SZENT ISTVÁN UNIVERSITY
GÖDÖLLŐ

Spatio-temporal dynamics of Cladocera and Copepoda assemblages in the Ráckeve –Soroksár Danube side arm

PhD dissertation thesis

Gergely Mészáros

Gödöllő
2015

Doctoral School

Name:	Biological Doctoral School
Discipline:	Biological Sciences
Leader:	Dr. Zoltán Nagy (DSc) Head of Institute Institute of Botany and Ecophysiology Szent István University
Supervisors:	Dr. Katalin Zsuga (PhD) Faculty of Agricultural and Environmental Sciences Szent István University

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Approval of the school leader Supervisor

Background and Objectives

The Ráckeve-Soroksár Danube (hereafter referred to as RSD) due to its geographical situation has always been of great importance for people living near it. Since the 19th century its major functions /discharge of floods from the main channel, drinking water supply, shipping route/ have decreased even disappeared. On the other hand these functions have been replaced by other and not less considerable forms of utilization.

In the 1960s the RSD became a popular place of relaxation and since the 1970s and 1980s more and more people from the capital city have been moving to the RSD area. Nowadays the RSD is considered to be one of the most intensively visited fishing areas.

All the facts mentioned above involve a lot of tasks to be solved. One of the biggest problems is that practically since the regulation of the waterway the process of alluvion has begun and its capability for purification has been decreasing. In addition due to the fact that the industrial and private water consumption is on increase, as well as the loading of waste water into the river, a significant and remarkably rapid eutrophication has begun in the RSD. This eutrophic process was studied and taken into consideration in several publications from the mid-fifties (BERINKEY-FARKAS 1956).

Although zooplankton as a biological factor does not belong inevitably to the elements to be examined by the VKI, based on numerous studies the zooplankton assemblage describes the quality of a certain water body very significantly.

Though Hungary has achieved significant results in research on the Danube, in regard with the side arms of the Danube publications are restricted only to the Szigetköz and Gemenc side arms and publications in accordance with the RSD are limited.

Taking the above factors into consideration my goals were as follows:

- extended and detailed spatio-temporal (complete longitudinal and a two-year period) studies as opposed to former examinations
- faunal description of Cladocera and Copepoda assemblages and presentation of dominant, common and rare species
- comparison and description of spatial heterogeneity, contrast diversing hydrodynamical and hydromorphological sections in RSD with regard to the quantitative and qualitative dynamics of crustacean assemblage
- examination of temporal influence of some environmental factors on the composition of crustacean assemblage
- emphasis on the utilization priorities of the Ráckeve-Soroksár Danube based on the achieved results

MATERIALS AND METHODS

My main points of choosing the sample stations were intended to represent the characteristic habitats in the RSD. I determined the stations at relatively similar distances so that I could cover the complete longitudinal section.

The RSD is divided into three sections by most authors (BOTHÁR 1973, GULYÁS és TYAHUN 1974) thus I took three-part-division into consideration when choosing the sample sites. My samples of plankton were taken at three stations in the upper section: Kvassay sluice, Gubacsi Bridge, a station in Soroksár region and in the middle section: Taksonyi Bridge, the backwater at Szigetcsép and a sampling station in Szigetszentmárton region. In the lower section I took samples at four sites: Ráckeve, the backwater at Dömsöd, the river section at Dömsöd and the sluice at Tass.

To achieve my goals I took samples at the same ten sites between September 2006 and August 2007 monthly, while between October 2007 and October 2008 bimonthly. Thus I collected 190 samples zooplankton samples so that I could explore tendencies and make related comparisons.

Throughout each sampling 100 litres of water was filtered through a plankton net (50 μm mesh size) using a bucket with a capacity of 10 litres. The samples were condensed into a capacity of 30 ml and preserved in situ in 5% formaldehyde solution. After homogenization I examined 3ml of each samples. The quantitative and qualitative data were analysed and applied to the filtered 100 litres of water.

Cladocera and Copepoda were identified to species level whereas throughout the specification of Copepoda I also took their different developmental stages (nauplii, copepodit,adult) into consideration. Species belonging to Harpacticoida suborder were identified to this taxanomic stage whereas in the charts I also represented the three developmental stages of Copepoda.

