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GASTROPODS IN THE BASIN OF THE RIVER FOJNIČKA

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Summary

The first detailed investigation of Gastropods in the basin of river Fojnička has been carried out in 2001–2002. The material has been sampled five times during four seasons (October 2001–September 2002) at 11 sites in the following waterways: the rivers Fojnička, Dragača, Željeznica, Kreševka and Lepenica. Measurement of certain physical and chemical parameters (BOD_5, water temperature, pH value, amount of dissolved oxygen, saturation with oxygen and one time measurement of concentration of nitrates and phosphates) has been carried out together with collecting of macroinvertebrates of zoobenthos. Since the knowledge of biodiversity of Gastropods in Bosnia and Herzegovina is at the very low level, the main objective of this paper is to give an overview of distribution of Gastropods communities in the Fojnička river basin. In these investigations, 11 taxa of Gastropods and 1468 individuals have been determined. The Gastropods made 16% of total settlement of macroinvertebrates of zoobenthos. Dominant species at investigated sites was *Ancylus fluviatilis*, while species *Acicula sp.*, *Saxurinator sp.* and *Valvata piscinalis* were just sporadically recorded. The largest number of individuals (657) and largest number of species (eight) was recorded at the mouth of the river Fojnička into the river Bosna.

Key words: Gastropods, macrozoobenthos, the river Fojnička, biodiversity

INTRODUCTION

The fauna of the benthos is an important indicator of the surface waters quality which has been frequently used in various monitoring programs.

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It is a very diverse animal group with a large number of various biosystematical groups and therefore there is a real assumption that at least some of them reacts to caused environmental changes due to the various human impacts. In comparison with other biological indicators, macroinvertebrates of zoobenthos have the following advantages:

- ✧ Sampling is simple, cheap and results in minimal negative impacts on the habitat,
- ✧ They are long living, numerous, and relatively sedentary organisms
- ✧ They are an important link in the fish and other freshwater aquatic predators food webs,
- ✧ They react very quickly to the presence of pollutants in the water.

After settling in the certain area, the largest number of macroinvertebrates stays at relatively limited area, often smaller than 5 m^2, during their whole life cycle. For these reasons, in contrast to the numerous biotic or chemical indicators, benthos reflects the state specific for the given site. The macroinvertebrates communities are heterogeneous and represented with various taxa, therefore there is a relative high probability that some of them will react to the changes of ecological conditions in aquatic environment, which is confirmed by the numerous international investigators (Mol, 1982; Wetzel, 1983).

Freshwater snails serve as hosts for a large number of other species (e.g., for complete development of sheep liver fluke (*Fasciola hepatica*), it is necessary presence of the snail *Lymnaea truncatula*, as a temporary host, while snail *Bithynia tentaculata* could at the same time be host for several fluke species (Matoničkin, 1978).

Natural enemies of freshwater snails are leeches, which eat snails by sucking them. For example, small leech (*Glossiphonia heteroclite*) is an enemy to the snail *Bythinia tentaculata* (Vagner, 2001).

Gastropods play an important role in the food web of aquatic ecosystems. In the first place, they are important as detrivores of rotting matter, plant parts and detritus. A large part of periphyton from water goes through digestive system of snails. This, in turn, serves as a food to the numerous animals, particularly to the fish and birds. Rodents, insectivors, and birds of prey also eat freshwater snails (Vagner, 2001).

Some 570 species of freshwater snails live in Europe today, and 60 of them live in the Western Balkans — ecoregion 5 (Illies, 1978).

There is still not enough data on species which inhabit benthos in waterways of Bosnia and Herzegovina. However, numerous scientists gave contribution to the knowledge and understanding of snails' biodiversity through investigations of total zoobenthos. The most important works in this field are investigations of the river Bosna watershed

