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USE OF BENTHIC MACROINVERTEBRATES IN THE DIAGNOSIS OF BEGA RIVER WATER QUALITY AND SELF-PURIFICATION PROCESS

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Abstract

The anthropic impact, having various forms, negatively changes the parameters of water quality and disturbs the living environment of benthic macroinvertebrates. The purpose of the present study is to present how the main sources of pollution influence the way of life of the benthic macroinvertebrates community. 20 quantitative benthic samples were collected from different benthic areas of the Bega River water during from June 2014 to February 2017. In addition to identify all the changes that occur in the structure of macroinvertebrates community due to the activities performed by the human population. For the study to lead to conclusive results, samples were collected upstream and downstream from the main sources of pollution. Macroinvertebrates identified the macroinvertebrates and performed tests to determine the density, abundance and frequency of the samples. Based on these data, it is observed that, the presence of benthic macroinvertebrates that are sensitive to pollutants and higher-quality water in the upstream segment waters sector compared to the waters of the central segment where we identified benthic macroinvertebrates that prefer a polluted living environment. In the downstream segment, we could see that the river has a better quality, because naturally flowing on a long distance, allows an improvement in water quality through the self-purification process emphasized by the occurrence of some sensitive groups to pollution.

*Key words:*Bega River, benthic macroinvertebrates, water quality

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1. Introduction

The structure of macroinvertebrates communities is one of the best indicators of water quality in all aquatic ecosystems (Mihăilescu, 2010). All the research that aimed at the role of macroinvertebrates as a bioindicator are based on the fact that these species play an important role in nutrient cycles in water (Ismail and Robescu, 2019; Keke et al., 2017; Medupin, 2019; Yunita et al., 2018). The macroinvertebrates show long-term changes, as opposed to analyzes of physico-chemical factors that only show the momentary situations (Gomoiu, 2010; Ochieng et al., 2019).

In many studies, one of the best important indicators of surface water quality is considered to be

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the distribution and structure of some macroinvertebrates community, being related to the total concentrations of phosphate, nitrogen, dissolved oxygen and ammonium (Badea et al., 2010; Baumgartner and Robinson, 2017; Cai et al., 2012; Kubosova et al., 2010; Medupin, 2019; Spătaru et al., 2018). The reason why they are good indicators of the burden of organic pollution is that benthic macroinvertebrates are always a real and constant compartment in the dynamics and structure of biocenosis in a water system (Chaloner et al., 2009; Cooper et al., 2009; Wallace and Eggert, 2009; Whiles and Grubaugh, 2000). In addition, benthic macroinvertebrates are used as indicators of water quality is that most of them have a short life cycle and live permanently in direct contact with the polluting environment, and they response quickly at the pollution conditions (Alhejoj et al., 2014; Marin et al., 2016; Moldoveanu and Rîşnoveanu, 2010; Ogbeibu and Oribhabor, 2010; Popa et al., 2018).

This study was conducted to reveal the effects of the impact of human activities as: drinking water treatment station of Sânmihaiu Roman village, Ghiroda village, wastewater treatment plant in Timisoara, on the dynamics of benthic community structure from the Bega River, as a good diagnostic of water quality and the self-purification process of the Bega River.

2. Materials and method

The samples have been collected during the period from June 2014 to February 2017, when 20 quantitative samples of benthic macroinvertebrates were collected every season from the Bega River. Using identification keys (McCafferty, 1983; McDonald et al., 1991; Petrovici, 2009; Thorp and Covich, 1991), the laboratory tests were conducted to identify benthic macroinvertebratesthe at order level, except for Oligochaeta (subclass level). The determinations of the benthic macroinvertebrates were made following morphological testing that aimed the main characteristics of each species (McCafferty, 1983; McDonald et al., 1991; Petrovici, 2009; Thorp and Covich, 1991).

In order to show the influence of the city of Timisoara, as well as of the adjacent pollution sources, the sample collection stations were located upstream of the city of Timisoara and downstream of the sources suspected of pollution. The sample collection was performed with the Ekman Sampler benthic collection device with a surface of 225 cm^2 and were subsequently washed with benthic nets (meshes of 250 µm), and then they were preserved in formaldehyde (Lixandru, 2006; Marin et al., 2016; Péterfi and Sinitean, 2007; Petrovici, 2009).

