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THE ASSESSMENT OF WATER QUALITY OF SHUSHICA RIVER (VLORA) BASED ON PRELIMINARY DATA OF BENTHIC MACRO INVERTEBRATES

ABSTRACT

This study was carried out on Shushica River, a branch of Vjosa River, located in the Vlora district south west Albania, during 2017. This river flows from the Kuçi area parallel with the main road in all her longitude. The recent process of rehabilitation of this road and the process of human population growth in this region is expected to have a severe impact in watershed and water quality of this area through reduction of microhabitat diversity and its associated biodiversity. During this study three stations were chosen randomly on the stream and samples were taken seasonally (Spring and Summer 2017). Here we are presenting the preliminary data based on the identification of a total number of 841 organisms. The collected samples include organisms from class: Annelid (Oligochaeta) and Insecta. Insects are dominating throughout all the sampling period. Between organisms of class Insecta dominant are the families Chironomidae and Simulidae (Diptera), Elmidae (Coleoptera), Hydropsychidae (Trichoptera), and Heptagenidae (Ephemeroptera). Based on the collected data the EPT index (abundances in the sample of the organisms belonging to the orders Ephemeroptera, Plecoptera and Trichoptera in comparison to the total number of organisms in the sample) was calculated. Based on the published data of different recent studies the water quality of the river is related directly with the higher relative abundance of those taxa.

Key words: *Shushica river, macroinvertebrates, SWRC index, benthic organisms*.

INTRODUCTION

Many people depend upon a constant source of clean water. When aquatic ecosystems break down, it threatens all who depend upon it. If the macroinvertebrates disappear because of adverse changes in the environment, then we not only lose a natural resource, but we eventually may lose ourselves in the bargain (Despommier, 2008).

Human activity has long been known to have dramatic effects on stream invertebrates (Hynes, 1993; Suren, 2000). Among other types of human disturbances to stream ecosystems, nutrient enrichment decrease macroinvertebrate richness by elimination of sensitive taxa (Paul and Meyer, 2001). According to Metcalfe (1989), biological assessments offer important advantages over chemical assessments, because they are more sensitive than chemical methods to determinate the pollution, even in small quantities.

Insects as part of macro-invertebrate fauna of rivers can be used as biological indicators for the evaluation of the biodiversity (Bauernfeind and Soldán, 2012). These organisms are sensible to every single change in the environment and are related to the factor that causes such modification, suggesting so the trend of the environment (Bode *et al*., 1996).

Nowadays many biotic indices are based on macroinvertebrates because they occupy a central role in the aquatic ecosystem by participating in the decomposition of organic matter and by constituting the major food source for other aquatic invertebrates, fishes and some birds (Callisto *et al.,* 2001).

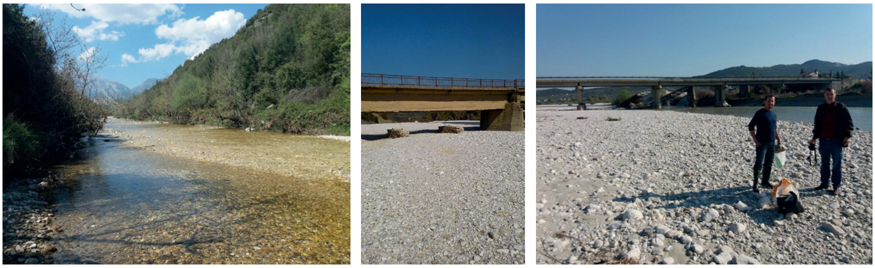
The evaluation of the taxa composition of macroinvertebrates of rivers can be used to decide their ecological and biological status. Due to the fact that they can be found in all aquatic habitats and samples can be collected and classified easily, benthic macroinvertebrates are classified as good bio-indicators of the water quality, (Keci *et al*., 2008; Paparisto *et al*., 2009). This study represents some statistical data of benthic macroinvertebrates fauna composition collected in "Shushica River" Vlore, Albania.

MATERIAL AND METHODS

Study area

Shushica or Vlora River flows in southern part of Albania. Shushica River is one of the tributary of the Vjosa River. It sources in the Vlorë County, near the village of Kuç and flows along 80 km into the Vjosa River. Its hydrological basin is about 715 km^2 (Pano, 1984). The agricultural use of the river basin is very intensive. The recently rehabilitation of national road Vlore-Kuç (2017) and the growing of the human population impact in this segment is expected to increase the level of impact in watershed, water quality and to reduce the microhabitat diversity and its associated biodiversity.

