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USE OF SIMILARITY INDICES ON THE ZOOPLANKTON FAUNA IN THE GROŠNICA AND GRUŽA RESERVOIRS

Aleksandar M. Ostojić

Institute of Biology, Faculty of Science, University of Kragujevac,
Radoja Domanovića 12, 34000 Kragujevac, Yugoslavia

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ABSTRACT. Investigations of the zooplankton fauna in aquatic ecosystems involving comparative study of two or more water bodies have been rarely conducted in our country. Such investigations can be of great significance, since they reveal the process of colonization of new ecosystems (such as reservoirs), i.e., the process of dispersion of organisms. Investigations of this kind have been carried out on two reservoirs in the vicinity of Kragujevac that differ fairly greatly in regard to time of formation, size, and trophic state. The faunistic composition of zooplankton in both reservoirs and the employed similarity indices showed great similarity as far as the qualitative composition of zooplankton is concerned. However, due to the nonexistence of data on zooplankton composition in the Grošnica reservoir during the period before formation of the Gruža reservoir, it is difficult to estimate reciprocal influence between the two reservoirs on faunistic composition of their zooplankton.

INTRODUCTION

Investigations of faunistic composition of zooplankton in reservoirs in Serbia began in second part of XX century. Ostojić [6] gave a review of research on zooplankton in reservoirs on the territory of present-day Yugoslavia.

Investigations of reservoirs, including study of their zooplankton fauna, are of considerable significance because they deal with new ecosystems that replace the former river ecosystems [3]. Great changes in physical and chemical factors of the external environment occur in the course of reservoir formation, such changes determining the formation of lake biocenoses where river ones formerly existed.

Zooplankton studies in our country have generally been short-term investigations, sometimes with a small number of samples. Up to now, there have been no attempts to compare the composition and production of zooplankton in two reservoirs located close to each other. The present work represents a part of results obtained during two-year intensive investigations of zooplankton in the Grošnica and Gruža reservoirs [5].

DESCRIPTION OF STUDY RESERVOIRS

The Grošnica and Gruža reservoirs were intended to serve as sources of water supply for the city of Kragujevac. The two reservoirs differ fairly greatly with respect to age, size, and trophic state. Ostojić [5] gave detailed characteristics of both reservoirs.

MATERIALS AND METHODS

Monthly sampling was carried out during the period October 1996 – September 1998. Qualitative samples of zooplankton were taken with a No. 25 plankton net, while qualitative samples were collected with 2-liter hydribiological bottles and then filtered across a plankton net. The samples were preserved with 4% Formalin at the collection site, while a smaller number were saved there and later processed in the livig state in the laboratory of the Institute of Biology, Faculty of Science in Kragujevac, where the samples are stored.

In comparing the faunistic composition of zooplankton during these two periods, we used the Sørenson similarity index [11]:

$$S = \frac{2C}{A+B}$$

where *A* is the number of species present in one population, *B* is the number of species present in the other population, and *C* is the number of species present in both populations.

As control we used Jaccard index (C_j) [9]:

$$Cj = \frac{j}{a + b - j}$$

where **a** is the number of species present in one population, **b** is the number of species present in the other population, and **j** is the number of species present in both populations.

RESULTS AND DISCUSION

In the Grošnica Reservoir were recorded 105 taxa and in the Gruža Reservoir were recorded 99 taxa [6, 7]. Very small number of taxa are constant components of the zooplankton fauna in both reservoirs, while the majority of species apeear in the composition of zooplankton only temporarely and with a small number of specimens [5]. Faunistic composition of zooplankton in both reservoirs is given in Table 1.

Tab. 1. Qualitative composition of zooplankton fauna in Grošnica and Gruža reservoirs

	Grošnica	Gruža
RHIZOPODA		
Arcella sp.	+	+
Centropyxis aculeata Stein	+	+
Cyphoderia margaritacea (=C. ampula) Ehrenberg	+	+
Difflugia corona Wallich	+	+
Difflugia limnetica Levander	+	+
Euglypha sp.		+
Nebella sp.	+	
Vahlcamptia limax (Duj.)	+	
HELIOZOA		
Actinosphaerium sp.	+	
CILIATA		
Carshesium polypinum L.	+	+
Colpidium sp.	+	
Didinium nasutum	+	+
Dileptus sp.	+	
Epistylis rotans Švec	+	+
Euplotes sp.	+	
Lacrimaria olor O.F. Müller	+	+
Lionotus cygnus Švec	+	
Lionotus sp.	+	
Metopus sp.		+
Oxitrichia sp.	+	
Paramecium sp.	+	
Stentor polymorphus Ehr.-Stein	+	
Stylonichia pustulata Ehrenberg	+	
Tintinidium fluviatile Kent.	+	+
Tintinnopsis lacustris Entz	+	+
Vorticella campanula Ehrenberg	+	
Vorticella sp.	+	+
Zoothamnium limneticum Švec		+
ROTATORIA		
Anuraeopsis fissa (Gosse)	+	+
Ascomorpha saltans Bartsch	+	+
Asplanchna girodi De Guerne	+	
Asplanchna sieboldi Leydig		+
Asplanchna sp.		+
Brachionus angularis angularis (Gosse)	+	+
Brachionus diversicornis diversicornis (Daday)	+	+
Brachionus diversicornis f. *homoceros* (Wierzejski)	+	+
Brachionus leydigii Cohl		+
Brachionus quadridentatus quadridentatus (Hermanns)		+
Brachionus quadridentatus f. *brevispinus* (Ehrenberg)		+
Brachionus quadrdentatus var. *cluniorbicularis* (Skorikov)		+
Brachionus urceolaris (O.F. Müller)	+	
Cephalodella catelina (O.F. Müller)	+	
Cephalodella gibba (Ehrenberg)	+	+
Cephalodella hoodi (Gosse)	+	
Cephalodella sp.	+	+
Chromogaster ovalis (syn=*Ascomorpha ovalis*) (Bergendal)	+	+

