Tisza	80	2.4	4.2	0.35	0.55

Copper

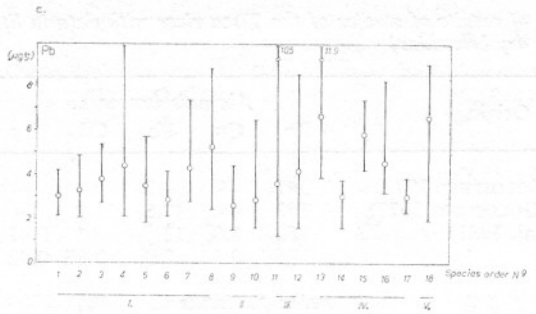
The results suggested that the Cu content in the branchiae of the particular species of fish is almost independent of the alimentation habit itself. Even within the groups the values relatively widely scatter (Fig. 1b). The highest values were found with some kinds of fish of mixed alimentation *(Blicca b., Cyprinus c., Pelecus c.)*, but we can mention the greater concentration experienced with the plantivorous *Hypophtalmichthys m.* and *Aspius a.* regarded as feeding with small animals and fish. We also mention that in the case of *Abramis b,* and *Stizostedion l.* the concentrations were smaller (Table 2) than in the Balaton kinds (SALÁNKI 1981, V. BALOGH—SALÁNKI 1986).



b) Cu

Lead

We found lead concentration in a relatively wide range within the single alimentation group as well as in the case of some species (Fig. 1c). The highest values could be measured in *Barbus b., Hypophtalmichthys n., Esoc l.* and *Acipenser r.*



c) Pb

The lowest mean values were found in the two plantivorous species, however, the sample number is small here. It is well known that lead is toxic for living organisms. According to Kőrös cadmium, similar to mercury, is bound to sulphur containing ligands e.g. cystein side chains of proteins, thus it blocks the work of a number of enzymes (Kőrös 1980).

We dealt with the histological study of Pb and Cd taken together because these two metals cannot be separated from each other with the mentioned method. Values for lead concentration are as a rule one order of magnitude greater than for cadmium. Therefore on the basis of microscopic picture we could undertake only a qualitative evaluation. Accordingly we got a positive result in the examined species and individuals whereby, except *Ictalurus n.* the quantitaive effect of lead dominated over cadmium (Figure 2).

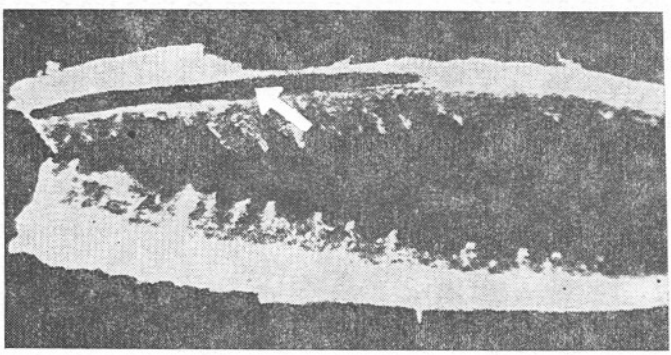
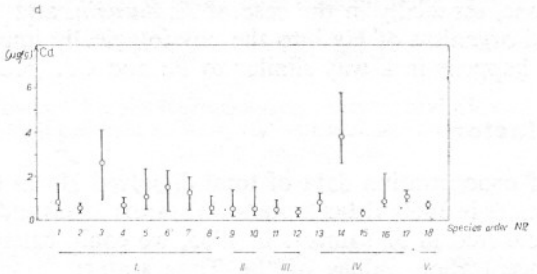


Figure 2. Left: Hemibranchia without respiratory epithelium, prepared from Tisza *Cyprinus* c. branchia, shown in plane "C". Darkening of a part of the cartilageous radius shows the accumulation of Pb+Cd together. Right: Detail of a hemibranchia of a control *Cyprinus c.* bred in an aquarium; negative for heavy metals.
(Method: Haider's (1964); 50*)

Cadmium

Similar to zinc cadmium concentrations changed in a narrow range with the exception of two species (Fig. 1d). Branchiae of *Blicca b.* and *Ictalurus n.* exhibited remarkably greater values. In the formation of nearly the same concentrations there may play a role the relatively higher cadmium content of the sediment, what is due to



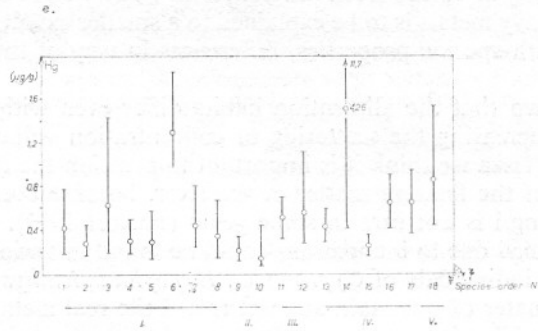
d) Cd

geochemical reasons (LÁSZLÓ—BERTA 1981, WAIJANDT—MRS. SZABÓ 1980). The Cd concentration of the water, however, is low.

The cadmium content in the branchiae of Tisza *Abramis b.* was lower than the values found with the Balaton and Zala river species, similarly this content remained below that of the Balaton values (SALÁNKI 1981). Results of microscopic studies related to this metal are treated under the heading of lead. The mechanism of binding and accumulating of cadmium, toxic for living organisms, is similar to that of lead. It can build in the place of zinc without substituting the biological function of the zinc-protein complex.

Mercury

Of the examined metals the concentration of mecrury changed in the widest range (Fig. 1e). Highest values were found in the branchiae of *Ictalurus n., Blicca b.,*



e) Hg

Pelecus c. and *Tinca t.* Lowest concentration values were found with species belonging to the plantivorous (Table 1).

For *Abramis b.* caught in Balaton and the Zala river the concenration values were similar, (V. BALOGH—SALÁNKI 1986), while the mercury content in the branchiae of Tisza *Stizostedion l.* was somewhat over that measured in Balaton *Stizostedion l.* (SALÁNKI 1981) (Table 2).

No mercury positive reaction was found in the histological studies below the value 0.29 µg/g, while over this a mercury positive reaction was characteristic

with some exceptions, especially in the case of *Ictalurus n.* and *Tinca t.* (Table 1). The building in the organism of Hg into the physiologically important mostly Zn-protein complexes happens in a way similar to Pb and Cd. (KŐRÖS 1980).

Concentration factor

Making use of concentration data of total dissolved Hg in the water of Tisza measured in 51 samples in 1980. (MRS SZABÓ—WAIANDT 1983) and of total dissolved Zn, Cu and Cd measured in 52 samples in 1985, we could calculate concentration factors. Mean concentration values of the Tisza water:
Hg: 0.12 µg/l, Cd: 0.37 µg/l, Cu: 4.4 µg/l, Zn: 27 µg/l. The value for the concentration factor of Zn is $2.3 \cdot 10^3$—$2.4 \cdot 10^4$; of Cu: $5.2 \cdot 10^2$—$2.1 \cdot 10^3$; of Cd $7.6 \cdot 10^2$—$1.0 \cdot 10^4$; of Hg: $1.2 \cdot 10^3$—$3.6 \cdot 10^4$. Considering the values of the particular alimentation groups we got the following set of concentration factors:

$$Hg > Zn > Cd > Cu$$

In spite of the fact that we have only one organ in view, the range between extreme values is astonishingly wide. At the same time the mean value for the single metals (Hg: $5.6 \cdot 10^3$; Zn: $3.8 \cdot 10^3$; Cd: $2.2 \cdot 10^3$; Cu: $1.0 \cdot 10^3$) was not markedly different.

Conclusions

There is a number of data in the literature showing that heavy metals accumulate to a different extent in different parts of the fish. (BADSHA—GOLDSPINK 1982, METHIS —CUMMINGS 1973, SALÁNKI 1981).

A comparative analysis of our results suggests that the accumulation in the branchiae tissues of the Tisza river fish is not an unequivocal process happening directly via breathing or comes from differences in body weight and measures. The accumulation of heavy metals is to be explained to a smaller extent with breathing, to a greater extent with specific properties, differences in way of living and alimentation.

It is well known that the alimention habits differ even within one genus. All these are factors increasing the scattering of concentration values.

In the case of Tisza we think it is important to mention the fairly extreme concentration values of the floating matter in the river, because even a change in the range of 1—2000 mg/l is not rare in some years (BANCSI 1977). Very fine grained floating matter formed due to inundations could be found in various amounts in the branchiae of some individuals of *Cyprinus c., Hypophtalmichthys m.* and *Carassius a.g.* This floating mater of uncertain amount raised the real metal concentration to an unceratin extent. That is why the obtained metal content results for some species can be regarded only as an orientation indicating the metal concentration of the river.

Summarizing it can be stated that the level of metals contaminating the environment in the water of the Tisza river is relatively low. It is markedly lower than the international level (RHEINBERICHT 1978) or what is regarded as dangerous in our country (Technical Data by the National Water Directory 1985).

In the present study we did not want to examine fish from the point of view of nutrition. There are data in the literature that a unit amount of fish contains 3—5 times less metals than the branchiae (BADSHA—GOLDSPINK 1982, MATHIS—CUMMINGS 1973). Accordingly we can suppose that the metal content in fish exhibits lower values than recognized as acceptable (Egészségügyi Közlöny 1975).

Tiszai halak kopoltyújának nehézfém tartalma

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Vízkémiai Laboratórium

Kivonat

A szerzők 132 db, a Tisza folyó szolnoki térségéből kifogott, 18 féle fajú hal kopoltyújának Zn, Cu, Pb, Cd és Hg tartalmát vizsgálták atomabszorpciós és mikroszkópos szövettani módszer segítségével. A random-szerűen kifogott halakat táplálkozási szokásaik szerint 5 csoportba sorolták. Vizsgálati eredményeikben a halkopoltyúk Zn, Cu, Pb, Cd és Hg koncentrációja a Zn-től a Hg felé csökkenő értéket mutattak.

A szerzők megállapították, hogy a kopoltyúk a vizsgált környezetszennyező fémeket nem tartalmazzák akut veszélyt jelző koncentrációban, mint ahogyan a Tisza vizének fémkoncentrációja is viszonylag alacsony; nem éri el a magyar és nemzetközi határértékeket. A kopoltyúk fémtartalmának ismeretéből irodalmi adatok alapján következtetni lehet arra is, hogy a halhús minősége jelenleg a fém-ionok koncentrációjának mennyisége szempontjából megfelel az élelmezés-egészségügyi követelményeknek.

Содержание тяжелых металлов в жабрах рыб Тисы

Ф. Чепаи и Я. Ваияндт

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Резюме

Авторы анализировали содержение меди, кадмия, цинка, хрома и ртути в жабрах 8 видов рыб с помощью атомноабсорпционного и микроскопического гистологического метода. Они группировали выловленных безвыборочно рыб в 5 групп по их привычкам питания. В результатах выясняется, что содержание меди, кадмия, цинка, хрома и ртути в жабрах исходя из меди и заключая ртутью показывает снижающиеся стоимости.

Авторы установили, что жабры не содержат таких металлов в концентрации, которая показала бы острую опасность; ситуация аналогична касательно концентрации металлов воды Тисы, она не достигает венгерских и международных предельных величин.

На основании литературных данных и данных о содержании металлов жабер можно с делать вывод, что качество мяса рыб в настоящее время соответствует санитарным требованиям на основе количества концентрации ионов металлов.

Sasržaj teških metala u škrgama riba srednje Tise

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Izvod

Autori su histološkim metodama atomskoabsorpcionim i svetlosnim mikroskopijom ispitivali prisustvo Zn, Cu, Pb, Cd i Hg u škrgama 132 jedinki, pripadnika 18 vrsta riba reke Tise sa područja Solnok. Random-postupkom izlovjene ribe razvrstavane su u pet grupa, na osnovu tipa ishrane.

Utvrdjeno je da koncentracija teških metala u škrgama riba pokazuje tendencniju smanjivanja vrednosti od Zn prema Hg. Takodje autori konstatuju da utvrdjena koncentracija ispitivanih teških metala u škrgama riba ne ukazuje na akutnu opasnost, samim tim što je koncentracija metala i u vodi Tise relativno niska, i nalazi se ispod madjarskih i medjunarodnih normi. Autori smatraju da riblje meso po kvalitetu i prema literaturnim podacima u odnosu na konstatovane količne metala u škrgama riba prema jonskim koncentracijama, udovoljava prehranbenim zdravstvenim zahtevima.

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FECUNDITY OF ESOX LUCIUS L. IN THE TISA RIVER

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Abstract

On the basis of collected material from 1980 to 1983 analysis of absolute and relative fecundity in relation to standard length, body mass and age, was done. In order to achieve this goal 73 mature female individuals were analysed. Also, correlation coefficient was estimated and very prominent individual variatons were noticed. Absolute fecundity was from 9495 to 114 205 and relative fecundity from 21.73 to 57.96 number of eggs. The average of absolute fecundity were largest in the groups of individuals with the largest values of body mass, body length and in the oldest age groups. The average values of relative fecundity were the highest in the groups of individuals characterized with small body mass, body length and age. All these data were calculated using the expression: $\log F = a \log x + b$. Variations between real and calculated values of above mentioned parameters for absolute fecundity are directed to real values and for relative fecundity to calculated values.

Introduction

Ichthyofauna of Tisa river is not completely investigated concerning qualitative and quantitative aspects.

Some recent papers bring some light to this problem RISTIĆ (1977), GRGINČEVIĆ (1977), MALETIN et BUDAKOV (1983) et BUDAKOV et MALETIN (1984).

Also, some economically very important, as well as some rare species are not known very well.

The purpose of this paper is to expand some previous investigations of *Esox lucius* L. concerning fecundity of this species in the Tisa river.

Materials and Methods

Material for investigation was collected in the period between 1980—1983 in Tisa river (Tisa II). In the analysis 73 sprawing female individuals were used (gonads were in the 4th maturity stage). Absolute and relative fecundity in relation to strandard length, body mass and age were investigated. The relationship between absolute and relative fecundity and body length, body mass and age groups is presented using linear regression: $y = ax + b$. Also, correlation coefficients are calculated.

Variations of absolute and relative fecundity in relation to standard length, body mass and age were calculated according to the formula: $\log F = \log x + b$, F=fecundity, x=basic biological parameter which shows relation between these basic biological parameters and fecundity (method of the smallest square and logarithmic values).

Tab. 1. *Absolute and relative fecundity of Esox lucius L. from Tisa depending on mass. Correlation*

n	MASS group	M±m	σ	ABSOLUTE	
				min—max	M±
4	0—400	310,0± 22,73	45,46	9 495,00— 16 578,40	13 235,40±
22	401—800	578,63± 26,37	123,71	10 965,00— 38 190,00	22 548,35±
22	801—1200	920,00± 24,96	117,08	26 100,00— 64 337,00	37 536,24±
13	1201—1600	1505,00± 31,90	114,85	28 008,50— 74 855,00	54 072,50±
7	1601—2000	1825,71± 44,05	116,31	39 556,80—101 606,40	71 420,17±
2	2001—2400	2240,00± 40,00	56,56	90 037,50— 92 820,00	91 428,75±
2	2401—2800	2605,00±195,58	275,77	79 337,80—110 120,80	94 729,30±
1	2801—3200	2900,00± —	—	—	114 205,00±

Tab. 2. *Absolute and relative fecundity of Esox lucius L. from Tisa depending on standard lenght.*

n	LENGHT group	M±m	ABSOLUTE		
			min—max	σ	M±
5	281—340	313,20± 8,42	9 495,00— 16 578,40	18,79	12 781,32±
18	341—300	352,22± 3,89	10 965,00— 38 190,00	16,50	23 810,56±
23	401—460	428,47± 3,62	19 598,40— 64 337,00	17,34	34 358,64±
15	461—520	492,66± 4,32	36 835,00— 74 865,00	16,74	51 897,55±
8	521—580	552,75± 6,11	39 556,80—101 606,40	17,23	73 747,33±
4	581—640	610,50±11,52	79 337,80—114 205,00	23,04	99 120,90±

Tab. 3. *Absolute and relative fecundity of Esox lucius L. from Tisa depending on age. Correlation*

n	AGE GROUP	ABSOLUTE FECUNDITY			
		min—max	M±m	σ	r
3	2+	28 131,60— 59 802,70	42 607,76±9254,12	16 009,63	
29	3+	9 495,00—110 120,80	42 810,15±4675,58	21 152,58	
21	4+	10 965,00—105 212,80	39 941,85±4311,29	19 745,74	0,811 49
18	5+	13 890,80—101 606,40	40 151,25±5937,55	24 462,74	
1	6+	—	79 337,80± —	—	
1	7+	—	114 205,00± —	—	

between fecundity and mass.

FECUNDITY			RELATIVE FECUNDITY			
m	σ	r	min—max	M±m	σ	r
1 712,24	342,48	0,670 69	30,62—48,94	42,60±4,08	8,17	0,092 10
1 376,19	6 454,36	0,693 14	26,10—53,04	37,16±1,57	7,39	0,219 41
2 405,72	11 282,85	0,746 31	29,44—57,96	39,82±1,80	8,48	0,408 76
3 853,76	13 873,57	−0,428 57	24,35—51,63	38,74±2,44	8,78	0,031 80
7 673,55	20 258,18	0,686 00	21,73—51,31	38,84±3,53	9,33	−0,139 95
1 395,40	1 967,52	−1,000 00	39,49—42,19	40,84±1,35	1,90	−1,000 00
15 437,49	21 766,86	1,000 00	32,93—39,32	36,12±3,20	4,52	1 000,00
—	—	—	—	39,38± —	—	—

Correlation between fecundity and standard lenght

FECUNDITY			RELATIVE FECUNDITY			
m	σ	r	min—max	M±m	σ	r
1405,68	3 134,68	−0,170 29	30,62—48,94	39,30±4,58	10,22	−0,740 85
1612,55	6 837,24	0,725 11	24,34—53,04	38,77±1,70	7,24	0,114 57
2361,06	11 309,51	0,383 46	26,48—57,96	38,74±1,89	9,08	0,165 36
2494,16	11 413,27	0,535 51	25,05—51,63	38,88±2,26	8,74	−0,028 40
7048,55	19 876,92	−0,024 23	21,73—51,31	38,92±3,06	8,64	−0,272 39
8060,19	16 120,38	0,840 25	32,92—42,19	38,45±1,96	3,92	0,053 03

between fecundity and age groups

RELATIVE FECUNDITY			
min—max	M±m	σ	r
34,73—44,81	41,38±3,33	5,76	
24,35—53,46	38,95±1,51	8,14	
21,73—57,96	39,25±2,08	9,54	−0,548 02
28.93—51,31	37,97±1,81	7,49	
	32,92±		
	39,38±		

Results and Discussion

The individual absolute fecundity is very different in *Esox lucius* L. and other fish species.

Minimal values of absolute fecundity measuring 9495 were presented in the smallest body mass groups up to 400 g and maximal 114 205 were in the largest mass group from 2801 to 3200 g.

Increasing average values of mass groups was associated with an increase of average values of absolute fecundity which were ranged from 13 235.40 to 114 205 number of eggs.

In the smallest mass groups correlation is positive and average and in larger mass groups is absent. The highest correlation is estimated in mass group measuring 801—1200 g ($r=0.746\ 31$).

Relative fecundity is calculated from 21.73 to 57.96 numbers of eggs. The largest values of relative fecundity are 42.60 in the mass groups up to 400 g and smallest 36.12 in mass group from 2401 to 2800 g. The highest correlation coefficient $r=0.408\ 76$ was present in the mass group from 801 to 1200 g. In other group this parameter was postitive, low or absent.

The smallest and the largest individuals as well as length values of absolute fecundity and average values of relative fecundity are present in the smallest and largest body length group with correlation coefficient $r=0.840\ 25$ which is positive and high or in relative fecundity positive and low ($r=0.165\ 36$) in body length group 401—460 mm.

Absolute fecundity of *Esox lucius* L. of age 2^+ and 3^+ has some values (42 607.76 —42 810.15 number of eggs, in the group 4^+ this value is decreased, and finally in the age group 7^+ value absolute fecundity is increased with a positive and high correlation coefficient (0.811 49).

In the relative fecundity correlation coefficient is negative and average (0.548 02).

Variations between real and calculated values for absolute fecundity in relation to body mass, body length and age groups (directed to the real values) are presented in the table 4.

The most prominent variations are presented in the mass groups 2001/2400 g directed to real values and measuring 5812.04 or 6.35%.

Regarding variations of relative fecundity which are directed to real values and they are smaller than calculated, making differences in all mass groups directed to calculated values.

Variations between real and calculated values concerning absolute fecundity depending on body length groups directed to real values are largest in the body length group 521—580 mm accounting for 3545.05 or 18.36%.

Variations of relative fecundity directed to real values are not detected. Calculated values are much higher.

Comparing variations between real and calculated values for absolute and relative fecundity, it was evident that they were higher in individuales labelled as 7^+ accounting for 47.50 or 10.12% and directed to real values.

In single mass, body length or age group minimal values of absolute and relative fecundity could be ten times smaller than maximal values (SPANOVSKAJA i SOLONINOVA 1983).

Our results confirm prominent individual variations. Similar results were reported by TARNAVSKIJ (1965), PERVOZVANSKIJ (1984), SAZANOVA (1979) i MOHOV (1980).

The medium values of absolute fecundity increased with increasing of average

Tab. 4. *Real and calculated values of absolute and relative fecundity of Esox lucius L. from Tisa depending of mass, length and age groups*

		n	X mass	X ab. fec.	cal. ab. fec.	diff.	%	X rel. f.	cal. r. f.	diff.	%
Mass group	0—400	4	310,00	13 235,40	12 815,15	430,24	3,17	42,60	52,00	−9,40	22,06
	401—800	22	578,53	22 548,35	23 263,95	−715,60	3,17	37,16	51,84	−14,68	39,50
	801—120	23	920,00	37 536,24	36 183,08	1 352,15	3,60	39,82	51,94	−12,12	30,43
	1201—1600	12	1505,00	54 072,50	57 533,22	−3 460,72	6,40	38,74	51,87	−13,13	33,89
	1601—2000	7	1825,71	71 420,17	70 184,07	1 236,09	1,73	38,84	51,87	−13,03	33,54
	2001—2400	2	2240,00	91 428,75	85 616,70	5 812,04	6,35	40,84	51,97	−11,13	27,25
	2401—2800	2	2605,00	94 729,30	97 747,37	3 018,07	3,18	36,12	51,77	−15,65	43,32
	2801—3200	1	2900,00	114 205,00	109 159,26	−5 045,73	4,41	39,38	51,90	−12,52	31,79
Lenght group	281—340	5	313,20	12 781,32	14 095,97	−1 314,65	10,28	39,30	42,76	−3.46	8,80
	341—400	18	352,22	23 810,56	19 606,25	1 204,30	17,65	38,77	42,80	−4,03	10,39
	401—460	23	428,47	34 358,64	35 508,61	−1 149,97	3,34	38,74	42,88	−4,14	10,68
	461—520	15	492,66	51 897,55	52 758,58	−861,03	1,63	38,88	42,94	−4,06	10,44
	521—580	8	552,75	73 747,33	60 202,27	3 545,05	18,36	38,92	42,98	−4,06	10,43
	581—640	4	610,50	99 120,90	95 550,33	3 570,56	3,60	38,45	43,02	−4,57	11,88
Age group	2+	3		42 607,76	32 889,55	9 718,20	29,54	41,38	40,59	0,78	1,92
	3+	29		42 810,15	43 063,88	−253,73	0,58	38,95	39,00	−0,05	0,12
	4+	21		39 941,85	52 920,75	−12 978,90	24,52	39,25	37,83	1,41	3,72
	5+	18		40 151,25	61 037,45	−20 886,20	34,21	37,97	37,04	0,92	2,48
	6+	1		79 337,80	69 291,69	10 046,10	14,49	32,92	36,35	−3,43	9,43
	7+	1		114 205,00	77 424,85	36 780,14	47,50	39,38	35,75	3,62	10,12

values of body mass, body length and age, and were the highest in the largest body mass, body length and the oldest groups.

Similar regularity was presented by TARNAVSKIJ (1965), TERLECKI (1973), BANËNENENE (1978) and KORVIN—KOSSAKOWSKI (1976) reports that increasing of absolute fecundity with increasing of body mass is linear, but with body length, change is parabolic line. Age does not affect absolute fecundity, but calculated values are regular.

Relative fecundity compared with changes in the body mass, body length and age of *Esox lucius* L. does not show regularity. According to the same author, with an increase of the egg diameter, relative fecundity also becomes higher.

Minimal and maximal values of relative fecundity *Esox lucius* L. from the Tisa river are much higher than values reported by SOLOV'EVA (1965), TERLECKI (1973), BANËNENENE (1978) and al.

In *Esox lucius* L. a real, relative fecundity has a tendency of increasing from northern to southern area.

Conclusions

1. Prominent individual variations of body mass, body length and age were noticed.
2. The medium values of absolute fecundity increased with an increase of average values of body mass, body length and age, and are the highest in the largest body mass, body length and age groups.
3. Relative fecundity is larger in the smaller body mass, body length and age groups.
4. Variations between real and calculated values for absolute fecundity depending on body mass, body length and age groups are directed to real values, but for relative fecundity they are directed to calculated values.

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A Tisza csukáinak termékenysége

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Kivonat

A szerző az 1980—83-ban gyűjtött 73 ivarérett ikráshal abszolút és relatív termékenységének vizsgálatát a testhossz, testtömeg és életkor függvényében, korrelációs koefficiensszámítással végezte. Megállapítást nyert, hogy az abszolút termékenység 9495—114 205, a relatív 21,73—57,96 ikrát tesz ki. A $\log F = a \log x + b$ képlettel számított abszolút termékenység átlagértéke a legöregebb és legnagyobb testtömegű és testhosszú egyedeknél a legnagyobb, a relatív pedig a legfiatalabb és legkisebb példányok esetében. A vizsgált paraméterek tényleges és számítással kapott értéke közötti eltérés az abszolút termékenység esetében a tényleges, a relatívnál a számított értékek felé hajlik.

Плодовитость щуки Esox Lucius L. в р. Тиса

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Резюме

На основании материала, полученного в период с 1980 по 1983 г.г. выполнен анализ абсолютной и относителной плодовитости в отношении к стандартной длине, весу и росту при осмотре половозрелых самок. Сделаны также расчеты коэффициентов корреляций. При этом установлены большие индивидуальные вариации. Абсолютная плодовитость наблюдалась в пределах от 9495,00 до 114 205, а относительная от 21,73 до 57,96 икринок. Средние значения абсолютной плодовитости самые большие в группах с самым большим весом, длиной и возростом, а относительная плодовитость — в группах, характеризующихся небольшим весом, длиной и младшим возростом. Расчет выполнен на основании формулы: $\log F = a \log x + b$.

Отступления между фактическими и расчитанными значениями указанных параметров для абсолютной плодовитости относятся в пользу фактических значений, а для относительной плодовитости — в пользу расчетных.

Plodnost štuke Esox lucius L. u Tisi

LJILJANA BUDAKOV

Pokrajinski zavod za zaštitu prirode u Novom Sadu

Izvod

Na osnovu materijala sakupljenog u periodu od 1980. do 1983. godine analizirana je apsolutna i relativna plodnost u odnosu na standardnu dužinu, masu tela i uzrast, pregledom 73 polno zrelih ženki. Izračunati su i koeficijenti korelacije. Konstatovana su velika individualna variranja. Apsolutna plodnost kretala se od 9495,00 do 114 205 a relativna od 21,73 do 57,96 komada jaja. Srednje vrednosti apsolutne plodnosti su najveće kod najvećih masenih i dužinskih i najstarijih uzrasnih grupa, a relativna plodnost kod manjih masenih, dužinskih i mladjih zurasnih grupa, računate formulom: $\log F = a \log x + b$. Odstupanje izmedju stvarnih i izračunatih vrednosti navedenih parametara za apsolutnu plodnost je u korist stvarnih vrednosti, a za relativnu plodnost u korist izračunatih.

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ARRANGEMENT AND NUMBER OF RADIAL CHANNELS ON THE SCALES OF PRUSSIAN CARP (Carassius auratus gibelio Bloch) FROM THE DEAD THEISS — BISERNO OSTRVO

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Abstract

The number and arrangement of radial channels is an important taxonomic character, helpful in determining the species, especially the natural hybrids frequent with fish. It is of a great importance to konw the radial channels when analysing the intestinal content of adephagans, where frequently scales of different fish can be found. The material for this work consisted of 177 specimens of Prussian carp (*Carassius auratus gibelio* BLOCH), from the Dead Theiss. The number of primary and secondary radial channels on the oral and caudal sides of scales was analysed, in relation to age, standard length and mass, in order to determine which channels and on which side of the scales vary the least, this being the most stable taxnomic character. The variation of primary and secondary radial channels is less on the caudal, than on the oral side of scales. The most stable is the number of primary radial channels on the caudal side of scales, while most variable is the number of secondary radial channels on the oral side of scales.

Introduction

The scales are frequently used for ichthyologic research, since they can give a lot of information about the life of fish. Besides the age, spawning and nutritional rings, an important element of scales relief are the radial channels. They can serve as taxonomic characters as they can be easily observed and they stay preserved, regardless how long the material is kept, or whether the scales passed through intestines. Букирев and Костарев (1961) and Бурдак (1979) stress that the morphologic characters of scales are a constant feature of the species. BALON (1963) and PUJIN et *al.* (1978) gave a key for determination of species within the genus *Abramis,* based on the number and arrangement of radial channels on scales, while SUSLOWSKA and URBANOWICZ (1984) propose a key for determination of 25 species of carp fish. The radial channels can help to determine natural hybrides (VUKOVIĆ 1971).

With regard to the fact that, about the morphology of silver carp scales, there is not much data in our literature, by this work we wanted to show the arrangement and number of radial channels and their variations.

Materials and Methods

The material was collected out of the Dead Theiss Biserno Ostrvo, in the period 1983—1985 and it consisted of 177 specimens of prussian carp. The scales were taken according to Чугунова (1959) above the side line vertrically in front of the dorsal fin. The primary and secondary radial

channels were counted, separately on the oral and caudal side of scales. Surveyed were also the lateral radial channels. The mass and standard length was measured, while the age was determined on the basis of scale rings. The number of radial channels is shown in relation to these parameters.

Results and Discussion

The protective function of scales of the prussian carp is more apparent, since in question is a benthonectonic form. For this reason the scales are thicker, larger and more deeply inserted in the cuticle. The oral side of scales is very creased.

The scales are classified into oral, caudal and lateral sides.

The primary radial channels always extend from the center towards the edges of scales. The secondary radial channels do not reach the edges or the center. One of the scale features of the prussian carp are the lateral radial channels, appearing on the scales of this species from the Dead Theiss — Biserno Ostrvo in the amount of 26% of individuals, mostly on the left side of scales.

As shown in Table 1, according to the variation coefficient (Kv) it is concluded that on scales the most stable is the number of primary radial channels on the caudal side, and that the variation number of primary and secondary radial channels is far smaller on the caudal than on the oral side of scales. The highest variation rate is for the number of secondary radial channels on the oral side scales. ŠENK (1969) is of the opinion that the secondary radial channels are one of the aberrations of scales. We are of the opinion that possibly they are one of the aberrations, but they could be considered as taxonomic characters. ŠENK and KALUDJERČIĆ (1963) analysed the relation between secondary radial channels and the growth rate of *Barbus meridionalis petenyi* and concluded that these channels are created equally in spring and autumn, most frequently in front or in the middle of damaged sclerite rings.

