THE SIGNIFICANCE OF MACROINVERTEBRATES FOR BIOMONITORING OF THE BOJANA RIVER

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Abstract. Macroinvertebrates are a group of organisms visible to the eye and spend most of their life cycle at the bottom of the water. Apart from serving as food for other aquatic organisms, these organisms are the most sensitive link in the aquatic ecosystem. Scientists also call them water ecosystem sensors because they are used to assess the state of a particular water habitat. This paper investigated the possibility of using these organisms in the biomonitoring of the Bojana River. The situation was assessed by analysing the macroinvertebrates at the mouth of this river. By analysing the presence and absence of certain species as well as the number of individuals within the population, an assessment of the water quality at the mouth of the river was made. It confirmed the effectiveness of these organisms in monitoring the situation in this location.

1 Introduction

1.1 River Bojana

The river Bojana (Buna) is an important natural resource of the Municipality of Ulcinj and the surrounding area. It flows through two states; Montenegro and neighbouring Albania. In this way, it connects Skadar Lake and the Adriatic Sea. Its length is 44.45 km, of which the upper part of about 20 km belongs to Albania, and the lower part of about 24 km to Montenegro and forms the border between Montenegro and Albania. It springs from Lake Skadar at 3.3m above sea level and flows into the sea at an elevation of 1-5m. It flows through the plain, meanders, and has a small drop of 22 cm/km (Hadžibrahimović, 2011).

1.2 Benthic macroinvertebrates

Given that benthic organisms are tied to the river bed, the composition of their biocenoses depends primarily on the type of bed, which is determined by the speed of the flow. In the upper part of the stream, where the speed of the water flow is the highest, rocky and stony bottom prevails, while downstream, it becomes gravelly and finally sandy and silty (Marić, Rakočević, 2009).

The macroinvertebrates of the lower reaches of the river are represented mainly by psammopeloreophilic organisms that prefer sandy and/or muddy substrates, such as various snails (Bithynia tentaculata, *Fagotia sp*., *Planorbis sp*., *Viviparius sp*.), molluscs (genera:

Dreissenia, *Anodonta*, *Sphaerium*), Chironomidae (*Chironomus thummi*, *Cryptochironomus sp*., *Procladius sp*.), Oligocheta (genera: *Nais, Pristina, Chaetogaster, Limnodrilus, Tubifex*), Nematoda (*Cephalobus sp*., *Aphanolaimus sp*.), Crustacea (*Pontogammarus sp*., *Chaetogammarus sp*.), Hirudinea (*Herpobdella spp*., *Helobdella spp*.), larvae of Trichoptera, Plecoptera, Ephemeroptera, Odonata (*Libellula fluva*), etc. (Marić, Rakočević, 2009).

.2 Problem background

Benthic invertebrates, especially insects, offer several advantages in biomonitoring. First, the small size and limited movement of benthic invertebrates, compared to vertebrates, makes sample collection relatively easy. Second, invertebrates generally do not require a permit to collect. Third, a certain number of taxa are known to be sensitive to pollutants. Finally, invertebrates reflect the ecological state for a longer time interval than the direct water quality measurement. Therefore, biomonitoring incorporates and integrates many different aspects of invertebrate biology into a single management and assessment tool. For example, mouthparts deformities in chironomid flies are used as an index for pollutants. Although they are useful and widely applicable, certain shortcomings (in their application) have also been recorded. Perhaps the biggest of them is the time and effort required to identify invertebrates (Likens, 2010).

Macrozoobenthos plays an essential role in the aquatic system (Laini et al. 2018; Dewiyanti et al. 2021; Yi et al. 2021), e.g., as a neutraliser of the aquatic environment by breaking down organic matters that enter the bottom of the waters into a food source so that the nutritional conditions of the waters become stable (Alavaisha et al. 2019). Changes strongly influence the macrozoobenthic composition, abundance, diversity, water quality, and the substrate where they live, so macrozoobenthos is also commonly used as biological water quality indicator (Kadim et al. 2013; Laini et al. 2018; Harahap et al. 2018; Herawati et al. 2020; Kefford et al. 2020; Lestari and Rahmanto 2020; Sulaeman et al. 2020; Baryshev 2021; Costa et al. 2021; Ndale et al. 2021; Prajoko et al. 2021; Sueb et al. 2021). (Kadim M. K. et al. 2022)

3 Methodology

For the collection and separation of macroinvertebrates, a semiquantitative method was used. It involves using a planktonic net to take samples from the river bottom. Samples are taken from carefully selected coastal locations. The extracted material is transferred to a white tub from which the animals are separated by species and transferred to bottles with 96% alcohol. During the separation, the individuals are counted and entered into the table. After that, the samples are transported to the laboratory.

