

ECOLOGICAL STATUS ASSESSMENT OF THE GRADAC RIVER (WESTERN SERBIA) BASED ON AQUATIC MACROINVERTEBRATES

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Abstract

The Gradac River is the first larger tributary of the Kolubara River. Situated in hilly and mountainous region, south from the city of Valjevo, with no larger pollution sources and with gorge which is regarded as nature reserve, this carst river could be considered as one of „nearly natural“ Serbian watercourses. The aim of this paper is to test ecological status of such „reference watercourse“ based on present aquatic macroinvertebrate communities. Macroinvertebrate samples were taken in the May of 2015 at five localities along the Gradac and its branches (the Bukovska and Zabava Rivers). For the ecological status assessment following metrics were applied: Saprobic Index (Zelinka & Marvan; SI), BMWP (Biological Monitoring Working Party) Score, ASPT (Average Score Per Taxon), Number of Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa, Total number of taxa, Participation of Oligochaeta (Tubificidae) in total community (% Oligochaeta), Number of families and Shannon-Wiener’s Diversity Index (SWI). A total of 55 aquatic macroinvertebrate taxa were identified. Insects were found to be the most diverse component of recorded fauna. Ephemeroptera were the dominant insect component in terms of diversity (14 taxa) and relative abundance (40% of total community). Values of used indices point to very good (I class) and good (II class) ecological status of the river. This result confirms previous investigations, and supports the fact that the Gradac River is one of a „nearly natural“ watercourses in the region.

Key words: Saprobic indices, biotic indices, ecological status, reference condition, Gradac River, Serbia

Сажетак

Река Градац је прва већа притока Колубаре и протиче кроз брдско-планински крај јужно од Ваљева (јужна Србија). Захваљујући одсуству значајнијих загађивача и са клисуром која је под заштитом државе као резерват природе, ова крашка река се сматра једним од неколицине сачуваних „скоро природних“ водотокова у Србији. Циљ овог рада је да се на основу анализе присутних заједница водених макробескичмењака провери „референтни“ статус Градца. У ту сврху у мају 2015. године је узоркована заједница водених макробескичмењака са пет локалитета дуж реке Градац и њене две саставнице (Буковска река и Забава). За оцену еколошког статуса коришћени су следећи показатељи: сапробни индекс по Зелинка-Марвану (Zelinka & Marvan ; SI), BMWP индекс, ASPT индекс, EPT индекс (број таксона група

Ephemeroptera, Plecoptera и Trichoptera), укупни број таксона, учешће представника групе Oligochaeta (Tubificidae) у заједници, број фамилија и Шанон-Винеров индекс диверзитета (Shannon-Wiener's index; SWI). У нашем истраживању идентификовано је укупно 55 таксона водених макробескичмењака. Инсекти су се издвојили као најбројнија компонента дате фауне. Међу инсектима група водених цветова (Ephemeroptera) се показала као најзначајнија, како по диверзитету (14 таксона), тако и по релативној бројности (40% укупне заједнице). На основу израчунатих показатеља еколошког статуса, статус реке Градац је оцењен као веома добар (I класа) и добар (II класа). На овај начин потврђени су резултати претходних истраживања ове реке, која се са правом сматра једним од очуванијих водотокова Србије.

Кључне речи: сапробни индекси, биотички индекси, еколошки статус, референтно „скоро природно“ стање, Градац, Србија

Introduction

The Gradac River is the first larger and water richest tributary of the Kolubara River. It is a relatively short watercourse. From the mouth of the Bukovska and Zabava Rivers, south from the city of Valjevo in western Serbia, the Gradac flows some 28 km, until it reaches its confluence with the Kolubara in the Valjevo. The river basin covers area of 171 km². The upper part of the river, known as „Suvaja“, in warmer periods of year usually runs dry, so it could be considered as a subterranean river. In the middle part, the river flows through the famous Gradac gorge, which is regarded as nature reserve. On the river, two smaller reservoirs - "Degurić" and "Gradac", are built. Nevertheless, situated in the hilly and mountainous region of eastern Dinarids, with no larger pollution sources and with gorge which is regarded as nature reserve, this carst river could be considered as one of „nearly natural“ Serbian watercourses. Only low local degradation can be attributed to the construction of dams and the impact of nearby railroad (Đikanović et al, 2010). Freshwater biomonitoring includes the collection, processing and analysis of aquatic organisms in order to assess the quality of freshwater ecosystems. Freshwater macroinvertebrates are important biotic component of ecosystems, and due to numerous advantages, they are the most commonly used group in freshwater biomonitoring (Rosenberg and Resh, 1993). International and national legislative (EU Water Framework Directive (WFD, 2000) and Official Gazette 74/2011) define parameters for such ecological assessment.

The aim of this paper is to test ecological status of the Gradac River, as „reference watercourse“, based on its benthic macroinvertebrate communities.