Tables 2, 3 and 4 show that the number of primary radial channels on the oral side of scales grows with age, while related to standard length and body mass, the number of these channels varies.

The number of secondary radial channels on the oral side grows from the age 3+ to 5+ at body length 141—300 mm and body mass up to 300 g and from 401 to 1000 g. ŠENK and KALUDJERČIĆ (1963) state that the total number of secondary radial channels with *Barbus meridionalis petenyi,* increased with age, while the creation of new channels decreased with age. The creation of secondary radial channels is in connection with the more intensive growth of the individuals, since they are far more intensively created at younger individuals. The creation of these channels is also connected with the sexual maturity, since they are created mostly in the years of sexual maturity.

Similar data are also given by KNEŽEVIĆ (1984) regarding creation of secondary radial channels with rudd *Scardinius erytrophtalmus,* in which the most intensive creation is in the first year of life in groups of narrow sclerite zones. PUJIN et *al.* (1978) state that in *Abramis brama* the number of channels on the caudal sides of scales was increased with age. This was not established on the oral side. For bream the increase of channel number was not established in relation to age.

The high maximal number of secondary radial channels on the oral sides of scales of prussian carp from the Dead Theiss — Biserno Ostrvo (14), and also the relatively high mean value (2.84) (Table 1.) could possibly be connected as per the quoted authors to age, because from this locality the caught fish were of older age categories.

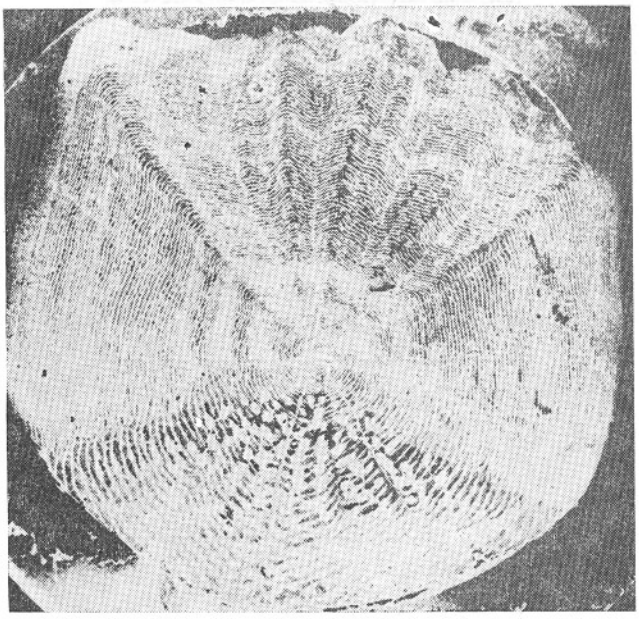

Fig. 1. Arrangemenet and number of radial channels on the scales of *Carrassius aurafus gibelio* from the depo Theiss-Biserno Ostrovo

Tab. 1. *The number of radial channels on the scales of Carassius auratus gibelio* BLOCH *in the Mrtva Tisa-Biserno ostrva (The Dead Theiss)*

Species and position of the channels	min—max	$\bar{x} \pm S\bar{x}$	σ	Kv
Primary radial channels on oral side of the scales	1—8	4,37±0,08	1,11	25,40
Secondary radial channels on oral side of the scales	1—14	2,84±0,16	1,83	64,44
Primary radial channels on caudal side of the scales	2—5	3,68±0,05	0,72	19,56
Secondary radial channels on caudal side of the scales	1—2	1,11±0,05	0,32	28,83

The primary radial channels on the caudal side of scales do not vary a lot in relation to age (Table 2), while in relation to standard length (Table 3) and body mass (Table 4) there are variations, but not so much as on the oral side of scales.

The number of secondary radial channels on the caudal side of scales does not vary a lot as compared to the stated parameters, and variation is also less than on the oral side of scales.

Conclusion

— The prussian carp is a benthonectonic form so that the scales are thicker, larger and more deeply inserted in the cuticle, and the oral side is more creased.

— One of the features of the scale of the prussian carp are the lateral radial

Tab. 2. *The number of radial channels on the scales of Carassius auratus gibelio* BLOCH *in the Mrtva Tisa-Biserno ostrvo (The Dead Theiss) according to the growth*

GROWTH	Primary radial channels on oral side of the scales		Secondary radial channels on oral side of the scales			Primary radial channels on caudal side of the scales		Secondary radial channels on caudal side of the scales		
	min—max	$\bar{x}$	min—max	$\bar{x}$	n	min—max	$\bar{x}$	min—max	$\bar{x}$	n
2+	1—5	3,00	5	5,00	1	3—4	3,50	—	—	—
3+	2—7	4,18	1—5	2,53	15	2—5	4,00	1—2	1,25	4
4+	1—8	4,37	1—7	2,65	61	2—5	3,61	1	1,00	20
5+	2—7	4,46	1—14	3,21	38	2—5	3,70	1—2	1,19	16
6+	2—6	4,37	1—5	2,77	9	2—4	3,12	1—2	1,25	4
7+	6	6,00	—	—	—	3	3,00	—	—	—

n — fish number

Tab. 3. *The number of radial channels on the scales of Carassius auratus gibelio* BLOCH *in the Mrtva Tisa-Biserno ostrvo (the Dead Theiss) according to the standard length*

Standard. length (mm)	Primary radial channels on oral side of the scales		Secondary radial channels on oral side of the scales			Primary radial channels on caudal side of the scales		Secondary radial channels on caudal side of the scales		
	min—max	$\bar{x}$	min—max	$\bar{x}$	n	min—max	$\bar{x}$	min—max	$\bar{x}$	n
141—160	3—5	3,80	1—4	1,50	4	3—5	3,80	—	—	—
161—180	4—5	4,60	3	3,00	1	3—4	3,40	2	2,00	1
181—200	1—5	3,66	3—5	4,00	2	3—4	3,66	—	—	—
201—220	3—7	4,50	1—3	1,66	6	4—5	4,10	1	1,00	1
221—240	3—6	4,43	1—5	1,87	8	2—5	3,86	1	1,00	5
241—260	4—8	5,28	1—6	2,18	17	3—5	3,86	1	1,00	7
261—280	2—7	4,13	1—8	2,71	28	2—5	3,64	1—2	1,28	7
281—300	1—6	4,24	1—14	3,39	46	2—5	3,57	1—2	1,05	20
301—320	2—6	3,83	2—6	3,36	11	2—4	3,25	1—2	1,33	3
321—340	4	4,00	2	2,00	1	4	4,00	—	—	—

n — fish number

Tab. 4. *The number of radial channels on the scales of Carassius auratus gibelio* BLOCH *in the Mrtva Tisa-Biserno ostrva (the Dead Theiss) according to the body mass*

BODY MASS (g)	Primary radial channels on oral side of the scales		Secondary radial channels on oral side of the scales			Primary radial channels on caudal side of the scales		Secondary radial channels on caudal side of the scales		
	min—max	$\bar{x}$	min—max	$\bar{x}$	n	min—max	$\bar{x}$	min—max	$\bar{x}$	n
1—100	3	3,00	2	2,00	1	4	4,00	—	—	—
101—200	3—5	4,25	1—4	2,50	4	3—5	3,62	—	—	—
201—300	1—5	4,00	1—5	3,00	3	3—4	3,60	2	2,00	1
301—400	3—6	4,50	2—3	2,50	2	4—5	4,17	1	1,00	1
401—500	3—7	4,44	1—5	1,92	12	2—5	4,08	1	1,00	4
501—600	2—8	5,32	1—6	2,13	15	2—5	3,72	1—2	1,14	7
601—700	2—6	4,17	1—5	2,18	11	3—5	3,58	1	1,00	4
701—800	2—6	4,22	1—8	3,06	35	2—5	3,37	1—2	1,06	16
801—900	1—7	4,17	1—14	3,48	27	2—5	3,60	1—2	1,28	7
901—1000	2—5	4,20	2—6	3,80	10	2—5	3,90	1	1,00	4
1001—1100	3—4	3,33	1—3	2,00	3	3—4	3,66	—	—	—
1201—1300	4	4,00	2	2,00	1	4	4,00	—	—	—

n — fish number

channels, appearing at 26% of individuals from the Dead Theiss — Biserno Ostrvo most frequently on the left side of scales.

— The most stable is the number of primary radial channels on the caudal side of scales, while the most highly varied is the number of secondary radial channels on the oral side of scales.

— The variation of primary and secondary radial channels is less on the caudal side, as compared to the oral side of scales.

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Az ezüst kárász pikkelyei csíkjainak elrendeződése és száma

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A halpikkelyek radiális csíkjainak száma és elrendeződése jelentős rendszertani bélyeg, amely elsősorban a természetes hibridek meghatározását segíti elő. A radiális csíkok ismeretének nagy jelentősége van a ragadozók emésztőcsatornája tartalmának elemzésekor is.

A szerzők összesen 177, a Holt-Tiszából származó ezüst kárász egyedének vizsgálatát végezték el. A pikkelyek orális és kaudális részén jelenlevő elsődleges és másodlagos radiális csíkjainak vizsgálata az életkor, a testhossz és a testtömeg összevetésével történt. Megállapítást nyert, hogy a pikkelyek kaudális részén elhelyezkedő, mind az elsődleges, mind a másodlagos barázdái kisebb méretűek az orálisokéihoz viszonyítva. Másrészt a pikkelyek orális részén elhelyezkedő másodlagos csíkok nagy változékonyságához viszonyítva az elsődleges kaudális csíkok állandósága nyilvánvaló.

Расположение и количество радиальных каналов на чешуях серебряного карася (Carassius auratus gibelio Bloch) из мертвой Тисы

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Резюме

Количество и расположение радиальных каналов у рыб являются важными классификационными характеристиками, которые могут в значительной степени содействовать при определении видов, особенно природных гибридов, часто появляющихся у рыб. Опытность в определении радиальных каналов имеет большое значение при анализе кишечного содержания хищных рыб.

Материалом для этой работы были серебряные караси *(Carssius auratus gibelio* Bloch) из Мертвой Тисы, в количестве 177 шт. Анализировалось количество первичных и вторичных радиальных каналов на губной и хвостовой частях чешуи по отношению к росту (возрасту), стандартной длине и весу рыбы.

Варьирование первичных и вторичных радиальных каналов меньше в хвостовой части, чем в губной части чешуи. Самым постоянным является количество первичных каналов хвостовой части чешуи, а самые большие вариации наблюдаются в количестве вторичных радиальных каналов губной части чешуи.

Raspored i broj radijalnih kanalića na krljuštima srebrenog karasa (Carassius auratus gibelio Bloch) iz Mrtve Tise

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Izvod

Broj i raspored radijalnih kanalića riba je važan taksonomski karakter koji može dosta da pomogne kod odredjivanja vrste, a naročito prirodnih hibrida koji su kod riba dosta česti. Poznavanje radijalnih kanalića je od velikog začaja kod analize crevnog sadržaja grabljivica.

Materijal za ovaj rad se sastojao od 177 primeraka srebrenog karaša (*Carassius auratus gibelio* Bloch) iz Mrtve Tise. Analiziran je broj primarnih i sekundarnih radijalnih kanalića na oralnoj i kaudalnoj strani krljušti u odnosu na starost, standardnu dužinu i masu ribe.

Variranje primarnih i sekundarnih radijalnih kanalića je manje na kaudalnoj nego na oralnoj strani krljušti. Najstabilniji je broj primarnih radijalnih kanalića na kaudolnoj strani krljušti, a najviše varira broj sekundarnih radijalnih kanalića na oralnoj strani krljušti.

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THE GROWTH OF SILVER CARP (Hypophthalmichthys molitrix Val.) IN THE DEAD THEISS

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Abstract

In order to increase the total production in carp fish ponds in Vojvodina, in the mid-seventies, some species of phytophagous fish from the so-called Chinese complex were introduced. At that time the silver carp *(H. molitrix)* got into open waters and in this new extended areal shows a successful adaptation manifested in growth both in length and body mass and its condition (fattening coefficient). The analysed samples were caught in a stagnant water type river lake (Dead Theiss — Biserno Ostrvo) during the period 1983—1985. The fish reached these waters by planting. They belong to age categories 2+ to 4+, having a body mass of 1,465—3,513 g. and standard length of 391—572 mm. The sex ratio in this water basin is 1:1, and the mean value of fattening coefficient is 2.06. The calculated values of growth show an intensive growth at all ages, especially in the first three years (age 0+ to 2+) where the relative increase is 118 resp. 56%. The growth of treated samples does not fall at all behind the growth of samples from the natural areal, showing a successful adaptation of this allochton species in this part of extended areal, where they have good living conditions (sufficient water and food during the year, a stable temperature and oxygen regime and an optimal pH.).

Introduction

The introduction of phytophagous fish from the Far East in the waters of Vojvodine was done in order to increase the ichthyo-mass and its biologic and economic values.

Their meliorative function is also of importance, in terms of slowing the eutrophication. The growth of fish production in this way is based on the unused or slightly used nutritional resources in a water eco-system. The planting of the Dead Theiss with species of the socalled Chinese complex, was strated ten years ago, when their breeding started in the fish ponds in this area. The most numerous of these species of fish is the silver carp *(H. molitrix)*. The other two species, the grass cap *(Ctenopharyngodon idella)* and the bighead carp *(H. nobilis)*, are present in smaller number. The appearance of this fish in our waters, has the attention of several researchers, who are analysing them from different aspects (RISTIĆ 1986, TOTH 1971, IVANOVIĆ 1973, KNEŽEVIĆ et JOVANOVIĆ 1983, PUJIN et *al.* 1986), while about their growth tempo two reports were made up to date (MALETIN et KOSTIĆ 1986, MALETIN et *al.* 1987).

Material and Methods

The material was collected during a period of three years (1983—1985) by means of nets 70 m long, mesh diameter 110 mm. A total of 71 samples of silver carp were analysed, aged 2+ to 4+ body mass 1,465—3,516 and standard length 391—572 mm/35 females, 27 males and 9 juveniles). The age and reconstruction of growth were determined on the base growth zones on scales by standard methods. The fattening coefficient (Q) was calculated according to Fulton, while the body mass — standard length ratio as a correlation coefficient (r). The difference in growth between females and males for $p<0.05$ and $p<0.01$ was evaluated by Student test and the sex ratio by Hi^2 test. Apart from the analysis of biologic parameters, the most important abiotic factors were followed: water temperature, oxygen regime and pH.

Results and Discussion

The body mass growth shows very good results. The tested samples in their third year of life (age 2+) on the average reach 1,465 g., the following year 1,934 g., and in the fifth year 3,516 g. (Fig. 1).

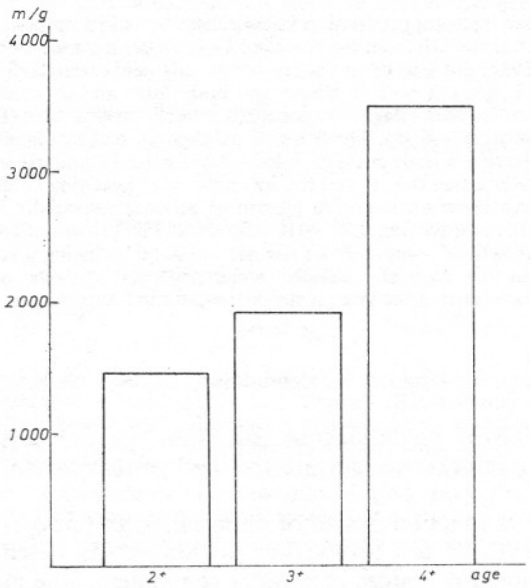

Fig. 1. Body mass growth tempo of *H. molitrix* in Mrtva Tisa

The growth in length is also very intensive. In the first year of life the samples reach on the average 115 mm of standard length, in the second 251 mm, in the third 291 mm, in fourht 474 mm and in the fifth 572 mm. An exceptionally high yearly absolute and relative growth can be noted especially in the first three years of life. In the second year the relative growth is 118% and in the third 56% (Fig. 2).

The growth in length was also analysed in relation to sex (Fig. 3). In the first two years of life it is more intensive in females, in the third it is almost equal, in the fourth it is again in favour of females, while later with the increase of growth in favour of males. These differences are, however, of no statistical importance. The sex ratio is 1:1. (Fig. 3).

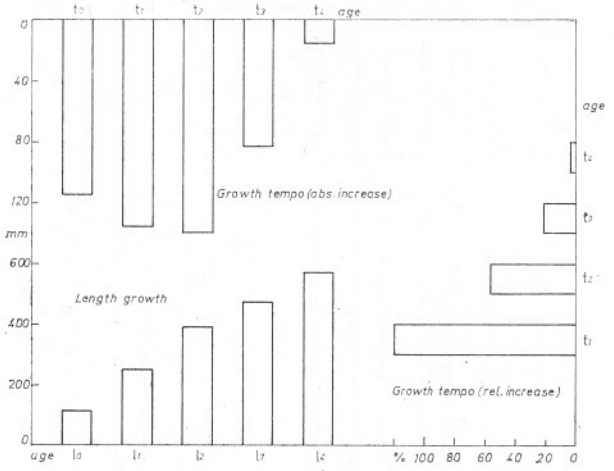

Fig. 2. Growth of silver carp *(H. molitrix)* in Mrtva Tisa-Biserno Ostrvo 1983—1985

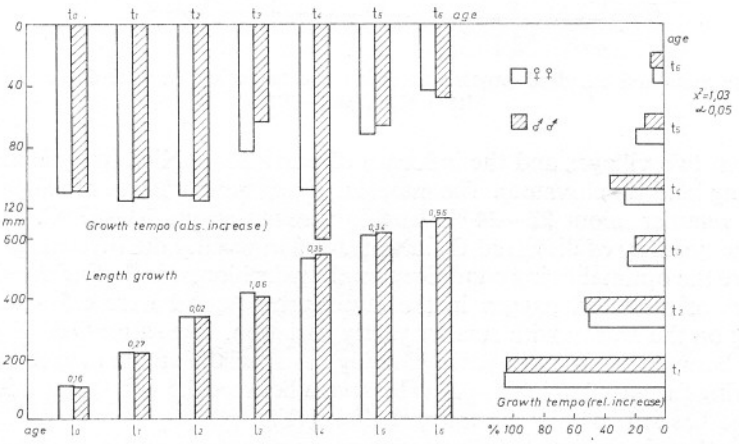

Fig. 3. Growth of females and males of silver carp *(H. molitrix)* in Mrtva Tisa-Biserno Ostrvo 1983—85

The total growth of this fast growing planktophag species was followed on the base of mass and growth correlation (coeff. r). The correlation coefficients are positive and high since $r>0.70$ in all growth categories (0.9619—0.9888). The fattening coefficient values (Q), which indicate the general condition, are very favourable and increase with age and are from 1.9696 (for age 2+) over 2.0980 (3+) up to 2.1109 (4+) (Fig. 4).

Regarding the abiotic factor, the Dead Theiss-Biserno Ostrvo is a water ecosystem where prevail very favourable conditions and most importantly, very stable living conditions. By this we mean the most important physico-chemical parameters: water temperature, oxygen regime and pH.

This stability is maintained first of all thanks to sufficient water quantity during the year and the lack of any polluting agent (excluding of course communal waste

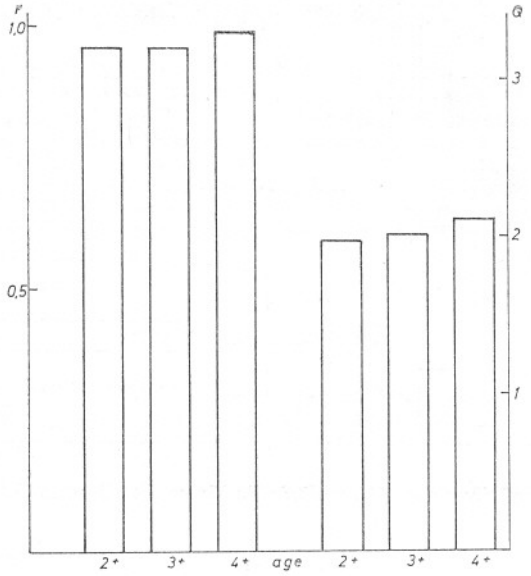

Fig. 4. Body mass and standard length correlation and coefficient of fattening of *H. molitrix* in Mrtva Tisa (1983—1985)

waters from two villages and the influence of nutrients applied in agriculture as the surrounding land is cultivated). The maximal spring temperatures of water are about 15 °C, in summer about 22—24 °C and in autumn about 10—13 °C. The oxygen regime, the quantity of dissolved O_2 in water and especially the percentage of saturation, secure the optimal living conditions to all hydrobionts, including the silver carp. The values of dissolved oxygen in the investigated period were 6.5—18.5 mg. l^{-1}, depending on the season with smaller yearly variation. The saturation of water with oxygen is between 80 to 190% (exceptionally). A specially stable oxygen regime prevailed during the year 1984. The pH values were between 7.5 and 9, but this relatively wide range lies still within the tolerant limits (Fig. 5).

Evaluating the growth of silver carp in a native areal and out of it, numerous authors gave different values, evaluating the success of adaptation in the extended part. So ZAŠEV (1961) and NIKOLSKI (1971) among the first in the world analysed the body mass and length growth of this planktophag in the Amur river basin, and these results are quoted in their discussions by ANTALFI et TÖLG (1972) studying the process of their acclimatization under the conditions in Eastren and Mid-Europe. Different growth rate in the waters of USSR was reported by HARITONOVA (1980), CHARYEV et RYLOV (1980) and many other authors stress that for the successful growth of silver carp, crucial is the food quantity and the length of vegetation period. Moderate results regarding the mass growth were observed in the waters of ČSSR by GAJDUSEK et LUSK (1982) and MÜLLER (1982) for some lakes in Switzerland. The best results were recorded in India, which can be understood having in mind the trophic rate of these water basins and the possibility of constant feeding all year long. (KARAMCHANDANI et MISHRA 1980).

A good mass and length growth of this allochthon fast growing ciprinide species in this part of extended areal (Dead Theiss-Biserno Ostrvo) is enabled due to very

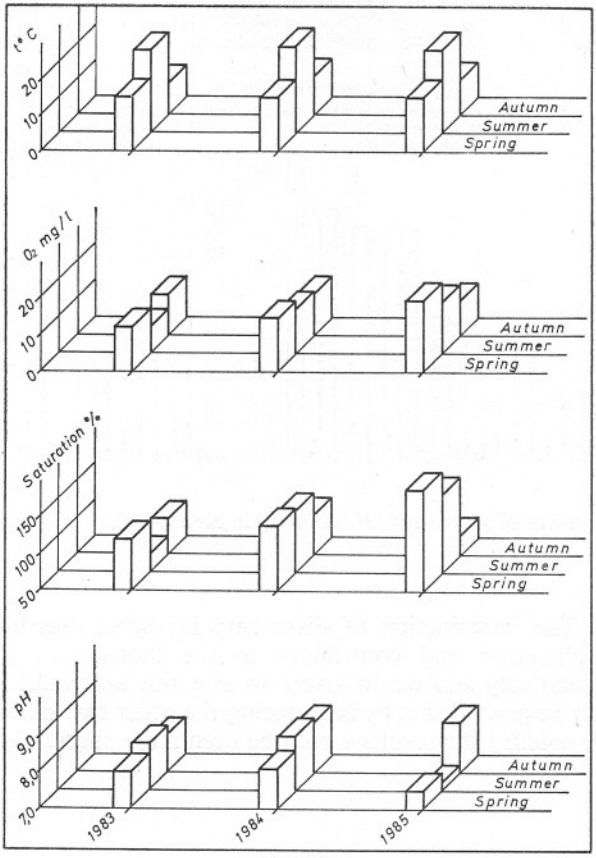

Fig. 5. Physical and chemical characteristics of water in Mrtva Tisa (mean seasonal values)

favourable and biotic abiotic factors, in the first place plankton as food not used sufficiently by autochthon planktophagous fish. This outstanding planktophag finds it abundantly and consumes it in great quantities, proved through intestinal analyses (PUJIN et *al.* 1986). The successful growth of silver carp in this river lake can also be noted by comparing these results with the growth rate of this introduced species in some other water eco-systems in Vojvodina such as the Danube and Bosut, another river lake Carska bara, parts of the hydrosystem Danube-Theiss-Danube canals and one fish pond (at Žabalj). The growth rate of the analysed individuals from the Dead Theiss falls only behind individuals from the fish pond, (Fig. 6).

Conclusion

H. molitrix has very successfully adapted in eutrophic waters of Vojvodina, testified by its intensive mass and length growth and high values of coefficients r and Q. The total growth in the Dead Theiss does not fall at all behind its growth in native areal, being the consequence of very favourble abiotic and biotic factors (sufficient water quantity all year long, stable temperature and oxygen regime, optimal pH and

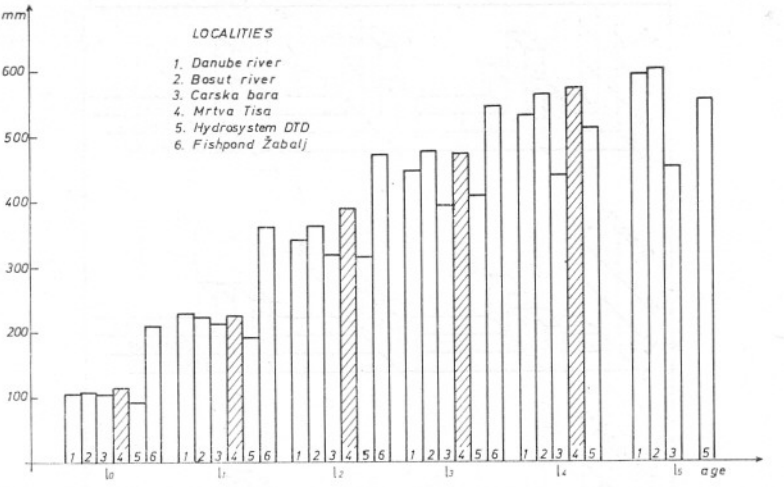

Fig. 6. Length growth of silver carp *(H. molitrix)* in diverse hydroecosystems of Vojvodina

abundant food). The introduction of silver carp in such a river lake is slowing the process of eutrophication and contributes to the increase of the total ichthyo production quantitatively and qualitatively so that this act could be considered as justified. It could be expected that by introducing the other two phitophagous species *(C. idella and H. nobilis)* the results would be even more successful.

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

Dr. Dániel Gál

Dr. DÁNIEL GÁL was born on 26th of December, 1934, in Lajosmizse. He studied from 1953 till 1957 at the Szeged University and graduated as teacher in biology and chemistry. He started to work in the Institute of General Zoology and Biology as a postgraduate student. His research field was the anatomy and histology of the amphibian autonomic nervous system. From 1958 until his death he worked in the Department of Zoology.

As hydrobiologist he studied the zooplankton of the river Tisza. Besides seasonal, ecophaunistic and saprobiologic investigations carried out on various sections of the river and dead arms he collected data for the Water Management of the Lower Tisza Region Szeged, and Kisköre Research Laboratory. He dealt with the effect of public and industrial sewage as well as the Kisköre river barrage on the living organisms of Tisza in his most significant papers on environmental protection. On the basis of his systematic samplings of a long section of river Tisza he started to write a synthetic complex study on the long distance and seasonal changes of the zooplankton and their determining abiotic and biotic factors. This awaited work summarizing his life-work regrettably cannot be finished any more.

As a lecturer he took part in the teaching of zoological taxonomy and organization of study excursions with great enthusiasm and good practical sense. Although he was on research status, he was devoted to teaching as well. He tried to promote the love of nature and life in his students with the help of thorough knowledge and experience.

As a colleague he never said "no" to any request. The interest of the department and the community was the most important for him and beyond the recognition of these, he always was among the first in the action.

His sudden death left a gap that cannot be filled, his absence is perceivable in several fields of life. We keep the rembrance of him and his life-work.

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TISZA-RESEARCH CONFERENCE XVIII (1987) COMPILED BY

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I. Participants of the Conference

Tisza-Research Conference XVIII (October 22 and 23. 1987, Novi Sad, Yugoslavia) has affirmed and deepened the continuity of investigating the Tisza. The results of the investigations which started in 1953 in the Hungarian reach of the Tisza have been primarily evaluated and discussed at the traditional annual Tisza-Research Conference, respectively reported to the professional and scientific public in "Tiscia", which is exclusively concerned with issues of Tisza-Research.

On the basis of incontestable results of the research it has been necessary to expand the investigations to the total length of the river from its source to its estuary. These unified investigations started in 1980, on the basis of an interuniversity collaboration between the University of Novi Sad and that of Szeged, and between the universities in Szeged and Užgorod.

This Tisza-Research Conference which took place in Novi Sad (for the first time outside Hungary) presented an exchange of scientific information, coordination of research methodology, insight and deepening of community investigations at an international level, too.

At XVIII Tisza-Research Conference 18 lectures have been given (7 concerning the Tisza reach in Hungary and 11 concerning the Yugoslav reach of the river). 43 participants attended the conference and took part in its work. The conference was organized by the Institute of Biology, Novi Sad, Tisza-Research Working Committee, Tisza-Research Study Group, University of Novi Sad, and the Vojvodina Academy of Science and Art, Novi Sad. It was financially supported by the Self-managing Community of Interest for Scientific Work of Vojvodina, Novi Sad, and the Self-managing Community of Interest for the Basic Regulation of Waters, Novi Sad.

The working part of the conference took place at the headquarters of the Vojvodina Academy of Science and Art, and on the second day a tour was organized to visit the protected natural reservation "Carska bara" in the Regional Park "Stari Begej" (the region of the estuary of Begej into Tisza).

The conference was also attended by the following guests: Professor Dr SLAVKO BOROJEVIĆ, academician, president of the Vojvodina Academy of Science and Art, Novi Sad

Professor Dr DRAGAN MUNITLAK, vice-chancellor of University of Novi Sad

Professor Dr ISTVÁN BENEDECZKY, honorary president of Tisza-Research Committee, Szeged

Dr GYÖRGY BODROGKÖZY, senior lecturer, acting president of Tisza-Research Committee, Szeged
Dr SÁNDOR GULYÁS, senior lecturer, committee member of Tisza-Research Committee, Szeged
Professor Dr SLOBODAN GLUMAC, director of the Institute of Biology, Novi Sad
Professor ANDOR RICHNOVSZKY, Eötvös József Tanárképző Főiskola, Baja
PAVLE KILIBARDA, Water Resources Management Organization Dunav—Tisa—Dunav, Novi Sad
ALEKSANDAR MAROŠAN, director of the Fish Management "Ečka", Zrenjanin
MÁRTA TÓTH, Institute for Technology and Agriculture "SZERVÓ MIHÁLY", Zrenjanin.