The sample collecting stations (S) were chosen to highlight the main sources of impurification and it were placed as follows (Fig. 1):

First station (S1) – it is located upstream area of Timisoara city, near Ghiroda village, upstream of the potable water treatment plant.

Station two (S2) – it is located downstream of Ghiroda village and upstream of the sewage water treatment plant of Timisoara.

Station three (S3) - it is located downstream of the sewage water treatment plant of Timisoara,.near Sânmihaiu Român village

Station four (S4) – it is located at 54 km from Timisoara city, near Otelec village.

The test used in this study was the frequency ($F = Ni*100/Np$), the abundance ($A = (ni / N)*100$) and the density ($Di = ni / Sp$), (Marin et al., 2016), (Sîrbu and Benedek, 2004), (Stan, 1995).

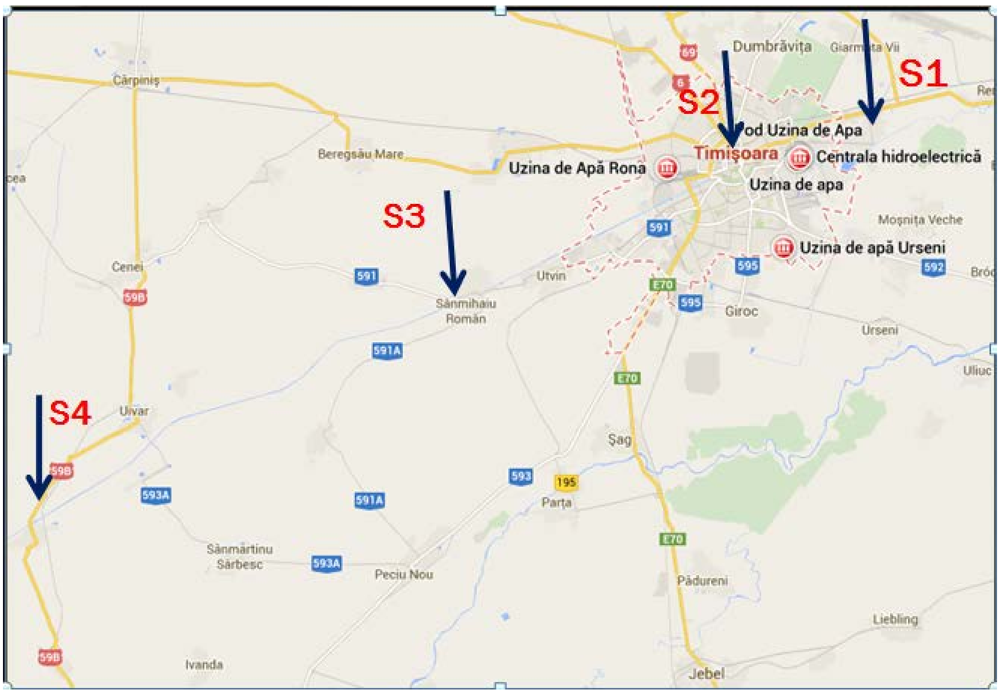

Fig. 1. The sample collecting stations from Bega River

3. Results and discussion

After the laboratory tests, ten groups of macros innevertebrates were identified (Table 1): *Oligochaeta*, Diptera (larvae of the families *Chironomidae, Ceratopogonidae* and *Tipulidae*), *Lamelibranchiata*, *Hirudin*, *Gastropoda*, *Isopoda*, *Nematoda*, *Trichoptera*, *Isopoda*, *Coleoptera*, *Odonata*, and Fig. 2 shows the macroinvertebrates density. Groups like the *Chironomidae* order *and Oligochaeta* subclass have a high tolerance to pollution and this thing has been demonstrated in a lot of studies and show larger tolerance limits, they being able to adapt to various environmental conditions (Benbow, 2009; Collier et al., 2010; Courtney and Merritt, 2009; Marchese et al., 2008 and Marin et al., 2016). Groups from *Odonata* order, *Lamelibranchiata* class and *Gastropoda* class, which are considered indicators of unpolluted water (Lorenz, 2003), where identified at the first station (S1).

