

METHODS OF BIOMONITORING APPLIED DURING ONE-YEAR RESEARCH OF THE KRIVAJA RIVER

Mihad Cikotić
University of Zenica
Faculty of Pedagogy
Bosnia and Herzegovina

Šefket Goletić
University of Zenica
Faculty of Mechanical Engineering
Bosnia and Herzegovina

ABSTRACT

There are many methods applied today in biomonitoring of the running wates. During one-year research of the Krivaja river – from November, 2001 to October, 2002 – a physico-chemical analysis of water was conducted. Also, some biotic indexes based on collected samples of macroinvertebrates of zoobenthos were applied. Namely, Shannon-Weaver's index of diversity and modified widen biotic index. Additionally, parameters of saprobic index according to Wegl were determined. The level of heterogeneity of macroinvertebrates of Krivaja was shown by calculating the index of variosity and coefficient of similarity of macroinvertebrates. Based on results of applied methods evaluating the water quality of the Krivaja river, we reached the conclusion that the river is a mountain running water of I-II class of quality, i.e. little to moderately polluted water.

Keywords: biomonitoring, saprobic index, biotic indexes, macroinvertebrates of zoobenthos

1. INTRODUCTION

The aquatic ecosystems are particularly affected by various types of pollution. Therefore, different researches of the aquatic ecosystems are conducted in order to find the best methods of permanent control of the water quality. Thus, we carried out one-year research of the Krivaja river as a significant right tributary of the Bosna river in its middle stream. The objective of one-year research of the Krivaja river is based on the series of assignments:

- to determine physico-chemical properties of the Krivaja water
- to make an analysis of both qualitative and quantitative structure of zoobenthos macroinvertebrates community of Krivaja
- to determine macroinvertebrates taxa and their distribution in the river
- to calculate Shannon-Weaver's index of diversity of macroinvertebrates
- to determine the heterogeneity level of macroinvertebrates based on index of variosity and coefficient of similarity
- to calculate parameters of the modified widen biotic index of macroinvertebrates (EBI index)
- to calculate parameters of the modified saprobic index according to Wegl

2. MATERIALS AND WORKING METHODS

The one-year researches of the Krivaja river were conducted from November, 2001 to October, 2002 [1].

The Krivaja river emerges from the Bioštica and Stupčanica rivers in the town of Olovo. It flows into the Bosna river in the town of Zavidovići following 56,6 km of the stream. This river runs through the mountainous areas, squeezing through the canyons, rugged rural areas as well as lowlands in its middle stream. During this research some measurements and analysis of physico-chemical parameters of the water were done: water temperature, amount and saturation of oxygen in the water, water flow, water pH, water BPK₅ and the concentration of nitrates (NO₃) and phosphates (PO₄). The sampling of zoobenthos macroinvertebrates was conducted on six selected locations. Two locations were chosen in the town of Olovo at the constituents of Krivaja (LA-Bioštica i LB-Stupčanica), whereas four remaining locations were chosen in the upper stream (L1-Boganovići), middle stream (L2-Stipin Han i L3-Vozuća), and lower stream (L4-Kovači). The macroinvertebrates sampling was conducted by “kick sampling“ method [2].

This was carried out in five occasions: 10 November 2001, 10 March 2002, 8 June 2002, 11 July 2002, and 26 October 2002. The samples were fixed with four-percent formaldehyde while the separation and determination of items was done in laboratory at Faculty of Science, University of Sarajevo, based on the relevant references [3,4,5].

Diversity of macroinvertebrates community was shown by Shannon-Weaver's index of diversity [6]. Water quality was determined by the methods of modified widen biotic index and modified saprobic index (EBI index) [7] according to Wegl [8].

3. RESULTS AND DISCUSSION

During one-year research of the Krivaja river, 90 samples of zoobenthos macroinvertebrates were taken on six selected locations. We found a total of 133 taxa counting 12,766 items in these samples. Selected „kick sampling“ method was appropriate for the type of running water such as Krivaja. The analysis of physico-chemical parameters showed that Krivaja is a strong colder mountain running water with homogenous and higher oxygen amount and saturation values as well as favourable water pH. The sediment consisted of large stones, gravel with less sand that is preferential to the development of zoobenthos macroinvertebrates of the running waters. The concentration of nitrates and phosphates did not exceed maximal values showing us that Krivaja is not affected by heavier organic pollution. The same case is with BPK₅ values. The middle values of physico-chemical parameters are shown in the table 1.

