COMPARATIVE DATA ON THE COMPOSITION OF ZOOPLANKTON IN THE PART OF THE RIVER DANUBE AND THE RIVER TISZA IN VOJVODINA (YUGOSLAVIA)

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Abstract. In the period 1987-1989 comparative examinations were conducted on the composition of zooplankton in Danube and Tisza on several localities. In the composition of zooplankton of these two rivers, a total number of 187 species and varieties were ascertained, out of which 31 *Protozoa*, 119 *Rotatoria*, 26 *Cladocera* and 11 *Copepoda*. The number of species in Danube was higher than the number of species ascertained in Tisza and we also observed differences depending on locality, that could be attributed to a great extent to the antropogenic influences. *Rotatoria* represent in both water currents the most diverse group, where most emphasized are genera *Brachionus*, *Keratella*, *Cephalodella*, *Colurella*, *Lecane* and *Trichocera*. On the basis of similarity index according to Sørensen (1948), the dendrograms show two complexes, one in Danube and the other in Tisza, which are linked through a locality downstream from the mouth of Tisza into Danube. The saprobity index according to Pantle and Buck (1955) in Danube, through all three years, indicates a betamesosaprobic pollution stage, while in Tisza in most cases a betaalfamesosaprobity.

Keywords: Antropogenic influence, clustering method, dendrogram, saprobity index, Sørensen similarity index.

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Introduction

Although hydrobiological researches in the Danube and Tisza were conducted for many years, there are not many works relating to comparative data for these two rivers. We recently carried out only a few works (Dobler and Schmidt, 1980; Tevanné Bartalis, 1987; Pujin et al. 1990).

Since these mostly relate to the composition of phytoplankton, the aim of this work is to give a comparative survey of zooplankton composition.

Material and methods

The examinations included the period 1987-1989. Samples were taken in monthly intervals in 6 localities: Bezdan (1), Novi Sad (2), Novi Banovci (3) by the river Danube, and Martonos (4), Novi Becej (5) and Titel (6) by the river Tisza, respectively. The material was collected with a plankton net No. 25 made of mill silk (nylon) and treated partially live, partially in fixed state (in 4% formalin). In order to establish the similarity, the index according to Sørensen (1948) was calculated, while the link is shown on dendrograms. Clustering method was made according to Sneath and Sokal (1973).

Results and discussion

During the examined period, a total number of 187 species and varieties were ascertained in the composition of zooplankton, out of which there were 31 *Protozoa*, 119 *Rotatoria*, 26 *Cladocera* and 11 *Copepoda* (Tab. 1.). Composition of zooplankton was slightly more diverse in Danube (total of 172 species and varieties), although there were differences depending on the locality. The highest number of species were ascertained at Bezdan (158), less at Novi Banovci (120) and the smallest number at Novi Sad (116). A total of 131 species and varieties was ascertained in Tisza, out of which 29 *Protozoa*, 82 *Rotatoria*, 17 *Cladocera* and 10 *Copepoda*. Here, the differences in relation to localities were also evident. So, 101 species were ascertained at Martonos, only 66 at Novi Becej, and 91 at Titel. We explain this by the influence of pollution brought through the canal Becej-Vrbas

at Novi Becej and by Begej which streams in Tisza at Titel.

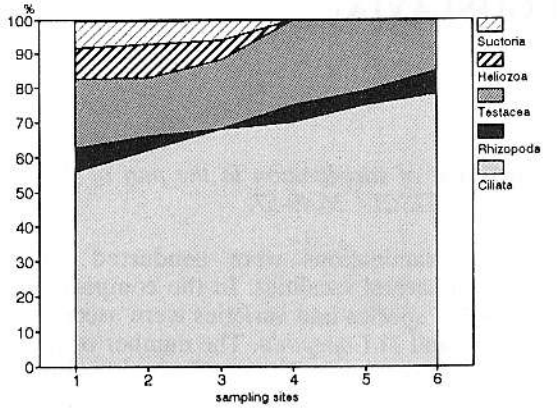

Fig. 1. Average percentage presence values of particular *Protozoa* groups in the Danube and Tisza (1987-1989).