During this study we sampled benthic macroinvertebrates along three station in Shushica River to assess the effects of nutrient enrichment on the taxonomic composition of the benthic macroinvertebrate community. The respectively station of this study are: station 1 -Vranisht; station 2- Gjorm bridge; station 3 - Shushica bridge (Fig. 1).



(a) *(b)* *(c)*

Figure 1. Three sampling station in Shushica River. a) St. 1- Vranisht; b) Gjormi Bridge; c) Shushica `Bridge.

Sampling

All the samples were taken during Spring and Summer, 2017, by kick sampling with a hand net (*1200 cm*^{2} opening and *0.5 mm* mesh size). The material is being collected according to methods suggested from Dowing and Ringler (1984), Campaioli *et al*. (1994), Bode *et al*. (1996; 1997), Rundle *et al*. (2002), Bauernfeind and Humpesch (2012). Organisms were taken from the river bottom (400 – 600 mm) with net in order to gain sufficient samples from larger depths of water. The material was placed in a bottle adding alcohol 70%. Macro invertebrates were removed randomly from the detritus and gravel and placed in a smaller watch glass for identification under a dissecting microscope (Tachet *et al*., 1980). Identification was made to family level except for group Oligochaeta.

Biodiversity and biotic Indices Calculation

a) Simpson (D) is a diversity index that provide important information on the commonness and rarity of species within the community. The diversity quantifying is an important tool for understanding the community structure (Magurran, 2004). Diversity within the benthic macro invertebrate community was described and statistically analyses using the Simpson's diversity index ("D"), calculated:

$$D = 1 - \sum_{i=1}^{s} (Pi)^2 \qquad (1)$$

"p" is the proportion of individuals in the "i" taxon of the community and "s" is the total i number of taxa in the community. This index places relatively little weight on rare species and more weight on common species (Krebs, 1994). Its values range from 0, indicating a low level of diversity, to a maximum of 1-1/s.

b) *Dominance* (d), d = *ai* / Σ *ai*: where "*ai*", is the number of individuals of a specie and "Σ *ai*" is the total number of individuals of all species (Fritz 1975; Schwerdtfeger, 1975). Based on the calculated values, the species were categorized in the following categories: Eudominant tax*on - Ed (d≥10.0%); Dominant taxon -D (5.0≤d<9.9%); Subdominant taxon -Sd (2.0≤d<4.9%); Recedente taxon- R (1.0≤d<1.9%); Subrecedente taxon - Sr(d <1.0%).*

c) *SWRC – Biotic Index:* The relation between water quality and the number of the SWRC – Biotic Index is described and documented by McGonigle (2000), S.W.R.C (2007). SWRC - Biotic Index is calculated for all the sampling stations of our study by the following formula (2), McGonigle (2000):

$$[\text{SWRC - Biotic Index}] = \frac{\sum (TV) * d}{D} \qquad (2)$$

TV is given tolerance values for all the families found during our study, McGonigle (2000), "*d*" is the density of each family and "*D*", the total amount of densities.

RESULTS AND DISCUSSION

a) species richness

A total number of 841 organisms were collected during the sampling period in three station of Shushica River (Tab. 1). In all samples carried out there are organisms from two class Insecta (Arthropoda) and Oligochaeta (Annelida). Insecta are dominant taxa during all the sampling period. The most dominant family in three stations is Heptagenidae, (Ephemeroptera) with the highest value of dominance respectively St.1 = 49.3%, St.2 =39.8% and St.3 = 58.7%, following by Chironomidae family (Diptera) with the value of dominance respectively St.1 = 7.2%, St.2 =15.0% and St.3 =17.8% and Baetidae family (Ephemroptera) with the value of dominance respectively St.1 =15.6%, St.2 =9.7% and St.3 =8.5%.

The distribution of taxa according to stations are: St. 1= 14 taxa, St.2= 13 taxa, St.3=13 taxa. The values of diversity calculated for each station are: Station 1: 2 taxa eudominant, 4 taxa dominant, 2 taxa subdominat and 6 taxoa subrecedente; Station 2: 3 taxa eudominant, 2 taxa dominant, 1 taxa subdominant, 3 taxa recedente and 4 taxa subrecedente; Station 3: 2 taxa eudominant, 2 taxa dominant, 3 taxa recedente and 6 taxa subrecedente. This situation may be explained with the small difference among the station and the other fact related with the same natural and atmospheric condition.

The group EPT (E-Ephemeroptera, P-Plecoptera, T-Trichoptera) represents with the highest number of organisms in the sampling stations, respectively: St.1 = 81.6%, St.2 =61% and St.3 =50%. This group is more sensitive if there is an organic pollution in an aquatic body, reflecting immediately on the number and diversity of organisms collected. In the two first station was found a family of order Plecoptera, Chloroperlidae family, that is related with high quality water.