Professor Dr SLAVKO BOROJEVIĆ welcomed the participants of the conference in the name of the Vojvodina Academy of Science and Art. He pointed to the fact that the Academy is well informed about the endeavours and results of the Study Group in investigating the Yugoslav reach of Tisza, particularly about the work of the members from the Institute of Biology. These investigations also, in the framework of the scientific policy of the Academy, present both the scientific policy of Vojvodina and an obvious example of a realization of universal research work at the international level. So these investigations contribute to the promotion of the cultural and scientific activities of the two countries linked by the Tisza. In the applied biological disciplines, and other disciplines, too, the results of these investigations are important for the protection of the genofund and environment in the vast agrosystems of Vojvodina and Pannonian Lowlands, the adequate and rational use of natural resources in the valley of the Tisza being of main concern.

Academician S. BOROJEVIĆ, the host of the Conference, expressed his hopes in the promotion of the research work and the extension of co-operation in this international project, wishing that the ratification of the already submitted proposal for the programmatical inclusion of the academies (Vojvodina Academy of Science and Art and Hungarian Academy of Sciences) in its realisation take place as soon as possible. He wished much success in the work of the Conference and a pleasant stay in Novi Sad to the guests.

In the name of the University of Novi Sad Professor Dr DRAGAN MUNITLAK, vice-chancellor, greeted the Conference and gave a brief survey of the educational organization at the University and its cultural and scientific role. He emphasized that since 1954, when the first part of the University, the Faculty of Agriculture started its activities, 12 faculties, 4 colleges, 6 pedagogical academies and 65 research institutes have become part of this highest scientific institution in Vojvodina. Its coming into existence was not fortuitous, but it was an organic process of the traditional social, economical, cultural and scientific development in this region. This is why the board of the University of Novi Sad pays due attention to the activities of the Tisza-Research Study Group. Its endeavours are highly appreciated not only with respect to the results so far, but still more with respect to the programme comprising the survey of the whole valley of the Tisza, the realization of which is supported by the University.

II. Review of the results of the former investigations in the Yugoslav reach of the Tisza

The programmatical and organized integration of the research group of the Institute of Biology in Novi Sad in the investigations of the Yugoslav reach of the Tisza started in 1978 as an inter-university co-operation (Novi Sad—Szeged). After

the election of the vice-president of the Project Council and a member of the editorial board of "Tiscia" from Novi Sad, the number of the researchers has been growing and the issues and content of investigations have been enlarged in some disciplines, but so far only in the field of microbiology, hydrobiology and zoocenology, and recently in macrophytes.

The basic program orientation bearing on the complex community investigations has been directed towards:

— the investigation of physico-chemical conditions of the soil and the water regime of the Tisza valley;

— the microbiological analysis of the composition and dynamics of the bacterioplankton;

— the quantitative and qualitative analysis of the seasonal dynamics of phyto- and zooplankton, bottom fauna and ichthyofauna;

— phytocenological investigations of macrophytes in the Tisza valley;

— complex zoocenological investigations of soil nematodes, insects, birds and mammals;

— the protection of nature, maintenance and promotion of natural resources in the Tisza valley.

These complex community investigations on the lower flow of the Tisza in Yugoslavia continue the former sporadical investigations in the Tisza valley. Works in ichthyology and ornithology appeared already in 1950, and those in hydrobiology, helminthology and terriology at the beginning of the seventies.

The results of the complex community investigations of the Tisza have shown a multidisciplinary character. Beside stating the situation concerning the composition and biocenotical evaluation of the communities of some ecosystem types along the Tisza valley, they have contributed to the realization of meliorating interventions, and also to the protection, maintenance and promotion of the environment and its components.

Considering the international situation of the river, the research programme of the Tisza was already included in the CMEA programme in 1984, under the theme III/1: "The ecological bases of the optimal use and protection of communities".

Investigations on the Yugoslav section of the river Tisza have been carried on by gradually increasing the number of collaborators, expanding (and deepening) the issues and contents of the investigations in various disciplines (Tab. 1 and 2). So far, the investigations have been partly carried on along the whole course of the river, from the border to the estuary (Syrphidae and Culicidae-Diptera and terriofauna), or they have had a stationary character (the region of Carska bara and Mrtva Tisa — microbiology, hyrdobilogy and inchthyology). The result of our investigations on the Yugoslav section of the Tisza are presented in the supplement 1 (P=publications) and in the supplement 2 (R=reports).

III. Reports on the studies of this Conference

Tiscia XXIII (1988) is the proceedings of XVIII Conference on investigations of the Tisza. The following seven papers presented at the Conference have been presented only in abstracts:

Tab. 1. *Papers of meetings*

Year	Confe rence	№		Discipline							
		Au- thors	Pa- pers	Flo- rist.	Micro- biol.	Hyd- ro- biol.	Entho- mo- log.	Orni- tho- log.	Terri- olog.	Para- sitol.	Ich- thyo- log.
1978	IX.	2	2	1		1					
1980	XI.	1	1	1							
1981	XII.	2	2	1		1					
1982	XIII.	6	5	1		2			1		1
1983	XIV.	6	3			1			1		1
1984	XV.	11	6		1	1	1	1	1		1
1985	XVI.	9	6		1	1	2		1		1
1986	XVII.	8	3		1	1				1	
1987	XVIII.	17	13	1	2	3	1			1	3
Total	9	63	41	5	5	11	4	1	4	2	7

Tab. 2. *Publications in the periodical Tiscia*

Year	Volum.	№		Discipline							
		Au- thors	Pa- pers	Flo- rist.	Micro- biol.	Hid- ro- biol.	Entho- mo- log.	Ich- thyo- log.	Orni- tho- log.	Terri- olog.	Para- sitol.
1979	XIV.	4	2	1		1					
1983	XVIII.	10	4	1		1		1		1	
1984	XIX.	5	2			1		1			
1985	XX.	14	6		1	1	1	1	1	1	
1986	XXI.	10	3		1	1		1			
1987	XXII.	8	3			1	1	1			
1988	XXIII.	26	12	1	4	2	1	3			1
Total	7	77	32	3	6	8	3	8	1	2	1

FEKETE, E.:

Chemical parameters and the tendency of water quality change of the river Maroš

Among the tributaries of the river Theiss, Maroš takes a special place, both regarding protection against flood and in relation to water quality. A short review is given about those geologic and hydrologic circumstances which determine the special water quality of the river in relation to Theiss.

The analysis made through mathematical-statistical methods for the O_2, N and P regime shows minimal water quality aggrevation. The water controll made in the recent years, indicates a considerable increase of nitrogen, nitrites and nitrates.

The obtained data significantly indicate the dependence between the biologic state and chemical parameters. It also should be mentioned that the results of heavy metal controlls are indicating the dependence of the density and species number of microorganisms in the water.

GÁL, D.

Seasonwise changes of the zooplanktone of the Dead Theiss — Tiszaug in the years 1981—1986

The zooplanktone investigation in the mentioned period (Testacea, Rotatoria, Entomostraca) in the Dead Theiss — Tiszaug, was made on the basis of monthly collected samples at three points: 1 — at the bridge, 2 — on the north end of Dead Theiss, 3 — in the middle between the first and second point. On all three points, mainly dominating were Rotatoria, both regarding the number of species and number of individuals, making 50—70% of total zooplanktone. Entomostraka appear as mean values (30—40%) except in spring, when occasionally the number of species and number of individuals reaches 60%. Testacea are represented with the smallest number of species and individuals. Between particular investigation points, the differences were considerable:

1. At the bridge open water is dominating. On this point the number of species is the largest, while the number of individuals of particular species is on average smaller.
2. The northern part of the Dead Theiss shows a strong eutrophication, almost throughout the year it is covered by water plants having the poorest zooplanktone.
3. The individuality of this midpoint is of transitional character. Open water is mainly dominating, although occasionally total coverage appears mostly by Potamogeton. As far as species are concerned it is poorer in relation to the first point, but particular species occasionally appear in large number of individuals. Because of that, the total density is here mostly the largest.

   Characteristic species on particular points:

   1. *Nebela collaris, Brachionus quadridentatus, Acroperus harpae*
   2. *Arcella stellata, Brachionus falcatus, Alona quadrangularis*
   3. *Difflugia corona, Lecane luna, Chydorus sphaericus*

MALIK, ERZSÉBET

The causes of fish pestilence and ammonium poisoning in eutrophic waters and polluted stagnant waters

In recent decades in fish ponds, resp. particular stagnant waters with intensive production, on several occasions, massive carp pestilence occured, caused by an unknown carrier of gill disease, known in literature as gill necrosis.

This work shows the measuring methods of increased ammonum quantity in eutrophic waters, while of interest was also to register the changes in carp behaviour. The fact is that changes in the gill tissues (hystolisis, hypertrophia and hyperlasia, degeneration of gill tissues, in some cases hyperemia resp. ischaemia) are showing great similarity to the symptoms of ammonium poisoning. The measuring of ammonium in blood was used as differential diagnosis. The concentration of N being 4—5 $mg \cdot dm^{-3}$ NH_4 in blood, proves a stress condition caused by ammonium.

DOBLER, ENIKŐ:

The Maroš river water quality

Out of four water quality parameters, the author has investigated saprobity and trophity. Samples for saprobiologic analysis were taken regularly from the year 1967 in weekly and fortnightly intervals at Mako, RK 25.5 and RK 2.0. The results are

shown by a differential curve on the basis of mathematical — statistical elaboration. One curve represents the seasonwise and the other the changes during five years. The analysis of trophicity of the river was made since the year 1974, by measuring the chlorophylle concentration. The results indicate a slow, but gradual increase.

The chlorophylle concentration in recent years, during the vegetation period, reached the average level even up to 400—500 mg/m³. At the same time, the total number of algae was also determined. In the eighties, besides the indication of species, the biomass of phitoplanktone was also established. The work shows the changes in the phitoplanktone and biomass for the last two years.

A. Vujić, Branka Božičić:

The influence of herbal cover on the number of layed eggs of particular mosquitos species
(Diptera, Culicidae)

Particular polyvoltine and rural species of mosquitos, show an exceptional affinity towards determined herbal species regarding the choice of place for egg laying. So particular herbal river belts become zones with the largest number of layed eggs.

In the work species of mosquitos are shown, at which a dependence appears for egg laying on the type of herbal belt along the river Theiss.

A good knowledge of herbal community zonality, enables the opportunity to forecast with great certainity the occurence of massive mosquito larvae appearance in a certain area. Such investigations were not made up to now in Yugoslavia.

Bába, K.:

Zoogeographic relations of snails from grass communities at two pannonic localities

The author had, according to the methods of Bába, in the year 1982, made parallel investigations in areas between Danube and Theiss, along the river Theiss, having loess, sandy, marshy and secondary grassy communities. It was established that the snail community of this two areas with 11 plant communities clearly differs. The area along the Theiss, with more types of soil and a flooded zone, has a richer fauna of snails. The grassy communities of both areas are inhabited mainly by continental species. Cholomediterranean elements appear in greater number between the Danube and Theiss. Quertion frainetto represents a differential faunistic element.

During investigation, two tendencies were noticed. The grassy communities are characterized by continental (pontic — pannonic, caspic-sanuatic, east-siberian) elements. With the process of marshy land flooding, east and west Siberian faunistic elements prevail. By successive overgrowing with grass, the cholomediterranean elements increase, similar to the noticed processes at closing of forest communities.

Gaskó, B.:

Data about the inhabitation of cerambycides on flooded areas of the rivers Theiss and Maroš

The author has since the year 1974 investigated Cerambycidae on the part of rivers Theiss and Maroš (Csongrád County). Most data was collected for the communities *Salicetum albae — fragilis* facies *Salix alba.* Almost completely was also elabo-

rated the investigation of Cerambycidae, whose larvae are developing in herbaceous plants. For Species whose nourishing plants are *Fraxinus, Ulmus* and *Quercus,* the basic informations are sporadic because they tend to overlap.

It was established that the inhabitation and displacement mechanism is different for xilophagous and caulophagous ceramibycides. In the area of Körtvélyes, out of 25 species consuming *Salix alba*, 20 (80%) were from branches, 2 (8%) out of broken tree trunks, 2 (8%) from rotten tree stumps, and 1 (4%) from underground parts of plants. Five species (12%) were stenooligophagous, while the rest was oligo or polyphagous. Their displacement is in the "green belt" of forest, which in the case of the river Maroš, represents a connection with the transilvanian mountains. The oligo- and polyphagous species, except *Salix alba*, are using also other kinds of trees, which ensures, during transportation of firewood, their displacement from corresponding conters. Such is the case with *Neoclytus accuminatus* along the river Maroš, brought from Northern America. With certain modifications, the situation is similar also for other xilophagous cerambycides from nourishing trees *Ulmus, Fraxinus, Populus, Quercus* ..., but their displacement in the green belt and from the centers is different.

Out of 19 species of Cerambycidae, which are developing in herbaceous plants, 18 (94,7%) are polyphagous, and 1 (5,3%) monophagous, whose population in the flood zone is connected to the nourishing plant *Euphorbia lucida* distributed island-like. Other species are settled in the flood zone, from the protected area. When the flooding zone is not under water a few years, due to high biotic potential, their population is reaching high densities, while after longlasting floods for 1-2 years, they can hardly be found.

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CENOLOGICAL RELATIONS OF MUD VEGETATION OF A HYPERTROPHIC LAKE IN THE TISZAALPÁR BASIN

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Abstract

The paper deals with the description of mud vegetation of a meander lake found in the area of the contemplated Alpár Reservoir. It has a floristical importance because it describes a new habitat of Eleocharis ovata in the Great Hungarian Plain. A cenological characterization of mud vegetation is given as well for the stands of Eleocharis ovata in the Tisza Valley not described previously.

The stands of Eleocharis ovata can be regarded as a considerably modified Eleocharito-Caricetum bohemicae association, influenced in its cenological structure by the high nutrient content of the sediment of the lake. Modification of the cenological structure is caused by the strong competitive ability of the Bidentetea (incl. Ranunculetum scelerati and Polygono-Bidentetum) species.

Introduction

The subsoil water gushes forth in several places in the contact zone of the Tiszaalpár Basin and the sand dunes of Kiskunság. In the event of appropriate relief relations, these little sources feed temporary lakes and bogs (SZALMA and LÉVAI 1987). A long meander along the border of sand dunes collects the water from such a source. This meander was formed by the receding water after the flooding of the Tisza River had ceased (Fig. 1). A small part of the meander was isolated by means of building lanes. Thus, the water of the source is sufficient to keep the lake inundated throughout the year. The water quality is considerably influenced by slop water, originating from a sheep fold which was built near the lake. The slop water flows to the lake without being cleaned.

These specific effects have caused the development of a curious habitat which has been subject to many kinds of research in recent years. The aquatic macrophyton vegetation of the meander lake has been studied — in connection with the chemical relations of the sediment and the water — by SZALMA and BODROGKÖZY (1985). Several pieces of algological data of KISS (1985) refer to this lake. Moreover, there is information on the radioactive element content of the mud (KEDVES and SZEDERKÉNYI 1986).

After this, a necessary step was to perform a detailed study on the mud vegetation of the lake. An advantageous occasion was offered in 1985 when the lake almost completely dried out. Therefore, extensive mud vegetation developed on the bottom.

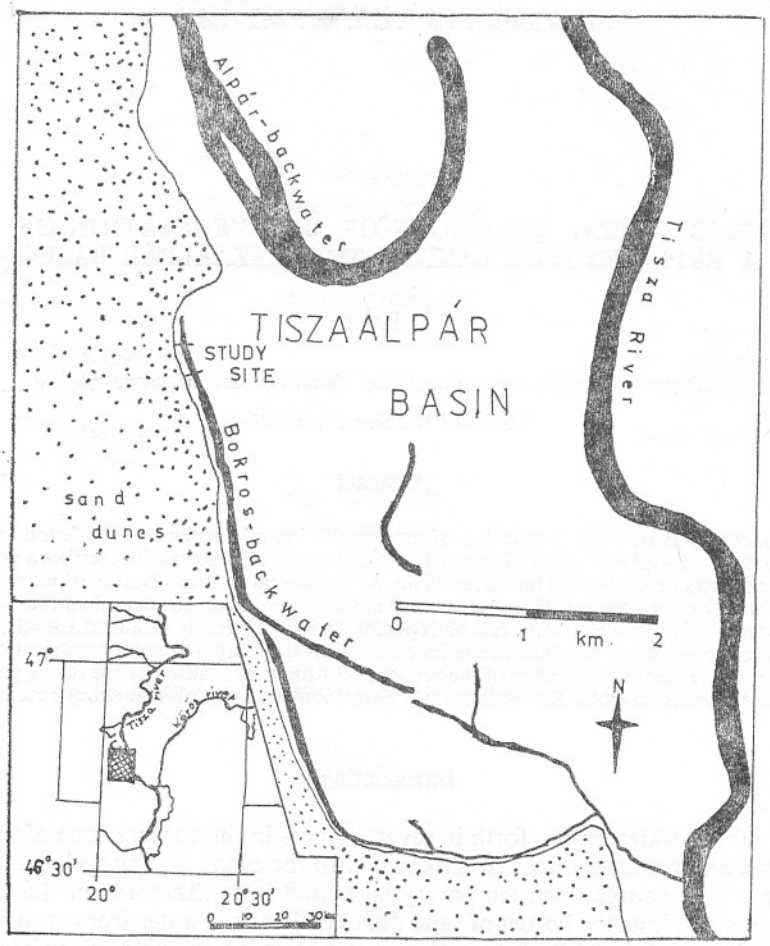

Fig. 1. Geographical location of the study area

Materials and Methods

37 cenological relevés were taken on the territory of the meander lake. The cenological table gives the relative cover of the species as a percentage. The plotted areas follow the cenologically homogeneous units of vegetation.

Therefore, the extent of the plots is different: it is between 15 and 25 m². Covering data of 20, most dominant, species were used in numerical classification of relevés.

The soil studies were performed by means of methods laid down in valid Hungarian standards. The soil samples were taken from typical units of vegetation.

Results

Characterization of the mud vegetation

1. Cenological approach

Table 1 çomprises the cenological data of the relevés. A significant part of the species may be classed among four higher cenotaxa: Phragmitetea Tx. et PRSG. 42, Isoëto-Nanojuncetea BR.-BL. et Tx. 43, Bidentetea Tx., LOHM., PRSG. 50 and Molinio-Juncetea BR.-BL. 49, 51. Species belonging to these cenotaxa cover 95% of the area (Table 1.)

Considering the cenological table, the vegetation of stands may be characterized as an *Eleocharito-Caricetum bohemicae* KLIKA 35 em. PIETSCH (61) 63 association, which was modified by the high nutrient content of the soil. The *Carex bohemica* is absent from the cenological relevés because the study site is outside the area where this species is found. In spite of this, the association structure corresponds, in many details, with those described by PIETSCH and MÜLLER—STOLL (1968) as *Eleocharito-Caricetum bohemicae.*

The description of the new habitat of *Eleocharis ovata* is significant floristically as well because this is the third occurrence of the species in the Tisza Valley (i.e. after Tiszaföldvár and Hódmezővásárhely). Its cenological relations have not yet been clarified in Hungary (Soó 1973).

Comparing the stands of the meander lake with cenological relevés taken by PIETSCH and MÜLLER—STOLL, it can be determined that the somewhat similar Phragmitetea *(Glyceria fluitans, Alisma plantago-aquatica, Oenanthe aquatica, Phragmites australis, Rumex hydrolapathum),* Bidentetea *(Bidens cernua, Bidens tripartita, Leersia oryzoides, Chenopodium rubrum),* Molinio-Juncetea *(Agrostis stolonifera)* species associate with a typical Isoëto-Nanojuncetea associatoin. A difference is shown in the essentially higher coverage of *Carex serotina, Bidens cernua, Polygonum lapathifolium, Atriplex oblongifolia* and *Ranunculus sceleratus.* The *Carex serotina* substitues for the role of *Carex bohemica* in the formation of association structure. This explains the higher dominance of *Carex serotina.* The high nutrient content of the soil explains the greater dominance of the above-mentioned Bidentetea species. Thus, the vegetation shows a transition to *Polygono-Bidentetum* FELFÖLDY, 43 and *Ranunculetum scelerati* SISSINGH in R. Tx. 50. associations.

The other Isoëto-Nanojuncetea species — *Cyperus fuscus, Juncus articulatus* and *Juncus bufonius* — relate to the cyperetosum fusci subassociation of the *Elechari-Caricetum bohemicae* association. The *Juncus articulatus* has similar dominance relations, as in the relevés of the Centaurium pulchellum variant described by PIETSCH and MÜLLER—STOLL. Therefore, the stand of *Carex serotina* and *Juncus articulatus* mentioned by POLGÁR (1937) may be regarded as a modified Eleocharito-Caricetum association; it does not belong to the *Cypero-Juncetum* association (c.f. Soó 1973).

The meander lake, in its eastern part, connects with the Molinio-Juncetea associations. The migration of Molino-Juncetea elements has a significant influence on the cenological relations of the lake. The higher coverage of *Agrostis stolonifera* and Poa trivialis is characteristic of the contact zone.

The traditional classification of relevés — based on character species — is not entirely satisfactory. Cenological judgement of several species may be manifold. For example, the *Ranunculus sceleratus* may be regarded as an Isoëto-Nanojuncetea species, as well as a Bidentetea, being similar to the *Juncus articulatus.* The *Agrostis stolonifera* has an aquatic form in the 7th and 8th relevés. It has a Phragmitetea rather than an Agrostion character. It is expedient that classification of such complicated association complexes be preformed by application of numerical methods.

Table 1. *Cenological data of relevés*

Number of stand:	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16
Total covering (%):	70	50	60	99	99	40	50	50	60	40	50	30	99	99	99	45
PHRAGMITETEA																
Alisma plantago-aquatica			+				10	10	1			4		+	1	+
Butomus umbellatus		+												+		+
Oenanthe aquatica (terrestris)	1	10	5	10	7	6	16	10	10	3	8	8	3	1	5	4
Rumex stenophyllus		+	+	1	2			1								
Glyceria maxima	+	8	1	5	1	2	+	3	3		1	4	2	1		1
Glyceria fluitans		+			+									+	+	
Rumex hydrolapathum													1	1	+	
Typha latifolia														+		1
Mentha aquatica	3		+							+						
Lythrum salicaria				+										1		1
Lycopus europaeus			+	3	5				+	1			1	5	3	2
ISOETO-NANOJUNCETEA																
Eleocharis ovata	1	3	8	+		6			5	4	1	4	4	1		2
Carex serotina	6	13	13	5	11	9	4	8	6	8	6	19	10	6	10	17
Juncus articulatus	1	4	8		1	8			3	25	20	6	3	2	+	4
Cyperus fuscus	2	5	2	2	1	5	+		1	1	6	4		5	6	3
Juncus bufonius	2	2	1		2	+	2			1	6	2	1	2	1	
Veronica beccabunga				1							1			1		2
BIDENTETEA																
Ranunculus sceleratus	8	10	15	8	15	10	8	8	16	30	40	35	50	40	30	28
Bidens cernua	6	3	4	12	15	4	20	22	25	10	6	2	2	20	15	15
Leersia oryzoides	1		1	2	2	6	4	4	3	2	3	8	15	3	5	6
Polygonum lapathifolium		2	1	3	5	2	2	3	1		+		1		5	
Bidens tripartita	1	+	+	+	1	2	2	1		+	1	+		2	2	1
Atriplex oblongifolia			+	1	1			+	1	2			2	1	2	4
Chenopodium rubrum			+			+								+		1
Chenopodium polyspermum				+						+			+		+	+
Xanthium italicum	+	+	3	1	+					+						+
Polygonum hydropiper				+			+							+		
Solanum dulcamara										+			2	+	1	6
Solanum nigrum	+		+								+	+		+	1	
MOLINIO-JUNCETEA																
Agrostis stolonifera	12	10	15	20	15	40	30	30	25	10	+	4	+	+		+
Poa trivialis	45	30	22	25	15					3						
OTHER SPECIES																
Echinochloa crus-galli					+			+					1	+	8	
Rumex crispus	1	+	+	+	1		2			+	1			1	1	2
Salix triandra (juv.)					+	+	+	+	+			+	1	2	2	
Plantago major	1		+		+					+			1			
Cirsium arvense	+			+	+							+			+	1
Sonchus arvensis					+	+					+			+		+
Malva neglecta	6	+	1				1			+		+				
Batrachium aquatile											+					2

Althaea officinalis 34+, 35+; *Chenopodium album* 3+, 33+, 43+, 35+; *Chlorocyperus glomeratus* 19+, 20+; *Conium maculatum* 5:1; *Eleocharis palustris* 14:2, 15:1, 35+; *Equisetum fluviatile* 14:2, 15:1, 18+, 30+; *Galium palustre* 1+, 16+; *Heleochloa alopecuroides* 35+; *Lycopus exaltatus* 5+, 15+, 16:2, 31+; *Lysimachia nummularia* 1+; *Matricaria maritima* 3+; *Myosotis palustris* 16+, 31+; *Phragmites australis* 14+, 21+; *Polygonum aviculare* 1+; *Potentilla reptans* 18+; *Potentilla supina* 14:1, 27:1, 36+; *Rorippa amphibia* 15+; *Rorippa sylvestris* 20+; *Sonchus asper* 18+, 28+, 29+; *Sonchus oleraceus* 16+, 31+, 33+; *Taraxacum officinale* 18+; *Teucrium scordium* 16+; *Trifolium repens* 2+, 3+, 27+.

17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
60	60	50	80	40	40	60	30	40	40	40	60	40	60	90	30	40	40	45	65	40
1			4			13		+	+	1	+	2				1		1		1
		+						4				+						+		
5	8	2	3	4	18	10	10	6		8	3	4	5	5	5	+	5	2	10	
								+	+	1				1			1		1	
1	1				1	13	8	10	10	5	6	1		1		3	1	4	12	1
+	+				+	+	+		+										+	
	1												5							
+	1												+			+			+	
		+																+	+	
1	3		+		1					+		+					1	+		+
2	4	6	+	+									5	1		+	1	1	4	+
4	1	6	10	2	4	3	5	2	4	8	10	2	5	+	5	30	25	23	20	50
6	11	3	3	4	14	5	6	18	15	12	14	38	15	18	18	4	12	12	14	13
10	12	13	14	15	10	10	20	20	15	15	25	15	7	6	7	25	12	10	2	3
1	5	4	7	18	10	10	10	10	5	4	10	10		6	2			2	+	2
4		3	4	4	1	1	5	2	3	2	15	2	17	14	17	1	1			
+	1			2					+	1	+		3				+			+
5	12	13	10	10	18	15	10	10	13	10	10	5	17	20	7	6	15	10	10	10
12	20	35	30	18	4	10	6	2	6	10	1	2	10	11	10	8	10	15	10	10
12	3	+	+	10	5	3	10	10	10	10	3	10	5	+	2	6	+	2	8	5
+				2	2	2	4	2	5	1		1	1	6	2	2	3	2	2	
1	1	+				1		+	+					1		+		+	+	
1	1	2	+	+	1		+	+	2			2	1	+			1	1	1	1
		1	2		1		2	1	1	+	+						1			
+		+			+							+							+	
	1							+		+	+		+	2	+				+	
1		+		+					+					+		+			1	
+	1							+					3			+	1	+	+	+
+											+	+	+			+	1			
6	4	6	8	+	6		4		6	8	+	3	+	1	17	5	3	10	+	3
6							+		2					3	8	5	7	1	2	
9	3	4	4	4	2	1	+		+	+	+			+		2		1		
2	3	1	1	4	3		2	2	+	+	+	2		1		1		1	2	1
4	1					+	+		2	1	3	+	1							
	1	1	1								+			+	+	+		+		
+	+			1					1	+	+		+		1					
	+			+	+					+	+		+				+	+		
+	+				+								+	1			+	+	1	
6		1							+		+	+		+				+		

2. Numerical classification of the mud vegetation

The numerical classification of the relevés forms six clusters (PODANI 1980) (Fig. 2).

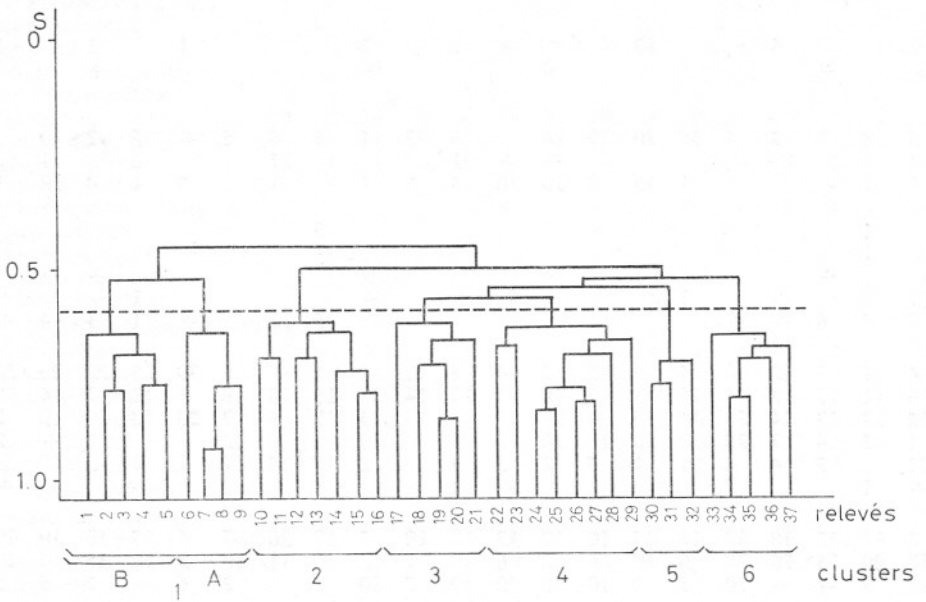

Fig. 2. Dendrogram of the 37 relevés based on Renkonen similarity index and simple average linkage. Dotted line shows the division level of groups

The first cluster links with the others on the lowest similarity level. The cluster may be divided into two subclusters. In the "A" subcluster, the *Agrostis stolonifera* and the *Bidens cernua* are dominant. In the "B" subcluster, the *Agrostis stolonifera* and the *Bidens cernua* are dominant. In the "B" subcluster, the *Agrostis stolonifera* associates with the *Poa trivialis*. The divided cluster supports the double character of the *Agrostis stolonifera*. The ratio of the Isoëto-Nanojuncetea species is the lowest in this cluster.

In the second cluster, the Bidentetea species are prevalent, covering 50—60% of the plotted areas. First is the *Ranunculus sceleratus* which has the highest ratio (28—50%). These relevés may be regarded as being close, typical representatives of the association *Ranunculetum scelerati*. The soil parameters of these vegetational units are shown in Table 2. As singularly high nitrogen content is characteristic of the soil; its value is more than 0.5% in the soil samples collected from a depth of 0—30 cm. High humidity content and soluble salt and nutrient concentration are features of the root zone (Soil sample I).