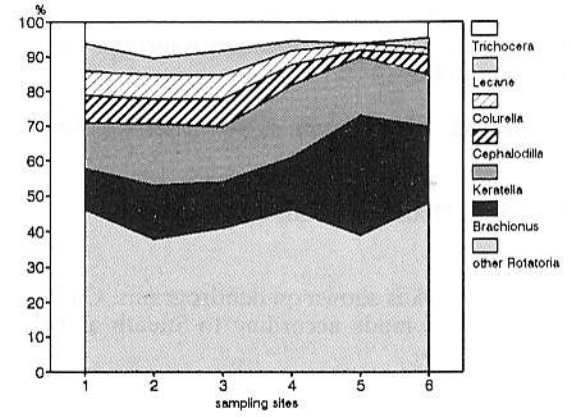

Fig. 2. Average percentage presence values of particular *Rotatoria* genera in the Danube and Tisza (1987-1989).

If we compare the composition of zooplankton in Danube and Tisza with earlier results, we can notice some differences. So for example, the differences in Danube are not so noticeable regarding the number of species as in the represented species. So Zivkovic (1987), on the basis of researches conducted in the period 1947-1963 and 1965-1973, has ascertained a total of 129 species and varieties of *Rotatoria* with 68% of typical plankton species, while the rest was mainly phytophil and met rarely and individually. This relates especially to the genus *Trichocera*, whose species are mainly represented among the macrovegetation in more still waters. According to this author, the same were mainly represented as individual samples, but now they appear more and more in some localities in Danube, and also in larger numbers (Pujin 1988, 1989, 1990; Pujin et al 1987, 1990 a, 1990 b).

These differences in Tisza are even more drastic. Kalafatic et al. (1982) ascertained in Tisza about 60 zooplankton species. This number was mainly maintained until 1979 (Pujin et al. 1984; Pujin and Ratajac 1983), to be of larger later, especially *Rotatoria* which we connect with the construction of a dam at Novi Becej and the influence of the HE Power Project Djerdap, affecting not only the mouth of Tisza into Danube, but also felt in Novi Sad (Pujin 1985; Kojcic et al. 1989; Pujin et al. 1990).

In relation to other groups, for example *Crustacea*, no essential changes were found (Ratajac and Rajkovic, 1985). In relation to the participation of particular groups in the composition of zooplankton, there are also some differences. So in the composition of *Protozoa*, the main components are *Ciliata*, participation of which ranges from 57.3% to 77.8% (Fig. 1), then *Testacea* (16.7%-25%). Only these two groups of *Rhizopoda-Protozoa* were represented in Tisza, while in the Danube we ascertained also *Helizoa* and *Suctoria*. As it was already mentioned, *Rotatoria* represent the most diverse group in the composition of zooplankton in these two rivers. These are the genera *Brachionus, Keratella, Cephalodella, Colurella, Lecane* and *Trichocera*. Their percentage participation varies depending on the locality (Fig. 2).

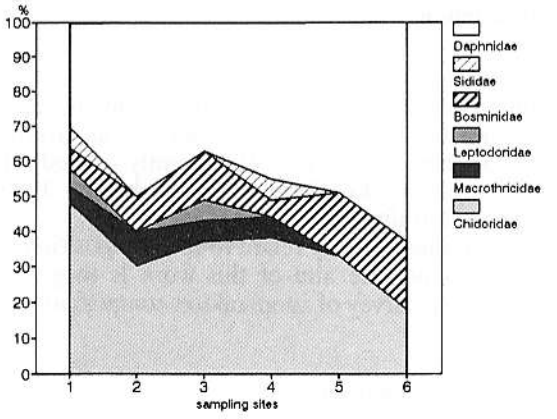

Fig. 3. Average percentage presence values of particular *Cladocera* families in the Danube and Tisza (1987-1989).

According to the earlier researches, the genera *Brachionus* and *Keratella* played an important role in the composition of zooplankton. An important place was taken also by the genera *Polyarthra*, *Synchaeta* (Zivkovic 1987; Pujin 1982, 1988; Pujin et al. 1987) and *Asplanchna*. Concerning the composition of *Cladocera*, the main components

are the families *Daphnidae* and *Chydoridae* (Fig. 3), which vary depending on the locality. The similar composition of *Cladocera* and *Copepoda* was also ascertained in Danube and Tisza by Ratajac (1987) and Ratajac and Rajkovic (1985), which means that up to now antropogenic actions did not considerably influence these groups. Analyzing dendrograms for particular groups, we noticed that for *Protozoa* and *Rotatoria* more mutual similarity was shown on localities in Danube as well as in Tisza (Fig. 4).