Tab. 1. Continue

	Grošnica	Gruža
Colotheca mutabilis (Hudson)	+	
Colurella adriatica Ehrenberg		+
Colurella colurus (Ehrenberg)	+	+
Colurella obtusa (Gosse)	+	+
Colurella uncinata uncinata (O.F. Müller)	+	+
Conochilus unicornis Rousselet		+
Dicranophorus rostratus (Dixon-Nuttal & Freeman)	+	
Euchlanis deflexa (Gosse)		+
Euchlanis dilatata Ehrenberg	+	+
Euchlanis meneta Myers	+	
Filinia longiseta (Ehrenberg)	+	+
Gastropus stylifer Imhof	+	
Hexarthra mira Hudson		+
Kellicottia longispina (Kellicott)	+	+
Keratella cochlearis cochlearis (Gosse)	+	+
Keratella cochlearis var. *hispida* Lauterborn	+	+
Keratella cochlearis f. *macracantha* (Lauterborn)	+	+
Keratella cochlearis var. *tecta* (Gosse)	+	+
Keratella cochlearis var. *tecta* f. *micracantha* (Lauterborn)	+	+
Keratella quadrata quadrata (O.F. Müller)	+	+
Keratella quadrata frenzeli Eckstein	+	+
Lecane (M.) bulla (Gosse)	+	+
Lecane (M.) closterocerca (Schmarda)	+	+
Lecane (M.) cornuta (O.F. Müller)	+	+
Lecane (M.) hamata Stokes		+
Lecane (M.) lunaris (Ehrenberg)	+	+
Lecane (M.) pyriformis Daday		+
Lecane (L.) flexilis (Gosse)	+	+
Lecane (L.) inermis (Bryce)	+	+
Lecane (L.) luna (O.F. Müller)	+	+
Lecane (L.) nana (Murray)	+	+
Lecane sp.		
Lepadella acuminata Ehrenberg		+
Lepadella patella patella (O.F. Müller)		+
Lepadella patella f. *biloba* (Hauer)	+	+
Lepadella patella f. *oblonga* (Ehrenberg)	+	+
Lepadella rhomboides rhomboides (Gosse)		+
Monommata orbis (Müller)=syn. *M. longiseta* (O.F. Müller)	+	
Notholca acuminata (Ehrenberg)	+	
Notholca labis Gosse	+	
Notholca squamula (O.F. Müller)	+	+
Philodina acuticornis Murray	+	
Philodina spp.	+	+
Polyarthra dolichoptera Idelson	+	+
Polyarthra dolichoptera f. *aptera* Hood		+
Polyarthra major Burckhard		+
Polyarthra vulgaris Carlin	+	
Pompholyx sulcata Hudson	+	+
Squatinella rostrum (Schmarda)	+	
Synchaeta kitina Rousselet	+	
Synchaeta stylata Wierzejski	+	+
Synchaeta sp.		+