The values of physico-chemical parameters give us the picture of homogenous conditions of climate, relief and other important parameters for the life of organisms in the Krivaja river along its stream. The values of water flow show all the strength of this running water. During the occasions of research, in November and March, we noticed an abrupt rise of water level as a result of unfavourable anthropogenous influence on forests in the area of the Krivaja stream.

Table 1: Middle values of physico-chemical parameters of the Krivaja.

Physico-chemical parameters	Air temperature (°C)	Water temperature (°C)	Water flow (m ³ /s)	Water pH	O ₂ amount (mg/l)	O ₂ saturation (%)	Water BPK ₅	NO ₃ (mg/l)	PO ₄ (mg/l)
Middle values	16.26	11.03	11.15	7.6	10.1	98.2	2.23	2.2751	0.094

Based on mentioned indicators we concluded that Krivaja is a favourable water habitat for the development of aquatic biocenoses. This claim is proven by the biocenologic analysis of benthos macroinvertebrates of Krivaja. The groups of macroinvertebrates found in the samples of Krivaja are shown in the table 2.

Table 2: Groups of zoobenthos macroinvertebrates of Krivaja.

Taxonomic categories	LA	LB	L1	L2	L3	L4	Σ items	Σ taxa	% presence
<i>Turbellaria</i>			1				1	1	0.007
<i>Gastropoda</i>	1	3	22	98	25	170	319	10	2.498
<i>Bivalvia</i>	1				1	1	3	2	0.023
<i>Oligochaeta</i>	314	240	120	61	29	179	943	7	7.386
<i>Hirudinea</i>	22	2	7	6		1	38	2	0.297
<i>Amphipoda</i>	1.929	3	103	13	3	2	2.053	1	16.081
<i>Ephemeroptera</i>	1.236	534	878	497	277	297	3.719	24	29.132
<i>Plecoptera</i>	376	148	385	164	59	106	1.238	22	9.697
<i>Odonata</i>	2	1	4	1	6	1	15	3	0.117
<i>Trichoptera</i>	545	116	389	379	39	215	1.683	37	13.183
<i>Diptera</i>	1.010	502	470	202	127	250	2.561	14	20.061
<i>Coleoptera</i>	53	37	41	37	3	22	193	8	1.511
Σ items	5.489	1.586	2.420	1.458	569	1.244	12.766	133	100

It should be emphasized in particular that there have been numerous groups of macroinvertebrates sensitive to water pollution, e.g. *Plecoptera*, some species of *Ephemeroptera*, and *Trichoptera*. When we looked at *Plecoptera* there was a higher numerosity of extremely sensible family *Leuctridae* with a total of 403 items found. These 22 found species of *Plecoptera* with 1.238 items show the high quality of Krivaja water. The highest numerosity of items was that of *Ephemeroptera* with 3.719 items found. Another large group was *Diptera* with 2.561 items indicating that researched running water were partially affected by organic waste from towns, e.g. pollution from Olovo. There have been 1.683 found items of *Trichoptera* in the benthos samples of Krivaja. This undoubtedly indicates the quality of water habitat as well as the river sediment and its faster flow. The most items of zoobenthos macroinvertebrates were found in the benthos samples of Bioštica (LA) – 5.489 items, and the least in the samples of Krivaja on location Vožuća (L3) – 569 items. Great number of items in the Bioštica samples was influenced by *Amphipoda* items found on the fallen leaves in October, 2002. – 1.929 items of crayfish. Low numerosity of macroinvertebrates items in the samples of Krivaja, on location Vožuća, is the result of unfavourable sediment (sand) for their development. We noticed the sediment being exploited from time to time by construction industry that additionally influences the low numerosity of items in these samples. The greatest number of items was found in the samples of July, 2002. – 3.698 items, and the least number in the benthos samples of November, 2001 – 1.485 items. Such a small number of sampled items was probably the result of many macroinvertebrates larvae measuring below 0.5 mm that could not have been sampled using the net with a 0.5 mm diameter. High values of Shannon-Weaver's index of diversity indicate that Krivaja is a mountain river with no major pollution in a successful self-cleansing process. Also, the EBI index middle values of 11.6 show the good water quality of Krivaja. It is worth notion that the values of EBI index in the samples of Krivaja on location Vožuća were 8.8 indicating the unfavourable sediment for the development of researched biocenosis. But the values of modified saprobic index according to Wegl – 1.7, give us the real picture of water quality of the Krivaja river. This value indicates that the water of Krivaja is little to moderately polluted, I-II class of quality, i.e. oligo-betamesosaprobic water. The values of index of variosity and coefficient of similarity indicate the partial burden of the water in the upper stream of the researched running water from the town of Olovo, while higher values downstream indicate the advanced self-cleansing process without additional sources of pollution along the stream of Krivaja. The middle values of applied methods in the research of Krivaja are shown in the table 3.