The ratio of the Isoëto-Nanojuncetea species increases in the third cluster. The most dominant species are the *Bidens cernua* and the *Juncus articulatus*. The dominance of *Juncus articulatus* and *Cyperus fuscus* is characteristic of the fourth cluster. The *Juncus articulatus* is a dominant species in the 3rd and 4th clusters as well. Therefore, its transition character between the Isoëto-Nanojuncetea and the Biden-

Table 2. *Summary of soil analysis for the hypertrophic lake*

Soil sample	Depth cm	Humidity %	hy_1 %	K_A	Total salts (%)	pH (H_2O)	pH (nKCl)	$CaCO_3$ %	Organic matter %	Total nitrogen %	mgK_2O/ 100 g	mgP_2O_5/ 100 g	Na^+ mg/100 g	Mg^{2+} mg/100 g	Ca^{2+} mg/100 g	SO_4^{2-} mg/100 g	HCO_3^- mg/100 g
I.	0—10	62.2	5.45	92	0.171	7.41	7.08	15.71	10.80	0.512	34.49	16.99	11.49	47.42	294.59	233.47	36.60
	10—20	59.8	4.65	79	0.160	7.31	7.03	10.56	10.75	0.535	20.09	15.98	8.62	23.10	190.38	107.93	47.58
	20—30	50.2	3.57	64	0.165	7.04	6.76	10.22	7.17	0.526	15.11	11.74	5.75	13.38	108.22	75.47	76.25
	30—40	41.2	2.05	51	0.138	7.14	6.90	9.37	4.75	0.300	7.75	24.25	2.76	6.08	58.12	28.59	62.22
	40—50	51.1	3.65	64	0.139	7.16	6.80	8.44	6.70	0.333	11.82	9.53	4.14	8.51	74.15	62.61	79.91
	50—60	43.6	3.10	60	0.139	7.55	7.07	9.29	6.02	0.294	9.21	26.27	3.30	7.30	38.08	65.22	39.65
II.	0—10	51.4	2.55	75	0.248	7.16	7.09	8.61	7.07	0.322	16.47	23.09	9.54	35.26	280.56	281.61	45.75
	10—20	35.2	2.06	56	0.131	7.43	7.14	4.90	3.75	0.233	10.35	29.22	2.99	4.86	58.12	38.45	42.70
	20—30	37.2	3.95	64	0.110	7.42	7.01	6.50	6.28	0.277	11.37	19.02	2.99	4.86	34.07	18.85	43.92
	30—40	38.3	4.57	67	0.120	7.45	6.90	8.28	6.07	0.329	11.14	13.20	2.82	4.86	26.05	5.93	48.80
	40—50	37.5	4.39	65	0.120	7.03	6.57	4.48	6.59	0.375	11.48	35.60	2.36	4.86	30.06	12.45	56.12
	50—60	33.8	4.22	63	0.095	6.54	5.95	0.68	6.91	0.355	16.92	59.80	2.82	4.26	19.04	1.19	47.58
III.	0—10	43.7	1.63	59	0.160	7.31	7.09	7.85	4.70	0.239	15.33	47.29	6.09	14.42	99.00	169.29	56.12
	10—20	27.2	0.92	43	0.085	7.70	7.47	4.39	2.44	0.120	8.53	44.87	1.90	1.20	41.58	69.06	42.70
	20—30	24.2	0.89	47	0.065	7.79	7.57	4.81	2.54	0.113	8.31	41.24	1.43	1.56	27.72	45.43	39.65
	30—40	22.1	0.51	34	0.058	7.69	7.59	3.63	1.55	0.067	5.59	30.55	1.20	3.60	29.70	54.97	53.07
	40—50	34.8	1.44	47	0.092	7.46	7.27	4.56	2.39	0.135	16.81	42.45	1.90	4.81	29.70	65.77	73.20
	50—60	41.0	2.65	57	0.095	7.50	7.05	4.64	4.44	0.244	25.08	50.11	2.53	4.81	27.72	40.85	59.17
IV.	0—10	53.8	4.61	87	0.164	7.23	6.94	12.07	11.54	0.504	28.93	14.47	11.49	27.63	180.18	144.11	54.90
	10—20	35.6	4.90	74	0.141	7.44	6.96	10.22	7.17	0.350	21.34	12.75	6.32	10.81	53.46	43.64	50.02
	20—30	37.6	3.92	68	0.141	7.31	6.75	10.30	6.17	0.302	18.96	10.45	6.55	13.22	49.50	32.10	78.08
	30—40	30.0	4.00	63	0.098	7.60	6.94	11.57	4.23	0.240	12.27	10.31	3.91	6.01	19.80	15.26	61.00
	40—50	26.3	3.49	59	0.098	7.73	6.96	11.99	3.60	0.168	13.41	12.17	3.28	2.40	19.80	6.38	57.34
	50—60	29.7	3.50	53	0.102	7.36	6.65	8.28	2.44	0.144	12.27	12.75	4.36	6.61	29.70	25.86	80.52

tetea is emphasized. The *Eleocharis ovata* and *Carex serotina* are found for the first time in higher coverage in the 4th cluster. The humidity of the soil is lower, as is the binding of the soil, than in the previous sample. The soil contains less nitrogen and potassium, but more phosphorus than in the sample of the 2nd cluster (see Tab. 2, Soil sample II).

Three relevés may be classed in the fifth cluster. The separation of this cluster is caused by the high coverage of *Juncus bufonius*. The high coverage of *Juncus bufonius* is closely connected to the sandy soil of the stands. The decreased coverage of the Bidentetea species is in connection with the lower nitrogen content of the soil (see Table 2, soil sample III).

The Isoëto-Nanojuncetea species are dominant in the sixth cluster. These five relevés represent the *Eleocharito-Caricetum* association (but compare with the previous part of the paper). Constant Bidentetea species are the *Ranunculus sceleratus, Bidens cernua, Leersia oryzoides* and *Atriplex oblongifolia* (due to the high nitrogen content of the soil). These species have a high nitrogen demand (ELLENBERG 1979) (see Tab. 2, Soil sample IV).

Demonstration of the relationships between the soil and the vegetation need further detailed studies (MÜLLER—STOLL and PIETSCH, 1985).

Conclusions

The soil of the meander lake has developed by way of organogenic sedimentation. The thickness of the layers of high organic matter is deeper than the soil samples. The age of the lake and its constant humidity condition assured the survival and dispersion of the *Eleocharis ovata*. The propagules of *Eleocharis ovata*, in all probability, arrived with the inundation currents of the Tisza from the northern part of the Great Hungarian Plain.

In the special habitat, a modified variant of the *Eleocharito-Caricetum bohemicae* association developed. The association structure is under the influence of the Bidentetea species.

The competitive ability of them is increased by the high nutrient content of the soil (MARKOVIĆ 1973). Presumably the described stands of the *Eleocharito-Caricetum ovatea* association represent a more tolerant variant of the typical associations against nutrient loading.

The building of the Alpár Reservoir will cause the decay of the unique vegetation and destroy one of the few habitats of the Eleocharis ovata in the Great Hungarian Plain.

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Egy hipertróf bokrosi meandertó iszapnövényzetének fitocönológiai viszonyai

BAGI I.

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A dolgozat egy — a létesítendő alpári víztározó területén található — meander-tó iszapnövényzetét írja le. Jelentőséget az tulajdonít a vizsgálatoknak, hogy a tó az *Eleocharis ovata* egy új lelőhelye. Sor került az iszapnövényzet cönológiai feldolgozására is, amely az *Eleocharis ovata* Tisza völgyi termőhelyein mindeddig nem történt meg.

Társulástanilag a növényállomány az *Eleocharito-Caricetum bohemicae* társulás egy erősen módosult változatának tekinthető, melynek struktúráját a tó aljazatának magas tápanyagtartalma jelentősen befolyásolja. A cönológiai struktúra módosulását a Bidentetea *(Ranunculetum scelerati. Polygono-Bidentetum)* fajok fokozott kompetíciós képessége okozza.

Фитоценозные условия грязевой флоры в гиперотрофическом меандер-озере, Бассейн Тисаалпари

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Резюме

Работа описывает грязевую флору меандер-озера в области создаваемого водохранилища в Тисаалпари. Анализы значительные потому, что озеро является новым месторождением *Eleocharis ovata*.

Грязевая флора была и ценологически обработана, это был первый случай месторождения *Eleocharis ovata* в долине Тисы.

Что касается флоры, она является сильно модифицированным вариантом объединения *Eleocharito—Caricetum bohemicae*, на чью структуру значительно влияет высокое содержание питательного вещества озера.

Модифицирование ценологической структуры объясняется развитой компетиционной. способностью видов Bidentetea *(Ranunculetum scelerati, Polygono-Bidentetum)*.

Fitocenološki odnosi vegetacije mulja ekstremno eutrofnog meandra jezera Bokros

BAGI I.

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Rad prikazuje vegetaciju mulja meanderskog jezera na području buduće akumulacije u kotlini Alpár. Ispitivanja imaju značaja u tome, što se u Panonskoj niziji ovo jezero javlja i kao novo nalazište vrste *Eleocharis ovata*. S druge strane ni fitocenološka obrada muljevite vegetacije na nalazištima *E. ovata* u dolini reke Tise dosada nije uradjena.

U cenotičkom pogledu zajdenica predstavlja modifikovanu *Eleocharito-Caricetum bohemicae* fitocenozu, čija je struktura pod bitnim uticajem visoke hranljive vrednosti jezerskog dna. Izmenjene strukturalne osobine uslovljene su pojačanim kompetetivnim sposobnostima članova Bidentetea zajednice *(Ranunculetum scelerati, Polygono-Bidentetum)*.

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VEGETATION OF THE LOWER TISA RIVER

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Abstract

The preliminary results on the recent autochthonous vegetation of the lower part of the Tisa river are presented. The investigations included forest, marsh, meadow, and meadow-steppe vegetation types.

Introduction

The phytocenological aspect of vegetation of the floodplain of the lower Tisa river has been insufficiently examined. An intensive melioration and certain other anthropogenic factors have considerably disturbed natural vegetation bordering the Tisa river and reduced it to a narrow belt. In a limited portion of the Tisa river shore, most vegetation belongs to the anthropogenic forest phytocenoses (Euramerican poplar, willow, and American ash). With regard to the floral composition, no specific features are shown. Natural vegetation is recorded only in the form of small oases, and it has preserved its characteristics despite the strong anthropogenic influence.

This paper describes the most important characteristics of recent autochthonous vegetation along the Tisa river banks which is threatened with decline due to a permanent anthropogenic influence.

Materials and Methods

Investigation into plant covering of the floodplain of the Tisa river (from Horgoš and Martonoš to its mouth into the Danube) was performed according to the method of BRAUN-BLANQUET (1928, 1951). Plant material was determined according to Flora SR Srbije (1970—1977) and JÁVORKA (1925, 1975). Sintaxonomic location of vegetation units was presented according to Soó (1964—1980) and Prodromus phytocoenosum Jugoslaviae (1986).

Results and Discussion

List of vegetation units
Class: **Salicetea purpureae** MOOR (1958) 1960
Order: **Salicetalia purpureae** MOOR (1958) 1960

Alliance: *Salicion triadrae* Malcuit 1929, Müller et Görs 1958 (non Br.-Bl. 1956)
Ass.: *Salicetum triandrae* Malcuit 1929
Alliance: *Salicion albae* Soó (1930) 1940
Ass.: *Salicetum albae-amygdalinae* Slavnić 1952
(*Salicetum albae-fragilis* Soó 1971)
Class: **Querco-Fagetea** Br.-Bl. et Vlieg. 1937
Order: **Populetalia albae** Br.-Bl. 1931
Alliance: *Alno-Quercion roboris* Horvat 1938
Ass.: *Populetum nigrae-albae* Slavnić (1942) 1952
Class: **Phragmitetea** W. Koch 1926
Order: **Phragmitetalia** W. Koch 1926
Alliance: *Phragmition communis* W. Koch 1926
Ass.: *Scirpo-Phragmitetum* W. Koch 1926
subass. *typhetosum (angustifoliae-latifoliae)* Soó 1973
subass. *phragmitetosum* Schmalle 1939
subass. *bolboschoenetosum maritimi* Ubrizsy 1961
Ass.: *Glycerietum maximae* Hueck.1931
Order: **Magnocaricetalia** Pign. 1953
Alliance: *Magnocaricion* W. Koch 1926
Ass.: *Heleochareto-Caricetum nutantis* R. Jov. 1958
Alliance: *Caricion gracilis* (Neuhä. 1959, Bal-Tul. 1963) Oberd. 1967, Soó 1968
Ass.: *Caricetum gracilis* R. Tx. 1937
Class: **Molinio-Arrhenatheretea** R. Tx. 1937
Order: **Molinietalia** W. Koch 1926
Alliance: *Deschampsion caespitosae* Horvatić 1930
Order: **Arrhenatheretalia** Pawl. 1926
Alliance: *Arrhenatherion elatioris* Br.-Bl. 1925
Ass.: *Arrhenatheretum medioeuropaeum* (Scherr. 1925/non Br.-Bl. 1915/)
Horvatić 1941
Order: **Agrostietalia stoloniferae** Oberd. 1967
Alliance: *Agropyro-Rumicion cripsi* Nordh. 1940
Class: **Festuco-Brometea** Br.-Bl. et R. Tx. 1943
Order: **Festicetalia valesiacae** Br.-Bl. et R. Tx. 1943
Allianc: *Festucion rupicolae* (sulcatae) Soó (1940) 1964
Ass.: *Coronillo-Festucetum sulcatae* Parabućski 1982
Alliance: *Artemisio-Kochion* Soó 1959
Ass.: *Agropyro-Kochietum prostratae* Zólyomi 1958
subass. *thymetosum* Stojanović (1981) 1983
subass. *artemisietosum* Stojanović (1981) 1983

Forest vegatation

Ass. Salicetum triandrae. The stands of this pioneer forest phytocenosis occur near running waters, occupying very small areas. They are exposed to long-term floods, while during summer to a sudden natural draining. Such extremes affect their specific stratification: a stratum of small trees and shrubs and a stratum of herbaceous plants.

Salix triandra L. is a dominant species. Also frequent are *Amorpha fruticosa* L and *Salix alba* L. while scattered are *Fraxinus americana* L., *Fraxinus lanceolata* Borkh., *Populus alba* L. and *Populus nigra* L. (near Bečej).

The stratum of herbaceous plants is characterized by certain floral luxuriance. Among others, *Poa palustris* L., *Agrostis alba* L., *Iris pseudacorus* L., *Lysimachia nummularia* L., and *Bidens tripartitus* L., are abundant to some degree.

Ass. Salicetum albae-amygdalinae. Of the natural forest phytocenoses found in the Tisa Basin, the most widespread are the stands of this association.

In the stratum of trees, owing to absolute domination of the species *Salix alba* L., very small numbers of other plant species are present. Considerably less frequent is *Salix triandra* L. while scattered are *Populus alba* L., *Populus nigra* L., *Fraxinus laceolata* BROKH., and *Fraxinus americana* L.

The stratum of shrubs is developed only in certain stands. Floristicly, it is a poor layer composed of *Farxinus lanceolata* Borkh., *Fraxinus americana* L., and *Amorpha fruticosa* L.

In the stratum of herbaceous plants the most frequent are *Rubus caesius* L., *Lysimachia vulgaris* L., and *Poa palustris* L. This layer is not developed in densily composed stands due to submergence by flood for a considerable length of time.

Ass. Populetum nigrae-albae. These forests have been almost completely declined and where replaced by the cultures of Euramerican poplar. They have been preserved only in the form of limited oases and recorded from raised areas, usually far from the river banks, at older alluvial deposits. They superseded oak forests which were cleared.

A dominant species in the stratum of trees is *Populus alba* L. In this layer also occur *Populus euramericana* (Dode) Guin., *Fraxinus americana* L., *Fraxinus lanceolata* BORKH., *Ulmus carpinifolia* GLED., *Ulmus laevis* PALL., and *Quercus robur* L.

In the stratum of shrubs a distinguished species is *Amorpha fruticosa* L. while certain such as *Morus alba* L., *Populus alba* L., *Ulmus carpinifolia* GLED. also occur.

The species *Rubus caesius* L. predominates in the layer of herbaceous plants.

Marsh vegetation

Ass. Scirpo-Phragmitetum. In the portion of the Tisa Basin studied, the stands of this phytocenosis are the most widespread and are developed at sites where backwater occurs during a considerable length of time.

Floral composition and other characteristics of the common reed localities analyzed, show certain variations depending upon habitat conditions. Only a very small number of species in stands belonging to the subassociation *Scirpo-Phragmitetum typhetosum (angustifoliae-latifoliae)* are observed owing to a permanent water during a year. At shallow water sites, drained during summer, the stands of the subassociation *Scirpo-Phragmitetum phragmitetosum* are developed. They are characterized by a relatively high percentage of marsh and meadow plant species. On slightly saline soils, among marsh and meadow species, the most distinguished is *Bolboschoenus maritimus* (L.) PALL. — subassociation *Scirpo-Phragmitetum bolboschoenetosum maritimi.*

Ass. Glycerietum maximae. In the ecological succession, these tall grasses are followed by stands of this association, being well developed near Sanad in the surroundings of Novi Kneževac. A characteristic of their composition is the presence of *Glyceria maxima* (HARTM.) HOLNOG. Of the marsh plants, considerable number and covering are observed in *Schoenoplectus lacustris* (L.) PALL. and *Lycopus europaeus* L. while less abundant are *Oenanthe aquatica* (L.) POIR., *Mentha aquatica* L., and *Lythrum salicaria* L.

Ass. Heleochareto-Caricetum nutantis. The stands of this phytocenosis are deve-

loped in the form of a narrow belt on somewhat more arid soils. They are in the immediate vicinty of stands of the association *Glycerietum maximae*.

The closest relationship with the association is shown with *Carex nutans* HOST. In all stands analyzed, this plant species is characterized by abundance and a considerable covering, in contrast to the species *Heleocharis palustris* (L.) R. BR., being relatively rare.

A certain specificity of these stands is indicated by the occurrence of the species *Stachys palustis* L., *Bolboschoenus maritimus* (L.) PALL., and *Glyceria maxima* (HARTM.) HOLMBG.

Ass. Caricetum gracilis. The stands of this community are found along the edges or open areas within autochthonous willow forests.

The most important characteristic species of the stands analyzed, is *Carex gracilis* CURT. In all stands the most abundant is the species *Sium latifolium* L., then *Stachys palustris* L., and *Oenanthe aquatica* (L.) POIR. On the organic-mineral substratum where stagnant water is retained, favourable conditions for certain aquatic plants such as the species of the genus *Lemma* and *Salvinia* are produced. At shallow depressions of the forest clearings, dense stands of this community representing the most luxuriant vegetation of the region, are found. In addition to a typical species *Carex gracilis* CURT., certain other species such as *Rumex hydrolapatum* HUDS. and *Senecio paludosus* L. are also distinguished. At the edge of the willow forests towards the levee, stands are characterized by an improverished floral composition. Most frequently predominates the species *Lysimachia vulgaris* L.

Meadow vegetation

Deschampsion caespitosae. Vegetation of wet, flood meadows is observed fragmentarily in the form of small oases surrounded by willow forests. The most important characteristic is imposed by the presence of *Scutelaria hastifolia* and *Lysimachia vulgaris* L. while somewhat less frequent are *Thalictrum flavum* L., *Thalictrum lucidum* L., *Polygonum aviculare* L. ssp. *heterophyllum* LINDM., *Stachys palustris* L., *Equisetum palustre* L., and *Calystegia sepium* (L.) R. BR.

Ass. Arrhenatheretum medioeuropaeum. Stands of this community of valley meadows are widespread in the Tisa Basin, mostly at levees. They are characterized by certain floral richness and a high percentage of the species *Arrhenatherum elatius* PRESL. somewhat lower percentage is found wiht *Pastinaca sativa* L., *Dactylis glomerata* L., *Lotus corniculatus* L., *Galium mollugo* L., *Daucus carota* L., *Vicia cracca* L., *Vicia hirsuta* (L.) S. F. GRAY, *Trifolium pratense* L., *Trifolium repens* L., and *Achillea millefolium* L.

Agropyro-Rumicion crispi. Vegetation of pastures which are periodically covered with flood water. In the region investigated it is spreading owing to the anthropogenic influence. The most important characteristics of stands of the vegetation described are imposed by the species *Alopercurus geniculatus* L., *Rumex crispus* L., *Rorippa sylvestris* (L.) BESS., *Rorippa austriaca* (CR.) BESS., *Mentha pulegium* L., *Agropyron repens* (L.) BEAUV., *Carex vulpina* L., and *Inula britannica* L.

Meadow-steppe vegetation

Ass. Coronillo-Festucetum sulcatae. Scattered stands in which *Coronilla varia* L. and *Astragalus cicer* L. are the most distinguished species growing at the highest points of the raised area bordering the river. Also numerous are *Festuca valesiaca*

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A Tisza alsó szakaszának vegetációja (Jugoszlávia)

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Kivonat

A Tiszavölgy alsó szakasza növénytakarójának eddigi fitocönológiai vizsgálata hiányos. Az intenzív meliorációs és egyébb antropogén hatás következtében az autochton növénytakaró még a hullámtéren is szegényes. A keskeny sávban húzódó hullámtér vegetációja elsősorban ültetett erdősáv, amelyet euro-amerikai nyár, fűz és amerikai kőris homogén monokultúrái képeznek, kizárva az összetettebb florisztikai jelleget. A természetes vegetáció csak fragmentálisan jelentkezik, és autochton jellegét csak kisebb, oázisszerűen fennmaradt foltokon őrizte meg.

A dolgozat a Tiszavölgy recens autochton vegetációjának alapvető jellegét ismerteti. Az állandó antropogén hatás feltételezi a még fennmaradt természetes vegetáció teljes felszámolását.

Растительность нижнего течения р. Тиса (Югославия)

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Резюме

Растительность инундационного района нижнего течения р. Тиса до настоящего времени фитоценологическими испытаниями была недостаточно изучена. Интенсивные мелиоративные мероприятия и другие антропогенные влияния в непосредственной близи р. Тиса привели к значительному нарушению природной растительности и ее сохранению на неширокой полосе. В ограниченном прибрежном поясе Тисы самая большая часть растительности относится к лесным фитоценозам антропогенным, включающим: европейско-американские тополя, ивы и американский ясень, не характеризующиеся особенностями в отношении состава растений.

Природная растительность обнаруживается в виде небольших оазисов, которые несмотря на антропогенные влияния, сохранили свои основные особенности.

В настоящей работе указываются основные, важные характеристики рецентной автохтонной растительности вдоль р. Тиса, которая учитывая антропогенные влияния, стоит пред угрозой полного исчезновения.

Vegetacija donjeg toka Tise

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Izvod

Vegetacija u inundacionom području donjeg toka Tisa dosadašnjim fitocenološkim istraživanjima nije bila dovoljno proučena. Usled intenzivnih meliorativnih zahvata i drugih antropogenih uticaja, prirodna vegetacija neposredno uz Tisa je u velikoj meri narušena i scedena na uzan pojas. U ograničenom priobalnom pojasu Tise najveći deo vegetacije zauzimaju antropogene šumske fitocenoze, koju čine: euro-američke topole, vrbe i američki jasen i u pogledu floristićkog sastava nemaju nekih posebnih odlika. Prirodna vegetacija je konstatovana samo u vidu manjih oaza, koje su i pored antropogenih uticaja sačuvale svoja osnovna obeležja.

U ovom radu se iznose osnovne i bitne karakteristike recentne autohtone vegetacije duž Tise, kojoj usled daljih antropogenih uticija preti potpuno isčezavanje.

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CHANGES OF SOME PHYSICO-CHEMICAL AND SAPROBIOLOGIC CHARACTERISTICS IN THE LOWER COURSE OF THEISS IN THE PERIOD 1980—1986

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Abstract

The researches of the lower course of the river Theiss in the period 1980—1986 point to certain changes in the physico-chemical and saprobiologic characteristics of water, in relation to earlier data. The erection of the dam at Novi Bečej and on the Danube (Djerdap) has slowed down the lower course of the river Theiss. During the research, changes in the oxygen regime have been noticed. The average values of diluted oxygen decreased by 7%, and the values of BOD_5 increased by about 10%. Regarding other parameters, the concentraion of ammonium ion increased, especially in the winter months. The saporobity index according to Pantle—Buck up to the year 1983 was mainly within the limits of betamezosaprobity, while in recent years points to transition towards betaalfamezosaprobity.

Introduction

The physico-chemical and saprobiologic researches of the lower course of the river Theiss have been performed for almost thirty years (MARIĆ, PUJIN 1962, STANOJEVIĆ, PUJIN 1973, PUJIN, STANOJEVIĆ 1979) according to which the Theiss was characterized as a relatively clean river, sutiable for diverse use, and by its saprobiologic characteristics, mainly as a water of betamezosaprobic type (STANOJEVIĆ, PUJIN 1979, PUJIN et *al.* 1984). However, recently the results point to certain changes of physico-chemical and saprobiologic characteristics of the water in relation to previous periods. Therefore, the aim of this work is to show these changes.

Materials and Methods

The research includes the period 1980—1986 on the localities: Martonoš, Padej, Novi Bečej, Žabalj and Titel. The following parameters were taken in consideration: the quantity of oxygen diluted in water (O_2 mg · dm^{-3}), water saturation with oxygen (O_2%), the chemical utilization of O_2 through $KMnO_4$, BOD_5 and ammonium ion (NH_4 mg · dm^{-3}). These analyses were performed by standard methods in use nowadays in such researches. The saprobiologic characteristics were determined on the basis of saprobity index according to Pantle-Buck.

Results

The quantity of oxygen diluted in water varies by season, year, and locality. Judging from the mean values, these variations are not so pronounced. They are more expressed at extreme values, especially the minimal ones. The mean values are mainly within the limits sufficient for normal life of organisms. In summer these values are the lowest, in spring and autumn slightly higher and in winter the highest (Fig. 1).

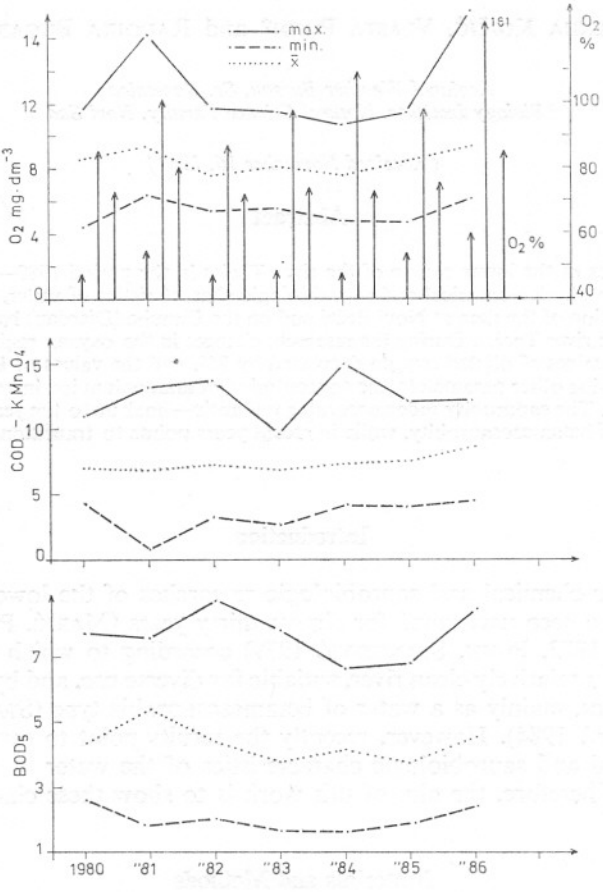

Fig. 1. Variations in the basic chemical parameters in the water of lower Tisa (1980—1986)

The differences are evident also in relation to localities. At Martonoš in spring and summer the values are more even and lower, in autumn and winter the values rise. then decrease and again slightly vary. Characteristic is the fall at Žabalj in all sea, sons. The same can be said for Bečej.. The saturation of water with oxygen at N-Bečej and Žabalj is considerably lower as compared to other localities (Fig. 2). The oxygen content in the investigated period was in the limits of 3.2—16.5 mg · dm^{-3}, with a minimal saturation of 35%. According to previous reports, the minimal saturation was about 70% (STANOJEVIĆ, PUJIN, 1973).

The mean values of oxydability through $KMnO_4$ also point to seasonal and local variations (Fig. 1. and Fig. 2). As it can be seen in the report, the mean values are over 5 mg · dm^{-3} and show that the Theiss in its lower course is considerably loaded with matters of organic nature. High values are in the year 1985 and 1986. With regard to seasons, evident are lower values in autumn, uneven in spring and winter. This load is very high at Novi Bečej, Žabalj and Titel.

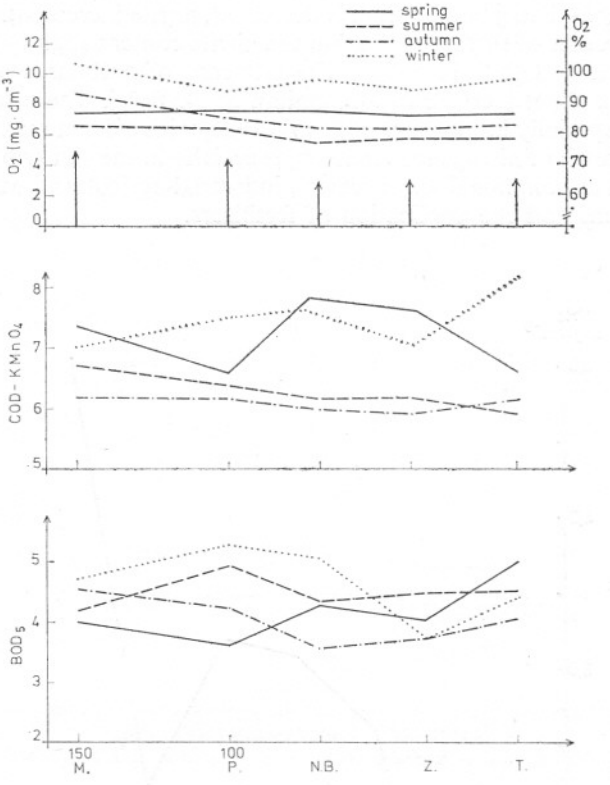

Fig. 2. Seasonal and localities variations of the basic chemical parameters in the water of lower Tisa (mean values 1980—1986)
M — Martonoš, P — Padej, N.B. — Novi Bečej, Ž — Žabalj, T — Titel

The biologic oxygen demand (BOD_5) aslo points to the aggrevation of water quality. While in the period 1968—1970 the values were about 2.1—3.8 (STANOJEVIĆ, PUJIN, 1973), in the investigated period these values appear mainly as minimal (Fig. 1. and Fig. 2), while the mean values are below 4 mg · dm^{-3}, but many times also above. In the investigated period, the values were between 1.2—10.2 mg · dm^{-3}. The values are uneven locally and seasonwise. The comparison of these values with diluted oxygen and saturation O_2, confirm that the increase of organic load corresponds to a reduced quantity of diluted oxygen. Some deviations from this natural law can be explained by the influence of some other factors important for the oxygen regime, first of all hidrologic ones (small quantity of water, slow flow).

Considerable aggrevation is reflected in the concentration of ammonium through ammonium ions. The ascertained values in the investigated period were 0.5—5.7 $mg \cdot dm^{-3}$ and point to a periodical pollution of the lower course of the Theiss (Fig. 3). These values are higher in the entrance profile at Martonoš, than at others (Fig. 4). Ammonium in the summer period makes 2—6% of the total nitrogen content and in winter even somewhat higher than 30%. Following the changes in the average values of ammonium on one side and nitrates and nitrites on the other, it could be concluded that the process of ammonium oxydation into nitrites is evident in the section Martonoš—Padej (ammonium is decreased, nitrite increased). Downstream of Padej, in the process of further oxydation the nitrite content slightly decreases, while the nitrate content slightly increases. The influence of pollutants at Novi Bečej is manifested by a slight increase of ammonium at N. Bečej. The nitrite content was considerable, especially in the years 1985 and 1986, with evident maximum in winter. An evident increase of nitrogenous matters, especially in the last two years, points to pollutants such as communal waste waters, industrial-agricultural waters, the waters from cattle farms and the application of fertilizers.