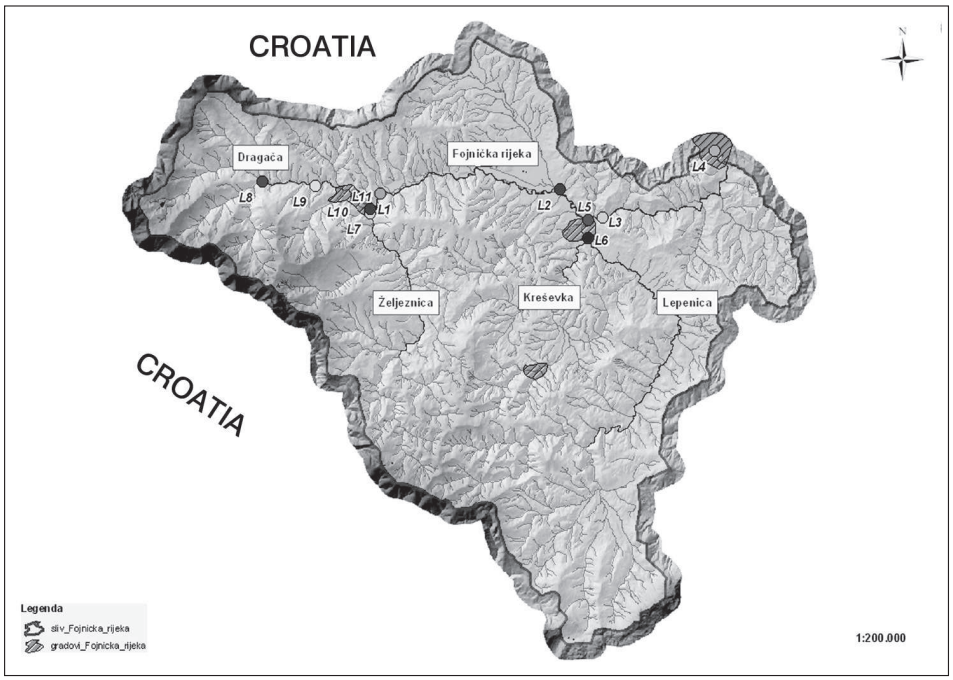


Fig. 1. Sampling locations (L1–L11)
Slika 1. Mjesta uzorkovanja (L1–L11)

(Bevanda et al., 1997; Vagner and Meštrov, 1997, 1998; Trožić–Borovac, 2001; Sofradžija et al., 2003 (a); Cikotić, 2004), the river Neretva (Sofradžija et al., 2003 (b)), the river Una (Vagner and Meštrov, 1997; Trožić–Borovac and Škrijelj, 2000), and the river Vrbas (Vagner and Meštrov, 1997).

Taking into account that Gastropods in the river Fojnička have been sporadically investigated, the objective of this paper is to give an overview of biodiversity of this very interesting group of molluscs in the investigated waterway, in order to give a contribution to the knowledge of this relativelly rich group of invertebrates.

The analysis of Gastropods in this paper relies on the achievements of investigations of macroinvertebrates of zoobenthos in the river Fojnička basin, in the periods October 2001, March 2002, May 2002, July 2002 and September 2002.

Investigated area

From the morphological standpoint, river Fojnička basin belongs to the hilly–mountain region with an area of 717.30 km^2. The upper part of the basin includes slopes of some of the highest mountain ranges in the

country (Mt. Bjelašnica and Mt. Vranica). The largest part of the basin covers forests up to 1600 m of altitude. Mountain turfs and shrubs are developed above the timberline. The basin of the river Fojnička has a very developed hydrological network, which is the result of specific bedrock type. The river Fojnička as a main watercourse in this area origins from rivers Željeznica and Dragača which have confluence some three km downstream of the town of Fojnička. Its tributaries are rivers Mlava and Lepenica whose watershed covers 41% of the total watershed of the river Fojnička. Other important waterways are rivers Kreševka, Crna and Bijela running into the river Lepenica, and small rivers Jezernica and Borovica running into the river Dragača.

Sampling sites are presented in Figure 1.

Moderate continental climate type prevails in the lowland part of the river basin while mountain climate type prevails in the higher parts.