After we analyzing the density of macroinvertebrates, it is clear that that, at the first stations (Ghiroda village) the density of individuals from the *Chironomidae* and *Oligochaeta* have a lower density comparing with the individuals from to the *Gastropoda* (Fig. 2). This means that the degree of polutin at the station S1 is very low. At the second station S2, after analyzing the density we showed an increase on the density values of groups *Gastropoda* and *Lamelibranchiata*, groups classified as indicators of unpolluted water (Fig. 2). Analyzing the groups there are considered pollution-sensitive, we noticed the highest density values at this station.

The influence of the city is very clearly shown at the station three on of these two groups (*Oligochaeta* and *Diptera*). At this station, compared with the previous stations, density of these groups is very high (Fig. 2). At station three (S3) it can also observe that the density values for pollution-sensitive groups (*Gastropoda*, *Lamelibranchiata*,) start to decline while density values of groups with significantly larger tolerance limits towards pollution (*Chironomidae* and *Oligochaeta*) increased. Individuals belonging to the *Isopoda* and *Hirudin* were identified as well in station S3, groups with larger tolerance at impurification while the individuals of the *Odonata* gradually disappear.

Station four (S4) was located at 54 km from Timisoara city, near Otelec village. At this station there was a decline in the density values of individuals that belong to the *Oligochaeta* and *Chironomidae*. The groups that belong to the *Trichoptera* and *Gastropoda*, as well as macroinvertebrates which are considered indicators of unpolluted water (according to Lorenz, 2003), were noticed. Analyzing the numerical abundance, this current study confirms that if one values of density increase, then the values of numerical abundance increase (Figs. 3-6).

After analysing the frequency of all macroinvertebrates (Fig. 7), the current work can indicate that groups belonging to the *Oligochaeta* showed 80% frequency in station S1, 60% frequency in station S2, 100% frequency in station S3 and 80% frequency in the last station. Groups belonging to the *Diptera* (especially larvae from *Chironomidae* families) have shown 60% frequency in the station S1, 80% frequency at the station S2, 100% frequency at station S3 and 60% frequency in the last one station.

Macroinvertebrates belonging to the *Nematoda* have shown 60% frequency at station S1, 20% frequency at second station, 60% frequency at station S3 and 40% frequency at station S4. Discussing the individuals belonging to the *Hirudin*, they displayed 10% frequency at the first station and 80% frequency in the third one, while individuals belonging to the *Isopoda* order had 40% frequency only at the third station.

Macroinvertebrates belonging to the *Gastropoda* had 100% frequency at station S1, 100% frequency at station S2, only 20% frequency at the station S3 and 60% frequency in the last one station (Fig. 7).

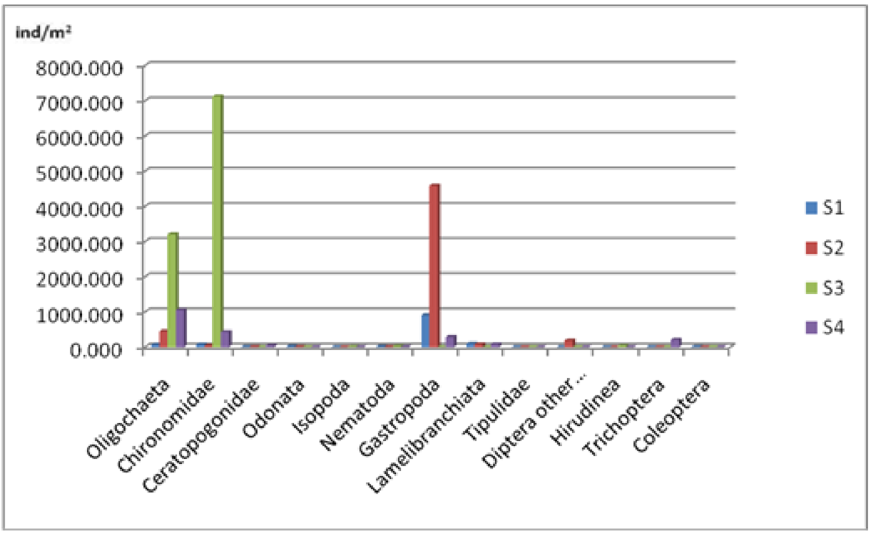

Fig. 2. Macroinvertebrates density (individuals/m^2) from Bega River

Table 1. Groups of macroinvertebrates in relation with the collection stations (present=+ and absent= -)