Table 3: Middle values of applied indexes evaluating the water quality of Krivaja

Location	LA	LB	L1	L2	L3	L4	Middle values
Index							
Shannon-Weaver's index	3.07	3.14	3.80	3.63	3.06	3.41	3.35
EBI index	12.60	12,00	14.00	12.00	8.80	10.20	11.60
Saprobic index	1.70	1.80	1.70	1.60	1.70	1.90	1.70

4. CONCLUSIONS

Based on analysis of both qualitative and quantitative structure of zoobenthos macroinvertebrates of the Krivaja river, in order to evaluate the water quality, we reach the following conclusions:

- the Krivaja river has favourable physico-chemical properties of water for the development of aquatic biocenoses
- the analysis of both qualitative and quantitative structure of zoobenthos macroinvertebrates of Krivaja based on 90 samples indicates their large biodiversity proven by the high values of Shannon-Weaver's index of diversity
- the saprobic index values of 1.7 indicate that Krivaja water is little to moderately polluted, I-II class of quality, i.e. oligo-betamesosaprobic water
- the „kick sampling“ method for macroinvertebrates was appropriate for the running waters such as Krivaja
- overall results as well as the application of different methods of monitoring: diverse, biotic, and saprobic approach can serve in finding the efficient control and establishing the permanent biomonitoring of the Krivaja river

5. REFERENCES

- [1] Cikotić, M.: The Macroinvertebrates of Zoobenthos of the Krivaja River as Indicators of Water Quality. Master's degree thesis. Faculty of Science, University of Sarajevo, Sarajevo, 2004.
- [2] Dall, C.P., Friberg, N., Lindergaard, C., Toman, M.J.: A Practical Guide of Biological Assessment of Stream Water Quality. In: Biological Assessment of Stream Water Quality, University of Ljubljana, Ljubljana, pp 97-117, 1995.
- [3] Nagel, V.P.: Bildbestimmungs – Schlüssel der Saprobien: Makrozoobenthon. Gustav Fischer Verlag, Stuttgart, New York, 1989.
- [4] Waringer J., Graf, W.: Atlas der Österreichischen Köcherfliegenlarven: unter Einschluß der angrenzenden Gebiete. Facultas Universitätsverlag, Wien, 1997.
- [5] Goletić, Š., Osmanović, S.: Adaptation of modern ecological and saprobian methods for monitoring of water ecosystems, Faculty of Science, University of Sarajevo, 2 (2) 55-67, 2006.
- [6] Shannon, C.E., Weaver, W.: The Mathematical Theory of Communication. University of Illinois, Press Urbana, I11 pp 19-21, 82-83, 104-107, 1949.
- [7] Ghetti, P.F.: I macroinvertebrati nell'analisi di qualità dei corsi aqua. Università di Parma, Cattedra di Idrobiologia, Trento, 1986.
- [8] Wegl, R.: Index für die Limnosaprobien. Wasser und Abwasser, 26:1-175, 1983.