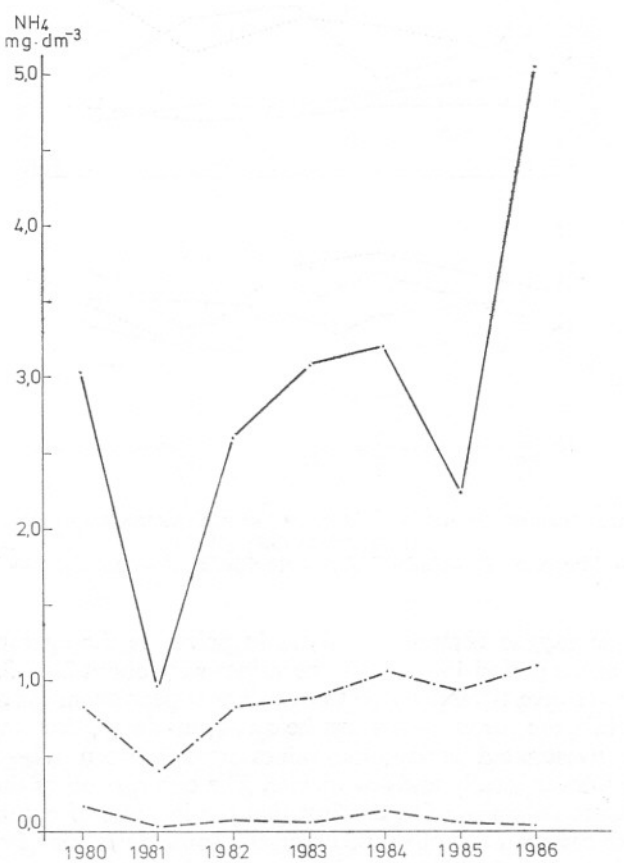

Fig. 3. Variations of ammonium ions NH_4^+ $mg \cdot dm^{-3}$ in the water of lower Tisa (1980—1986)

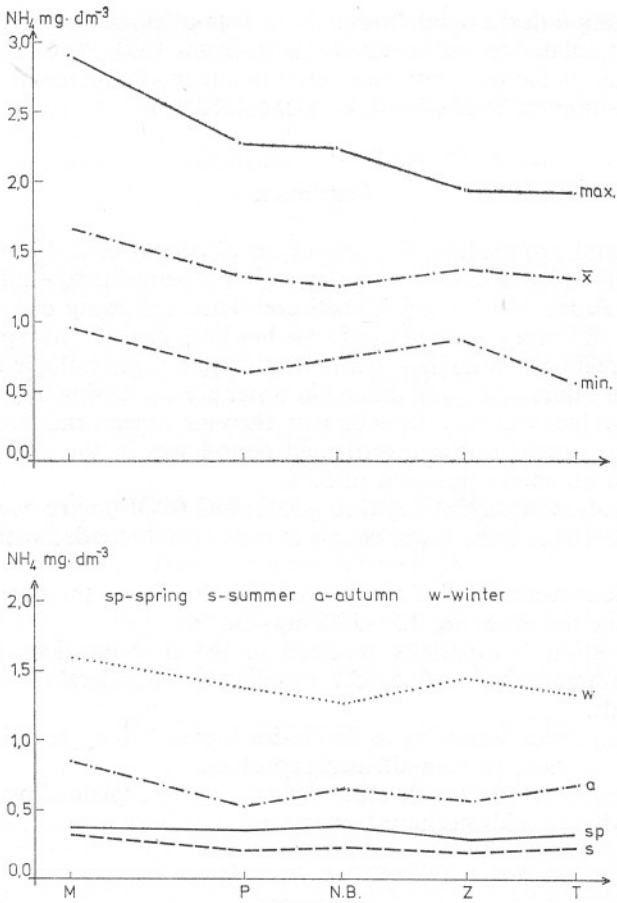

Fig. 4. Localities and seasonal variations of ammonium ions (NH_4^+ mg · dm^{-3}) in the water of lower Tisa (mean values 1980—1986)
M — Martonoš, P — Padej, N. B. — Novi Bečej, Ž — Žabalj, T — Titel

Saprobiologic characteristics according to Pantle—Buck also point to certain deterioration of water quality in the last years (Table 1).

Tabl. 1. *Saprobity index according to Pantle—Buck in the lower course of the Theiss (1980—1986)*

Years Localities	1980	1981	1982	1983	1984	1985	1986
MARTONOŠ	2.15	2.30	2.20	2.30	2.40	2.50	2.45
PADEJ	2.20	2.40	2.40	2.40	2.30	2.30	2.40
NOVI BEČEJ	2.25	2.25	2.25	2.60	2.50	2.50	2.50
ŽABALJ	2.20	2.40	2.40	2.40	2.40	2.45	2.45
TITEL	2.20	2.40	2.40	2.40	2.50	2.50	2.50

The saprobity indexes point from beta to beta-alfamezosaprobity, being a certain aggravation, related to earlier data (MARIĆ, PUJIN 1969, PUJIN, RAJKOVIĆ 1979). In particular seasons the saprobity index even points to alfa-mezosaprobity, as it was the case in the spring of 1982 (PUJIN, RATAJAC 1983).

Conclusion

From the results of the investigations of the physico-chemical and saprobiologic characteristics of the lower course of the Theiss in the period 1980—1986 in the localities Martonoš, Padej, Novi Bečej, Zabalj and Titel, following can be concluded:

The quality of lower course of the Theiss has been aggravated especially in relation to oxygen regime, ammonium concentration and saprobiologic characteristics.

The average values of oxygen diluted in water are decreasing by about 7%, compared to earlier values and vary depending on the year, season and locality.

The oxygen content in the investigated period was in the limits of 3.2—16.5 $mg \cdot dm^{-3}$, with minimal saturation of 35%.

The mean values of oxydability through $KMnO_4$(COD) were over 5 $mg \cdot dm^{-3}$, showing that the Theiss in its lower course is considerably loaded with organic matters.

The biologic consumption of oxygen (BOD_5) also shows the degradation of the water quality, the values being 1.2—10.2 $mg \cdot dm^{-3}$.

This aggravation is especially reflected in the concentration of ammonium, given through ammonium ion (0.5—5.7 $mg \cdot dm^{-3}$). Considerably high values fall in winter periods.

The saprobity index according to Pantle-Buck points to aggravation with values pointing more and more to beta-alfamezosaprobity.

The stated aggravations beside other factors, can be explained by the slowing of the river flow, due to hidrotechnical operations.

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A Tisza alsó szakasza fizikai—kémiai és szaprobitási értékeinek ingadozása az 1980—86-os időszakban

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Kivonat

A Tisza alsó szakaszán 1980—86-ban végzett kutatások a víz fizikai-kémiai és szaprobiási értékeinek ingadozását eredményezte. Lassult a lefolyás, hőmérsékletcsökkenés és kevesebb lebegőanyag volt megállapítható. Az oxigén háztartása is ingadozott. Míg az oldott oxigén állandóan 4 mg/l volt, addig az átlagos értéke 7%-kal csökkent. A telítettség 35—117%-os értékei szintén csökkenést, viszont a biológiai fogyasztás 5-ös értéke 10%-os növekedést jelent. A többi kémiai paraméterek közül az ammónia-ionok telítettsége növekedett, míg a pH, vízkeménység, alkáliság, P, Ka, Na ingadozása elenyésző. Pantle-Buck szaprobitási indexe alapján 1983-ig a betamezoszaprobitás, az 1983—86-os időszakban viszont az alfamezoszaprobitás volt jellemző.

Изменения некоторых физико-химических и сапробиологических характеристик нижнего течения р. Тиса в период 1980—1986. г.г.

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Резюме

Исследования нижнего течения р. Тиса в период 1980—1986. г.г. указывают на некоторые изменения физико-химических и сапробиологических характеристик воды по отношению к данным, полученным ранее. Эти изменения наблюдаются прежде всего в уменьшении расхода, температуры воды, а также паряще-плавучего материала. Изменения также наблюдаются и в отношении режима кислорода. Количество растворенного в воде кислорода всегда превышает 4 мг. $л^{-1}$, но средние значения уменьшаются на ок. 7%. Насыщенность воды кислородом была 35—117, что также является уменьшением, а значания $БПК_8$ увеличиваются на ок. 10%. Из остальных химических параметров необходимо обратить внимание на увеличение концентрации ионов аммония.

Почти неизмененными являются значения pH, жесткости воды, щелочности, фосфора, калия и натрия.

Индекс сапробности по Пантле-Буку в периоде до 1983 года, в основном был в пределах бетамезосапробности, а в период 1983—1986 г.г. наблюдается переход от бета к альфа мезосапробности.

Promene nekih fizičko—hemijskih i saprobioloških karakteristika donjeg toka Tise u periodu 1980—1986

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Izvod

Istraživanja donjeg toka Tise u periodu 1980—1986. ukazuju na izvesne promene fizičko-hemisjih i saprobioloških karakteristika vode u odnosu na ranije podatke. Te promene se ogledaju pre svega u smanjenju protoka, temperature vode i samnjenju lebdećih materija. Takodje su konstatovane promene u kiseoničkom režimu. Količina kiseonika rastvorenog u vodi je uvek preko 4 $mg \cdot l^{-1}$, ali prosečne vrednosti opadaju za oko 7%. Zasićenost vode kiseonikom se kretala od 35—117%, što je takodje smanjenje, a vrednosti BPK_5 su u povećanju za oko 10%. Od ostalih hemijskih parametara posebno treba istaći povećanje koncentracije amonijum jona.

Skoro nepromenjene su vrednosti Ph, tvrdoće vode, alkaliniteta, fosfora, kalijuma i natrijuma.

Indeks saprobnosti prema Pantle-Buck-u u periodu do 1983 god. uglavnom se kretao u granicama betamezosaprobnosti, dok u periodu 1983—1986 ukazuje na prelaz od beta ka alfa mezosaprobnosti.

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PHOSPHATASE ACTIVITY OF WATER AS A PARAMETER OF THE RIVER TISA WATER MONITORING

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Abstract

In this paper the results of microbiological and enzymological examination of the Yugoslav part of the river Tisa water are presented. During the period from 1983 to 1986 the water of five localities was analyzed.

Classical microbiological parameters, such as total number of planktonic bacteria, number of heterotrophic bacteria, and T/H index of saprobity (the ratio between the total number of planktonic bacteria and the number of heterotrophic bacteria), being conventionally used as indicators of the level of saprobity of surface freshwaters, were compared with the index of phosphatase activity, a new indicator of the water eutrophication degree.

Statistically significant correlation between classical microbiological and the new biochemical indicator of organic load of the river Tisa affirms the index of phosphatase activity as a reliable parameter for a fast preliminary estimation of the saprobity degree of surface freshwaters.

Introduction

In recent years the investigation of metabolic activity has been increasingly used in assessment of both trophic level and the degree of pollution of certain aquatic ecosystems. JONES (1972) proposed measurment of relative phosphatase activity as an indicator of biomass and general trophic conditions of aquatic habitats suggesting that water enzymatic activity may serve as a useful inducator of surface water eutrophication.

Most microorganisms synthesize phosphatases, enzymes that catalyze orthophosphate release from organic phosphomonoesters. This was confirmed by our previous studies (MATAVULJ et *al.*, 1976; 1978).

In the microbiological study of eutrophic marine water of Tokyo Bay, TAGA and COBORI (1978) found positive correlation between the activity of alkaline phosphatase and standard indicators of water quality (the number of heterotrophs, count of phosphatase producers, inorganic and organic phosphate content, the amount of proteins, chlorophyll and DNA).

JONES (1972) gave the equation which involves phosphatase activity with total phosphate content and total biomass. Various biochemical parameters, particularly the activities of some enzymes (phosphatase, proteinase, cellulase) are already being used in estimate of trophic level and degree of pollution of surface waters (VERSTRAETE et *al*, 1976; KARPUSHIN and MELJNIKOV, 1972; ZDANOVSKI, 1977).

Our previous studies on phosphatase activity of waters with different degrees of eutrophication suggested possible use of water enzymatic activity as an indicator of its organic load (MATAVULJ et *al.* 1983; 1984a; MATAVULJ and FLINT, 1987). In this paper, the river Tisa with characteristic changes of water saprobity degrees (depending on locality and season) served as an object for check and affirmation of phosphatase activity index, the new biochemical parameter used in water condition estimates.

Materials and Methods

Microbiological assays comprised standard, cultivating, and direct methods. The total count of planktonic bacteria was determined by ultrafiltration on Sartorius membrane filters with pore diameters of 0.2 μm, after RAZUMOV (1932). The colonies of aerobic heterotrophic bacteria were counted on plates of Nutrient Agar (Torlak MPA).

Phosphatase activity was measured with p-Nitrophenyl-phosphate (pNPP) as a substrate by the modified method, described by FLINT and HOPTON (1977). Enzymological analyses preceeding calculation of water phosphatase activity index (MATAVULJ, 1986) included measurement of total activity of acid, neutral and alkaline phosphatases in an original (untreated) water sample.

Results and Discussion

The counts of saprophytic bacteria, represented as means of the results from four years of study, show that water of the river Tisa belonged to 2nd—3rd class after Kohl's (1975) categorization (it belonged to 3rd class only at Titel). From Fig. 1 it may also be seen that, as a rule, water quality is better in early summer than in autumn.

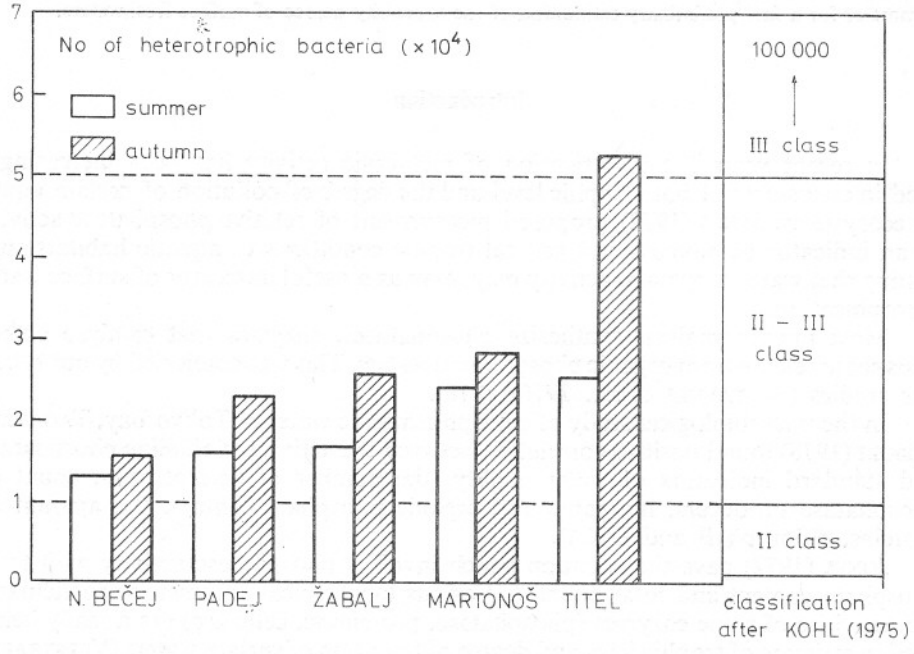

Fig.1

Judging by T/H index of saprobity (the ratio between total number of planktonic bacteria and number of heterotrophic bacteria) the same conclusion may be drawn, i.e. water from all sectors tested was of better quality in early summer than in autumn. According to this criterion, water of the river Tisa belonged to moderately polluted and/or polluted waters.

Our long-term comparative investigations of standard microbiological and biochemical indicators of water quality, with respect to its organic load, and new enzymological indicators of saprobity degree e.g. the level of eutrophication of different surface waters (MATAVULJ et *al.* 1982; 1984b; MATAVULJ, 1986) resulted in the proposed introduction of a new system of categorization of surface freshwaters, regarding degrees of their organic load, on the basis of the index of phosphatase activity of water (PAI). PAI represents a mean value of the acid, neutral, and alkaline phosphatase activities of original water sample (Table 1).

Tab. 1. *The proposal of a system of surface freshwater categorization regarding degrees of their organic matter load, based on the water enzymic activity, i.e. index of water phosphatase activity* (MATAVULJ, 1986)

Phosphatase activity index (μmol/s/dm³ pNP) 30 °C	Proposal of category name		Characteristic of water (conditionally)	Equivalent to classes according to		
				Kohl (1975)	Tümkling (1969)	Pantle—Buck (1955)
below 0.01	I	A	MAXIMALLY CLEAN	I	I	KATAROBIC ZONE
0.01—0.10		B	VERY CLEAN			
0.10—0.25	I—II		CLEAN			
0.25—0.50	II	A	SATISFACTORILY CLEAN	I—II		OLIGO-SAPROBIC ZONE
0.50—1.00		B	SLIGHTLY POLLUTED	II		
1.00—2.50	II—III		MODERATELY POLLUTED	II—III	II	β-MESO SAPR. ZONE
2.50—5.00	III	A	POLLUTED	III		β—α MESO-SAPROBIC ZONE
5.00—7.50		B	VERY POLLUTED	III—IV	III	
7.50—10.00	III—IV		DIRTY	IV		α-MESO-SAPR. ZONE
10.00—15.00	IV	A	VERY DIRTY		IV	POLY-SAPROBIC ZONE
above 15.00		B	MAXIMALLY DIRTY			

Statistically significant correlation between heterotrophic count as a standard indicator of water quality and a new enzymological parameter may be observed from the Fig. 2. Somewhat lower degree of correlation was recorded between PAI and the total number of bacteria (Fig. 3) which is probably due to the fact that milipore-filter bacterial count includes dead, dormant, and inactive cells. This is consistent with the results of our previous investigations of natural surface waters (MATAVULJ et *al.* 1982; 1984a; MATAVULJ, 1986).

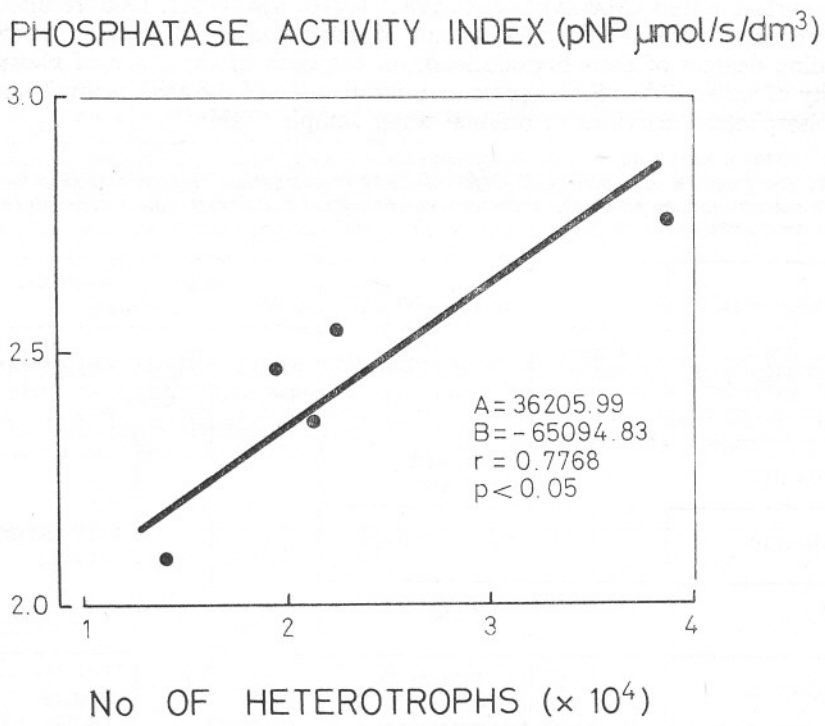

Fig. 2. Correlation between the viable bacteria count and water phosphatase activity index

Fig. 4 illustrates the negative correlation between PAI and T/H index of saprobity. This phenomenon points out positive correlation between the level of enzyme activity and the water saprobity degree, the latter being represented as T/H index. Statistically significant degree of correlation between neutral phosphatase activity and T/H index of saprobity (Fig. 5) deserves to be specially emphasized. Consequently, when calculating PAI as an indicator of organic pollution of surface freshwaters, neutral phosphatase activity should be taken into account.

Considering that phosphatases are primarily indicators of water pollution with organic phosphates, our proposed classification of surface freshwaters according to degree of organic load on the basis of PAI is only conditional. We deem that an index of water enzymic activity would be a much more reliable indicator of water organic pollution if it also comprised the levels of activities of some other enzymes such as proteinases, dehydrogenase, lipases, saccharases, cellulases, etc. In this respect, we have started examining β-glucosidase activity of the river Tisa water, since

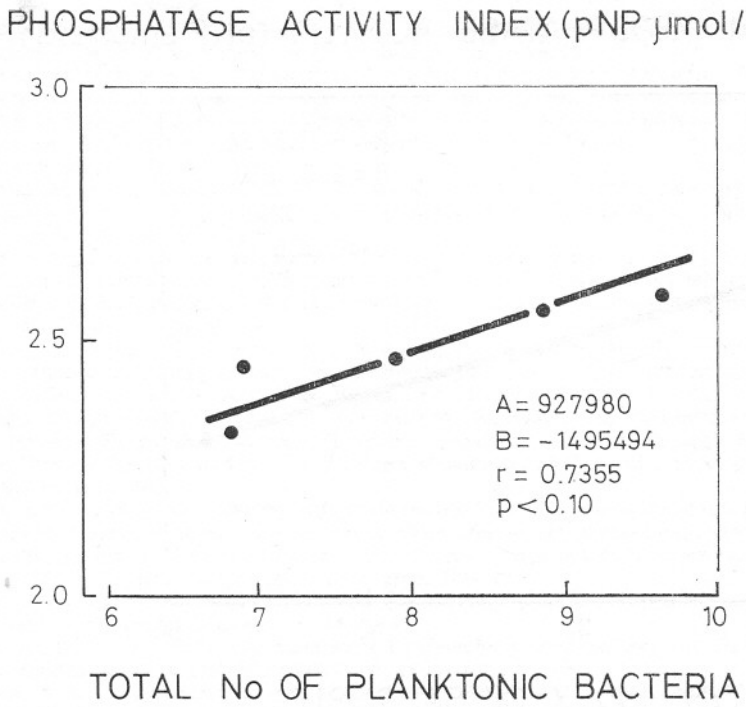

Fig. 3. Correlation between the total number of bacteria and water phosphatase activity index

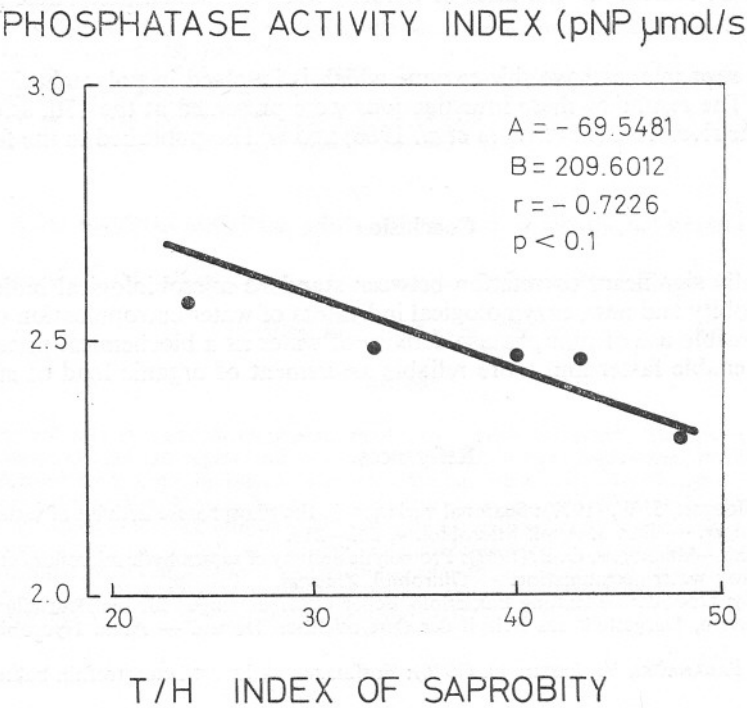

Fig. 4. Correlation between the T/H index of saprobity and water phosphatase activity index

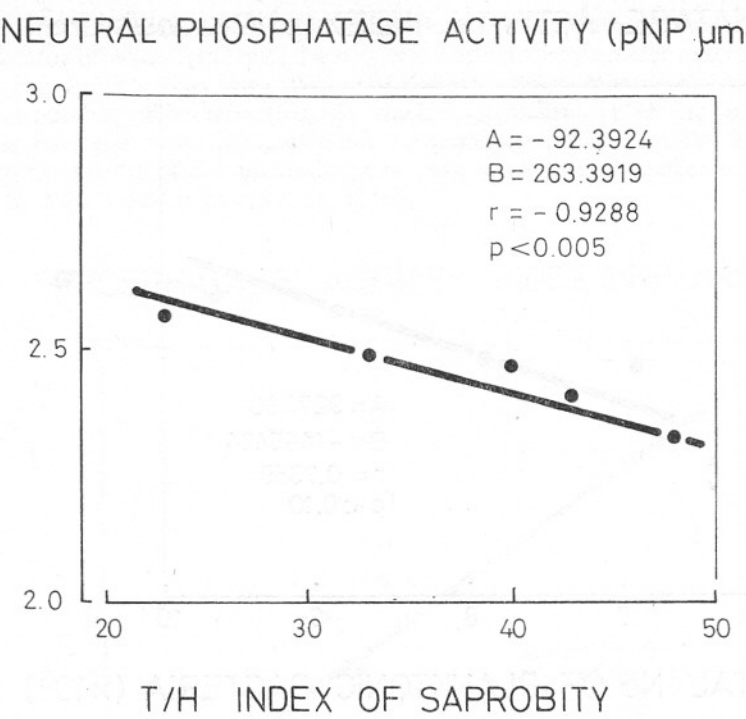

Fig. 5. Correlation between the T/H index of saprobity and water neutral phosphatase activity

most aerobic saprophytes have this enzyme which is involved in polysacharide biodegradation. The results of these investigations were presented at the 17th scientific meeting on the river Tisa (MATAVULJ et *al.* 1986) and will be published in the following paper.

Conclusion

Statistically significant correlation between standard microbiological indicators of water saprobity and new, enzymological indicators of water eutrophication degree points out possible use of phosphatase activity of water as a biochemical parameter which might enable faster and more reliable assessment of organic load of surface freshwaters.

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A víz foszfatáz aktivitása mint a Tisza vizének monitoring paramétere

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Kivonat

A szerzők a Tisza jugoszláv részlegének martonos—padé—töröbecse—zsablya—titeli szakaszán 1983—1986-os időszakban végzett mikrobiológiai és enzimológiai vizsgálatának eredményeit ismertetik. A felszíni vizek szaprobitásának meghatározása hagyományos mikrobiológiai paraméterek (a baktériumplankton teljes száma, a heterotrof baktériumok száma, a T/H szaprobitási index) és a víz foszfatáz aktivitási indexének mint újkeletű szaprobitási indikátornak összevetésével történt. A Tisza vizének szerves anyagokkal való megterhelése az összevetett paraméterek (a hagyományos és új biokémiai indikátor) által kapott, statisztikailag szignifikáns korrelációs mutatója arra utal, hogy a víz foszfatáz aktivitási indexe mint megbízható paraméter elősegítené a felszíni vizek szaprobitási fokozatának gyorsabb és megbízhatóbb meghatározását.

Фосфатазная активность воды как параметр мониторинга воды реки Тиса

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Резюме

В статье представлены результаты микробиологических и знзимологических исследований, выполнеенных на реке Тиса в югославской части. В периоде с 1983 по 1986 г.г. анализу подвергались пробы воды, отбор которых осуществлялся в пяти пунктах (места: Мартонош, Падей, Нови Белей, Жабаль и Тител).

Классические микробиологические параметры, в том числе общая численность бактериопланктонов, количество гетеротрофных бактерий и Т/Х индекс сапробности (отношение между общим количеством планктонных бактерий и количеством гетеротрофных бактерий, установленными на питательном агаре), которые стандартно применяются как индикаторы уровня сапробности поверхностных пресных вод, сравнивались с индексом фосфатазной активности воды, новым индикатором степени сапробности воды.

Статистический показатель соотношения между классическими микробиологическими и новыми биохимическими индикаторами органической нагрузки воды р. Тиса, подтверждает индекс фосфатазной активности воды как надежный параметер более быстрой и достоверной предварительной оценки степени сапробности поверхностных пресных вод.

Fosfatazna aktivnost vode kao parametar monitoringa vode reke Tise

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Rezime

U radu su prikazani rezultati mikrobioloških i enzimoloških istraživanja jugoslovenskog dela reke Tise. U periodu od 1983 do 1986. godine analizirani su uzorci vode sa pet lokaliteta (Martonoš, Padej, Novi Bečej, Žabalj i Titel).

Klasični mikrobiološki parametri kao što je ukupna brojnost bakterioplanktona, broj heterotrofnih bakterija i T/H indeks saprobnosti (odnos izmedju ukupnog broja planktoniskih bakterija i broja heterotrofnih bakterija utvrdjenog na hranljivom agaru), koji se standardno koriste kao indikatori nivoa saprobnosti površinskih slatkih voda, poredjeni su sa indeksom fosfatazne aktivnosti vode, novim indikatorom stpena saprobnosti vode.

Statistički sginifikantna korelacija izmedju klasičnih mikrobioloških, i novih biohemijskih indikatora organskog opterećenja vode reke Tise, afirmiše indeks fosfatazne aktivnosti vode kao pouzdan parametar za bržu i verodostojniju preliminarnu procenu stepena saprobnosti slatkih površinskih voda.

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THE DOMINANT BACTERIOFLORA IN THE WATER OF THE RIVER TISA AND THE MRTVA TISA (YUGOSLAVIA)

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Abstract

During 1987 the dominant microflora of the river Tisa and the Mrtva Tisa was investigated. The result obtained indicate that the bacterioplankton of waters analyzed had far better conditions for count expression on media being poorer in nutrient contents than on standard nutrient agar.

In this respect, when using microbiological parameters as indicators of surface water quality we also recommend determination of number of the dominant, i.e. oligotrophic microflora of surface water. For this component of bacterioplankton both per se and in relation to viable count gives important information about the conditions of water investigated.

Introduction

Microbiological examinations of surface waters in Yugoslavia are mainly limited to smaller number of analyses prescribed by our law and regulations. These analyses are mainly limited to the sanitary aspect of water condition estimate, which is doubtless important. However, the results of recent investigations in the world indicate that in such examinations oligotrophic bacteria — the dominant microflora of surface waters — were not included (ISHIDA and KADOTA 1977, 1979, 1981, ISHIDA et *al.* 1979, 1982; KUZNECOV et *al.* 1879). This very component of microflora is the active factor whose enzymes of wide range of activities are of primary importance in surface water autopurification processes.