The dendrograms of *Cladocera* and *Copepoda* show rather uniform index at all localities in relation to loc. 5 (Novi Becej), where the similarity index is much lower (Fig. 5). This can be attributed to the influence of canal Becej-Vrbas, which affects this group by its pollution. Analyzing the saprobity index according to Pantle and Buck (1955), obtained on the bases of represented zooplankton species and their relative abundance, we can see that in all the three examined years in Danube, the values were lower, indicating betamesosaprobity, while in Tisza the indexes indicated beta-alfamesosaprobity (Fig. 6). Contrary to our data, Dobler and Schmidt (1980) indicate on the basis of represented phytoplankton species that Danube is more polluted than Tisza. The causes of this are probably different sampling periods, since also in our earlier investigations we established saprobity index values in Tisza within the limits of betamezosaprobity, which in recent years are deteriorating (Stanojevic and Pujin 1973; Pujin and Stajonevic 1979; Pujin and Rajkovic 1979).

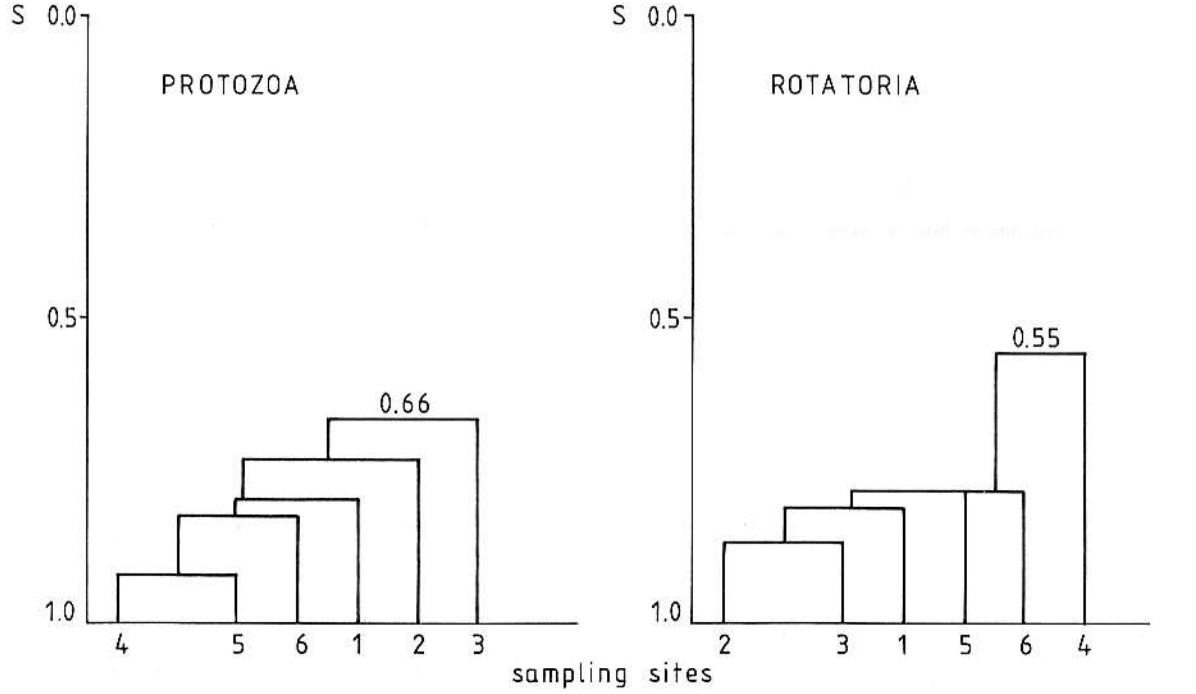

Fig. 4. Dendrograms at different sampling sites. Danube: 1-Bezdan, 2-Novi Sad, 3-Novi Banovci; Tisza: 4-Martonos, 5-Novi Becej, 6-Titel.

