

THE CRUSTACEAN ZOOPLANKTON COMMUNITIES (CRUSTACEA: COPEPODA, CLADOCERA) OF SPECIAL NATURE RESERVE „OBEDSKA BARA“

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ABSTRACT: In order to preserve fragile and sensitive aquatic ecosystems, such as Special Nature Reserve (SNR) “Obedska bara”, a monitoring protocol should be implemented, including the utilization of various bioindicators, biomonitors and biomarkers. Copepods and cladocerans, as a part of the freshwater zooplankton communities, prefer habitats with stable and constant physical, chemical and biological parameters, and therefore could be used as the precise bioindicators. The aim of this study was to obtain copepod and cladoceran species diversity and abundance as valuable data, which could be further used as a sensitive and accurate model for the assessment of SNR „Obedska bara“ status. During the research period, five copepods and three cladocerans species were collected from two prospected localities: *Cyclops vicinus*, *Acanthocyclops robustus*, *A. vernalis*, *Eucyclops serrulatus*, *Eudiaptomus gracilis*, *Daphnia magna*, *D. pulex* and *Bosmina longirostris*. The most abundant species were *C. vicinus* and *D. magna*. The species diversity and population densities of freshwater crustaceans are correlated with the numerous abiotic and biotic factors. Although SNR “Obedska bara” belongs to the list of protected areas, it is still exposed to the strong anthropogenic influence.

Key words: freshwater zooplankton, Obedska bara, species diversity, Copepoda, Cladocera

INTRODUCTION

The need for the nature and biodiversity protection has become a necessity, in the past few years, if the humankind wants to survive on this planet. Nowadays, this necessity has been recognized worldwide, primarily because of the influence of the scientific community and the media, who have created the current status of the various ecosystems more understandable, customized and available to the general public. Disregarding the politics, nationality or religion, people worldwide have become ecologically more conscientious and increasingly involved in various forms of ecological associations and citizen sciences.

According to the statistics of the United Nations, the number of the Protected Areas in the world has increased from 9214 in 1962, to 102102 areas in 2003, that is, from 2.4 to 18.8 million km². In the Republic of Serbia, the current surface of the protected areas is 5.91% of the territory. The Spatial Plan of the Republic (Official Gazette of RS, No.

88/10) stipulates that by 2021, about 12% of the territory of Serbia will be protected. Till today, the total number of protected areas is 463, of which: 5 national parks, 16 nature parks, 16 landscapes of exceptional features, 71 nature reserves and special nature reserves, 42 protected habitats with cultural- historical values and 313 natural monuments.

According to the Law on Nature Conservation (Official Gazette of RS, No. 36/2009, 88/2010), the nature reserves (NR) are the areas of unchanged natural features with representative natural ecosystems, whereas, the special nature reserves (SNR) are the areas with unchanged or slightly changed nature, and of specific importance due to the certain characteristics and natural values where, if present, a human population lives in unity with nature.

Of the total number of SNRs in the Republic of Serbia, 55.2% territorially belong to the Autonomous Province of Vojvodina. One of the oldest SNRs, not just in Serbia but worldwide, is "Obedska bara", placed under protection in 1874. SNR „Obedska bara“ is a large swamp-forest area along the river Sava. It represents the largest flooded area in Serbia, with authentic and fragile wetland vegetation, wet meadows and forests, famous by a significant biodiversity richness and evenness and important presence of rare and endangered species of national and international importance. Since 1977, SNR „Obedska bara“ has been proclaimed as a swamp area of the international significance by the Ramsar Convention. It is also included in the List of areas of special significance for the birds of Europe (Important Bird Area project, IBA) and UNESCO's list of the world's most important wetland areas. Concerning the strong anthropogenic influence on this fragile area, the three-stage protection regime has been established on a total area of 9820 ha: 1st degree of 315 ha, 2nd degree of 2.565 ha and 3rd degree of 6.940 ha. Recently, within the protection regime of SNR "Obedska bara", the protective zone of 19.611 ha has also been established (Mezei et al., 2018a).

In order to preserve such fragile ecosystems, a monitoring protocol should be implemented, including the utilization of various bioindicators, biomonitors and biomarkers. The anthropogenic stressors, especially from industry and agricultural practice represent a significant concern to the health of the aquatic ecosystems and species, due to their different mechanisms of action, persistence and acute and chronic toxicity.

Zooplankton has been widely used in the assessments of aquatic pollution, as they are sensitive to small changes in the environment. The crustacean zooplankton prefers habitats with stabile and constant physical, chemical and biological parameters (Balakrishna et al.). These organisms could be used as the precise bioindicators for water quality, eutrophication, pollution and presence of contaminants. The aim of this study was to obtain copepod and cladocerans species diversity and abundance as valuable data, which could be further used as a sensitive and accurate model for the assessment of SNR „Obedska bara“ status.