For this reason, in this work, an attempt was made to examine the quality of water according to microbiological indicators in the water of the Mrtva Tisa and the Tisa, paying special attention in these examinations to oligotrophic microflora.

The Mrtva Tisa is the old flow of the river Tisa, formed by cutting the river bed in the last century (in 1858). Considering that in the Mrtva Tisa a large number of fish species find favourable life conditions, the Mrtva Tisa has been used for fishing, while recently this region has been developing fishing tourism. Considering the importance of bacterioplankton as a mineralisator of organic matter, but also in the first chain in the cycle of fish nutrition, in our opinion too little attention was paid to this component, since the data about the bacterioflora in the water of the Mrtva Tisa are sparse (RISTIĆ et *al.* 1974). This work includes study of the water quality of the Mrtva Tisa on the base of microbiological indicators, while in order to compare the water condition, a parallel water quality examination was conducted for the Tisa, upstream and downstream of the Mrtva Tisa.

Materials and Methods

The samples for microbiological analyses of the Mrtva Tisa water (at Čurug and Bačko Gradište) and the Tisa (at Novi Bečej and Žabalj) were taken during the year 1987, under aseptic conditions, and analyzed in the microbiological laboratory of the Institute of Biology in Novi Sad. The total number of bacterioplankton was determined by a direct method of Bacteriological filtration (RAZUMOV 1932), using membrane filters „Sartorius" No. 2. The viable count of heterotrophic bacteria was determined on nutrient agar. The count of oligotrophic bacteria was also determined by cultivation on nutrient agar which was diluted ten, one hundred, and one thousand times respectively, as well as on F-5 medium (ISHIDA and KADOTA 1977).

In addition, water phosphatase activity was determined on paranitrophenyl-phosphate (pNPP) as a substrate (MATAVULJ et al. 1982). The categorization of waters investigated was made both on the basis of viable count of bacteria (KOHL 1975) and on the index of enzyme activity (MATAVULJ et al. 1982). The water condition assessment was made on the basis of T/H index (e.g. ratio between total number of planktonic bacteria and viable count of bacteria) as well as on O/H index (e.g. ratio between oligotrophs and viable count). The results obtained are shown as average values for the year 1987.

Results and Discussion

The data presented in this report suggest that the bacterioplankton of the water tested had far better conditions for growth on media which are poorer in nutritious matter than on standard nutrient agar (Fig. 1). For example, in the water of the river Tisa at Novi Bečej and Žabalj the number of colonies on diluted nutrient agar was 3.5 and 5.5 times higher than that on nutrient agar (MPA), while in the Mrtva Tisa at Čurug — 3 and at Bačko Gradište — 7.2 times higher. This fact indicates a considerable error of standard methods for examination of surface waters, and at the same time shows the domination of autochtonous microflora over the heterotrophic, i.e. points to the satisfactory power of autopurification. It is also noticeable in the results shown in Fig. 1 that the largest number of bacterioplankton (obtained by cultivation on nutrient media) was recorded on agar diluted ten or even hundred times, while on medium F-5 (proposed for this purpose for counting of oligotrophic bacteria in surface waters by ISHIDA and KADOTA 1977) the number of colonies was far smaller.

When comparing the total number of bacterioplankton, obtained by direct method, with the count of colonies grown on media differing in nutrient contents, it can be noticed that the latter is much closer to the former if media applied were poorer in nutrients (Fig. 2.). In all the samples analyzed the viable count obtained on poor nutrient media was higher than that achieved on standard nutrient agar. However, at Žabalj locality the viable count has even reached the total number of bacterioplankton (Fig. 3).

For all these reasons, we would suggest the use of diluted nutrient media for the study of microbiological indicators of surface water quality which also include oligotrophic, i.e. dominant microflora of surface waters.

The results of microbiological examinations of the water from the Tisa and the Mrtva Tisa in 1987 indicate that the Tisa water at Novi Bečej belonged to 2nd to 3rd class (after KOHL), that is, to polluted waters (according to T/H ratio), whereas at Žabalj water was even more polluted (Table 1). In the Mrtva Tisa the water at Čurug belonged to the same category as at Žabalj (according to Kohl and T/H ratio) and was of better quality at Bačko Gradište. Only according to enzymatic activity the Tisa water belonged to 3rd-B category, and the Mrtva Tisa water even

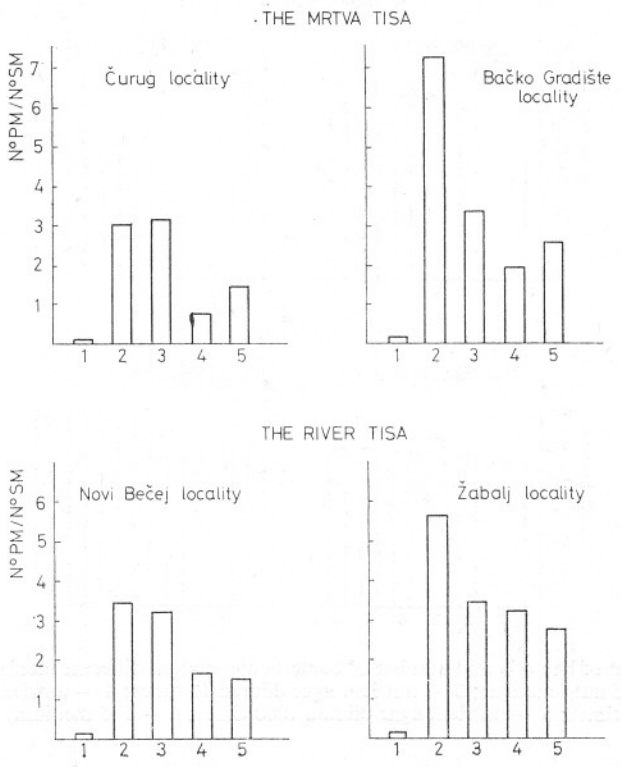

Fig. 1. Ratio of the number of bacteria counted on poor nutrient medium (PM) and number of bacteria counted on standard nutrient agar (SM). (1 — standard nutrient agar, 2 — diluted 10 times; 3 — diluted 100 times; 4 — diluted 1000 times; 5 — F-5 medium)

Tab. 1. *The river Tisa and the Mrtva Tisa water quality according to microbiological and enzymological indicators*

Indicator of water quality / Locality	After Kohl (1975)	T/H index	Phosphatase activity index
The river Tisa Novi Bečej	II—III	polluted	IIIB
The river Tisa Žabalj	III—IV	highly polluted	IIIB
The Mrtva Tisa Čurug	III—IV	highly polluted	IVB
The Mrtva Tisa Bačko Gradište	II	moderately polluted	IVB

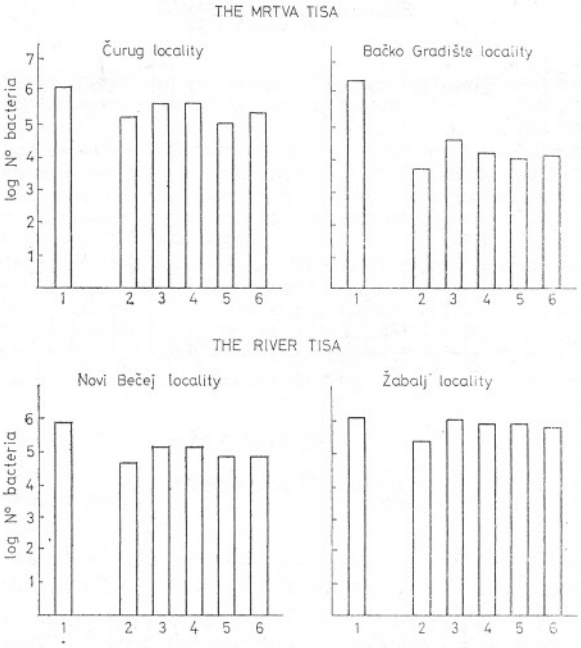

Fig. 2. Total count of bacteria and number of bacteria counted on different media. (1 — total number; 2 — standard nutrient agar; 3 — nutrient agar diluted 10 times; 4 — nutrient agar diluted 100 times; 5 — nutrient agar diluted 1000 times; 6 — F-5 medium)

to 4th-B category, which was possibly due to phytoplankton bloom. It should be mentioned that in the Mrtva Tisa in the summer period 800 000 individuals of phytoplankton per ml were recorded, with the prevailance of cyanobacteria.

Conslusion

According to the results obtained by estimation of dominant microflora in the water of the Tisa and the Mrtva Tisa during the year 1987, we can conclude the following:

The bacterioplankton had far better growing conditions on media which are poor in nutritious matter than on standard nutrient agar.

For examination of microbiological indicators of surface water quality by cultivating methods, we suggest the use of diluted nutrient agar media which maintain the oligotrophic, i.e. dominat microflora of surface waters.

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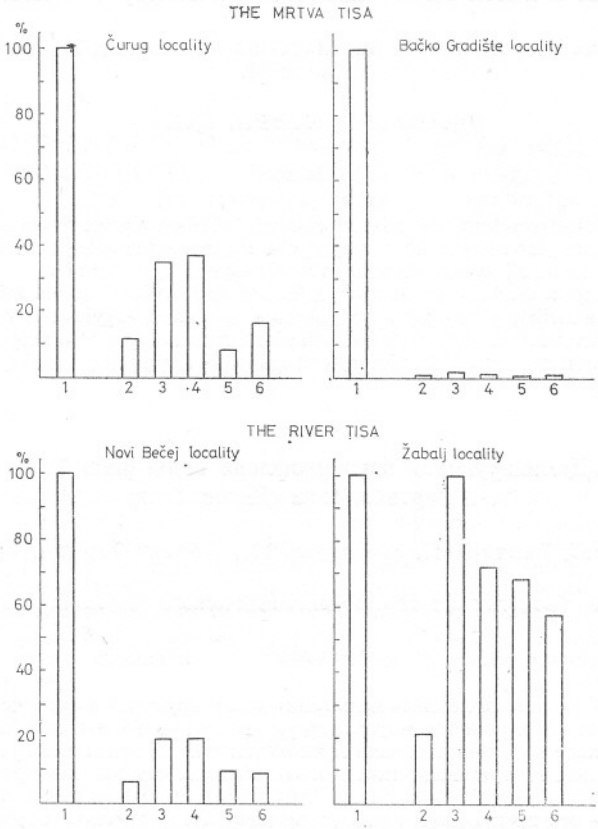

Fig. 3. Percentage of number of bacteria counted on different media related to total number of bacterioplankton

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A Tisza és a Holt-Tisza domináns bakterioflórája (Jugoszalávia)

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Kivonat

A Tisza és a Holt-Tisza domináns mikrofiórájának 1987-ben végzett vizsgálata alapján megállapítást nyert, hogy a nutriens anyagokban szegényebb táp messzemenőleg kedvezőbbnek bizonyult a bakterioplankton számbeli gyarapodására, mint a hagyományos táptalaj.

A szerzők a kapott eredmények alapján, a felszíni édesvizeket indikáló mikrobiológiai paraméterek alkalmazása mellett, javasolják a felszíni vizek domináns, vagyis oligotróf mikroflórájának mennyiségi meghatározását is. Ugyanis a bakterioplankton e komponense magában is, valamint a heterotróf baktériumok mennyiségéhez viszonyított aránya is, a vizsgált vizek állapotáról megbízható adatokat szolgáltat.

Доминирующая бактериофлора воды реки Тиса и мертвая Тиса (Югославия)

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Резюме

В течение 1987 года выполнялись испытания доминирующей микрорастительности реки Тиса и Мертвая Тиса. Полученные результаты указывают на то, что для бактериопланктона подвергаемых анализу вод, существовали лучшие условия для увеличения его количества на средах, с пониженным содержанием питательных веществ, чем на стандартных питательных средах.

Учитывая эти результаты, при применении микробиологических параметров как индикаторов качества воды пресноводных поверхностных экосистем, рекомендуется также и определение численности доминирующей, т.е. олиготрофной микрорастительности поверхностных вод. Этот компонент бактериопланктона, сам по себе, а также и его отношение к численности гетеротрофных бактерий, дает ценные данные о состоянии испытываемых вод.

Dominantna bakterioflora vode reke Tise i mrtve Tise (Jugoslavia)

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Izvod

Tokom 1987. godine istraživana je dominatna mikroflora reke Tise i Mrtve Tise. Dobijeni rezultati ukazuju na to da je bakterioplankton analiziranih voda imao daleko bolje uslove za ekspresiju brojnosti na podlogama siromašnijim u sadržaju nutrijenta nego na standardnoj hranljivoj podlozi.

Imajući u vidu ove rezultate, kada se koriste mikrobiološki parametri kao indikatori kvaliteta voda slatkovodnih površinskih ekosistema, preporučujemo takodje i odredjivanje brojnosti dominantne, tj. oligotrofne mikroflore površinskih voda. Ova komponenta bakterioplanktona, kako sama za sebe, tako i njen odnos prema brojnosti heterotrofnih bakterija, pruža dragocene podatke o stanju ispitivanih voda.

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DEVELOPMENTS IN THE COMPOSITION OF BIOCENOSIS IN THE LOWER TISA RIVER (YUGOSLAVIA), CAUSED BY HYDROLOGICAL CHANGES

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Abstract

The construction of the Hydroelectric Power Plant on the Danube and the dam on the Tisa at Novi Bečej have slowed down the flow of the river, thus causing certain changes in physical and chemical properties and in the composition of biocenoses. The saturation of oxygen decreased, BOD_5 increased as well as the concentration of ammonia ion, particularly in winter months.

In the compositon of zooplankton, the number of *Rotatoria* species increased, as well as population densities of the dominant species. In the bottom fauna, the dominant group is *Oligochaeta,* represented by 10—16 species belonging to families *Naidae* and *Tubificidae*. There have also been certain changes in the composition of ichthyofauna. There is less sterlet, more predatory fishes and carp and generally less other fish.

Introduction

Research in the Yugoslav part of the Tisa river has been carried out for more than 20 years (MARIĆ, PUJIN 1962, 1969, STANOJEVIĆ, PUJIN 1973). The length of the period enabled us to point to some developments in the composition of biocenoses, caused, first of all, by certain hydrotechnical projects and other anthropogenic factors. The construction of the Hydroelectric Power Plant "Djerdap" on the Danube slowed down its flow rate, which could be felt all the way upstream to the Tisa's estuary. The construction of the dam at Novi Bečej the Tisa also made some hydrological changes which affected both the physical and chemical properties of the water and its flora and fauna. Some properties were positively affected, some were mostly unchanged and still others suffered negative changes (MILOVANOVIĆ et *al.* 1985, KOJČIĆ, STANOJEVIĆ 1985, PUJIN et *al.* 1984, PUJIN 1985, DJUKIĆ, KILIBARDA 1985, RATAJAC, RAJKOVIĆ 1985, BUDAKOV et *al.* 1985). The objective of this survey was to indicate some major developments in the basic hydrochemical parameters which brought about changes in certian components of biocenoses.

Materials and Methods

The material was collected from 1980 to 1986. The following physical and chemical parameters were studied: content of oxygen dissolved in water (O_2 mg · dm^{-3}), saturation of water by oxygen (O_2%), BOD_5 (O_2 mg · dm^{-3}), COD (via $KMnO_4$ mg · dm^{-3}) and ammonia ion NH_4^+ mg · dm^{-3}). Of biocenological components, we studied the composition of zooplankton, bottom fauna and ichthyofauna. The methods applied were the currently used standard ones.

Changes in the Basic Chemical Properties

As already mentioned, the construction of the dams or storage lakes changes the hydrological regime, which affects water characteristics in various ways. With respect to the Tisa, their positive effect was detected in the improved clarity, due to the decrease of the amount of suspended mater. According to some previous studies, the lower Tisa water had been characterized by a high content of suspended materials (PUJIN, STANOJEVIĆ, 1979). In relation to pH, hardeness, alkalinity phosphates, K and Na, no major changes were observed in the twenty-year period. Oxygen regime has increasingly deteriorated. Althought the values varied in years, seasons and water levels, the amount of oxygen had been satisfactory in earlier years and saturation by oxygen was mostly between 80 and 90% (PUJIN, STANOJEVIĆ 1979, STANOJEVIĆ 1979). Now, this value is about 70%, and sometimes even less (Fig. 1). Seaso-

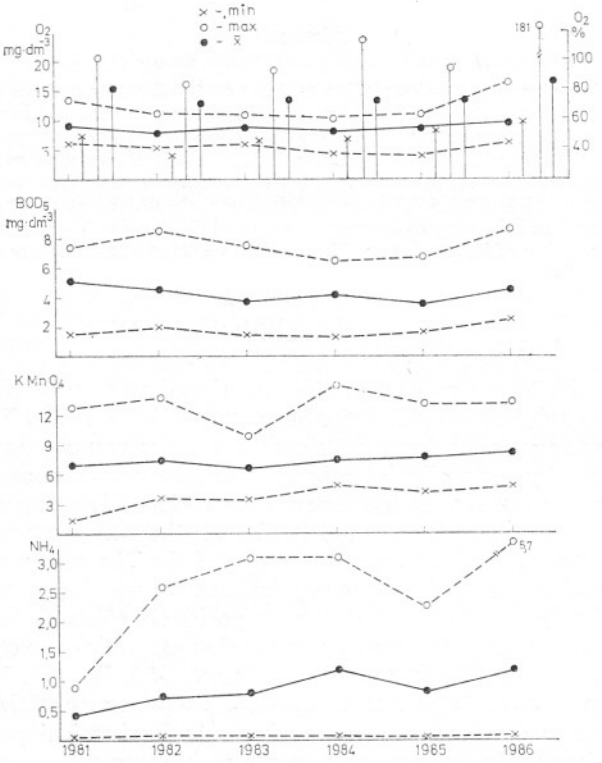

Fig. 1. Variations in the basic physical and chemical parameters in the water of the lower Tisa (1981—1986)

nal variations are evident, with particularly low values observed in summer and autumn (Fig. 2). This has recently caused massive fish deaths in certain sections, which had never happened in the Tisa before. Other chemical parameters, such as ammonia ion in particular, deteriorated. Its value in winter rises sharply (Fig. 2).

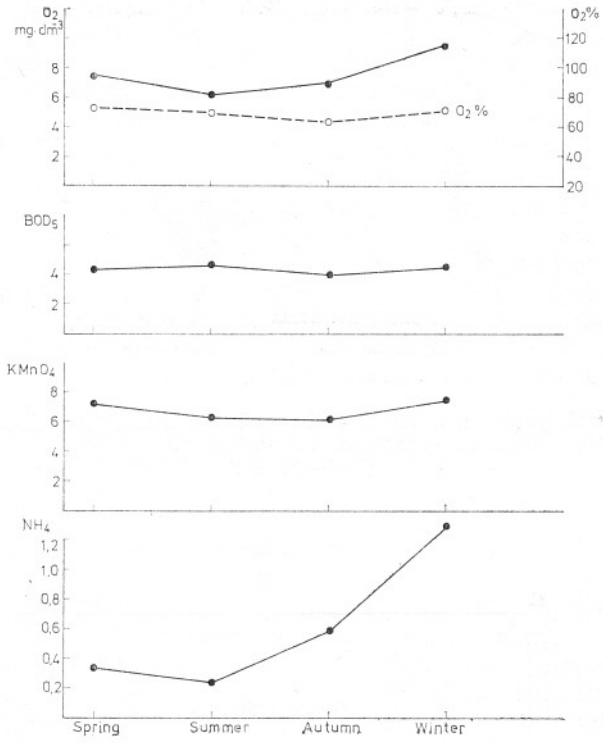

Fig. 2. Seasonal variations of the basic physical and chemical parameters in the water of lower Tisa (mean values for the period 1981—1986)

Changes in the Composition of Zooplankton and bottom Fauna

The main component in the zooplankton are Rotatoria, Cladocera and Copepoda. The most varied are Rotatoria and the number of their species varies in years and seasons. In the twenty-year-long period, it varied from 35 to 80. Until the construction of the dam at Novi Bečej, the number of species varied, on an average, from 35 to 40 (PUJIN, STANOJEVIĆ 1979, PUJIN, RAJKOVIĆ 1979, PUJIN et *al.* 1984). However, after the construction of the dam, the number of Rotatoria increased, and in the last several years it almost doubled. The species which had been present before remained, but new ones, typical of slow waters, appeared. The qualitative composition of Rotatoria is dominated, both in the number of species and in population densities, by several genera *Branchioumus, Keratella, Asplanchna* and *Trichocerca.* The others appeared in 1—2 species and a small number of individuals. This compostion has also undergone certain changes in the percentage of the above mentioned genera. Before the dam was built, *Brachionus* had accounted for 27.1%, *Keratella* for 12.5%, *Asplancha* 8.5, *Trichocerca* 6.3 and the others for 45.8%. After the dam was built, the *Branchionus* content declined and that of *Keratella* and *Trichocera* almost doubled (Fig. 3). The content of the other species also decreased to some extent. There were no major changes in the composition of Crustacea (RATAJAC 1985).

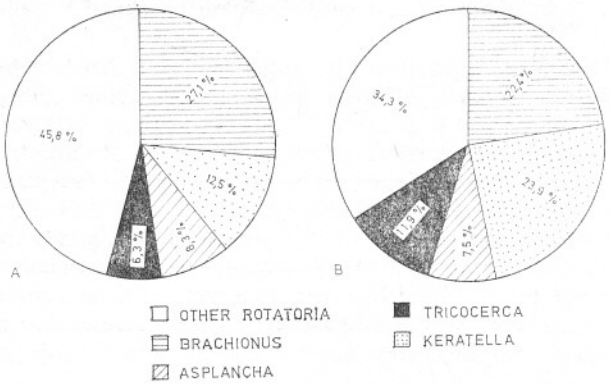

Fig. 3. Share of certain genuses of Rotatoria in the qualitative composition of *Rotatoria* in the lower Tisa, before the construction of the dam at Novi Bečej (1974—1978, A) and afterwards (1980—1986, B)

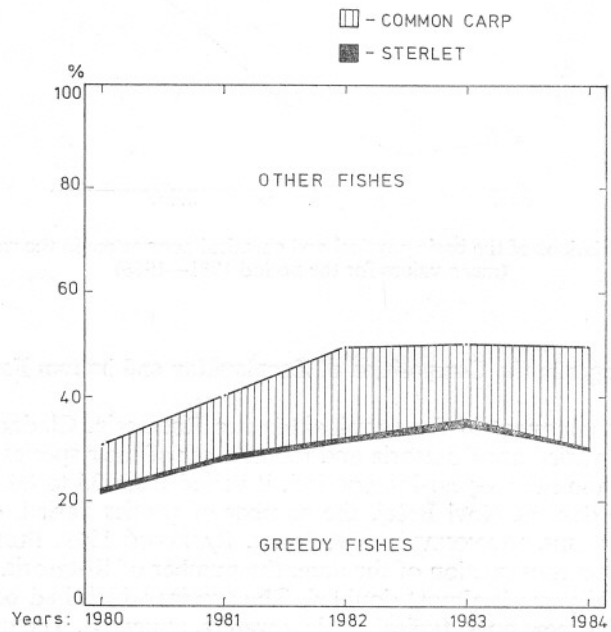

Fig. 4. Share of cetain fish species in the structure of catch in the lower Tisa (1980—1984)

The river bed fauna is dominated by Oligochaeta. The number of species varies in years and seasons and ranges between 11 and 16 (Djukić 1979, Pujin et *al.* 1984, Djukić, Kilibarda 1985). Although the qualitative composition has not changed significantly, it should be emphasized that the number of individuals among the species of *Limnodrilus hoffmeisteri, Isochaeta michelsoni* and *Branchyura sowerbyi* increased. This is also associated with the slow-down of the flow and the increase in

the content of organic matter in the sediment, which is particularly important for the above mentioned species. It is necessary to note that *Branchyura sowerbyi* had not been observed in the Tisa before 1977 (DJUKIĆ 1983, DJUKIĆ, STANOJEVIĆ 1983).

The ichthyofauna in the Tisa has also been affected by the changes in the hydrological regime, probably also due to other anthropogenic influences (pollution, massive catch etc.). The fish typical of the Tisa was sterlet. However, it has accounted for only about 1% of the catch in the recent years. Predatory fishes (pike-perch, catfish, and pike) as well as carp are on an increase, while the others are disappearing. The increase in the number of predatory fishes and carp is also associated with stocking, which has been done in the Tisa for a number of years (pike-perch nests, young carp). The ratio of predatory fish and their prey is proper, with the growing the number of other fish declines, as they are mostly food for the predatory fish. The composition of ichthyofauna in the last 10 years has changed with the newly introduced fish from the Far East *(Ctenopharyngodon idella, Hypophtalamichthys molitrix, H. nobils)* which get into the Tisa in the process of stocking with young carp and also from fish-farms which use water from Tisa. These fishes have so far been well adapted to the conditions and have had a fairly good growth rate.

Conclusion

Based on the years of research in physical, chemical and biocenological properties of the lower Tisa, the following conclusions can be made:

The construction of the Hydroelectric Power Plant on the Danube and the dam on the Tisa at Novi Bečej have slowed down the flow of the river, thus causing certain changes in physical and chemical properties and in the composition of some members of biocenoses. The negative effect of these changes was observed in the oxygen regime and concentration of ammonia ion in the water. The saturation by oxygen decreased (on an average by about 10%), BOD_5 increased as well as the concentration of ammonia ion, particularly in winter months.

In the composition of zooplankton, the number of Rotatoria species increased, as well as population densities of the dominant species.

In the qualitative composition of Rotatoria, the dominant role is played by: *Brachionus, Keratella, Asplanchna* and *Trichocerca.* After the dam was built, *Keratella* and *Trichocerca* genuses increased in numbers.

The compositions of Cladocera and Copepoda did not exhibit major differences.

In the bottom fauna, the dominant group is Oligochaeta, represented by 10—16 species belonging to families Naididae and Tubificidae. After the construction of the dam, the number of individuals of the species *Limnodrilus hoffmeisteri, Isochaeta michelsoni* and *Branchyura sowerbyi* particularly increased.

B. sowerbyi had not been found in the Tisa before 1977.

There have also been certain changes in the composition of ichthyofauna. There is less sterlet, more predatory fishes and carp and generally less other fish.

These changes are associated with those in the hydrological regime but also with other anthropogenic influences (pollution, stocking with fish, catch intensity ets.).

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A Tisza alsó (jugoszláviai) szakasza biocönózisaiban beállt változások a hidrobiológiai viszonyok változása következtében

VLASTA PUJIN

Egyetemi Biológiai Intézet, Újvidék

Kivonat

A vaskapui vízerőmű („Djerdap I"-Duna), valamint a törökbecsei (Tisza) vízlépcső megépítése által a Tisza folyásának lelassulása következtében beállt egyes fizikai-kémiai tényezők megváltozása, biocönózisok összetételének változását idézte elő. Nevezetesen az O_2 mennyisége csökkent, míg az OBF, valamint az ammónia-ionok mennyisége növekedett, elsősorban a téli hónapokban.

A zooplankton összetételében a Rotatóriák fajainak számbeli gyarapodása, valamint domináns fajaik sűrűségének emelkedése volt kimutatható. A fenékfauna Oligochaeta csoportját a Naididae és Tubificidae család 10—16 faja képezi. Az ichtyofauna összetételében is meghatározott változás állt be. Amíg a kecsege létszáma csökkent, addig a ragadozó fajok és a ponty állománya növekedett, ami egyrészt a halasításnak tudható be.

Изменения в составе биоценоза в нижнем течении реки Тиса (Югославия), обусловленные гидрологическими изменениями

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Резюме

Строительством гидроэлектростанции «Джердап» на р. Дунай, а также шлюза на р. Тиса у г. Нови Бечей, течение реки Тиса успокоилось, что повлияло на изменение некоторых физическо-химических характеристик, а также на изменения в составе биоценоза.

Содержание кислорода уменьшилось, а $БПК_5$ и ионов аммония увеличилось, особенно в зимний период.

В составе зоопланктона увеличилось количество видов *Rotatoria* а также и плотность популяций доминирующих видов. В фауне дна реки доминирующей группой является *Oligochaeta*, в которой наблюдается 10—16 видов из семьи *Naididae* и *Tubificidae*. Наблюдаются также некоторые изменения в составе ихтиофауны. Улов стерляди уменьшился, а хищных рыб и карпа увеличился, что в некоторой степени является и результатом рыбовведения.

Promene u sastavu biocenoza u donjem toku reke Tise (Jugoslavija) prouzrokovanih hidrološkim promenama

Vlasta Pujin

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Izvod

Izgradnjom hidroelektrane "Djerdap I" na Dunavu, kao i brane na Tisi kod Novog Bečej došlo je do uspora toka Tise, što je prouzrokovalo promene nekih fizičko-hemijskih karakteristika, kao i promene u sastavu biocenoza. Sadržaj kiseonika se smanjio, a BPK_5 kao i sadržaj amonijum jona se povećao, naročito u zimskim mesecima.

U sastavu zooplanktona povećao se broj vrsta *Rotatoria*, kao i gustina populacija dominantnih vrsta. U fauni dna dominantnu grupu čine *Oligocheata*, predstavljene sa 10—16 vrsta iz familija *Naididae* i *Tubificidae*. Takodje su zapažene izvesne promene u sastavu ihtiofaune. Ulov kečige se smanjio, a povećao ulov grabljivica i šarana, što je donekle i rezultat poribljavanja.

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STRUCTURE AND DYNAMICS OF ZOOPLANKTON IN THE DEAD THEISS

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Abstract

The dead Theiss Čurug—Biserno ostrvo represents a branch of the river Theiss, created after the cutting of the river bed in the last centruy. In the period 1983—1987, the structure and dynamics of the zooplankton in this eco-system, important for fishing, were investigated. In the stated period in the structure of zooplankton, a total number of 80 species were ascertained, out of which 16 *Protozoa* (20%), 43 *Rotatoria* (53,75%), 13 *Cladocera* (16,2%) and 8 *Copepoda* (10%). The most frequent species out of *Rotatoria* belong to the genera *Branhionus, Keratella* and *Polyarthra.* These genera make the most represented genera also in other waters of the Pannonian basin. It may be of interest to mention the presence of the species *Liliferotrocha subtilis,* appearing more and more frequently, not being recorded earlier. Out of Cladoceras, most frequently are present the species *Bosmina longirostris, Daphnia cuculata* and *D. longispina,* while of *Copepodas Eudiaptomus gracilis* and *Thermocyclops crassus.*

The number of species varies yearly and seasonally. The largest number is in the summer period. The quantitative structure is also variable yearly and seasonally. The largest values were recorded in the year 1984, 6.730 ind. dm^{-3}.

Introduction

The Dead Theiss Čurug-Biserno ostrvo represents the old flow of the river Theiss, created after cutting the river bed in 1958. BUKUROV (1948).

Characterized this stagnant tributary as a lake and was of the opinion that "it will be a deep lake for long, since instead of river mud, it is covered with eolitic material and swamp vegetation". For a long period this eco-system has been used for fishing, since very good living conditions prevail for the life and nutrition of a great number of fish species. Therefore it is used more and more in fishing tourism. For this reason it is becoming the object of hydrobiologic researches (RISTIĆ et *al.* 1974, KALAFATIĆ et *al.* 1982, PUJIN et *al.* 1986). As the zooplankton represents an important component in the nutrition of many kinds of fish, the aim of this work was to present the structure and dynamics of zooplankton in this insufficiently investigated locality.