Conclusions

On the basis of comparative examinations of the zooplankton composition in the part of Danube and Tisza in Vojvodina (Yugoslavia), the following could be concluded:

In the period 1987-1989, a total number of 187 species and varieties were ascertained in these two rivers, out of which 31 *Protozoa*, 119 *Rotatoria*, 26 *Cladocera* and 11 *Copepoda*. The number of species in Danube was higher (172) than that in Tisza (131), differences were also observed

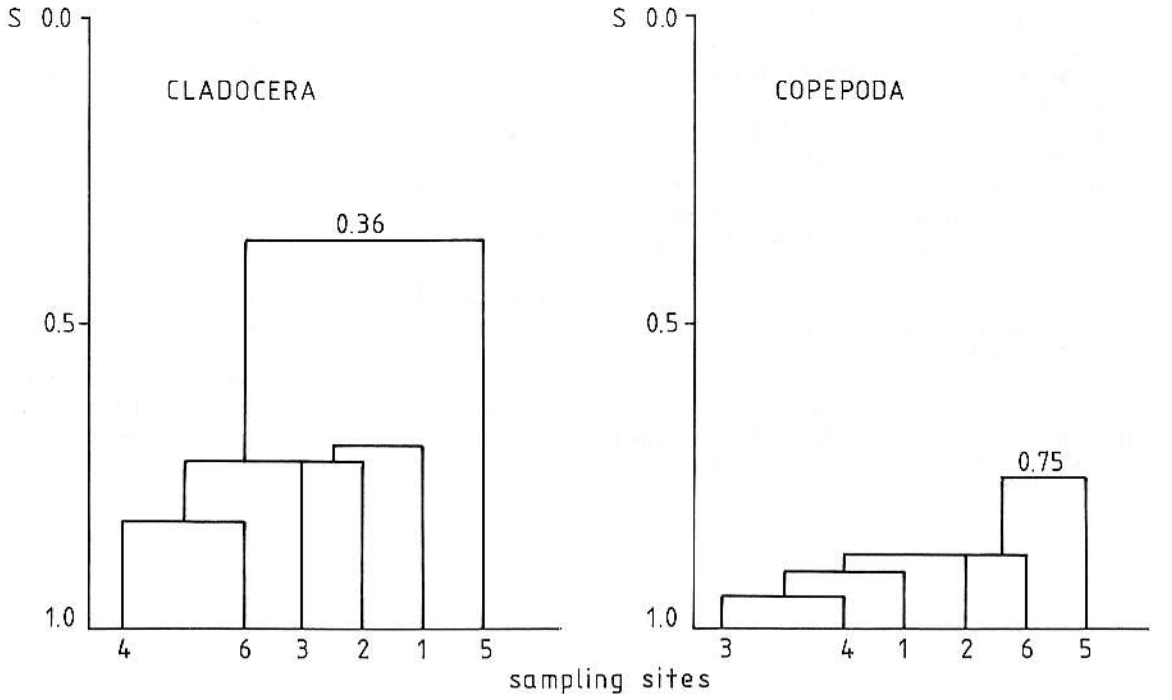

Fig. 5. Dendrograms at different sampling sites. Danube: 1-Bezdan, 2-Novi Sad, 3-Novi Banovci; Tisza: 4-Martonos, 5-Novi Becej, 6-Titel.