I carried out the statistical analyses using the PAST program (Hammer et al. 2001). Cluster analysis and the non-metrical multidimensional scaling (NMDS)

were applied to explore the similarity pattern of the sampling stations. Throughout both methods the Euclidean distance algorithm was used and the data were standardised by deviation. In the course of each NMDS study I tested the ordination by Kruskal Stress and made up Shepard diagram. Correspondence analysis was applied to examine the species related to the sampling stations.Shannon and Berger-Parker diversity was used to describe the diversity of the stations.

I studied the relation between the environmental factors and the abundance at the sampling stations using linear correlation and determined the rate of correlation related to Cladocera adult Copepoda and larva. I compared the changes of zooplankton abundancy with three different temporal datasets so that I could test the influence of environmental factors on the abundancy. I averaged the temperatures and the rainfall of seven days, 14 days and 30 days preceding samplings and calculated the water level fluctuation related to each period.

The three different datasets showed the period in which the environmental factors had the highest influence on the crustacean assemblage.

Results

I identified 40 Cladoceran taxa of the 190 plankton samples taken between 10 September 2006 and 26 October 2008.The alluvion of the river bank is due to the fact that nearly the 64% of the assemblage consists of benthic and metaphysic organism and 25% of Cladoceran assemblage indicates eutrophic environment. The most common organisms are *Chydorus sphaericus* and *Bosmina longirostris*. I identified 3 rare Cladoceran species: *Diaphanosoma mongolianum*, *Pleuroxus denticulatus,* and *Chydorus gibbus* and 18 taxa in Copepoda assemblage. *Thermocyclops crassus* and *Eucyclops serrulatus* rank among the most common species. The cosmopolitan and common *Diacyclops bicuspidatus, Eucyclops speratus* and *Mesocyclops leuckartii* was observed only at few sample stations.

In the back water at Dömsöd the average and maximal individual number was the highest due to the special conditions of the area. A permanent increasing individual number was observed from Kvassay sluice to Szigetcsép.

Only one sampling showed that in the back water at Szigetcsép the average density rate of adult Copepoda is remarkable due to the high individual number of *Eucyclops macruroides* and *Eucyclops serrulatus*

I experienced similar phenomenon in both Shannon diversity and the rate of abundance:in the RSD from Kvassay sluice the diversity was continuously increasing. It reached its maximum in the middle section and from this point the diversity showed a decreasing tendency. I observed the highest Shannon diversity rate at Ráckeve and a relatively high rate at the 4^{th} and 5^{th} sample station.

I measured the lowest diversity at Szigetszentmárton and Dömsöd. Both stations have similar hydrodynamic and hydromorphologic conditions since at both places the velocity of water flow is bigger and the bottom is pebbly in comparison with the other sampling stations. The diversity in the back water at Szigetcsép and Dömsöd was higher.

I compared Shannon diversity of each sample station in pairwise comparison with the diversity t-test. As a result of this method I explored that Kvassay sluice strongly differed from the other sampling stations.

In the study related to the sampling station at Szigetcsép the results were similar. I observed five significant differences compared to the other stations.
In the one-year period based on monthly samplings I compared the seasonal changes using Cluster and NMDS analisys. The first samples to be examined were taken in September, October and November 2006. In this period the stations at Gubacsi bridge and Dömsöd segregated significantly from the other eight stations that were very similar. Therefore similar dynamics can be described at sampling stations under remarkably different conditions.
In the winter season Kvassay sluice differed remarkably from the other stations while Szigetcsép and Szigetszentmárton showed great similarity.
The spring samples showed considerable spread and the similarity of sampling places was the slightest. The highest similarity was found at the two stations of Dömsöd, at Taksony Bridge and Szigetszentmárton. Alongside these places the river bank has been modified and in the main vegetation period the macrophyte assemblage was poor in number at Szigetszentmárton and Dömsöd. Nevertheless the fact, that in the beginning of the vegetation period the flora was in similar condition at these sampling stations throughout the examined period, is of great importance.
The summer period differed from the other seasons remarkably, as the conditions of the sample stations had the most significant similarity. Only Kvassay sluice and Dömsöd showed considerable difference. In this period the macrophytic assemblage reaches its final developmental stage.The high similarity is due to the fact that in the whole section of the side-arm the phytophil species are dominant.
I used correspondence analysis to explore the dominant species of each stations. I studied the samples from the whole sampling period and took each seasons