Materials and Methods

The research includes the period 1983—1987. The material was collected in seasonal intervals. The samples for qualitative structure were taken by a plankton net made of milling silk No. 22, while for the quantitative analyse the method of filtering 1 l water was applied. The material was mainly tested in fixed state, in 4% formalin.

Results and Discussion

In the qualitative structure of zooplankton, as in other waters, participate the groups of *Protozoa, Rotatoria, Cladocera* and *Copepoda.* In the investigated period, a total number of 81 species were ascertained, out of which 16 *Protozoa,* 43 *Rotatoria,* 14 *Cladocera* and 8 *Copepoda.* The structural content of the zooplankton, expressed in percentage, would be represented as follows: *Protozoa* 20%, *Rotatoria* 53%, *Cladocera* 17% and *Copepoda* 10%. The list of Protozoa is not complete as the material was tested in fixed state, and as such was not suitable for more detailed determination. The number of species varied yearly and also seasonally. The greatest variation is in the summer period and the smallest in winter. The greatest variation in relation to particular years are in spring, since in this period the conditions also vary. The represented species by year are shown in Tab. 1.

As it can be seen, the number of species varies by year although the limits are not large. Mainly, yearly about 50 species are recorded in the first three years and a somewhat larger number, 59 and 61 in the years 1986 and 1987. In this list, besides the genuine plankton species, included are periphitonous species.

In such waters during tests these species also appear, so that we usually take them in consideration. As in other waters of Vojvodina, the most diverse group is Rotatoria. The represented species appear also in other waters and if we would compare the qualitative structure of the Dead Theiss with the river Theiss, we would notice that over 70% of represented species of *Rotatoria,* could be found in both eco-systems (PUJIN, STANOJEVIĆ 1979, PUJIN, RAJKOVIĆ 1979, PUJIN 1983). Besides the variation of species number by year, evident are also the differences by season (Fig. 1).

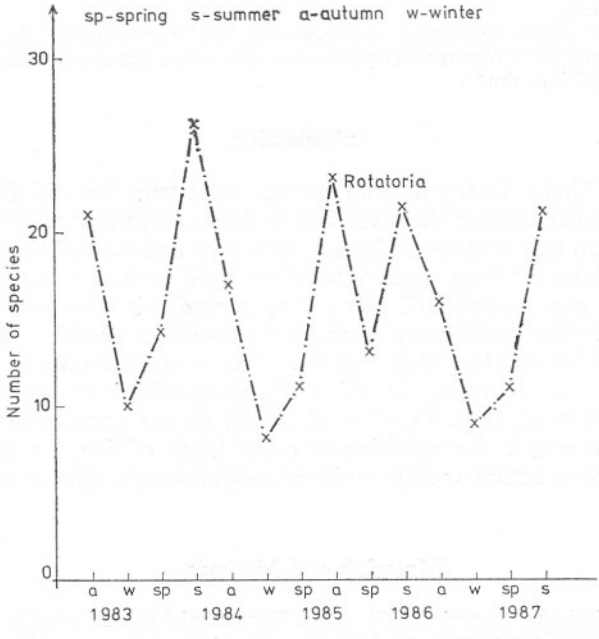

Fig. 1. Seasonal variatons of the number of species Rotatoria in the Dead Theiss Čurug—Biserno ostrvo (1983—1987)

Table 1. *Qualitative composition of zooplankton in the Mrtva Tisa (Yugoslavia) for the period 1983—1987*

Species	1983	1984	1985	1986	1987
Protazod					
Actinosphaerium eichorni (EHR.)		+		+	+
Aspidisca costata (DUJ.) CL et L.	+	+		+	
Arcella vulgaris EHR.	+	+	+	+	+
Centropyxis aculeata STEIN	+	+	+		
Difflugia limnetica LEVANDER	+	+	+	+	+
D. pyriformis PERTY	+		+		
Carchaesium polypinum L.			+	+	
Didinium nasutum O.F.M.				+	+
Dileptes anser O.F.M.			+	+	+
Epistylis plicatilis EHR.	+	+			+
Paramecium aurelia EHR.	+	+	+	+	+
P. caudatum EHR.			+	+	+
Tintinnidium fluviatilis STEIN et KENT	+	+	+	+	+
Tintinnopsis lacustris ENTZ.	+	+	+	+	+
Vorticella campanulata EHR.	+	+	+	+	+
V. microstoma EHR.			+	+	+
Rotatoria					
Anueropsis fissa GOSSE	+	+	+	+	+
Asplanchna brightwelli GOSSE	+	+	+	+	+
A. priodona GOSSE	+	+	+	+	+
A. sieboldi (LEYDIG)		+		+	
Brachionus angularis GOSSE	+	+	+	+	+
B. budapestinensis DADAY	+	+	+	+	+
B. calyciflorus PALLAS	+	+	+	+	+
B. diversicornis DADAY	+			+	+
B. leydigi COHN				+	+
B. quadridentatus HERMANN	+			+	
B. urceolaris O.F.M.	+	+		+	
B. urceolaris var. *rubens* EHR.			+	+	
Cephalodella gracilis EHR.	+	+	+		
C. tecta DONNER	+				
C. ventripes (DIXON—NUTALLI)	+	+			
Colurella adriatica (EHR.)	+		+	+	+
C. colurus (EHR.)	+	+	+	+	+
C. oblonga DONNER			+		
C. uncinata (EHR.)	+	+	+	+	+
Dicranophorus forcipatus (MÜLL).			+		
Epiphanes senta (MÜLLER)					+
Euchlanis dilatata (EHR.)		+		+	
E. oropha GOSSE	+				
Filinia brachiata (ROUSSELET)			+		
F. longiseta (EHR.)	+	+	+	+	+
Keratella cochlearis GOSSE	+	+	+	+	+
K. cochlearis var. tecta GOSSE	+	+	+	+	+
K. hiemalis CARLIN	+	+			
K. quadrata (MÜLLER)	+	+	+	+	+
K. valga f. *monospina* (KLAUSSENER)	+	+	+	+	+
Lecane ludwigi (ECKSTEIN)	+	+			
L. lunaris (EHR.)	+	+	+		
Liliferotrocha subtilis RODEWALD			+	+	+
Polyarthra dolichoptera IDELSON	+	+	+	+	+
P. euryptera WIERZEJSKI	+	+	+	+	+

Species	1983	1984	1985	1986	1987
P. major BURCKHARDT	+	+			
P. vulgaris CARLIN	+	+	+	+	+
Pompholyx sulcata HUDSON			+	+	+
Rotaria neptunoidea HARRING				+	+
R. rotatoria (PALLAS)	+	+	+	+	+
Synchaeta stylata WIERZEJSKI		+		+	+
S. pectinata EHR.	+	+	+	+	+
Trichocerca capucina (WIER. et ZACHARIAS)			+	+	+
T. rattus (MÜLLER)	+	+	+	+	+
Cladocera					
Alona quadrangularis (O.F.M.)	+	+	+	+	+
Alonella excisa FISCHER					+
Bosmina coregoni BAIRD	+	+	+		+
B. longirostris (O.F.M.)	+	+	+	+	+
Ceriodaphnia quadrangula O.F.M.					+
Chydorus sphaericus O.F.M.	+	+			+
Daphnia cuculata SARS	+	+	+	+	+
D. longispina O.F.M.	+	+	+	+	+
Diaphanosoma brachyurum (LIEVIN)	+	+		+	+
Leptodora kindti (FOCKE)		+	+		
Moina micrura (KURZ) ŠRAMEK—HUŠEK		+		+	+
M. rectirostris (LEYDIG)					+
Scapholeberis kinhi SARS					+
Sida cristalline (O.F.M.)		+			+
Copepoda					
Acanthocyclops robustus (SARS)				+	+
A. vernalis (FISCHER)	+	+	+	+	+
Cyclops strenuus FISCHER				+	+
C. vicinus ULJANIN	+	+	+	+	+
Eucyclops serrulatus (FISCHER)				+	+
Eudiaptomus gracilis SARS	+	+	+	+	+
Mesocyclops leuckarti CLAUS		+	+	+	+
Thermocyclops crassus (FISCHER)	+	+	+	+	+

Cladocera and Copepoda were represented with far smaller number of species. In the investigated period, we ascertained 14 species Cladocera and 8 species *Copepoda*. In this case, as with Rotatoria, we considered genuine plankton species — *Bosmina longirostris, Moina micrura,* the species of the genus *Daphnia* and *Ceridaphnia,* as well as periphitonous *Chydorus, Leptodora* and *Sida.* It should be mentioned that *L. kindti* and *S. crystallina* appeared in particular periods in greater number. These species are characteristic for slow and stagnant waters with a well developed macro-vegetation. ŽIVKOVIĆEVA (1973) asertained *S. crystallina* in Obedska bara (Vujića okno) as permanently present in the period April to September. The same author noted as dominant species *Bosmina longirostris,* which was the case also in the Dead Theiss.

The majority of ascertained species of Copepoda appeared in all investigated years, except *A. robustus, C. strenuus* and *E. serrulatus.* A similar structure of Cladocera and Copepoda was ascertained in the Theiss (RATAJAC 1981, PUJIN et *al.* 1984). In relation to variation in number of the species Cladocera and Copepoda by year, the largest number appeared in 1987 (13 species Cladocera and 8 Copepoda),

the smallest in 1985. Seasonal variation of species number is also expressed. The largest number appear in summer and the least in winter (Table 2).

According to the results of previous investigations, a similar structure of zooplankton was ascertained (RISTIĆ et *al.* 1974). However, according to KALAFATIĆ et *al.* (1982), a much poorer zooplankton structure is quoted for this eco-system, especi-

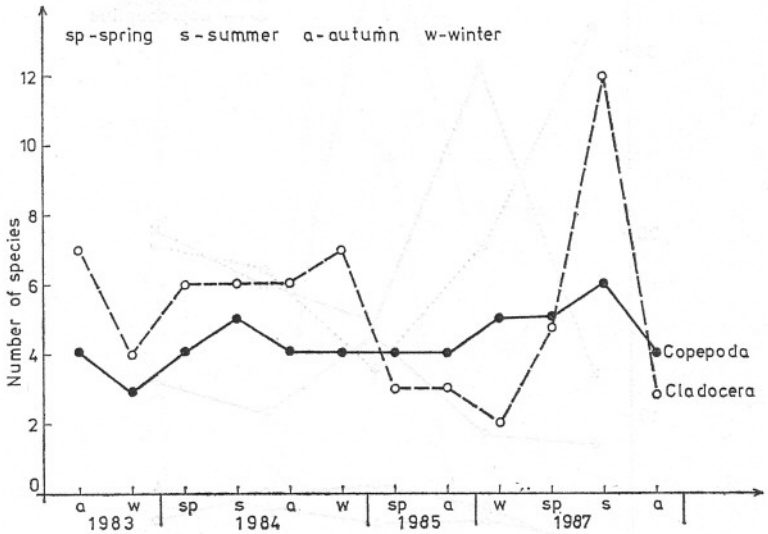

Fig. 2. Seasonal variations of the number of species Crustacea in the Dead Theiss Čurug—Biserno ostrvo (1983—1987)

ally regarding Rotatoria — only 11 species. According to these data, the number of species of Cladocera was somewhat larger (15), while the number of Copepoda was the same (8). These differences probably can be attributed to the period of sample taking. Namely, the quoted authors were taking the samples only in April and June.

The quantitative structure of zooplankton varies by year (Fig. 3). The largest values were obtained in the year 1984. On the base of these values, this eco-system could be characterised as eutrophic with differences in the degree of eutrophisation, depending on the region. These differences were pointed out also in previous researches (RISTIĆ et *al.* 1974).

Seasonal variations of the quantitative structure are also expressed. Since, for the production of zooplankton, crustacea are exceptionally important, we are giving the variations on Fig. 4 for Copepoda and Cladocera by season for the year 1987. The particulars show that the maximum of Cladocera and Copepoda fall in summer, while nauplius stadium of Copepoda in spring. In the winter period the values are the lowest.

Conclusion

On the basis of dynamics and structure of zooplankton in the Dead Theiss Čurug-Biserno ostrvo, in the period 1983—1987, we can conclude the following:

In the investigated period in the structure of zooplankton, a total of 80 species

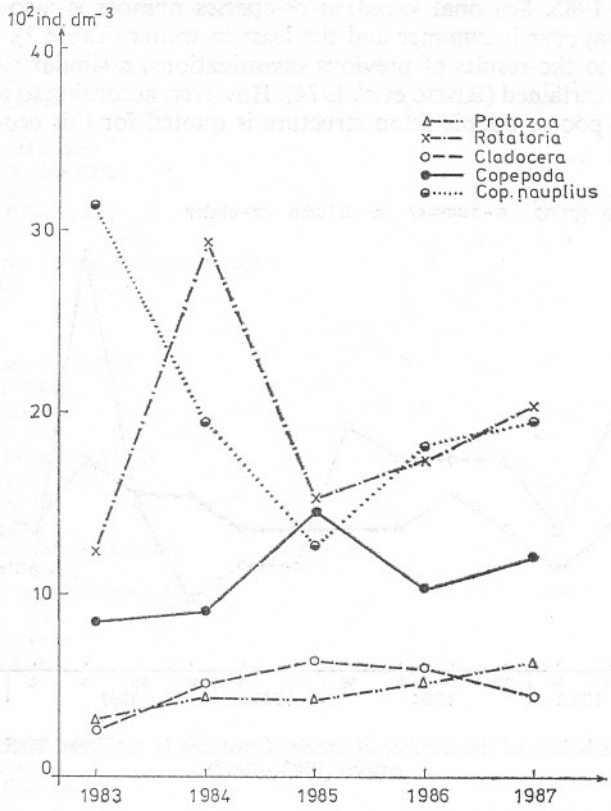

Fig. 3. Mean values (ind. dm^{-3}) of zooplankton in the Dead Theiss Čurug—Biserno ostvro (1983—1987)

was ascertained, out of which 16 Protozoa (20%), 43 Rotatoria (53.75%), 13 Cladocera (16.2%) and 8 Copepoda (10%).

Rotatoria represent the most diverse group and the largest number of species belong to the genus *Brachionus, Keratella, Polyarthra.* Especially interesting is the appearance of species *Liliferotrocha subtilis,* which was not recorded earlier while now it is more and more present in summer.

Of Cladoceras, permanently present are species *Bosmina longirostris, Daphnia cuculata* and *D. longispina,* and of Copepoda, *Eudiaptomus gracilis* and *Thermocyclops crassus.*

In relation to the river Theiss, about 70% species in the Dead Theiss are present in both water eco-systems.

The number of species varies by year and seasonally. The largest number of species appear in summer, the smallest in winter.

The quantitative structure also varies yearly and seasonally. The highest values were recorded in 1984, 6.730 ind.dm^{-3}.

On the base of such a structure, we can characterize the Dead Theiss Čurug-Biserno ostrvo as an eutrophic water with certain variations of degree, depending on the region.

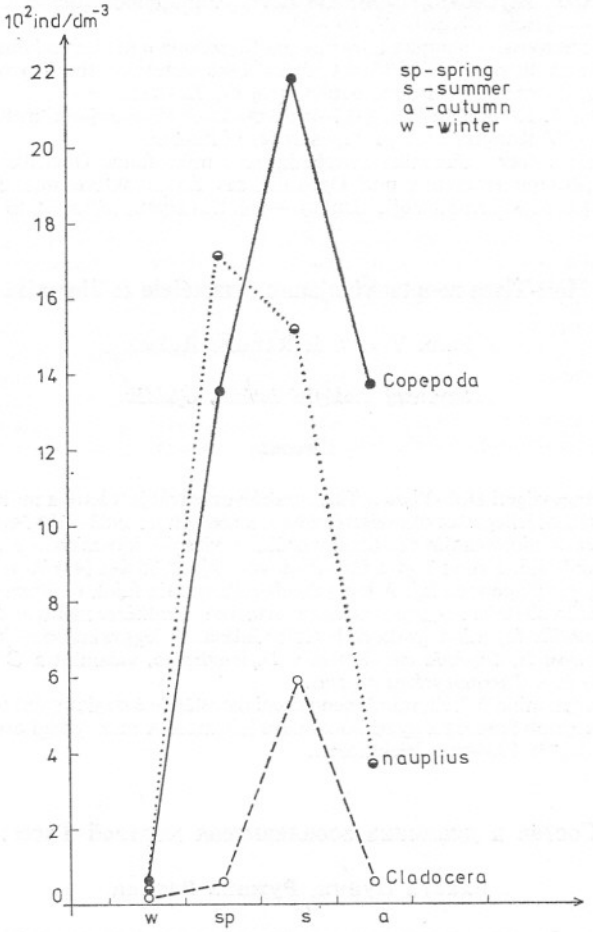

Fig. 4. Seasonal variations of numerical values of Crustacea in the Dead Theiss Čurug—Biserno ostrvo (1987)

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A Holt-Tisza zooplanktonjának összetétele és dinamikája

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Egyetemi Biológiai Intézet, Újvidék

Kivonat

A csúrog—gyöngyszigeti Holt-Tisza a Tisza szabályozásával jött létre a múlt században. Ebben a halászat szempontjából jellegzetes ökoszisztémában, a szerzők az 1983—1987-es időszakban a zooplankton összetételét és dinamikáját tanulmányozták. A vizsgált időszakban a zooplankton összetételében 80 faj fordult elő. Ennek 20%-a (16) Protozoa faj, 53.75%-a (43) Rotatoria, 16,2%-a (13) Cladocera, és 10%-a (8) Copepoda faj. A leggyakoribb Rotatoria fajok (a *Branchionus, Keratella* és *Polyarthra*) az Alföldön általában elterjedt nemhez tartoznak. Említésre méltó az ezidáig nem regisztrált *Liliferotrocha subtilis* faj mind gyakoribb előfordulása. A leggyakrabban jelenlévő Cladocera fajok: *Bosmina longirostris, Daphnia cuculata* és a *D. longispina,* valamint a Copepodák közül az *Eudiaptomus gracilis* és a *Thermocyclops crassus.*

A zooplanktonnak mind fajbeli, mind mennyiségi összetétele évszakonként és évenként különbséget mutat. A legnagyobb fajszám a nyári hónapokra jellemző. A mennyiségi összetétel legnagyobb értéke (6.730 ind. dm^{-3}) 1984-ben jelentkezett.

Состав и динамика зоопланктона мертвой Тиссы

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Резюме

Мертвая Тиса в районе м. Чуруг—Жемчужный остров является рукавом реки Тиса, созданным пересечением русла реки еще в прошлом веке. В период с 1983 по 1987 г.г. проводились испытания состава и динамики зоопланктона этой, в рыболовном отношении, интересной экосистемы. В течение вышеуказанного периода, в составе зоопланктона наблюдалось всего 80 видов, из которых 16 Protozoa (20%), 43 Rotatoria, (53,75%), 13 Cladocera (16,2%) и 8 Copepoda (10%). Чаще всего к составу вида Rotatoria относятся роды *Brachionus, Keratella Polyarthra.* Указанные часто появляются и в других водоемах паннонского бассейна. При этом интересно указать на присутствие вида *Liliferotrocha subtilis,* появляющегося все чаще, что ранее не наблюдалось. Из Cladocera чаще всего наблюдается присутствие видов *Bosmina longirostris, Daphnia cuculata* и *D. longispina,* а из *Copepoda-Eudiaptomus gracilis i Thermocyclops crassus.*

Количество видов варьирует как по годам, так и по сезонам. Самое большое количество наблюдается в летнем периоде. Количественный состав также варьирует по годам и сезонам. Самые большие значения наблюдались в 1984 годи — 6.730 инд. $дм^{-3}$.

Sastav i dinamika zooplanktona mrtve Tise

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Izvod

Mrtva Tisa Čurug—Biserno ostrvo predstavlja rukavac reke Tise nastao presecanjem korita još u prošlom veku. U periodu 1983—1987 ispitivani su satsav i dinamika zooplanktona ovog u ribolovnim pogledu interesantnog ekositema. U navedenom periodu u sastavu zooplanktona ukupno je konstatovano 80 vrsta, od toga 16 Protozoa (20%), 43 Rotatoria (53,75%), 13 Cladocera (16,2%) i 8 Copepoda (10%). Najčešće vrste u sastavu Rotatoria pripadaju rodovima *Branchionus, Keratella* i *Polyarthra*. Ovi rodovi čine najzastupljenije rodove i u drugim vodama panonskog bazena. Interesantno je navesti prisustvo vrste *Liliferotrocha subtilis*, koja se sve češće javlja, a ranije nije bila zabeležena. Od Cladocera su najčešće prisutne vrste *Bosmina longirostris, Daphnia cuculata* i *D. longispina*, a od *Copepoda, Eudiaptomus gracilis* i *Thermocyclops crassus*.

Broj vrsta varira kako po godinama, tako i sezonama. Najveći je u letnjem periodu. Kvantitativni sastav takodje varira po godinama i sezonama. Najveće vresnosti su zabeležene 1984. god. 6.730 ind. dm^{-3}.

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EUTROPHICATION OF THE DEAD THEISS INDICATED BY OLIGOCHEATE

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(Received September 08, 1988)

Abstract

The study of oligochaete communities in the dead Theiss in the period 1983—1987 shows a very rapid process of eutrophication in this stagnant tributary. On the base of average percentage presence of oligochaete, it is clearly visible that dominant are eutrophic species, such as: *Limnodrilus sp., L. hoffmeisteri, L. claparedeanus, L. udekemianus* and *Potamothrix hammoniensis* characterizing their environment as eutrophic. At the same time the number of individuals and their bio-mass have the tendency of expressive increase, which is the characteristic of eutrophic waters.

Introduction

By analysing the presence of oligochaeta communities, a very good estimate of the eutrophication degree can be made for stagnant waters. How current and important this problem is, shows in the work of research teams throughout the world, and their numerous reports about the process of eutrophication in shallow stagnant waters as well as in large, deep mountain lakes of Switzerland, Sweden and other countries: LANG and LANG—DOBLER 1980, LANG and HUTTER 1981, LANG 1984 and MILBRINK 1980. Recently, studies of the eutrophication process were made also in Vojvodina, DJUKIĆ 1984. So in this work, the trophic status of a stagnant water river lake of the dead Theiss is presented, according to the presence of oligochaeta species.

Materials and Methods

The bottom fauna samples form the dead Theiss were collected seasonally in the period 1983—1987. The silt (mud) was taken by a dredge, type "Ekman-Birge". The collected material was prepared in the laboratory by standard treatment methods. Determination was made on live oligochaete individuals. The number of individuals is represented as a total number of individuals per m^2 of observed surface, while the bio-mass of oligocheate, as freshly weighed individuals in g/m^2.

Results and Discussion

Within the frame of complex hydrobiologic reasearch of the dead Theiss, the structure and dynamics of oligochaete fauna in the period 1983—1987, was followed. So on the base of obtained data, it was possible to determine also the trohpic status of this stagnant tributary.

On Fig. 1. it can be clearly seen, according to relative abundance of the oligochaete species, that dominant were — *Limnodrilus* sp. (juvenile), *Limnodrilus hoffmeisteri L. claparedeanus, L. udekemianus, Potamothrix hammoniensis* and *Psamoryctides barbatus,* so that the majority of oligochaete communities are eutrophic species. Over 70% of the species are eutrophic, enduring eutrophic environment, determined according to the classification of LANG 1984, who had determined the trophic status of lakes in Switzerland according to the presence of oligochaete, pooling the species into oligotrophic, mesotrophic and eutrophic.

The studied river lake is situated in the region of arable land with an intensive agriculture, which, due to inflow of nutritive elements has a great influence on the increase of primary and secondary production. For this reason, the quantitative analyse of oligocheate in the investigated period, shows a tendency of expressed increase of individual's number (even up to 5 300 ind./m^2) as well as the bio-mass up to 17 g/m^2 yearly, which is characteristic for eutrophic waters. So this locality can be considered, according to quantitative analysis, as eutrophic.

Further research of this eco-system in the future from the aspect of eutrophication, will probably give solutions for the slowing of this process.

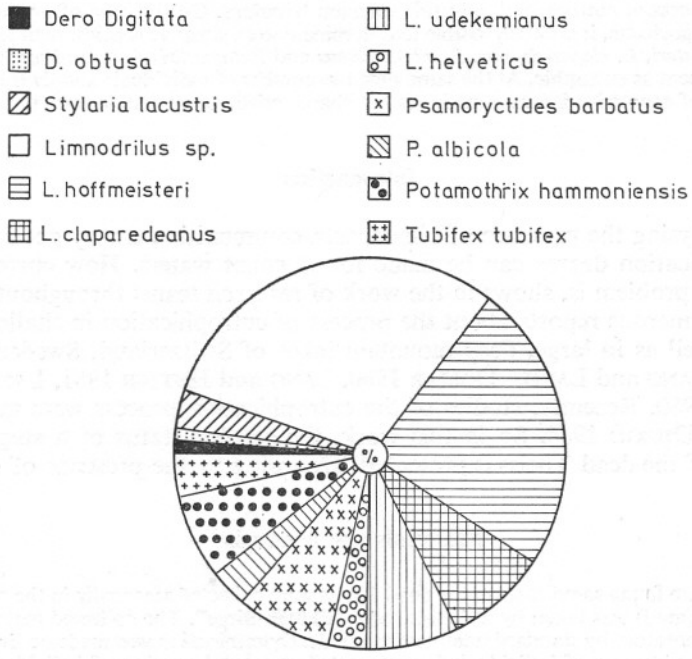

Fig. 1. Average percentual presence values of particular oligochaete species in the dead Theiss (1983—1987)

Conclusion

The studies of the structure and dynamics of oligochaete in the dead Theiss in the period 1983—1987 have shown that this stagnant tributary (former riverbed of Theiss) has a very rapid process of eutrophication.

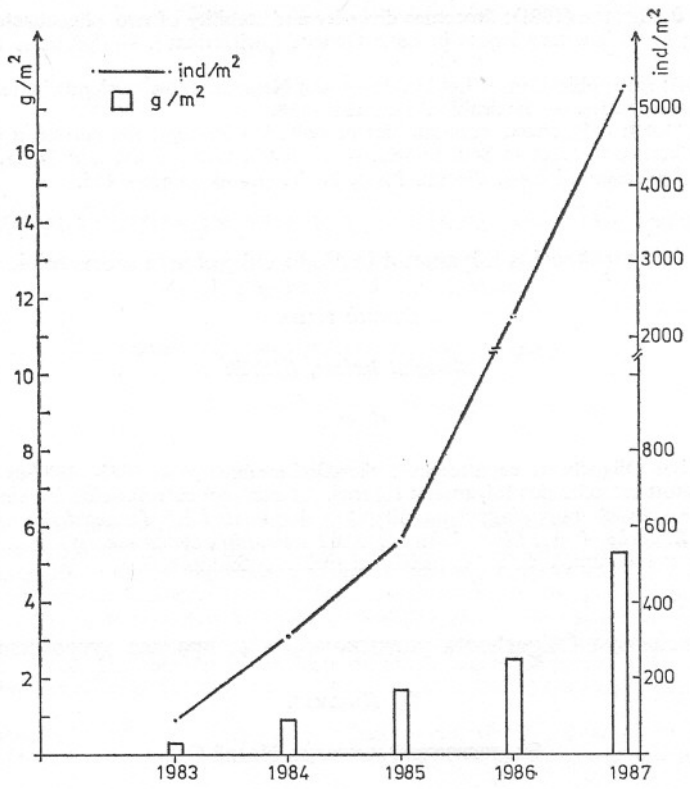

Fig. 2. Mean yearly values of the number of oligochaete (ind · m^{-2}) and the bio-mass (g.m^{-2}) in the dead Theiss (1983—1987)

The relative abundancy of oligochaete species has shown that dominating were eutrophic species — *Limnodrilus* sp. (juvenile forms), *L. hoffmeisteri, L. claparedeanus, L. udekemianus* and *Potamothrix hammoniensis,* which by their large number define the environment in which they live.

The quantitative analysis of oligochaete ascertained an expressed increase of the number of individuals and their bio-mass, which is characteristic of eutrophic waters. For these reasons, the dead Theiss, in the classification of water currents through oligochaete as indicators of eutrophication, can be classified as an eutrophic water.

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Az autrofizaciós folyamatot indikáló Oligochaeta szervezetek

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Kivonat

A Holt-Tisza Oligochaeta együtteseinek vizsgálati eredménye az 1983—1987-es időszakban a holtág felgyorsított eutrófizációs folyamatát tükrözi. Az ezirányú eutrófizációs folyamatra utal egyrészt az átlagos százalékarány alapján megállapított domináns fajok *(Limnodrilus hoffmeisteri, L. claparedeanus, L. udekemianus, Limnodrilus* sp. és a *Potamothrix hammoniensis)* jelenléte, másrészt megnövekedett egyedszámuk és a biomassza kiemelkedő feldúsulása.

Организмы Oligochaeta указывающие на процесс эутрофизации

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Резюме

Изучение популяции Oligochaeta в Мертвой Тисе в период 1983—1987 гг. указывает на ускоренный процесс эутрофизации. На процесс эутрофизации указывает с одной стороны присутствие следующих доминантных видов *Limnodrilus hoffmeisteri, L. claparedeanus, L. udekemianus, Limnodrilus* sp. и *Potamothrix hammoniensis*, а с другой — увеличение числа особей, а также значительное нарастание биомассы.

Oligochaeta kao indikatori eutrofizacije u mrtvoj Tisi

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Izvod

Proučavanje oligohetnih zajednica Mrtve Tise u periodu od 1983—1987. godine pokazuju da ova mrtvaja ima veoma ubrzan process eutrofizacije. Na osnovu prosečne procentualne zastupljenosti oligoheta se jasno vidi da su dominirale eutrofne vrste *L. hoffmeisteri, L. claparedeanus, L. udekemianus, Limnodrilus* sp. i *Potamothrix hammoniensis* i one zapravo karakterišu sredinu u kojoj žive, kao eutrofnu. Istovremeno su broj individua i njihova biomasa imali tendenciju izrazitog povećanja, a to je osobina eutrofnih voda.

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MACROZOOBENTHOS IN THE RIVER TISZA AND ITS INFLUENTS

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(Received September 05, 1988)

Abstract

In the studied section of the Tisza, the Oligochaets and the Chironomids were the dominant species of the macrozoobenthos, and the population density of Oligochaets was higher than that of Chironomid larvae. From the 14 Oligochaet species the Tubifex nowaensis was found in the channel line of Tisza, and *Limnodrilus* species and the *Branchiura sowerbyi* in the coastal zone.

From the 21 Chironomid species, *Chironomus fluviatilis, Harnischia fuscimanus* and *Polypedilum intermedius* were dominant. During the present studies seven new Chironomid species were found in the Hungarian fauna. The numbers of species in the Oligochaet communities of Tisza decreased in the late years, but the Chironomid communities became richer, mainly because of occurence of limnophyl species.

In the influents loaded with sewages (Sajó, Zagyva) only the Oligochaet species remain vital. The influence of industrial and communal sewages results in decrease of invertebrate fauna of Tisza.

Introduction

On behalf of the Main Department of Environmental Protection of National Water Conservancy Office samples were collected from various profiles of Tisza from Tokaj to Szeged between 16—24 September, 1985. The aim of this work was to analyze the changes in the invertebrate fauna of Tisza and the effect of influents on its biocenosis.