Groups	***Station 1 (S1)***	***Station 2 (S2)***	***Station 3 (S3)***	***Station 4 (S4)***
Oligochaeta	+	+	+	+
Lamelibranchiata	+	+	-	-
Hirudinea	-	-	+	-
Nematoda	+	+	-	+
Gastropoda	+	+	-	+
Ceratopogonidae	+	+	-	+
Chironomidae	+	+	+	+
Tipulidae	+	+	-	-
Trichoptera	-	-	-	+
Isopodae	-	-	+	-
Coleoptera	+	-	-	-
Odonata	+	-	-	-

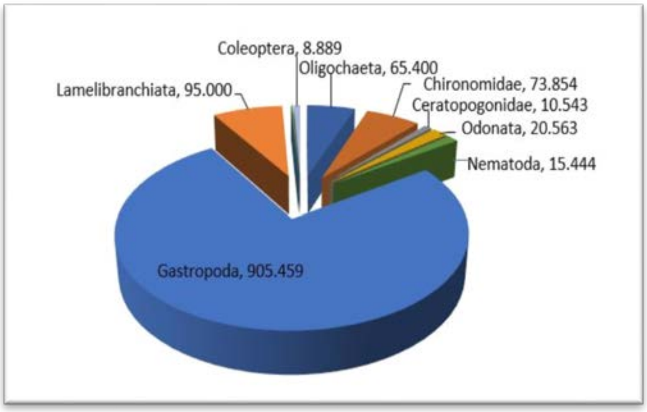

Fig. 3. The numerical abundance of the macroinvertebrates group at station 1

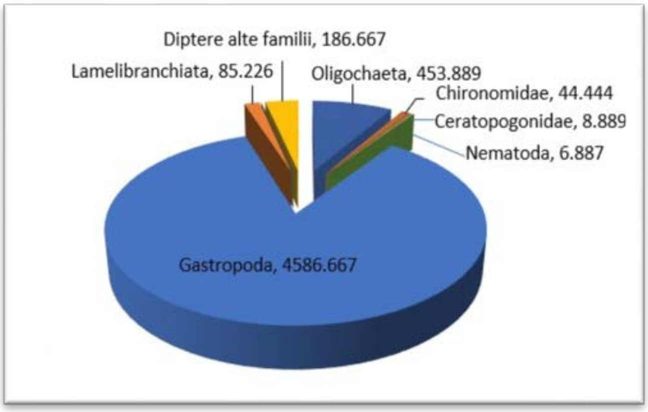

Fig. 4. The numerical abundance of the macroinvertebrates' group at station 2

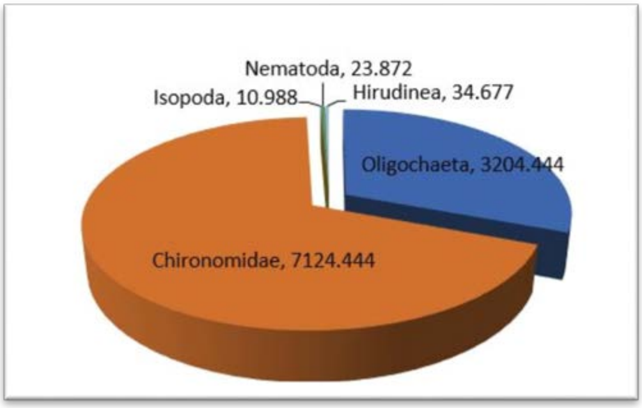

Fig. 5. The numerical abundance of the macroinvertebrates' group at station 3

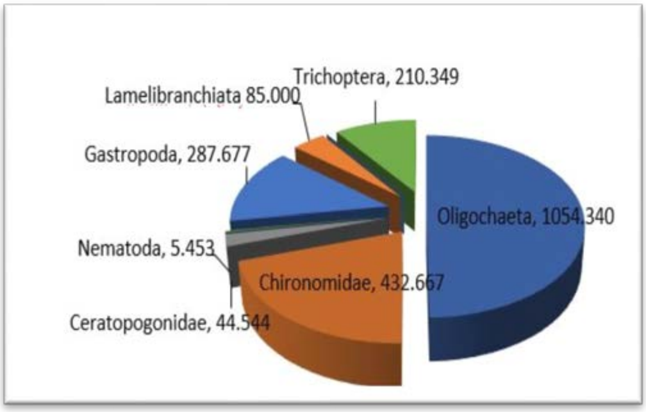

Fig. 6. The numerical abundance of the macroinvertebrates' group at station 4

Macroinvertebrates belonging to the *Trichoptera* had a 10% frequency at the first station and 40% frequency at the last station. Individuals belonging to the *Lamelibranchiata* have shown, then 100% frequency at both station 1 and 2, 20% frequency at station S3 and 80% frequency in the last one station. Macroinvertebrates belonging to *Odonata* were found at a rate of 40% frequency only at station S2 (Fig. 7).

Similar studies have been carried out at the level of other lentic ecosystems such as the Mures River, the Cerna River or the Jiu River where the effects of the pollutants on the benctonic macroinvertebrates communities have been investigated (Dumbravă-Dodoacă and Petrovici, 2010; Marin et al., 2011; Răescu et al., 2011).

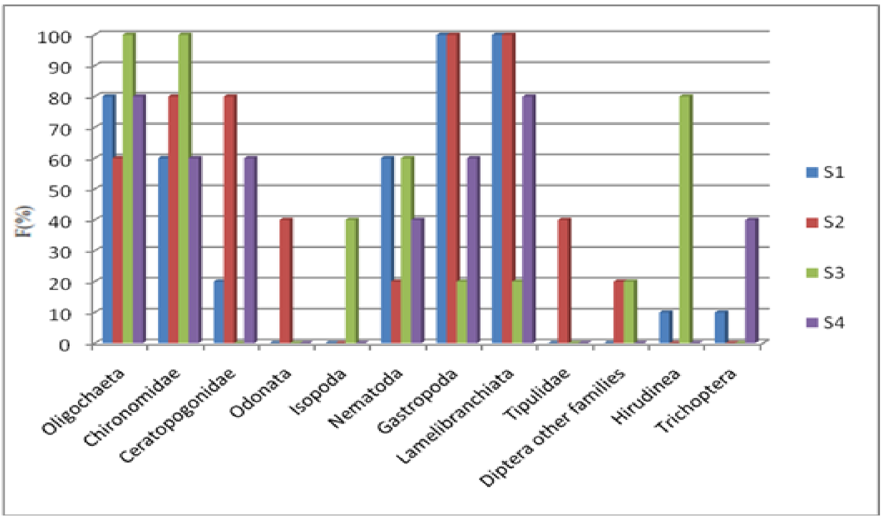

Fig. 7 . Macroinvertebrates' frequency in the Bega River (%)

4. Conclusions