into consideration. Based on the samples taken throughout the whole sampling period the species belong to three clearly different groups. According to the study *Ceriodaphnia reticulata, Ceriodaphnia quadrangula, Leydigia leydigi, Pleuroxus aduncus, Eucyclops serrulatus, Eucyclops macruroides, Paracyclops fimbriatus* were identified at Gubacsi bridge and in the back water of Szigetcsép. These species are described by GULYÁS és FORRÓ (1999) as the species of eutrophic stagnant waters and can be regarded as phytophyl species. In regard with Copepodan assemblage besides the cosmopolitan *Eucyclops serrulatus* the *Eucyclops macruroides* can be observed mainly along the shoreline in the fauna of lakes whereas for *Paracyclops fimbriatus* the muddy bottom is favourable.

On the basis of the study only one third of species can be found at Tass, Ráckeve, Kvassay sluice, Soroksár and Szigetszentmárton. Among these species *Ceriodaphnia quadrangula, Leydigia leydigi Pleuroxus aduncus* can be observed in varied habitats e.g. in eutrophic waters. The study also showed pelagic species and species living in detritus.

In accordance with Cluster analysis and NMDS the correspondence analysis also evaluated the back water and the sampling station at Dömsöd as similar habitats in spite of the fact, that the habitats diverse completely in respect of hydromorphology. The study showed the presence of *Graptoleberis testudinaria* and *Alona costata* at Dömsöd. *Pseudochydorus globosus* was the closest to the back water at Dömsöd. *Chydorus sphaericus* can also be found in the back water and its habitat is relatively at the same distance from the back water at Dömsöd, Kvassay sluice and the sampling station at Szigetszentmárton.

I analysed the relation between environmental factors: temperature, rainfall, water level and zooplankton abundancy using linear correlation.

My results are as follows:

Throughout the week, before sampling most of the significant correlation was found between temperature and abundancy (8 cases) and a lower rate of negative correlation was shown between rainfall and abundancy. The most remarkable

correlation between temperature and Cladoceran assemblage was found at Gubacsi bridge, Ráckeve and Tass.

At Szigetszentmárton all the examined assemblages were found in negative correlation with all the three environmental factors and even Dömsöd showed a minimum rate of difference. At this sample station a low rate of positive correlation was observed between the temperature and Cladoceran assemblage.

Throughout comparing abundancy and the dataset from the period before the biweekly sampling only the temperature showed significant positive correlation.

At five sampling stations in different assemblages positive correlation was recorded between abundancy and rainfall. In other cases rainfall had slight, negative influence on abundancy. The study showed similar results in water level fluctuation. All the three assemblages had positive correlation between individual number and water level fluctuation exclusively at Kvassay sluice. Related to Szigetszentmárton and Dömsöd all the three factors showed negative correlation in accordance with abundancy.

Throughout the examination of the monthly dataset I observed numerous differences compared to the previous results. The rate of correlation between abundancy and the temperature was decreasing. Moreover I found significant, negative relation between water level fluctuation and abundancy.

All the three environmental factors showed negative correlation with the abundancy in the open water sampling sites.

New scientific results

1.) New results of the faunal study:

- Throughout the survey I showed 36 Cladoceran and 13 Copepodan species and this is the second biggest number of species compared to the former studies.
- In the Cladoceran assemblage instead of *Bosmina longirostris Chydorus sphaericus* proved to be the most significant species. In the Copepodan assemblage *Thermocyclops crassus* can be regarded the most considerable species. These facts show the metamorphosis of the crustacean fauna in the RSD. The dominant species can be regarded either cosmopolitans found everywhere or they rank among phytophyl species.
- The two most different stations are Kvassay sluice and the station at Dömsöd whereas the most varied assemblage can be observed at Taksony bridge, Ráckeve and in the back water at Dömsöd.
-In crustacean assemblage Copepodan species are dominant while the remarkable rate of Cladoceran species at Kvassay sluice is an unexpected result. In low-streaming waters nauplii and copepodits can be found in high number whereas in stagnant sections (back waters) a higher rate of adult individuals can be observed.