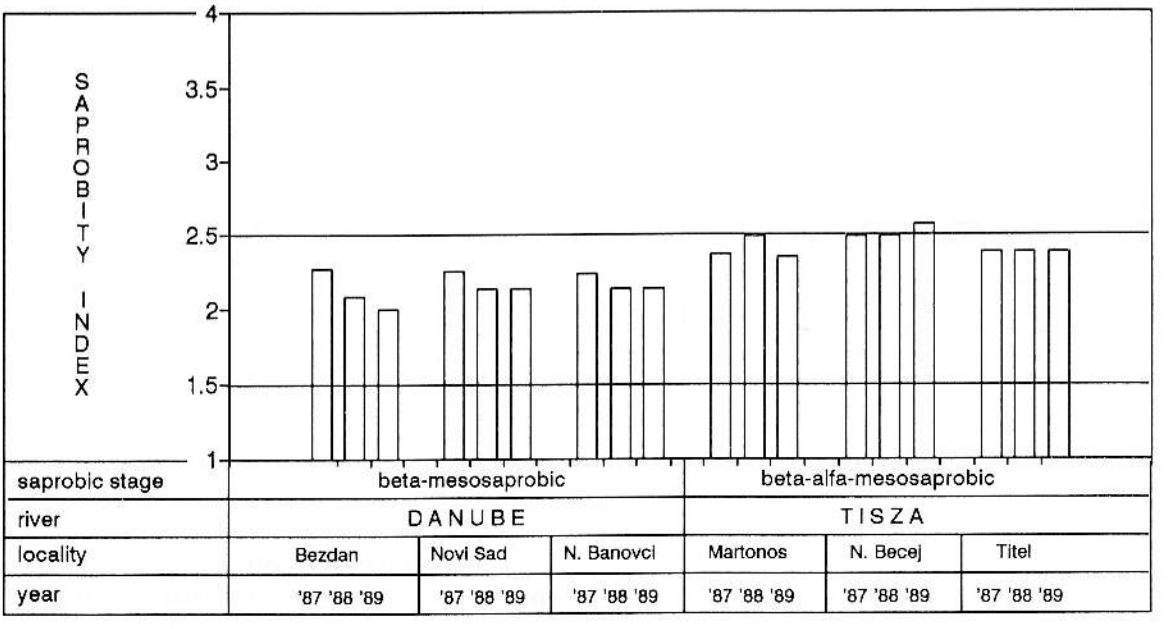

Fig. 6. Saprobity index of the Danube and Tisza (1987-1989) according to Pantle and Buck (1955)

depending on localities, that could to a great extent be connected to antropogenic influence of hydrotechnical actions and pollution.

Rotatoria represent the most diverse group in both water currents, among which especially emphasized are genera *Brachionus, Keratella, Cephalodella, Colurella, Lecane* and *Trichocera*.

On the basis of similarity index according to Sørensen (1948), the dendrograms indicate two complexes when in question are *Protozoa*, *Rotatoria* and *Cladocera*, which are linked through localities downstream the mouth of Tisza into Danube. The composition of *Copepodas* is similar.

The saprobity index according to Pantle and Buck (1955) indicates a betamesosaprobity grade of pollution in Danube in all three years, while that is beta-alfamezosaprobic in many cases for Tisza.

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APPENDIX

Tab.1. Qualitative composition of Zooplankton in the Vojvodina section of the river Danube and the River Tisza (1987-1989) Danube: 1.Bezdan, 2.Novi Sad, 3.Novi Banovci, Tisza: 4.Martonos, 5.Novi Becej, 6.Titel

Species	Localities					
	DANUBE			TISZA		
	1.	2.	3.	4.	5.	6.
PROTOZOA						
Actinophris sol EHR.	+	+				
Actinosphaerum eichorni EHR	+	+	+			
Acineta sp. EHR.	+					
Amoeba verrucosa EHR.	+	+				
A.vulgaris EHR.	+			+	+	+
Aspidisca costata (DUJARDIN) CI.L.	+	+		+	+	+
Carchesium polypinum L.	+	+	+	+	+	+
Centropyxis aculeata STEIN	+	+		+	+	
C.discoides EHR.	+			+	+	+
Chilodonella cuculus O.F.M.	+	+			+	+
Ch.uncinata EHR.	+			+	+	+
Colpidium colpoda (EHR.) STEIN	+	+		+	+	+
Difflugia corona WALLICH	+	+	+			
D.limnetica LEVANDER	+	+	+	+	+	+
Didinium nasutum O.F.M.	+	+				
Dileptus anser O.F.M.			+			
Epistylis plicatilis EHR.			+	+	+	
Lembus pusillus QUENNERSTEDT	+	+				
Paramecium aurelia EHR.	+	+	+	+	+	+
P.bursaria (EHR.)	+		+	+		+
P.caudatum EHR.	+	+	+	+	+	+
P.trichium STOCKES				+	+	+
Stylonychia mytilus EHR.	+			+	+	+
Tintinnidium fluviatile KENT	+	+	+	+	+	+
Tintinnopsis lacustris ENTZ	+	+	+	+	+	+
Tokophrya quadripartita CLAP.et LACH.	+	+	+			
Vorticella campanulata EHR.	+	+	+	+	+	+
V.convalaria (L.) HOLAND	+	+	+	+	+	+
V.microstoma EHR.	+	+	+		+	+
ROTATORIA						
Anureopsis fissa (GOSSE)	+	+	+	+	+	+
Ascomorpha agilis ZACHARIAS	+					
A.ovalis (BERGENDAHL)	+	+				
Asplanchna brightwelli GOSSE	+	+	+	+	+	+
A.girodi DE GUERNE	+	+		+		+
A.herricki DE GUERNE	+	+	+	+		+
A.priodonta GOSSE	+	+	+	+	+	+
A.sieboldi (LEYDIG)	+		+	+		+
Brachionus angularis GOSSE	+	+	+	+	+	+
B.angularis f.bidens PLATE	+	+		+		
B.bidentata f.inermis (ROUSS.)	+	+				+
B.budapestinensis DADAY	+	+	+	+	+	+
B.calyciflorus PALLAS	+	+	+	+	+	+
B.calyciflorus f.anureiformis BREHM	+	+	+	+	+	+
B.calyciflorus f.amphyceros EHR.	+	+	+	+	+	+
B.diversicornis DADAY	+	+	+	+	+	+
B.falcatus ZACHARIAS					+	+
B.forficula (WIERZEJSKI)				+	+	+