The analysis of benthic communities from the Bega River shows the occurrence of ten groups of invertebrates: *Oligochaeta* subclass, Diptera order (larvae of the families *Chironomidae, Ceratopogonidae* and *Tipulidae*), *Lamelibranchiata* class, *Hirudin* class, *Gastropoda* class, *Isopoda* order, *Nematoda* phylum, *Trichoptera* order, *Isopoda* order, *Coleoptera* order *Odonata* order. The *Diptera* (preponderantly represented by *Chironomidae* Family) families and *Oligochaeta*, had 100% frequency.

Regarding the other groups, they occurred in the benthos it is depend of the degree of water pollution and to the sub-layer submitted to analysis found in different stations.When the river flows through Timisoara city, the benthic community shows a rather high degradation of water quality in the Bega river. Passing over the major sources of pollution, we observe self-purification process in the water quality of the river, evidenced by the appearance of the individuals of the *Trichoptera*.

In conclusion, can be noticed that indicators of unpolluted water (*Lamelibranchiata*, *Trichoptera*, *Gastropoda* and *Odonata*) have been identified in the first and the second station groups while these indicators were absent in station three. The highest density values of the unpolluted water indicators were noticed in the second station while the highest density values of the groups with high tolerance to pollution (*Diptera*, *Oligochaeta*) were noticed in the third station.

In the last station, the density values of the groups with high tolerance to pollution decreased and macroinvertebrates that are considered indicators of unpolluted water appear. Analyzing these data, this work can conclude that the superior sector of the studied area has superior water quality and if during the river there are no major sources of pollution, the process of self-purification takes place.

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