MATERIAL AND METHODS

The study was conducted from June till December in 2017 at SNR "Obedska bara", at two localities: "Kula" (K) and "Obrež" (O). The copepods and cladocerans were collected by a plankton net (diameter 15 cm, length 60 cm, mesh 80 µm). The net was towed obliquely,

at the average depth of 30 cm, by an investigator on the motorboat, at the lowest speed for 1 minute. The sampling was replicated three times. According to Simões et al. (2015), the lack of different depth samples has not been considered as a procedural error for the data comparison, as the water was shallow at the prospected sites (4 to 6 m deep) and the water layers were mixing constantly. The sampling was conducted in the morning to avoid bias and obtain precise data, due to the vertical migrations of zooplankton.

After the examination of the total zooplankton sample under a binocular microscope (maximum magnification 160x), in order to identify all the present taxa, one-fourth of each sample was observed in detail. Copepods and cladocerans were collected from the rest of the zooplankton and the abundance was calculated as a number of specimens per liter (ind/L). The collected crustacean species were identified according to Dussart (1969), Dussart and Defeye (2006).

RESULTS AND DISCUSSION

During the research period five copepod and three cladoceran species were collected from both prospected localities: *Cyclops vicinus* Ulyanin, 1875, *Acanthocyclops robustus* (Sars G.O., 1863), *Acanthocyclops vernalis* (Fischer, 1853), *Eucyclops serrulatus* (Fischer, 1851), *Eudiaptomus gracilis* (Sars G.O., 1863), *Daphnia magna* (Straus, 1820), *Daphnia pulex* (Leydig, 1860) and *Bosmina longirostris* (O. F. Müller, 1776).

The most abundant copepod species was *C. vicinus* (Cyclopoida) (K: 30.06%, O: 27.63%) and cladocerans *D. magna* (K: 20.69%, O: 18.42%) (Figure 1 and 2). The monthly variations in abundances are shown in Figures 3 and 4.

The crustacean zooplankton population densities, abundance and species diversity are conditioned by their customary annual fluctuations (Mezei et al., 2018a). Yiğit (2006) highlighted that freshwater crustacean abundance is higher in spring and autumn and lower in summer and winter, as it is restricted by adequate food availability. According to Hansen and Jeppesen (1992), the abundance and the food quality are important elements of *C. vicinus* population densities, since the first and the most abundant generation develop during the spring algal bloom.

The freshwater crustacean seasonal dynamics and abundance vary through the season regarding the numerous factors, such as the water temperature, the water regime, drought, predation, food quality and availability. These factors are the natural stressors on which zooplankton species can respond with their evolutionary developed adaptability and plasticity, such as specific development, diapause and migrations.

Copepods, cladocerans and rotifers, produce diapausing or “resting” eggs during annual reproductive cycles. These dormant stages are evolved as an adaptation to the periods of harsh environmental conditions, such as anoxia, drought and extremely low or high temperatures. The copepods and cladocerans have complex life cycles in which the asexual phase of reproduction is dominant, with occasional, short periods of sexual reproduction. According to Mezei et al. (2018a), the annual cyclic parthenogenesis consists of a long phase of an asexual reproduction, when females hatch from the eggs in the spring and parthenogenetically produce new females throughout the summer. In autumn, females start to produce males, after which follows a short phase of a sexual reproduction. Nauplii produced asexually are brooded by the female. The sexual

reproduction results in eggs that is dormant over winter and hatch in the following spring (Mezei et al., 2018b).

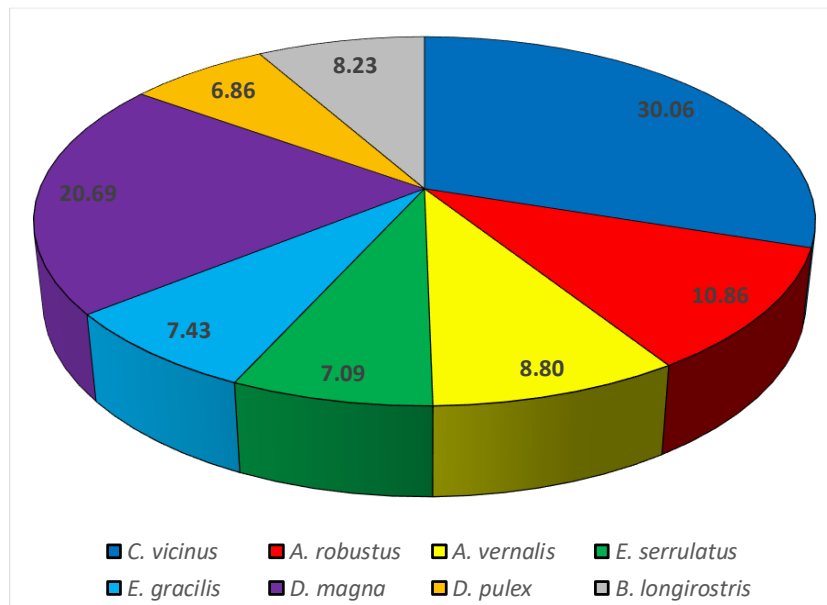


Figure 1. Copepod and cladocerans species diversity at locality "Kula"