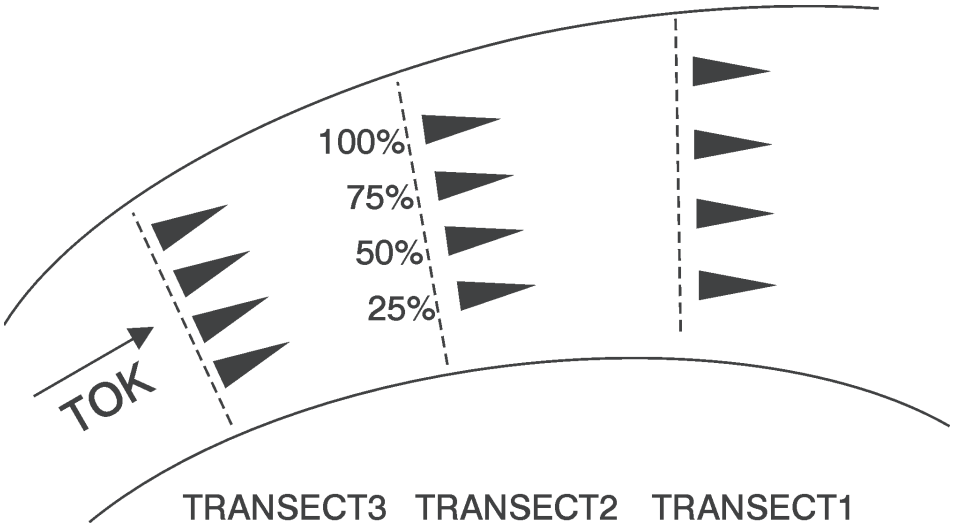
Administratively, the river Fojnička basin is located in four cantons (Sarajevo, Central Bosnia, Zenica–Doboj, and Herzegovina–Neretva) and seven municipalities (Konjic, Hadžići, Fojnica, Kreševo, Ilidža, Kiseljak and Visoko). Some 50 000 inhabitants live in the direct contact with the river basin. There are no significant industrial facilities in this area.

River Fojnička, being the most important surface running water in this river basin, runs mainly through magmatites, and quartz–daze, daze–quartz graphite and quartz–daze–hlorite shales. The river Lepenica as the most important tributary to the river Fojnička, due to the very pronounced presence of limestone from Devon and Triasic, exhibits increased hardness of the water in the lower part of the course. Barite exploitation in the vicinity of the river Kreševka, and the presence of barite in this area, result in increasing concentration of the SO_4 in the water of Kreševka river.

MATERIAL AND METHODS

The investigations of macroinvertebrates of zoobenthos in the river Fojnička basin were conducted in the period October 2001–September 2002. The material has been sampled five times during four seasons (October 2001, March 2002, May 2002, July 2002 and September 2002) at 11 sites in the following waterways: the river Fojnička, Dragača, Željeznica, Kreševka and Lepenica.

The Gastropode community was sampled using standard hand net with implementation of kick sampling method (Figure 2). Hand net is made of wooden handle 2 m long and metal frame (25 x 25 cm) and the net with mesh size of 0.5 mm in diameter. During the sampling procedure, the net is oriented with its entrance facing the water current. Kick sampling is simple and quick method and it includes transect of the wa-



ter course in three points with distance of at least 10 m from each other. At each sampling point, three or four samples have been gathered at various depth and at the distance which was 1/4 of the total width of the river bed from each other (25%, 50%, 75% and 100%). They are all included in one subsample. In this way, three subsamples which made one sample, have been gathered after completion of each transect point. In kick sampling method, the net is fixed firmly to the river bed with mouth facing the water current. After that, it is necessary to uplift sediment with one leg, some 40 cm opposite to the water current and then wait until water washes out all organisms. After the sediment is settled down, this process should be repeated some 1.5 — 2 meters towards the mainstream part of the watercourse. In this way the sediments are collected and mixed in the water. Collected samples are fixed in 4% formaldehyde solution in glass bottles. A label with data on site and date is enclosed in the sample. After separation and determination using binoculare microscope, specimens are preserved in 70% alcohol solution in glass bottles with enclosed labels containing data about the sample. For determination of Gastropods, the key by B o l e (1969) has been used.

RESULTS AND DISCUSSION

In 153 samples of macroinvertebrates from the watershed of river Fojnička, gathered in the period October 2001–September 2002, 9 175 in-