In comparison with all taxa of benthic macroinvertebrates collected in some

Albanian river (Shkumbini, Osumi, Devolli and Mati River) in this river in the third station for the first time was found Leptophlebiidae family almost with small value of dominance (0.4%).

Related to the data of table 2 the total number of individuals is decreased from the first to the third station this occurrence is closely related to the geomorphic change and erosive condition.

Table 1. Classification of station according to values of dominance of taxon

	Eudominant (d≥10.0%)	*Dominant (5.0≤d<9.9%)*	*Subdominant (.0≤d<4.9%)*	*Recedente (1.0≤d<1.9%)*	*Subrecedente (d <1.0%)*	*Total (Taxon)*
Station 1	2	4	2	-	6	14
Station 2	3	2	1	3	4	13
Station 3	2	2	-	3	6	13

Table 2. Data presented based on sampling stations.

Order	Family	St. 1 Nr	St. 1 Dominance	St. 2 Nr	St. 2 Dominance	St. 3 Nr	St. 3 Dominance
Ephemeroptera	Ephemerellidae	39	8.3% (D)	-	-	1	0.4% (Sr)
	Heptagenidae	231	49.3% (Ed)	45	39.8% (Ed)	152	58.7% (Ed)
	Baetidae	73	15.6% (Ed)	11	9.7% (D)	22	8.5% (D)
	Caenidae	-	-	1	0.9% (Sr)	-	-
	Leptophlebiidae	-	-	-	-	1	0.4% (Sr)
Plecoptera	Chloroperlidae	11	2.3% (Sd)	1	0.9% (Sr)	-	-
Trichoptera	Hydropsychidae	-	-	8	7.1% (D)	2	0.8% (Sr)
	Sericostomatidae	-	-	2	1.8% (R)	-	-
	Polycentropodidae	-	-	1	0.9% (Sr)	-	-
	Rhyacophilidae	25	5.3% (D)	-	-	-	-
Diptera	Ceratopodonidae	1	0.2% (Sr)	-	-	4	1.5% (R)
	Chironomidae	34	7.2% (D)	17	15.0% (Ed)	46	17.8% (Ed)
	Tipulidae	25	5.3% (D)	18	15.9% (Ed)	2	0.8% (Sr)
	Culicidae	3	0.6% (Sr)	3	2.7% (Sd)	19	7.3% (D)
	Tabanidae	-	-	1	0.9% (Sr)	1	0.4% (Sr)
	Empididae / Sf.Atalantinae	2	0.4% (Sr)	2	1.8% (R)	4	1.5% (R)
	Simulidae	20	4.3% (Sd)	-	-	-	-
Coleoptera	Elmidae	2	0.4% (Sr)	2	1.8% (R)	4	1.5% (R)
	Hydrophilidae	-	-	-	-	1	0.4% (Sr)
	Gyrinidae	-	-	1	0.9% (Sr)	-	-

Odonata	Gomphidae	2	0.4% (Sr)	-	-	-	-
Annelida	Oligochaeta	1	0.2% (Sr)	-	-	-	-
	TOTAL	469		113		259	

D - Simpson Index is considered a measure of diversity. Based on value of index D = 0.703768 (tab. 3) of Shushica river is evident the increase of the heterogeneity or richness of macroinvertebrates' community (Magurran, 2004). This index is in accordance also with the taxon richness data of the entire river expressing above by parameter dominance (d).

Table 3. The calculation of Simpson index (D) of "Shushica" river.

Order	Family	Nr	P_i	$(P_i)^2$
Ephemeroptera	Ephemerellidae	40	0.047562	0.002262
	Heptagenidae	428	0.508918	0.258997
	Baetidae	106	0.12604	0.015886
	Caenidae	1	0.001189	0.000001
	Leptophlebiidae	1	0.001189	0.000001
Plecoptera	Chloroperlidae	12	0.014269	0.000204
Trichoptera	Hydropsychidae	10	0.011891	0.000141
	Sericostomatidae	2	0.002378	0.000006
	Polycentropodidae	1	0.001189	0.000001
	Rhyacophilidae	25	0.029727	0.000884
Diptera	Ceratopodonidae	5	0.005945	0.000035
	Chironomidae	97	0.115339	0.013303
	Tipulidae	45	0.053508	0.002863
	Culicidae	25	0.029727	0.000884
	Tabanidae	2	0.002378	0.000006
	Empididae / Sf.Atalantinae	8	0.009512	0.000090
	Simulidae	20	0.023781	0.000566
Coleoptera	Elmidae	8	0.009512	0.000090
	Hydrophilidae	1	0.001189	0.000001
	Gyrinidae	1	0.001189	0.000001
Odonata	Gomphidae	2	0.002378	0.000006
	Oligochaeta	1	0.001189	0.000001
	TOTAL	841		0.296232
		$D = 1 - \sum_{i=1}^{s}(P_i)^2$		0.703768

b - *Water quality bio-classification based on EPT-Richness and Stroud Water Research Centre - Biotic Index (S.W.R.C., 2007)*