The first data on the bottom fauna of Tisza were published by Horváth (1962). The studies on endobenthos were begun by Ferencz. His research served as a basis for identification on the bottom fauna of the Tisza, and at present, several specialists are involved in this work. Due to the research started in 1962 at present there is a very rich collection of data on the bottom fauna of the Tisza. The macrozoobenthos of the Szeged and Kisköre sections of Tisza and that of its influents Maros, Szamos, Bodrog, Sajó and Zagyva are known from the studies of Csoknya and Ferencz (1972, 1975) and Ferencz (1968, 1969, 1974a, 1974b). The Oligochaets are the dominant elements of macrozoobenthos of our rivers (Ferencz 1981), as their individual numbers are higher than that of molluscs and Chironomid larvae in the bottom fauna of Tisza and its influents. Based on studies of horizontal distribution of zoobenthos and of the longitudinal profiles it was stated that the coastal biotops provide more favourable life conditions for the Oligochaets, than the bottom of the main current of the river (Ferencz 1968, 1981). The upper section of the Tisza provides less fa-

vourable conditions for the living organisms than its lower sections because of its strong current and coarser silt. Between its influents the largest population of Oligochaets is found in the Lónyai-channel (1.206 i.m^{-2}), while in the Szamos, Sajó, Körös and Maros there are very thin populations of them.

In the studies of the Tisza, 22 Oligochaet species were found, and nearly all of them belonged to the Tubificids. More than 50% of the individuals belonged to *Limnodrilus hoffemeisteri, L. Claparedeianus, L. udekemianus* and *L. profundicola.*

The data recorded by PUJIN et *al.* (1984) on the lower section of the Tisza in Yugoslavia, showed similar results, and Sporka (1982) also observed dominance of *L. hoffemeisteri* in the river Laborec in Czechoslovakia. This species can be found in very different types of water and silt because of its ecological valency (FERENCZ 1981).

The studies on Chironomid fauna of Tisza have been started and are continued by SZÍTÓ (1973, 1974, 1978, 1981).

Materials and Methods

The sediment samples were taken from 19 profiles of the Tisza and its influents (Figure 1, Table 1). In each profile three samples were taken by means of a modified Ekman dredge of 18×31 cm surface at various distances from the right (1) and left (2) bank, and from the channel line (S). The weight of the empty EKMAN dregde was about 30 kg. This made possible to take sediment samples both from the coastal zone and from the channel line.

The sampling sites are denoted by symbols of three numbers or letters (BANCSI et *al.* 1981). Accordingly the symbol 011 means that the sample was collected in the profile no. 1., near the right bank (Tables 1—3., Figures 1—3.).

In the influents, the sediment samples were collected at 500—1000 m from the mouth. The distance from the bank was determined by the slope of the bank, the water depth, and the structure of sediment (Table 1).

Each sample was placed in a separate dish, then washed in a sieve of 250 μm mesh size, and the living organisms were immediately picked from the remained sediment. For identification a Zeiss made microscope was used, and the organisms were divided into groups of Oligochaets, Chironomids, Molluscs and "other". The worms and the larvae of insects were preserved in 85% alcohol and the Gastropods and Lamellibranchiats in 3% solutions of formalin.

The identifacation of Oligohaets was carried out based on studies of Brinkhurs (1963) and Ferencz (1979), and that of Chironomids on studies of Bíró (1981), Cherenovskii (1949), Lanz (1962) and Pinder et al. (1983).

Results and Discussion

The number of individuals of Oligochaets was generally lower in the sediment samples originating from the channel line of the Tisza, than that in the sediment samples from the coastal zones (Figure 2). The maximum number of individuals was found in the section of Kisköre water reservoir (profile No. 9., i.m^{-2}). Oligochaets were not found in the sediment of the channel line under the Kisköre water reservoir (tailwater, profile No. 11.), and above and under the mouth of Körös (profiles No. 15 and 17.).

In the sediment of left and right banks Oligochaets were always found, except for one case of each bank (profiles No. 15. and 11.). The maximum number of individuals was found in the retained water of Kisköre reservoir of Tisza: 900 i.m^{-2} in the sample collected near the right bank of profile No. 10.

In studies of longitudinal profiles of the Tisza in 1985 14 Oligochaet species were found (Table 2). One species belonged to Naididae, one to Lumbriculidae and 12 to Tubificidae. Compared to studies carried out in 1979 the fauna of Oligochaets decreased in species, as at that time there were 22 species (FERENCZ 1981).

Table 1. *Data of sampling spots (1985)*

Symbol	River	Riv. km	Distance from bank (m)	Depth of water (m)	Water temperature (°C)	Type of sediment
1	2	3	4	5	6	7
001	Tisza		23,0	0,8	14,3	clayey sand
01S	Tisza	556,5	—	7,5	14,3	roug h sand
012	Tisza		15,0	3,5	14,3	clayey sand
021	Bodrog		15,0	2,5		deep clayey
02S	Bodrog	1,0	—	4,0	15,4	deep clayey
022	Bodrog		15,0	4,0		deep clayey
031	Tisza		30,0	12,5		fine sand
03S	Tisza	518	—	12,5	14,8	fine sand
032	Tisza		30,0	7,5		fine sand
041	Tisza		15,0	6,5		fine sand
04S	Tisza	497	—	8,0	15,0	rough sand
042	Tisza		10,0	6,0		fine clay
051	Sajó	1,0	5,0	3,0		fine clay
05S	Sajó	1,0	—	3,0	16,6	gravel
052	Sajó		2,0	1,0		gravel
061	Tisza		12,0	3,0		gravel
06S	Tisza	495	—	7,0	21,0	gravel
062	Tisza		30,0	0,6		gravel
071	Tisza		10,0	5,8		sandy clay
07S	Tisza	468	—	5,8	17,0	rough sand
072	Tisza		10,0	4,5		fine sand
081	Tisza		25,0	4,0		clayey
08S	Tisza	439	—	9,1	16,5	rough sand
082	Tisza		13,0	8,1		clay and sand
091	Tisza	15	10,0	4,0		clay
09S	Tisza	145	—	10,5	17,0	clay
092	Tisza	415	13,5	6,0		clay with lots of organic matter
101	Tisza		25,0	7,0		clayey sand
10S	Tisza	406	—	10,5	18,5	fine and rough sand
102	Tisza		30,0	7,0		clayey sand
111	Tisza		15,0	2,0		rough sand
11S	Tisza	390	—	15,0	16,5	fine sand
112	Tisza		15,0	1,6		fine sand
121	Tisza		6,0	2,0		fine sand
12S	Tisza	336	—	10,0	17,5	rough sand
122	Tisza		15,0	1,5		fine sandy clay
131	Zagyva	0,5	1,0	0,5	17,5	clay
13S	Zagyva	0,5	—	1,5	17,5	clay
132	Zagyva	0,5	0,6	0,4	17,5	clay
141	Tisza		0,6	3,0		fine sand
14S	Tisza	320	—	9,5	18,0	fine sand
142	Tisza		12,0	5,5	18,0	clay
151	Tisza		7,0	4,0		fine sand
15S	Tisza	245	—	8,0	18,2	rough sand
152	Tisza		20,0	8,5		rough sand
161	H-Körös		12,0	7,5		fine sand
16S	H-Körös	1,0	—	9,5	18,8	fine sand
162	H-Körös		6,0	3,5		fine sand
171	Tisza		7,0	3,0		fine sand and clay
17S	Tisza	239	—	4,0	18,0	find sand
172	Tisza		7,0	1,5		fine sand
181	Maros	1,0	10,0	0,8		fine sand
18S	Maros	1,0	—	3,0	18,3	fine sand
182	Maros	1,0	4,0	2,5		rough sand
191	Tisza	174,0	7,0	1,0		clayey, deep, reduced
19S	Tisza	174,0	—	3,5	18,8	rough sand
192	Tisza	174,0	5,0	1,0		clayey sand

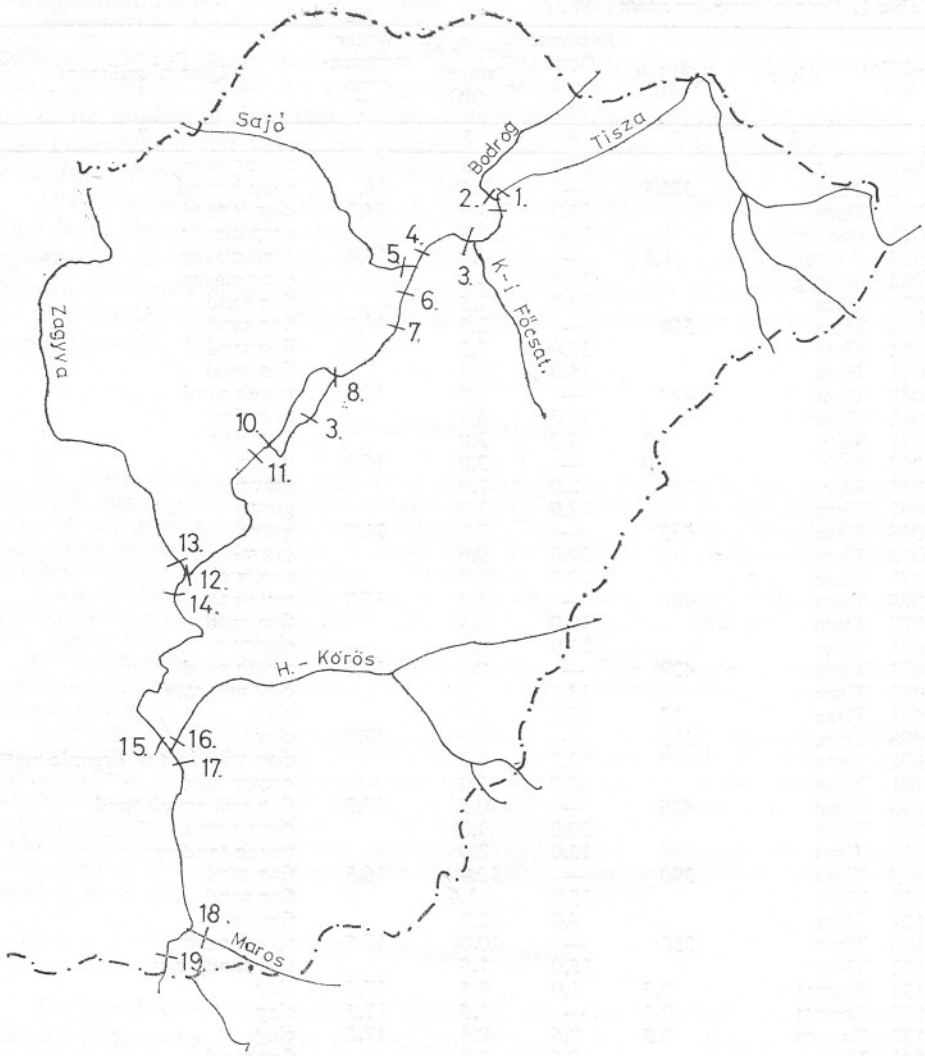
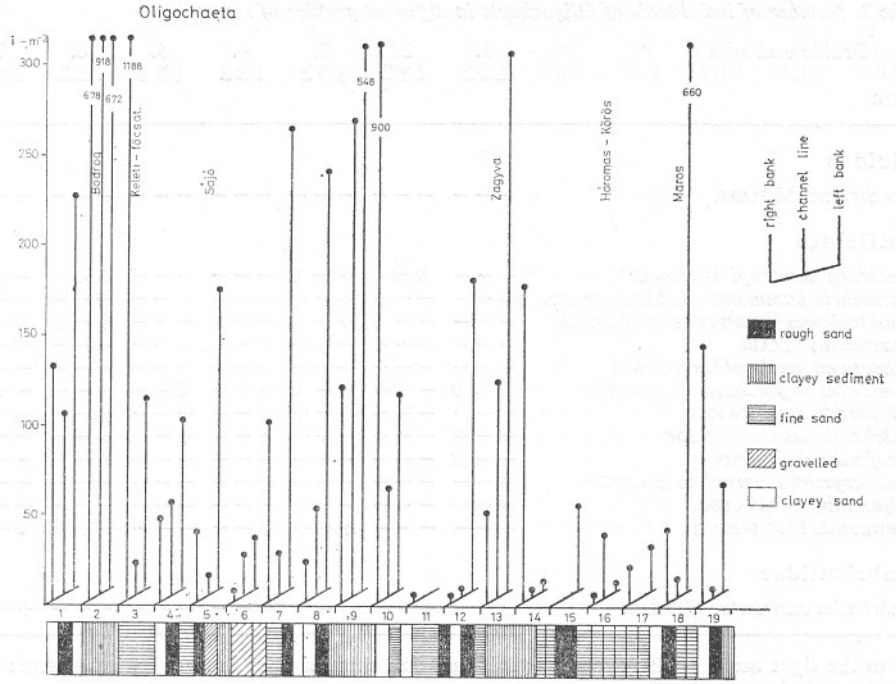


Figure 1. Sampling spots of sediment analyses in 1985

The *Limnodrilus* species were found both in the coastal zone and in the channel line of the studied river section, but the *L. hoffmeisteri* showed the highest population. The *Tubifex newaensis* was also found everywhere except for one sampling spot of the Tisza. The *Branchiura sowerbyi* appeared in the retained section of the Tisza and in the region of Kisköre reservoir it formed very high population density together with *Potamothrix moldaviensis* and *P. hammoniensis* (profiles No. 8. and 10).

Based on a comparison of the results of longitudinal profile studies in 1979 (FERENCZ 1981) and in 1981 (Table 2) it was stated that the Oligochaet fauna of the Tisza was poorer in species, but the population density increased. The *L. hoffmeisteri* remained dominant (Table 2).



Figu re 2. Individual number of Oligochaets in the Hungarian section of Tisza

The region of the mouth of influent Bodrog (profile No. 2.) was rich in Oligochaets (672—918 i.m^{-2}) and both in the coastal zone and in the channel line the B. sowerbyi was the dominant species (Table 2). Near the right bank of the Easteren Main Channel (profile No. 3.) the sediment contained 1.188 individuals per m^2, and the *L. hoffemeisteri* was the most frequently found. The Oligochaet fauna of Sajó was as poor as in 1979 (profile No. 5., Table 2), similar to the mouth of Hármas-Körös (profile No. 16.). Concerning the influents Zagyva (profile No. 18.), the coastal zone of their left bank showed higher population density (Table 2) and dominance of *Limnodrilus* species.

The influents Sajó and Zagyva are loaded with industrial and communal sewage, which results in negative effects on living organisms, especially in the region of the Tisza under the mouths of these influents (profiles No. 6., 14., and 15.). Some authors are of the opinion that the quality of water influences the species composition of Oligochaets only indirectly through the bottom (KORN 1963) and the bottom quality has got decisive role in it (WACHS 1967, PAOLETTI and SAMBUGAR 1984). The clayey sediment makes possible a higher number of individuals, than the gravelly, sandy sediment (Table 2). In general the population density of Chironomid larvae was higher in the coastal zones, than near the channel line, but there were found some discrepancies, too (profiles No. 1., 3., 6., 7., 10., 11. and 18.). The nutrient supply may influence the dispersion, as it has been stated by HILSENHOFF (1967). As the water movement is slower in the coastal zone, the settling of floating materials and organic matters is faster.

The importance and scale of drift is emphasized by GEE (1984). Based on our

Table 2. *Number of individuals of Oligochaets in different profiles of rivers*

Taxon \ Profile and spot	1. 1 S 2	2. 1 S 2	3. 1 S 2	4. 1 S 2	5. 1 S 2	6. 1 S 2	7. 1 S 2
Naididae							
Dero digitata MÜLLER	– – –	– – –	– – –	– – –	– – –	– – –	– – –
Tubificidae							
Branchiura sowerbyi BEDDARD	– – –	0 0 0	+ – 0	– – –	– – –	+ + –	– – –
Potamothrix hammoniensis MICHAELSEN	+ – –	– – +	+ – +	– – –	+ – –	– – –	+ – +
P. moldaviensis VEJDOVSKY et MRAZEK	– – –	– – 0	+ + +	– + +	– – –	+ – +	0 + +
P. isochaetus HRABE	– – –	– – –	– – +	– – –	– – –	– – –	+ – +
Isochaeta michaelseni LASTOCKIN	– – –	– – –	– – +	– – –	– – –	– – –	– – –
Limnodrilus hoffmeisteri CLAPAREDE	0 0 0	– 0 +	+ – 0	+ + +	0 + +	– – –	– + –
L. claparedeianus RATZEL	+ – –	– – –	+ – +	– – –	– – –	– – –	– – –
L. udekemianus CLAPAREDE	– – +	– – +	– – –	+ – –	+ – –	– – –	– – +
L. profundicola VERRIL	– – 0	– – –	– – –	– – –	– – –	– – –	– – –
Psammoryctides moravicus HRABE	– – –	– – –	– – +	– – –	– – +	– – –	– – –
Tubifex tubifex MÜLLER	– + –	– – –	– – +	– – –	– – –	– – –	+ – –
T. newaensis MICHAELSEN	+ – –	– – –	+ – +	+ – –	– – –	– + –	0 – +
Lumbriculidae							
Lumbriculus variegatus MÜLLER	– – –	– – –	– – –	– – –	– – –	– – –	+ – –

Key to the signs used: 1—19: Profile; 1: left bank; S: channel line; 2: right bank; Absent: —; Found: +; in large mass: 0

Table 3. *Number of individuals of Chironomids in different profiles of rivers*

Taxon \ Profile and spot	1. 1 S 2	2. 1 S 2	3. 1 S 2	4. 1 S 2	5. 1 S 2	6. 1 S 2	7. 1 S 2
Tanypodinae							
Procladius choreus MEIGEN	+ + +	+ – +	+ – +	– – –	– – –	– – –	– – –
Tanypus punctipennis MEIGEN	– – –	– – –	– – –	– – –	– – –	– – –	– – –
Chironominae							
Chironomini							
Ch. aprilinus MEIGEN	– – –	– – –	– – –	– – –	– – –	– – –	– – –
Ch. fluviatilis LENZ	– + +	– – –	– – +	– – –	– – –	– – –	– – –
Ch. plumosus LENZ	– – –	– – –	– – –	– – –	– – –	– – –	– – –
Ch. reductus LIPINA	– – –	– – –	– – –	– – –	– – –	– – –	– – –
Ch. riparius MEIGEN	– + –	– – –	– – –	– – –	– – –	– – –	– – –
Ch. semireductus LENZ	– – +	– – –	– – –	– – –	– – –	– – –	– – –
Cryptochir defectus KIEFFER	– – –	– – –	– – –	– – +	– – –	– – –	– + –
Einfeldia dissidens WALKER	– – –	– – –	– – –	– – –	– – –	– – –	– – –
Endochir signaticornis KIEFFER	– – –	– – –	– – –	– – –	– – –	– – –	– – –
Glyptotend. fodiens KIEFFER	– – –	– – –	– – +	– – –	– – –	– – –	– – –
Harnischia fuscimanus KIEFFER	– – –	– + –	+ – +	– – –	– – –	– – –	+ + –
Limnochir. nervosus STAEG.	– – –	– – –	– – –	– – –	– – –	– – –	– – –
Microchir. conjugens KIEFFER	– – –	– – –	– – –	– – –	– – –	– – –	– – –
M. tener KIEFFER	– – –	– – –	– – –	– – –	– – –	– – –	– – –
Paratend. connectens LIPINA	– – –	– – –	– – –	– – –	– – –	– – –	– – –
P. intermedius TSH.	– + –	– – –	– + –	0 – –	– – –	– + +	– 0 –
Polyped. breviant. TSH.	– – –	– – –	– – –	– – +	– – –	– – –	– – –
P. sclaenum SCHRANK	– – –	– – –	– – –	– – –	– – –	– – –	– – –
Thienemannimyia northumbrica EDWARDS	– – –	– – –	– – +	– – –	– – –	– – –	– – –

Key to the signs used: 1—19: Profile; 1: left bank; S: channel line; 2: right bank; Abs t: –; Found: +; in large mass: 0.

8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2
− − −	− − −	+ − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −
0 − +	+ 0 0	+ + 0	− − −	+ − −	− − +	− − −	− − −	+ − −	+ − −	− − −	+ − 0
+ − −	0 + +	+ − −	− − −	− − −	− + +	− − +	− − −	− − −	− − −	− − −	− − +
+ + −	− 0 +	0 + 0	− − −	+ − −	− − −	− − +	− − −	− − +	− − −	+ − −	− + +
+ − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −
− − −	− − −	− + −	− − −	+ − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −
+ − +	+ + −	+ − +	− − −	+ − −	0 + +	− + +	− − −	− + −	− − −	0 + −	+ − +
− − −	− − −	− − 0	− − −	− − −	+ + +	− − −	− − −	− − −	− − −	− − −	+ − −
+ − −	+ + +	− − −	− − −	− − −	+ + −	+ − 0	+ − −	+ + −	− − −	+ − −	+ − +
− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	+ − −	− − −
+ − −	− − −	− − −	− − −	− − −	+ + +	− − −	− − −	− − −	− − −	− − −	− − −
− − −	− − −	− − −	− − −	− − −	− − −	− − +	− − −	− − −	− − −	+ − −	− − −
+ + −	− + −	+ + −	− − +	+ + +	− − −	+ + +	+ − −	− + −	+ − +	− − +	− − −
− − −	− − −	− − −	− − −	− + −	− − −	− − −	+ − −	− − −	− − +	− − −	− − −

8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.
1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2	1 S 2
− − −	− − +	− − +	− − −	− − −	+ − −	− − −	− − −	− − −	− − −	− − −	− − −
− − −	− + −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −
− − −	− − −	− − −	− − −	− − −	− + −	− − −	− − −	− − −	− − −	− − −	− − −
− − −	− − −	− − −	− + −	− − +	0 0 +	− + +	− − +	− − −	− − −	+ − −	− − +
− − −	− − −	− − +	− − −	− − +	− − −	− − −	− − −	− − −	− − −	− − −	− − −
− − −	− − −	− − −	− − −	− − −	− + −	− − −	− − −	− − −	− − −	− − −	− − −
− − −	− − −	− − −	− − −	− − −	+ + −	− − −	− − −	− − −	− − −	− − −	− − −
− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	+ + +	− − −
− − −	− − −	− + −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −
− − −	− − −	− − −	+ − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −
− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −
0 + −	− + +	− − −	− + −	− − −	+ + −	− − −	− + +	− − −	− − +	− + −	− − −
− − −	− − −	− − +	+ − +	− − −	− − −	− − −	− − −	− − −	− − −	− − −	+ − −
− − −	− − −	− + −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −
− − −	− − −	− − −	− − −	− − −	+ − −	− − −	− − −	− − −	− − −	− − −	− − −
− − −	− − −	− − −	− − +	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −
+ + −	− − −	− − −	+ − −	− − −	− − −	− − −	− − −	− − −	− − +	− + −	− − −
− − −	− − −	− − −	− − −	+ − −	− − −	− − −	− − −	− − −	− − −	+ + +	− − −
− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− + −	− − −
− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −	− − −

data it is remarkable that the number of individuals of different groups of organisms have not increased significantly downstream. It can be explained with the fact that the water-level is low. The number of individuals of invertebrates is also influenced by the substrate quality (PERCIVAL and WHITEHEAD 1926, ZWICK 1984). Our data show that the population density of Oligochaets was high in all the sampling spots, where the sediment consisted of fine sand, clay or clayey sand (Figures 2—3).

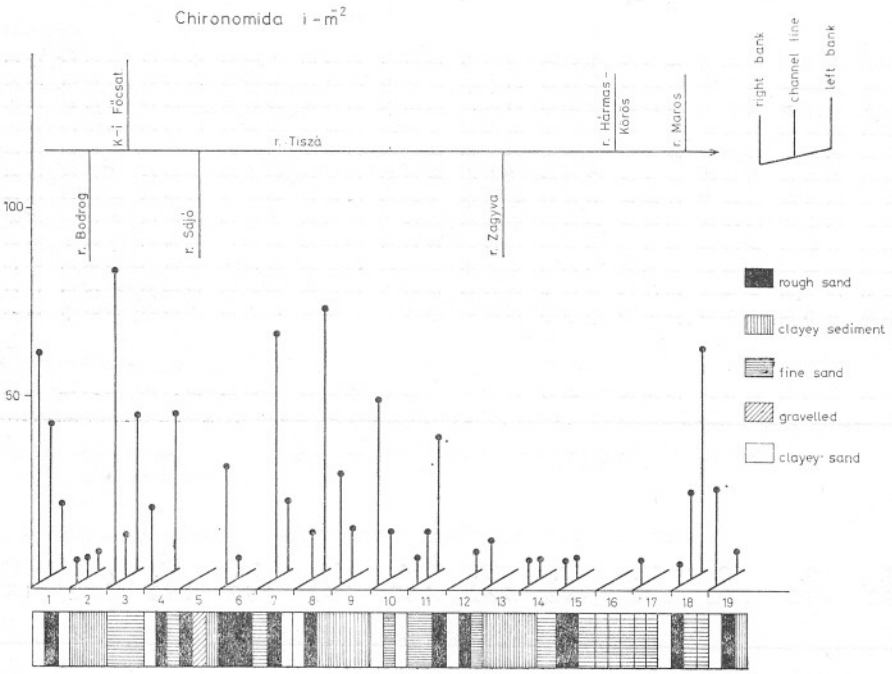


Figure 3. Individual number of Chironomids in the Hungarian section of Tisza

In the present study 21 Chironomid species were found, two of them were predators, and the rest were phytophagous. The individual number of larvae was 0—113, but they were not found in the mouths of Sajó and Körös. Certainly the reason was the naturally low number of individuals (Szító 1981).

The species *Chironomus fluviatilis, Harnishcia fuscimanus* and *Paratendipies intermedius* were found everywhere in the river Tisza, and in some profiles these species were dominant (Table 3).

Compared to data of longitudinal profiles analyzed in 1979, the number of species of Chironomids increased from 14 to 21. But the earlier dominant *Polypedilum nubeculosum* (gr.) disappeared, and the subdominant *Chrypto chironomus* (defectus) was found only in some profiles and its population density was low. Appearance of new *Polypedilum* species in the Tisza is thought to be the result of the five years long drought as during this period the water level of Tisza was constantly low. This situation made possible the appearance of species euryök (lymnophyl, perlorheophyl species) in the Tisza, but their appearance can be also supported by the influences of the two dams constructed on the Tisza (near Tiszalök and Kisköre). Our

statement is supported by the fact, that dominance of *Chironomus fluviatilis* characteristic for the rivers, was found to be significant in some profiles, but similar situation was found with *Harnischia fuscimanus* and *Paratendipes intermedius* species, characteristic for stagnant waters (Table 3). Based on these observations it can be stated that in the low water periods during the vegetation season the Chironomid fauna of the river is transformed significantly. Such changes are speeded up by the effects of dams and the lymnophyl fauna is replaced with rheophyl one. In the sediment samples taken from the channel line of Tisza, both species were found in high individual number, which points to their high level adaptability.

During these studies some new Chironomid species were found in the Hungarian fauna. They are the following: *Einfeldia dissidens, Glyptotendipes fodiens, Harnischia fuscimanus, Paratendipes connect, Polyediulum breviantennatum, Polypedim scalaenum, Thienemannimyia northenshumbrica.* The invertebrate faunae of the Tisza in the retained water section were found to be the richest over the dam. But the communal and industrial sewages of towns Szolnok and Martfű flowing into influents Sajó and Zagyva reduce the invertebrate fauna.

Near the clayey banks of the river one larva of *Palingenia longicauda* (Ephemeroptera) and in the sampling spots of deep silt one larva of *Aeschna affinis* and *Libellula depressa* (Odonata) were found in each profile from Tokaj to Szeged. They were not found in the mouth of influents.

The molluscs were found first near the mouth of the river Bodrog *(Unio pictorum, Valvata piscinalis, Lythoglyphus naticoides)*, where they were also found earlier (B. Tóth et *al.* 1981). But in the mouths of influents they were not found.

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A Tisza és mellékfolyói makrozoobentosza

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Kivonat

A Tisza vizsgált szakaszán a makrozoobentoszban az *Oligochaeta* és *Chironomida* fajok domináltak, az *Oligochaeta* egyedsűrűség általában meghaladja a *Chironomida* lárvákét.

A 14 *Oligochaeta* faj közül a Tisza sodorvonalában a *Tubifex newaensis*, a parti régiókban a *Limnodrilus* fajok és a *Branchiura sowerbyi* a leggyakoribbak.

A 21 *Chironomida* faj közül dominánsak a *Chironomus fluviatilis*, a *Harnischia fuscimanus* és a *Polypedilum intermedius*. A vizsgálat során hét, Magyarország faunájában új *Chironomida* faj fordult elő.

A Tisza *Oligochaeta* faunája az utóbbi években fajszegényebb, a *Chironomida* fauna elsősorban a limnophil fajok megjelenése miatt gazdagabb lett.

A szennyvizekkel terhelt mellékfolyókban (Sajó, Zagyva) csak az *Oligochaeta* egyedek élnek meg. Az ipari és kommunális szennyezés hatása a Tisza gerinctelen élővilágának szegényedésében tükröződik.

Макрозообентос Тисы и ее притоков

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Резюме

В анализированном отрезке Тисы в макрозообентосе доминировали виды Oligochaeta, Chironomida, концентрация особи Oligochaeta превышает концентрацию личинок Chironomida.

В быстрине Тисы из 14 видов Oligochaeta их самые частные Tubifex newaensis, а в районе берега виды Limnodrilus и Branchiura sowerbyi.

Из 21 Chironomida доминирующие *Chironomus fluviatilis*, *Harnischia fuscimanus*, *Polypedilum intermedius*. При анализе найдены 7 новых в фауне Венгрии видов Chironomida. Фауна Oligochaeta Тисы в последние годы беднеет, в то время как фауна Chironomida обогащается появлением видов limnophil.

В притоках вместе со сточными водами Шайо, Задьва выживалит только особи Oligochaeta. Влияние промышленного и коммунального загрязнения отражается в обеднении беспозвоночных организмов Тисы.

Makrozoobentos Tise i njenih pritoka

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Abstrakt

U makrozoobentosu na istraživanoj deonici Tise dominiraju Oligochaeta i Chironomida, pri čemu gustina larava Oligochaeta nadmašuje larve Chironomida. Od 14 vrsta Oligochaeta *Tubifex nowaensis* je najfrekventniji u matici reke, dok u priobalnoj zoni dominiraju vrste roda Limnodrilus i *Branchiura sowerbyi*. Od 21 vrsta Chironomida dominantne su: *Chironomus fluviatilis*, *Harnischia fuscimanus* i *Polypedilum intermedius*. Konstatovano je 7 novih vrsta Chironomida za faunu Madjarske.

Fauna Oligochaeta Tise zadnjih godina pokazuje opadanje vrsta nasuprot Chironomida, koja se pre svega zbog pojave limnofilnih vrsa obogaćuje.

U pritokama Sajó i Zagyva, opterećenim otpadnim vodama, žive samo Oligochaeta. Uticaj industrijskog i komunalnog zagadjenja reflektuje se u osiromašenju beskičmenjačkih predstavnika reke Tise.