dividuals and 147 taxa were determined. 11 species and 1468 individuals belong to Gastropods, which makes 16% of the total zoobenthos settlement (Table 1). The largest number of species (eight) and the largest number of individuals (657) was present at the mouth of the river Fojnička into the river Bosna site (L4), and just one species was recorded at the site of river Dragača — Tovarište (L8) with three individuals. The species *Ancylus fluviatilis* was found at eight sites. It reaches the highest abundance at the site of river Dragača before the confluence with the river Željeznica (L11), while the minimal number of the individuals was recorded at the same watercourse at the site Tovarište. The species *Lymnea (Radix) sp.* was recorded at eight sites. It reaches the highest abundance at the river Fojnička, the site Ribnjak (L2) — eight individuals, and the lowest at the river Dragača — the site Reumal (L10), the river Fojnička after the mouth of the river Lepenica (L3), and at the mouth of the river Lepenica into the river Fojnička (L5) — just one individual. The species *Viviparus viviparus* was recorded at six sites, with the highest number of individuals (643) at the site L4. Species *Acicula sp*, *Saxurinator sp*., *Theodoxus danubialis*, *Theodoxus fluviatilis*, *Valvata piscinalis* are represented with the small number of individuals at investigated sites. *Planorbis planorbis* and *Renea sp*. were recorded at two sites (Table 1).

According to V a g n e r (2001), water temperature was rarely limiting factor for snails living within their natural geographic areal. However, since the temperature influences primary production and the quantity and quality of produced biomass, the abundance of snail population depends on the type of available food. On the basis of measured values, in all periods of investigations, seasonal variations of water temperature could be noted of which the lowest was in the spring area.

Temperature regime influences reproduction of freshwater snails. It is possible to note difference among populations of the same species living at the habitats with variable temperature regime.

The freshwater snails use oxygen for their metabolic activities. Therefore, the oxygen is limiting factor for survival of snails at some sites. Pulmonates (which could use atmospheric air for breathing) could live some time in anaerobic conditions, but their eggs must be in touch with oxygen during their development.

The results of measurements of disoloved O_2 and saturation with O_2 in the watershed of the river Fojnička, in the spring and in the summer season, have shown that values of these parameters have been almost the same, while in the fall these values are a bit higher.

pH water value is an important factor for presence or absence of snails. Low or high pH values at habitats optimal for the development of snails are limiting factor (V a g n e r, 2001). pH water value at investigated sites of the river Fojnička and their tributaries varies from slightly

acidic to the slightly alkaline. The recorded results indicate small variations in the concentration of hydrogen ions.

The snails are particularlly sensitive to the presence of heavy metals Zn, Cu, Hg and Ag (V a g n e r, 2001).

Water reservoirs have negative impact on survival of snails (V a g n e r, 2001). Significant variations in the flow rate influence the washing out of snails downstream from the reservoirs, while mud in suspension has an abrasive impact on snail. Mud also decreases penetration of light, reduces primary production, and decreases level of dissoloved oxygen. Snail eggs can not develop when they are covered with mud. Also, the number of snail individuals and species decreases during construction works carried out in the river bed.

The species *Viviparus viviparus* was present at six investigated sites. Representatives of this species live mainly in the waters with rich vegetation and they are dominant species at the site L4. Viviparidae are the only one viviparus snails in the ecoregion 5. They are a relatively weak indicator of water quality and they live mainly in beta–mesosaprobic waters (II class). They were also found in the river Bosna watershed (Trožić–Borovac, 2001) and in the river Krivaja (Cikotić, 2004).

Ancylidae are small family of freshwater pulmonat snails, which is in our zoogeographical region represented with just two species: *Ancylus fluviatilis* (river limpet) and *Acroloxus lacustris* — lake limpet. The species *Ancylus fluviatilis* was recorded at large number of sites in the investigated area. It lives in running waters in salmonid region with strong water currents. It indicates slightly polluted waters. This species lives on rocky river bed in the running waters in Europe (Hynes, 1970). It is present in almost all rivers in Bosnia and Herzegovina which belong to I–II, II, II–III class (if they are well aerated), such as the river Bosna and its tributaries Lašva and Željeznica (Trožić–Borovac, 2001), Krivaja (Cikotić, 2004), Vrbas, Drina, Neretva, Bregava, Trebižat (Vagner et al., 1991). This species lives throughout Europe besides Iceland and tundra region (Marković, 1998).

Lymnaeidae with species *Lymnaea (Radix) sp.* was present at eight investigated sites, with small number of individuals. Individuals of this species mainly live in waters which are rich of limestone and in betamesosaprobic–alphasaprobic waters. This species have also been found in the river Krivaja (Cikotić, 2004).

Planorbidae include pulmonate snails whose shell is bended in one plain and which live in freshwaters. Their blood is colored with the red pigment hemoglobine, they can accept oxygen more actively and therefore can live in standing and slow running waters. The species *Planorbis corneus* was found with small number of individuals at three sites (L4, L7 and L9), while species *Planorbis planorbis* was found with only one individual at the sites L4 and L6. The species from genus *Planorbis* have also been found in the river Krivaja (Cikotić, 2004).