Material and Methods

The sampling was performed in the May 2015 (high water level regime) at five sampling sites (table 1; figure 1). Semi-quantitative samples were taken with a standard benthological hand net (25x25 cm, 500 µm mesh size), in accordance with the AQEM protocol (Hering et al, 2003). All samples were preserved with 60-80% ethanol solution and further processed in the laboratory. Identification of macroinvertebrates was done by using appropriate taxonomic keys.

Table 1. Sampling localities at the Gradac River

Locality	N lat	E long	Altitude (m.a.s.l.)
GRADAC 1 (Bukovska R.)	44° 09'20.77"	19°53'10.36"	376
GRADAC 2 (Zabava R.)	44° 09'15.10"	19°53'04.88"	375
GRADAC 3 (Lastra)	44° 09'31.92"	19°52'56.44"	368
GRADAC 4 (Ćelije)	44°14'00.06"	19°51'58.14"	251
GRADAC 5 (Degurić)	44°14'29.10"	19°53'11.37"	214

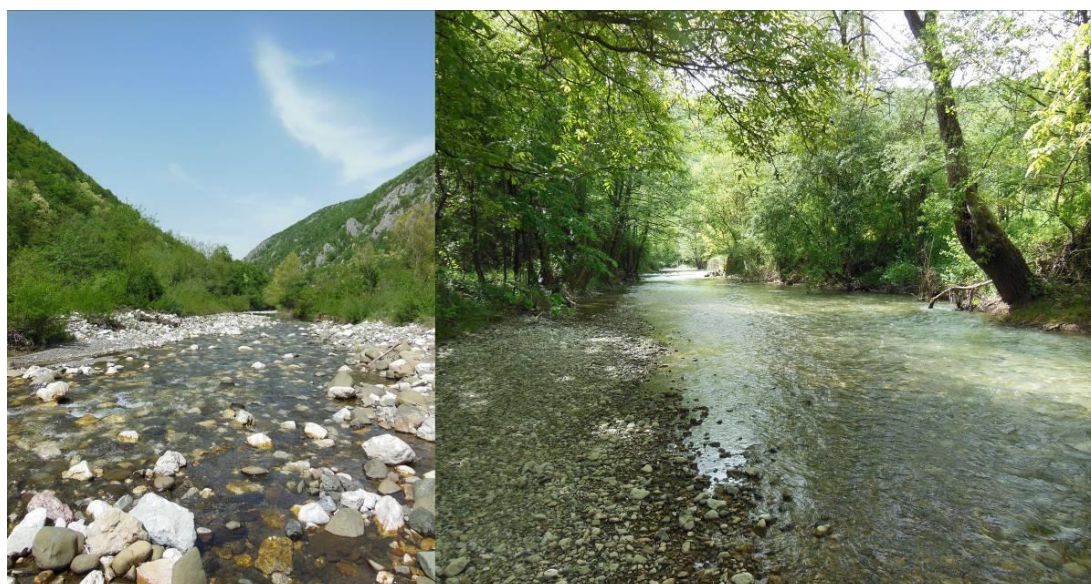


Figure 1. Gradac River; a) the upper part (the Lastra locality) b) the middle part (the Ćelije Monastery), (photo M. Ilić, May of 2015)

Saprobiological analysis was carried out using a list of bioindicator organisms according to Moog (2002). For the ecological status assessment the following metrics were applied: Saprobic Index (Zelinka & Marvan; SI), BMWP (Biological Monitoring Working Party) Score, ASPT (Average Score Per Taxon), Number of Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa, Total number of taxa, Participation of Oligochaeta (Tubificidae) in total community (% Oligochaeta), Number of families and Shannon-Wiener's Diversity Index (SWI). The AQEM software was used for all calculations (AQEM, 2002). Water quality assessment was performed in accordance with the national legislation (Official Gazette of the R. of Serbia 74/2011), based on ecological status classes for small and medium-sized streams, altitude up to 500 m, with the dominance of large substrates (type 3), in the case of the Gradac River. The branches, the Bukovska and Zabava Rivers, were assessed as small streams

outside of the Pannonian basin which were not covered by 96/10, ie. as type 6 according to current legislative (Official Gazette of the R. of Serbia 96/2010).