SWRC - Biotic Index is calculated for the three sampling stations of Shushica River (tab. 4, 5). The situation of water quality in three station is: the first station (Vranisht) noticed the best water quality and a slight impact (SWRC = 3.79); meanwhile in both two other stations this impact is increasing progressively but remains always within the values of good bioclassification. Regarding of differences between values of index among station we can say that in the downstream part of this river there is an increase of impact of rural area, an increase of agriculture activity and also a higher level of erosion of soil. All this components indicates directly in the diversity of macroinvertebrates community reflecting that and in the bioclassification of water quality. As results we can says the water quality of Shushica River is good with a slight impact in downstream stations.

Table. 4 Water bio-classification by S.W.R.C., 2007.

S.W.R.C. – Biotic Index (values & classification)	0 – 3,75 *(Excellent)*	3,76 – 5,0 *(Good)*	5,10 – 6,50 *(Fair)*	6,60 – 10,00 *(Poor)*
Station 1		*3.79*		
Station 2		*4.07*		
Station 3		*4.31*		

Table. 5 SWRC - Biotic Index calculated for all the sampling stations of Shushica River.

Taxon		Density			TV*Density		
		Stations			Stations		
	Tv	1	2	3	1	2	3
Ephemeroptera	*3.6*	343	57	176	1234.8	205.2	633.6
Trichoptera	*2.8*	25	3	0	70	8.4	0
Trichoptera (Hydropsychidae)	*5*	0	8	2	0	40	10
Plecoptera	*1*	11	1	0	11	1	0
Diptera (Chironomidae)	*6*	34	17	46	204	102	276
Diptera (Tipulidae)	*3*	25	18	2	75	54	6
Diptera (Simulidae)	*6*	20	0	0	120	0	0
Diptera (Anthericidae)	*2*	0	0	0	0	0	0
Other Diptera	*6*	6	6	28	36	36	168
Odonata (Anizoptera)	*4*	2	0	0	8	0	0
Odonata (Zygoptera)	*7*	0	0	0	0	0	0
Megaloptera	*0*	0	0	0	0	0	0
Coleoptera	*4.6*	2	2	5	9.2	9.2	23

Isopoda	*8*	0	0	0	0	0	0
Decapoda	*5*	0	0	0	0	0	0
Amphipoda	*6*	0	0	0	0	0	0
Gastropoda	*7*	0	0	0	0	0	0
Pelecypoda	*7*	0	0	0	0	0	0
Oligochaeta	*8*	1	0	0	8	0	0
Hirudinea	*8*	0	0	0	0	0	0
Turbelaria	*8*	0	0	0	0	0	0
TOTAL Density		469	112	259			
TV*Density					1776	455.8	1116.6
SWRC - Biotic Index = [Σ (TV*d)]: D					3.79	4.07	4.31
Bioclassification					good	good	good

CONCLUSION

All 841macroinvertebrates specimens collected in Shushica River during year 2017 belongs to the two classes Insecta and Oligochaeta and to 22 families.

In the third station for the first time was found Leptophlebiidae family almost with small value of dominance (0.4%).

The dominant family in three stations was Heptagenidae, (Ephemeroptera) with the highest value of dominance, St.1 = 49.3%, St.2 =39.8% and St.3 = 58.7%, following by Chironomidae and Baetidae families.

The group EPT (E-Ephemeroptera, P-Plecoptera, T-Trichoptera) consist of most number of organisms in the sampling respectively: St.1 = 81.6%, St.2 =61% and St.3 =50%.

In the two first stations was found a family of order Plecoptera (Chloroperlidae) family that is related with high quality water.

Based on value of index D = 0.703768 in Shushica river is evident a high value of the heterogeneity and richness of macroinvertebrates' community.

According to SWRC – index the water quality in three stations represents within bioclassification "good". The first station (Vranisht) noticed the best water quality with a slight impact (SWRC = 3.79).

As results we can says the water quality of Shushica River is good with a slight impact in downstream stations.

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