Nerithidae with genus *Theodoxus* whose species *Theodoxus danubialis* and *Theodoxus fluviatilis* inhabit waters rich in limestone, mainly on the sides of rocks and their upper parts, as well on other firm objects submerged in the water, strongly adjusted to the surface. In some periods small individuals can adjust to the shell of larger individuals and with radula they damage shell of these individuals. In this way they obtain calcium and other materials necessary for building of their own shell (Marković, 1998). They live in oligo to beta mesosaprobic and beta mesosaprobic waters, and rarely in beta to alpha mesosaprobic waters. Relatively small number of individuals was present at L4. This species was also found in the river Bosna (Trožić–Borovac, 2001), the

river Usora (Vagner, 1998), mouth of the river Vrbanja (Bevanda et al., 1997) and in the river Lašva (Vagner et al., 1991).

Valvatidae are small, up to 7 mm tall snails, which inhabit bottom of brook and larger watercourses where current is not so strong, and lakes. The species *Valvata piscinalis* was represented with just one indivudual at the site L4.

According to literature data (Vagner and Meštrov, 1998) at the mouth of the river Fojnička into the river Bosna in the period 1989 — 1990, Gastropoda made 13% of the total settlement of zoobenthos.

CONCLUSION

The results of investigations of macroinvertebrates of zoobenthos in the watershed of the river Fojnička in the period October 2001–September 2002 have shown the presence of 11 taxa and 1468 individuals of Gastropodes. Gastropods made 16% of total settlement of macroinvertebrates of zoobenthos. A dominant species in investigated sites was *Ancylus fluviatilis*, while species *Acicula sp*., *Saxurinator sp*. and *Valvata piscinalis* were just sporadically recorded. The largest number of individuals was recorded at the mouth of the river Fojnička into the river Bosna — 657.

A very low number of species was recorded in the fall season which was caused by intense precipitation and high water level in the watershed of the river Fojnička.

Negative human impact has been noted at certain sites in the settlements (municipality sewage system goes directly into recipient, construction works in the river bed and on the river banks, etc), which lead to the changes in optimal conditions for aquatic fauna, and decrease in their diversity and abundance.

However, it was not possible to carry out proper assessment of biological water quality on the basis of just one community, for example the community of freshwater snails, since the number of recorded snails was low at one site and saprobic valence ranged from oligo to beta-mesosaprobic water. For these reasons higher levels of saprobity (alpha–betaosaprobic and polisaprobic) are not included.

Sažetak

GASTROPODI U SLIJEVU FOJNIČKE RIJEKE

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Prvo detaljno istraživanje gastropoda u slijevu Fojničke rijeke provedeno je tijekom 2001.–2002. godine. Materijal je uzorkovan pet puta u tijeku četiriju godišnjih sezona (listopad 2001. — rujan 2002.) na 11 lokaliteta, i to na sljedećim vodotocima: Fojnička rijeka, Dragača, Željeznica, Kreševka i Lepenica. Istodobno s prikupljanjem uzoraka makroinvertebrata zoobentosa, mjereni su i neki fizikalno–kemijski parametri (BPK_5, temperatura vode, pH–vrijednost, količina otopljenog kisika, zasićenost kisikom i jednokratno mjerenje koncentracije nitrata i fosfata). Imajući u vidu činjenicu da je biodiverzitet gastropoda u Bosni i Hercegovini na dosta niskom stupnju istraženosti, cilj je ovog rada sagledavanje distribucije zajednice gastropoda slijeva Fojničke rijeke. Navedenim je istraživanjima identificirano 11 taksona i 1 468 jedinki gastropoda i činile su 16% od ukupnog naselja makroinvertebrata zoobentosa. Dominantna vrsta na istraživanim lokalitetima jest *Ancylus fluviatilis*, dok se sporadično susreću vrste *Acicula sp*., *Saxurinator sp*. i *Valvata piscinalis*. Najveći broj vrsta (osam) i najveći broj jedinki (657) zapažen je na lokalitetu ušća Fojničke rijeke u Bosnu.

Ključne riječi: gastropodi, makrozoobentos, Fojnička rijeka, biodiverzitet

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