2.) Throughout the comparative analysis of crustaceans in the RSD I found the following:

- During the comparison of the sampling stations based on their Cladoceran and Copepodan assemblages the similarity/diversity of the habitats did not always reflect the expected results based on the hydromorphological conditions.
- The sampling station at Kvassay sluice diverse remarkably from the other stations furthermore the zooplankton of the studied back waters slightly differs from the nearby waters.

3.) Examination of the temporal dynamics of Cladoceran and Copepodan assemblages:

-According to my results seasonal patterns can be observed in the forming of crustacean assemblages. Throughout the zooplankton comparison of the habitats the most considerable similarity in summer while the most significant difference in spring was found.

4.) Related to the influence of environmental factors on the zooplankton assemblages I found as follows:

-Temperature proved to be the most dominant environmental factor and it is in significant positive correlation with zooplankton abundancy.

-Considerable diversity cannot be observed between the influence of temperature on abundancy and the weekly, biweekly, monthly temperature changes. It means that the zooplankton reacts to the air temperature in a short period.

-Rainfall has negative influence on individual number in short period while no influence on the abundance of crustaceans or a low rate of it was found in the upper and middle sections.

-At Kvassay sluice the influence of water level fluctuation was shown in short period while in the lower section slight negative influence on zooplankton abundancy during a longer period was experienced

-High-streaming sampling stations such as Kvassay sluice, Szigetszentmárton, Dömsöd clearly differs from the other habitats. Regarding all the three studied time periods /weekly,biweekly,monthly/ in case of the three examined assemblages /Cladocera, larvae, adult Copepoda/ almost each environmental factor showed negative relations. I found it to be significant only in three cases.

Conclusion and proposition

My results show that in order to classify a given area of water we can achieve more detailed knowledge by using biological factors, such as zooplankton assemblage, than by classification based on hydromorhology. I have come to the conclusion that the dominant species have changed and they are either cosmopolitans found everywhere or phytophyl species. This fact shows that the RSD has been eutrophicated at a high rate. In accordance with the qualitative and quantitative relations the sampling stations in the middle section were the richest in species furthermore the abundancy was the highest. In this section the river bank has not been modified, beaches have not been set up and on the other hand several areas have become natural conservation area. The correspondence analisys showed the absence of species belonging only to one habitat. The other statistics methods proved that the seasonal changes of zooplankton in different and distant habitats are similar in a given period of the year. Zooplankton is initial nutrition for fish fauna and it is available in the right quality and quantity in the whole RSD. Consequently in respect of fish farming the important factors exist and they would help the utilization of the facilities more efficiently.

In the Ráckeve-Soroksár Danube arm varied riverbank sections, bottom and macrophyte assemblages can be found and by reasonable development new spawning grounds, which are favorable not only carp species, could be established. In this way the facilities of the area could be utilized and fish farming would be more profitable. The RSD project in process with the aim of habitat improving could also support the development of this region.

In connection with the habitat improving I suggest the establishment of a monitoring system to examine biotic and abiotic factors so that the exact conditions of given habitats could be studied and the changes could be observed. This method would also support to get valuable knowledge due to which a more efficient environmental protection and preservation could be carried out.

I think the yearly and seasonal study of the faunal dynamics would be justified. Moreover comparing them with hydrochemical data should also be taken into consideration. This conclusion must be regarded significant because certain species seem to be extremely sensitive to the oxygen content and the chemical composition of water.

I suggest charting and detailed examining of the macrophyte assemblage. The composition of weeds and its changes reflect the condition of the habitat and long-term changes in process. Furthermore several indicator species can be found among them and they are a source of nutrition. Furthermore suitable macrophyte assemblage is of great importance as a spawning ground of certain species.

I also suggest marking out the priorities of utilization concerning each area since they indicate and result in several requirements in accordance with water quality. It is vital to take these requirements /water utilization, recreational possibilities, fishing/ into consideration since they could mean a kind of contribution to optimizing the cost.

Publications in the topic

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Mészáros G. (2006): A Ráckevei Duna-ág biológiai vízminősítése – X. Országos Felsőoktatási Környezettudományi Diákkonferencia, Eger