Tab. 1. Continue

	Grošnica	Gruža
Testudinella patina (Hermann)	+	+
Testudinella patina f. *trilobata* Anderson & Shepard	+	+
Trichocerca (T.) capucina Wierzejski & Zacharias	+	+
Trichocerca (T.) cylindrica (Imhof)	+	
Trichocerca (T.) elongata Gosse		+
Trichocerca (T.) jenningsi Voigt	+	
Trichocerca (T.) pusilla Lauterborn		+
Trichocerca (T.) rattus f. *carinata* (Ehrenberg)		+
Trichocerca (D.) similis (Wierzejski)	+	+
Trichocerca (D.) tenuior (Gosse)		+
Trichotria poccilum (O.F. Müller)	+	
Trichotria tetractis tetractis (Ehrenberg)		+
CLADOCERA		
Alona affinis (Leydig)	+	+
Alona guttata G.O. Sars	+	+
Alona rectangula G.O. Sars	+	+
Bosmina (E.) coregoni Baird	+	+
Bosmina (B.) longirostris var. *cornuta* (Jurine)	+	+
Bosmina longirostris var. *similis* Sars		+
Ceriodaphnia quadrangula (O.F. Müller)	+	
Chydorus sphaericus (O.F. Müller)	+	+
Daphnia cucullata f. *kahlbergensis* Schoedler	+	+
Diaphanosoma brachyurum (Liėvin)	+	+
Graptoleberis testudinaria (Fischer)		+
Iliocryptus agilis Kurz	+	+
Leptodora kindti (Focke)	+	+
Leydigia quadrangularis (Leydig)	+	+
Moina micrura Kurz		+
Pleuroxus aduncus (Jurine)	+	
Simocephalus vetulus (O.F. Müller)	+	+
COPEPODA		
Acanthocyclops (A.) robustus (G.O. Sars)		+
Acanthocyclops (A.) vernalis (Fischer)	+	+
Cyclops strenuus Fischer	+	+
Cyclops vicinus Ulianine		+
Eucyclops macruroides (Lilljeborg)	+	
Eudiaptomus gracilis (G.O. Sars)	+	+
Microcyclops varicans (G.O. Sars)	+	
Paracyclops sp.	+	
Thermocyclops crassus (Fischer)	+	
Harpacticoida	+	+

Based on the qualitative composition of zooplankton in the Grošnica and Gruža reservoirs, values of the Sørensen [11] and Jaccard [9] similarity indices comprised 0.67 and 0.50, respectively, indicating relatively great similarity of zooplankton composition in the two investigated reservoirs. Inasmuch as the two reservoirs are geographically close to each other, climatic conditions are very similar.

In study of diversity of the zooplankton communities in Canadian lakes, Patalas [8] said that "there are many factors which control the distribution of planktonic animals in Canadian lakes: postglacial history, hydrology, geology and climate are the most important ones" (first factor is not important for reservoirs).

At least three conditions define the presence or absence of species in a lake or reservoir [8]:

1. the species must have had an opportunity in the past to be dispersed into the area;
2. it must successfully compete within already existing communities;
3. it must survive in or adapt to chaning physical and chemical condition.

Environmental conditions can dictate whether the colonists develop small or large populations in the course of colonization. This is especially true in the case of species that "require" hard water and/or eutrofication [4].

Because the Grošnica reservoir is older, it can be supposed that some of the species present in both accumulations traveled in various ways from it to the Gruža reservoir. Differences in dominance and constancy of taxa common to both reservoirs are a consequence, among other things, of different environmental conditions [5]. It is certain that influence on faunistic composition of zooplankton in the Gruža reservoir is also exerted by the Međuvršje reservoir on the Western Morava river (into which the Gruža river empties). From the qualitative composition of zooplankton in the Međuvršje reservoir, it can be seen that many species represented in it also inhabit the Gruža reservoir [1]. A question to which no precise answer can be given is whether or not the Gruža reservoir exerts influence back on the Grošnica reservoir, since the Gruža reservoir is home to species not registered in earlier investigations of zooplankton in the Grošnica reservoir (the most conspicuous examples of this are *Kellicottia longispina* and *Eudiaptomus gracilis*). Because no investigations of the Grošnica reservoir were conducted just before formation of the Gruža reservoir, it is impossible to know where these two species appeared first.

Investigating lake plankton in Costa Rica, Haberyan *et al.* [2] established diversity of neighboring lakes and their relative independence in regard to chemistry, location, and formation, the data on plankton indicating a weak connection between abiotic and biotic characteristics of the lakes. For this reason, long-term monitoring of the lakes is recommended in order to establish the true relationship between abiotic factors, plankton, and the ichthyofauna.

Unfortunately, the influence of accumulation on zooplankton of reservoir-forming rivers was not investigated in the indicated studies. It has been established that reservoirs enrich the composition and abundance of zooplankton downstream from where they are formed, zooplankton composition and

structure undergoing alteration with increase in distance from the reservoir [10]. Attention should be paid to these questions in future investigations.

Our results suggest that their proximity to each other is one of the factors dictating the similar composition of zooplankton in the Grošnica and Gruža reservoirs. However, the lack of data on the Gruža reservoir for the period immediately after its formation and on the Grošnica reservoir before formation of the Gruža reservoir prevent us from drawing any precise conclusion as to reciprocal influence of the investigated reservoirs on the composition of their zooplankton. Such data would make possible a proper estimation of the process of colonization of new ecosystems (like the Gruža reservoir). Colonization is a continuous process that transpires in both new and old ecosystems. It is usually considered that an interval of ≥ 1 yr is needed for dispersal of many species of zooplankton into new habitats, so metapopulation dynamics (i.e., dispersion between aquatic ecosystems) can play a part in seasonal successions and other local dynamic processes in certain zooplankton communities [4].

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