Different keys were used for their identification. The use of the molecular biological method of DNA barcoding is planned for further research.

It is also planned to detect and measure the co-concentration of heavy metals using the spectrophotometric method. All data will be processed using Excel for graphical representation. The obtained graphics will facilitate the analysis and observation of the obtained data as well as drawing conclusions.

4 Results

Table 1 shows the research results at the mouth of the Bojana River from July 2020. The taxa registered during this research as well as their abundance, are clearly visible. The data can be directly used to assess the situation at this site. These data will be combined with other data to create a database for further monitoring of the situation on the Bojana River.

Table No. 1

BOJANA RIVER MOUTH, JULY 2020	
SPECIES AND GROUPS	**NUMBER**
Theodoxus fluviatilis	17
Radix spp.	23
Lymnaea spp.	4
Dreissena polymorpha	0
Pisidium nitidum	0
Oligocheta	0
Hirudinea	7
Gammarus spp.	118
Corophium volutator	17
Asellus aquaticus	4
Atyaephyra desmarestii	300
Ephemeroptera	6
Odonata	13
Heteroptera	18
Trichoptera	12
Coleoptera	25
Chironomida	26
Total	619

It is evident that the freshwater shrimp *Atyaephyra desmarestii* is the dominant species at this site. Individuals belonging to the *Gammarus* genus are also abundant. Other species are represented in smaller numbers.

The invasive clam species *Dreissena polymorpha* was not found at the site. This invasive species is registered at higher elevations. Since it tolerates increased salt concentrations well, it is assumed that the influence of another factor prevented its survival in this area, which needs to be further investigated.

Regarding bioindicator species, we can refer to the presence of Ephemeroptera larvae. They are indicators of clean water. In our sample, they are very few, which may indicate a certain degree of pollution or the effects of a higher salt concentration, which is very variable at the mouth.

5 Further work

In further work, research should also be carried out at other priority locations along the Bojana River. The research should be repeated several times during the season to monitor the presence and absence of certain species in different locations and at different time intervals.

DNA barcoding should also be applied in research to enable precise identification of individual species and determine their origin.

Further research is planned to monitor the physical and chemical characteristics of water. It is also important to detect and measure the concentration of heavy metals and other pollutants. All obtained results should be compared, and interdependence noted. For easier comparison, all obtained data should be displayed graphically using Excel.

Based on all the information, a database should be formed, which will be used to monitor the situation on this river further. Based on this data, we can determine the impact of certain factors, such as climate change.

6 Conclusion

Through this research, we can conclude that the macroinvertebrate community can be used for biomonitoring of the Bojana River. Analysis of the presence or absence of bioindicators, invasive and other species, as well as data on the numerical state of the populations of these species, can provide a complete picture of the state of the entire ecosystem. If we include the monitoring of chemical parameters and the concentration of toxic pollutants in these studies, that picture will be much clearer and more precise. Determining the species composition of this community and determining the state within the population for each species creates a database that we will in due course compare with the new state. Based on the presence or absence of certain species and on the basis of changes in their number, we can determine and register all changes within the community.

In our case, we have a small number of Ephemeroptera larvae, which are indicators of clean water. A small number of larvae from this group may indicate the presence of pollution. A large number of individuals that are tolerant to elevated salt concentrations, such as freshwater shrimp, rule out the possibility of contamination. Thus, the low number of Ephemeroptera is associated with increased salt concentrations at the mouth where salt and fresh water mix. Based on the analysed data, we can conclude that the water is clean, but this is not a guarantee that it will remain so. Therefore, such research has to be repeated constantly to enable continuous insight into the state of the ecosystem.

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