Results and Discussion

A total of 55 aquatic macroinvertebrate taxa were identified. Having in mind that some groups, most notably chironomids, were not identified to the species level, the diversity is presumably higher. Insects were found to be the most diverse component of recorded fauna. Ephemeroptera were the dominant insect component in terms of diversity (14 taxa) and relative abundance (40% of total community). The highest diversity was found at the site Gradac 4 (Ćelije Monastery), with 34 identified taxa, while the lowest was found at the locality Gradac 3 (Lastra) with 17 recorded taxa only. It could be noted that recorded diversity is lower than in some previous investigations, for example 87 taxa were reported by Đikanović et al (2010) based on two-year investigations. Regarding taxonomic composition, the dominance of EPT (Ephemeroptera, Plecoptera and Trichoptera) with 31 recorded taxa is expected for this type of medium-sized hilly river (Paunović, 2007), and corresponds to some previous reports (Đikanović et al, 2010). In regards to the percentage participation of the major taxonomic groups, Ephemeroptera were also found to be the most abundant component (40% of total community), while EPT taxa participation was approximately 60% of total community. It should be mentioned that besides the EPT taxa, Diptera were also important component, in terms of diversity (11 taxa), and relative abundance (27%). Regarding ecological classification of taxa based on its saprobic valence (Moog, 2002), the majority of taxa were adapted to the low degree of organic pollution (β –mesosaprobic taxa; 14,2%), while taxa sensitive to organic pollution (oligo- and xenosaprobic) were also abundant (13,5% of community). Taxa tolerating higher organic load (α –mesosaprobic taxa) were rare, making only 5% of detected community. Taxa adapted to high organic pollution (polysaprobic taxa) were not found in this investigation. A significant share of taxa which were not assessed regarding its saprobic preferences, making two thirds of found community (67%), should be noted. Assemblages at all localities have more or less the same structure regarding sensitivity to organic pollution (figure 2). Only at locality Gradac 3 a somewhat higher share of α –mesosaprobic taxa could be noted.

Figure 2. Percentage participation (%) of main saprobic groups in the investigated communities of the Gradac River

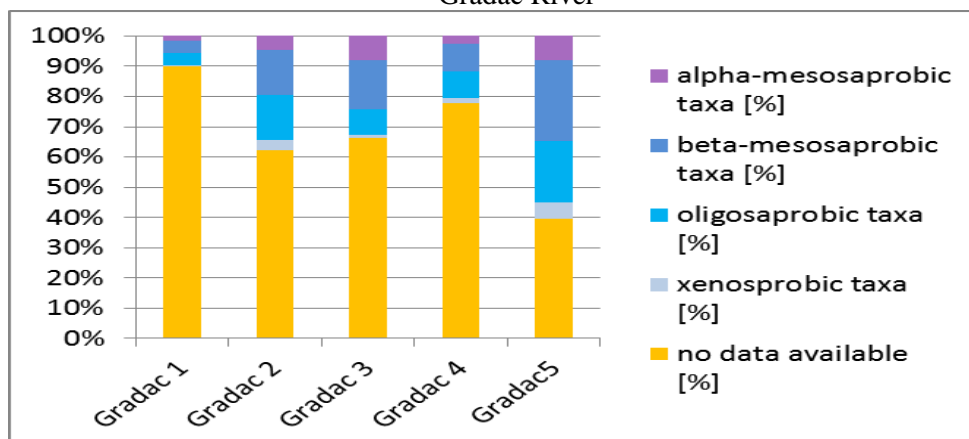


Table 2. Values of calculated metrics and water quality classes for the Gradac River

Locality	Gradac 1		Gradac 2		Gradac 3		Gradac 4		Gradac 5	
Total No. of Taxa	24	I	27	I	17	II	34	I	31	I
No of Families	17	I	18	I	14	I	20	I	22	I
SI	1.64	I	1.5	I	1.92	II	1.54	I	1.66	I
BMWP	89	II	99	I	83	II	126	I	116	I
ASPT	6.85	II	7.07	I	6.92	II	7.41	I	7.25	I
SWI	1.39	III	2.68	I	2.05	II	2.49	I	2.79	I
EPT	2	III	4	II	15	III	12	I	3	I
Oligochaeta (%)	0	I	0	I	0	I	0	I	0	I
Average	II		I		II		I		I	

Calculated values of used indices point to very good (I class) and good (II class) ecological status of the river (table 2). The better overall ecological status in the lower river stretch (localities Gradac 4 and 5) compared to its upper stretch, should be noted. It could be explained by more diverse habitats in this lower stretch, and due to more diverse macroinvertebrate community, as well as with absence of dry periods (contrary to upper part „Suvaja“), which in absence of larger/major pollution sources along this river, results in such situation. The high share of taxa which lack ecological preferences (taxa which were not used for assessment), suggests a caution when interpreting the results, and points to the necessity of further improvement of the evaluation system, and its adjustment to this region.

As obtained results of ecological assessment are in accordance with results of previous investigations (period 2003-2006; Đikanović et al, 2010), it could be stated that the Gradac river maintain high ecological status, and thus could be regarded as one of clear rivers („reference“ or „nearly natural“ watercourse) in Serbia. However, despite such good status, the imperative remains further preservation and protection of this jewel among rivers of Serbia.

Conclusion

The Gradac River is regarded as one of „nearly natural“ Serbian watercourses. Ecological status assessment was performed based on sampled benthic macroinvertebrates and appropriate national legislative. It was confirmed reference (very good; class I) ecological status of this river, for the majority of investigated localities. Somewhat poorer ecological status (good; class II) was registered at the two localities, belonging to upper river part called „Suvaja“, which occasionally get dry (subterranean river). Having in mind previous investigations of the river it could be stated that the Gradac truly is one of the well preserved Serbian rivers. However, despite this results, the imperative should remain further, and even better preservation and protection of this river.

Acknowledgments

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