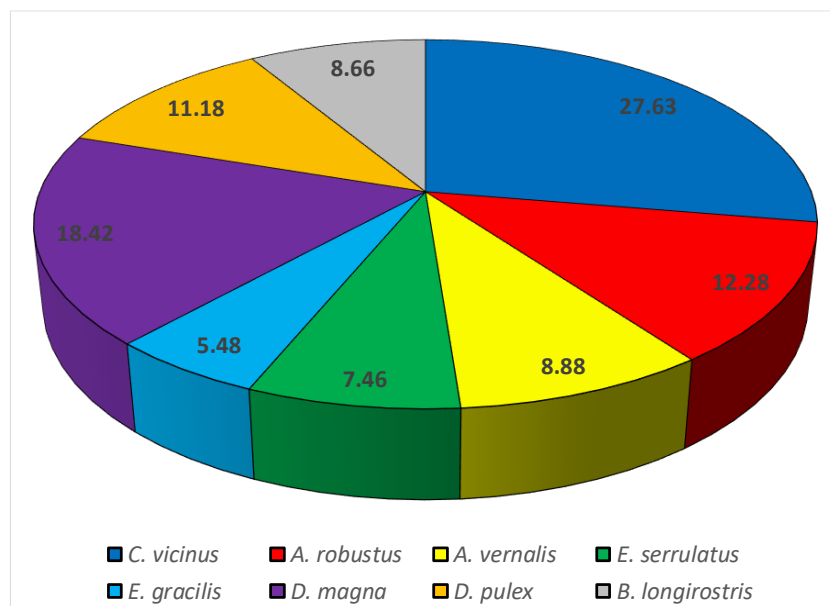


Figure 2. Copepod and cladocerans species diversity at locality "Obrež"

The low number or absence of the observed species during the summer and winter months could be explained by the dormancy or diapause. The main factors for the diapause initiation or termination are: temperature, photoperiod, population density, poor or no food sources, food quality, maternal necessity, the presence of predators, or the combination of these factors. The dormancy or diapause helps zooplankton to survive in small and shallow water bodies (Marten and Reid, 2007), especially those

which drastically change the water level or dry periodically, which is the case with SNR “Obedska bara”. The diapause occurs in certain developmental stages and induces the metabolism decrease and the development interrupting for a specific time interval. According to Marten and Reid (2007), as long as the water content in sediment exceeds 15%, the diapaused copepods can survive for a long period of time in the sediment of the temporary water bodies, especially those with no free water present. The *C. vicinus* summer diapause could be explained by a high predation pressure during these months and the dependency of herbivorous nauplii on high food availability (Seebens et al., 2009).

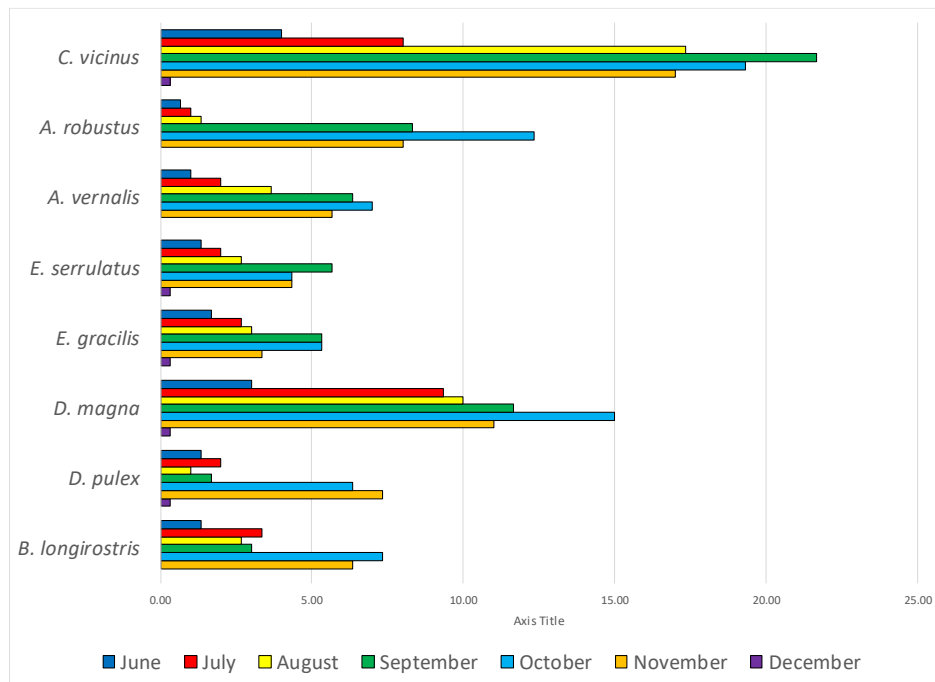


Figure 3. Copepod and cladoceran seasonal dynamics at locality “Kula”