Species	Localities					
	DANUBE				TISZA	
	1.	2.	3.	4.	5.	6.
B.leydigi COHN	+	+	+	+		+
B.patulus (O.F.M.)	+		+		+	
B.plicatilis MULLER				+	+	
B.urceolaris (O.F.M.)	+	+	+	+	+	+
B.urceolaris v.rubens EHR.	+	+	+	+	+	+
Cephalodella auriculata (MULLER)	+	+	+	+		+
C.catellina (MULLER)	+	+	+	+		+
C.eva (GOSSE)	+		+			
C.exigua (GOSSE)	+					
C.forficula (EHR:)	+	+	+	+		
C.gibba (EHR.)	+	+	+	+	+	+
C.gracilis EHR.	+	+	+	+		+
C.tecta Donner	+					
Colurella adriatica (EHR.)	+	+	+	+		
C.colurus (EHR.)	+	+	+	+		+
C.dicentra GOSSE	+	+	+	+		+
C.obstusa (GOSSE)	+	+	+			
C.uncinata (EHR.)	+	+	+			
C.uncinata f.bicuspidata (EHR.)	+					
C.uncinata f.deflexa GOSSE	+					
C.oblonga DONNER	+	+	+	+		
Conochiloides natans SELIGO			+			
Dicranophorus uncinatus (MLINE)			+			
D.forficatus (MULLER)			+			
Dissotrocha aculeata (EHR.)	+					
Epiphanes macroura BARROIS et DADAY	+					
E.senta (MULLER)	+	+	+	+	+	+
Euchlanis dilatata (EHR.)	+	+	+	+	+	+
Filinia cornuta brachiata (ROUSSELET) nom.nov.	+		+	+		
F.longiseta (EHR.)	+	+	+	+	+	+
F.longiseta var.passa (O.F.M.)	+	+	+			
F.terminalis (PLATE)	+					
F.opoliensis ZACHARIAS	+	+	+	+		+
Gastropus stylifer IMHOF				+		+
Hexarthra mira (HUDSON)	+	+	+	+		+
H.fennica LEVANDER				+		
Kellicottia longispina KELL	+	+	+			
Keratella cochlearis (GOSSE)	+	+	+	+	+	+
K.cochlearis var.tecta (LAUTERBORN)	+	+	+	+	+	+
K.cochlearis var.tecta f. micracantha (LAUTER.)		+		+		
K.cochlearis f.macracantha (LAUTER.)	+			+		
K.cochlearis f.connectens (LAUTER.)				+		
K.cochlearis var.robusta (LAUITER.)	+	+	+	+		+
K.cochlearis var hispida LAUTERBORN	+	+	+	+		
K.cochlearis var irregularis LAUTERBORN	+	+	+	+		
K.cochlearis var.irregularis f.wartmani (ASPER,HEUSCHER)				+		
K.paludosa (LUCKS)				+		
K.quadrata (O.F.M.)	+	+	+	+	+	+