Freshwater crustaceans are known for their vertical migrations, induced by numerous factors. Usually they are described as ontogenetic, seasonal and diel migrations. The ontogenetic migrations are caused by the certain life stages metamorphosis. The copepods and cladoceran have a complex life cycle, consisted of six naupliar stages, five copepodid stages and an adult stage. Depending on the species, temperature and food, the complete life cycle could be finished in a few days or weeks. The seasonal migrations are determined by season and the water regime, especially by the seasonal changes of water temperatures, saturated oxygen, pH, available food sources and predation. SNR “Obedska Bara” has specific hydrological features. The water deficit is characteristic during the summer and winter months, and has been usually caused by the draught, the reduction of the open water surfaces, weak flow and the anthropogenic influence. The diel migrations are frequent among crustaceans, where due to the numerous factors they migrate from the water surface to the bottom and vice versa. One of the main reasons for this phenomenon is predation.

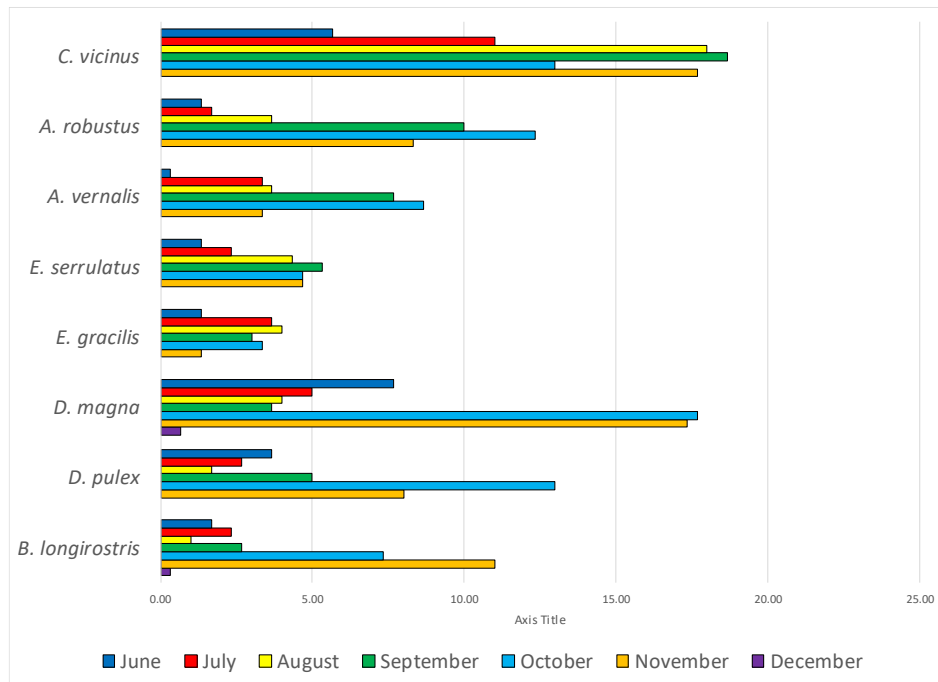


Figure 3. Copepod and cladocerans seasonal dynamics at locality "Obrež"

Both prospected localities are in the zone of the 3rd degree protection, they are rich in fish and the sport fishing is allowed with special permission. Many copepod and cladoceran females are usually eaten by fish or amphibians before they gain the proper size necessary for the reproduction or before successful oviposition. According to Pijanowska and Stolpe (1996) the females sometimes manage to release the egg clutches before predation, or the eggs remain viable after the ehippial female is eaten by the predator and the eggs passed through the predator digestive system.

CONCLUSIONS

The species diversity and abundance of the freshwater crustacean communities were correlated with the numerous abiotic and biotic factors. According to the obtained results, the main factors that influence the copepod and cladocerans species diversity, abundance and seasonal dynamics are water temperature, seasonal water level changes and the anthropogenic influence. The human irresponsible behaviour and negligence could have devastating effects on the biodiversity of protected areas, such as SNR "Obedska bara". Therefore, the area of the 1st and the 2nd degree of the protection should be if possible extended and continuously monitored.

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