Species	Localities					
	DANUBE			TISZA		
	1.	2.	3.	4.	5.	6.
K.quadrata var.frenzeli (ECKSTEIN)	+	+	+	+	+	+
K.quadrata var.dispersa (CARLIN)	+	+	+	+	+	+
K.qudrata f.reticulata CARLIN	+		+	+		
K.testudo (EHR.)		+	+	+		+
K.ticinensis (CALLERIO)				+		
K.tropica (APSTEIN)	+	+				
K.valga (EHR)	+	+	+	+		
K.valga f.monospina (KLAUS.)	+	+	+	+	+	+
Lecane bulla (GOSSE)	+	+	+	+		
L.closterocerca (SCHMARDA)	+		+			
L.hamata (STOKES)	+					
L.luna MULLER	+	+	+	+		+
L.lunaris (EHR.)	+	+	+	+		+
L.quadricarinata (STENROOS)	+	+	+			
L.ungulata (GOSSE)	+					
Lepadella ovalis (MULLER)	+					
Lepadella patella (MULLER)	+					
L.quinquecostata (LUCKS)	+					
L.rhomboides (GOSSE)	+					
Liliferotrocha subtilis RODEWALD	+	+	+			+
Mytilina bicarinata (PERTY)	+					
M.mucronata (EHR.)	+	+		+		+
Natholca acuminata (EHR.)	+		+	+		
N.squamula (O.F.M.)	+	+	+	+		+
Philodina citrina EHR	+	+	+	+		+
Ph.roseola EHR.	+	+	+	+		
Platyias quadricornis (EHR.)	+					
Polyarthra dolichoptera IDELSON	+	+	+	+	+	+
P.euryptera WIERZEJSKI	+	+	+	+		+
P.major BURKHARDT	+	+		+		
P.remata SKORIKOW	+					
P.vulgaris CARLIN	+	+	+	+	+	+
Pomhlyx complanata GOSSE		+	+	+	+	
P.sulcata HUDSON		+				+
Rotaria neptunia (EHR.)		+	+		+	+
R.neptunoides HARRIG	+	+	+	+	+	+
R.rotatoria (PALLAS)	+	+	+	+	+	+
Synchaeta oblonga EHR.	+	+	+	+	+	+
S.pectinata EHR.	+	+	+	+	+	+
S.stylata WIERZ.	+		+	+		
Testudinella patina HERMANN	+	+	+	+		
Trichotria pocillum (O.F.M.)	+					
T.tetractis EHR.	+		+	+		
Trichocerca capucina (WIERZ et.ZACHARIAS)	+	+	+	+		
Tr.collaris (ROUSS.)		+	+			
Tr.dixon-nuttali JENNINGS		+	+			+
Tr.cylindrica (IMHOF)	+	+	+			
Tr.longiseta (SCHRANK)		+				
Tr.porcellus (GOSSE)	+	+				
Tr.pusilla (JENNINGS)		+	+			
Tr.rattus (MULLER)	+	+	+	+	+	+
Tr.stylata (GOSSE)		+	+			
Tr.tenuior (GOSSE)	+					

Species	Localities					
	DANUBE				TISZA	
	1.	2.	3.	4.	5.	6.
CLADOCERA						
Acroperus harpae BAIRD	+					
Alona affinis (LEYDIG)	+			+		
A.costata SARS	+					
A.quadrangularis (O.F.M.)	+	+	+	+	+	+
Alonella excisa (S.FISCHER)	+		+	+		
A.nana (BAIRD)	+					
Bosmina coregoni BAIRD	+		+			
B.longirostris (O.F.M.)	+	+	+	+	+	+
Ceriodaphnia quadrangula (O.F.M.)	+	+	+	+		+
Chydorus ovalis KURZ	+					
Ch.sphaericus O.F.M.	+	+	+	+	+	+
Daphnia cuculata SARS	+	+	+	+		+
D.hyalina LEYDIG	+					
D.longispina O.F.M.	+	+	+	+	+	+
D.pulex LEYDIG					+	
Diaphanosoma brachyurum LIEVIN	+			+		
Leydigia leydigi (SCHOLDER)	+		+	+		
Leptodora kindti (FOCKE)	+		+	+		
Moina brachiata (JURINE)	+		+			
M.micrura (KURZ) SRAMEK-HUSEK	+	+	+	+		+
Macrothrix laticornis (JURINE)	+	+	+	+		
Peracantha truncata (O.F.M.)	+	+	+			
Rhyncotalona rostrata (KOCH)	+		+			
Scapholeberis kingi SARS				+	+	+
S.mucronata SARS				+		+
Simocephalus vetulus (O.F.M.)	+	+	+	+		+
COPEPODA						
Acanthocyclops robustus SARS	+	+	+	+	+	+
A.vernalis FISCHER	+	+	+	+	+	+
Cyclops strenuus (FISCHER)	+					
C.vicinus (ULJANIN)	+	+	+	+	+	+
Diacyclops bicuspidatus SARS	+		+	+		
Eucyclops serrulatus FISCHER	+	+	+	+	+	+
E.speratus (LJILJEBORG)	+	+	+	+		+
Eupdiaptomus gracilis SARS	+		+	+		+
Macrocyclops albidatus JURINE				+		+
Mesocyclops leuckarti CLUS	+	+	+	+	+	+
Thermocyclops crassus (FISCHER)	+	+	+	+	+	+
total	158	116	120	101	66	91