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Assessment of Water Quality of Shkumbini River, Albania

ANILA PAPARISTO*, PRANVERA LAZO†, ELTJON HALIMI, SONILA DUKA†,
ETLEVA HAMZARAJ, ODETA LAKNORI and BLEDAR PEPA
Department of Biology, Faculty of Natural Sciences, University of Tirana, Tirana, Albania
E-mail: anila_paparisto@yahoo.com

Albania is rich in water resources including lakes, rivers, spring water, lagoons and sea, with a considerable quantity of available water. Water quality monitoring of Shkumbini river (181 km long) was carried out based on the investigation of two different parameters: biological parameters based on some insect and insecticide colonies, used as bio-indicators and chemical-physical parameters of the water of the river. Two different stations positioned along the river segment paper-peqin, was selected as the object of present study. EPT-Biotic index and biotic index of family/sequence level, as well as biotic index parameter [Stroud water research center] was used for water quality bioclassification more than 17 families [*Ephemerelidae*, *Baetidae*, *Hydropsychidae*, *Simuliidae*, *Cerapotogonidae*, *Gomphidae*, *Corduliidae*, *Cordulegasteridae*, etc.] dominated by species of *Trichoptera*, order *Ephemeroptera* and followed by *Odonata* order families are reported in this paper. Water quality parameters *i.e.*, pH, electrical conductivity, dissolved matter, dissolved oxygen, total suspended solids and nutrients were monitored in two different stations along the same segment of the river. The water quality assessment is based on: NIVA classification and the European Community directive on "quality of fresh waters supporting fish life". The conclusions from the chemical analyses are in good accordance to those obtained from biological parameters.

Key Words: Shkumbini river, Bioindicators, Biomonitoring, Eutrophication, Chemical-physical parameters, Water quality.

INTRODUCTION

Biological assessments of environmental impact on water quality and water species as part of them are used since early 90's[1]. Many local and national governmental agencies are developing several methods of measuring flowing water health in their countries since 1972[2,3]. The usage of macro invertebrates in methods of water quality assessment has added an important standard in many countries and environmental boards[2-6].

Macro invertebrates are ideal indicative organisms as their different kinds are related to different levels of water quality. They also live in different conditions and being related in food chains in water systems they may be used for ecosystems' health assessment[2].

†Department of Chemistry, Faculty of Natural Sciences, University of Tirana, Tirana, Albania.

An analysis of macro invertebrates' collection, is as well efficient in chemical and physical water quality assessment[2], which easily proves the change in time of its conditions. The aim of such a quick biomonitoring is merely to define the existing damage level at time of biomonitoring.

EXPERIMENTAL

Sampling sites: Shkumbini river has a length of 181.4 km. Its average flow is 61 m^3/s, with a flowing modul from 25.21l-27.3l0 s/km^2 and flowing coefficient varying from 0.59 [Rrogozhine] to 0.73 [Qukes].

Shkumbini is one of the most erosive rivers of Albania country. Its solid flow varies from 36 kg/s [Murrash] to 180 kg/s [Rrogozhine], flowing modul from 806 ton/km^2 [Murrash] to 2460 ton/km^2 [Rrogozhine]. These figures are related to the relieve contrast fissure of draw, soft formations, poor flora, *etc*.

Insects and other macro invertebrates sampling was realized during the year 2007 in five monitoring stations as presented in Fig. 1. This article discussed the results of stations 4 and 5 only.

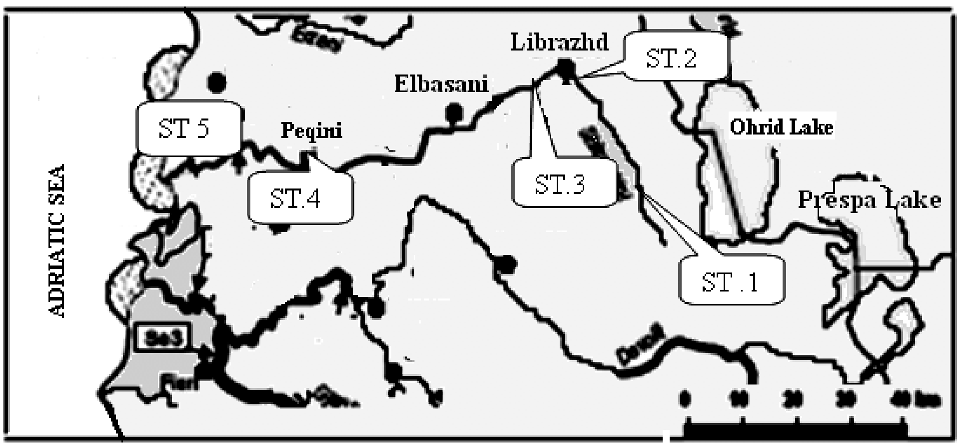


Fig. 1. Presentation of stations according to river length

Sampling method: The material is gathered based on different methods[7-11]. Based on these methods was selected the bentic net with holes of 0.5 mm each. The material taken from the net in every sample passed through the tray where was cleaned up from large sized objects such as: stones, pieces of stick, *etc*. In each case the net was cleaned up by the brush. After that, the material was placed in a 300 mL bottle adding ethanol 70 % and lastly was transported to the laboratory. During defining process of the species we referred to publications of several authors[3,12-17].

RESULTS AND DISCUSSION

Water quality bioclassification: Water quality bioclassification of river was carried out based in some biological parameters: (a) EPT-biotic index, (b) biotic index family/sequence level. EPT-Biotic index is calculated by the following formula[18,19]:

$$[\text{EPT} - \text{Biotic index}] = \frac{(\text{TV})\text{d}}{\text{D}} \quad (1)$$

where TV are tolerance values for the families constituting EPT group, d is the density of each family and D, the total amount of densities.

Bioclassification was based on the data of the following table where are presented biotic index parameter [Stroud water research center] of organic water pollution and its quality.

No. family EPT-Richness	< 2	2-5	6-10	> 10
Index value [S.W.R.C]	6.6-10.0	5.1-6.5	3.76-5.0	< 3.75
Water quality	Poor	Clean	Good	Excellent

From the quantitative processing of the experimental data was judged: On situation of the populations at sampling stations, variability in species and quantity of the founded populations trying to give some possible arguments about the observed changes.

Considering the number of the individual stations (Table-1) is in the first place compared to station 5 (Table-2). As if in the previous stations, referring to insects four sequences is noticed *i.e.*, *Ephemeroptera*, *Trichoptera*, *Diptera* and *Odonata*. Sequence *Plecoptera* is not met. With a larger family number of 3 is presented *Odonata* sequence, followed by *Ephemeroptera* and *Diptera* sequences of 2 families each. *Trichopteras* are presented by the family of *Hydropsychidae*, which has the highest density, 17 individuals and a frequency of 50.4 %. It is followed by *Odonata* with *Gomphidae* family with a density of 4.3 individuals and frequency of 12.9 % as well as from *Ephemerelidae* and *Baetidae* with the frequencies of 9.9 and 8.9, respectively. The other families are presented with a lower frequency. The greater number of individuals with whom is presented *Hydropsychidae* family shows for oxygenated and high quality water.

The high number of *Gomphidae* in this part of river is explained by their feeding way as predators. In this station *Dipteras* are found with a higher density and frequency. [*Simuliidae* family with a frequency of about 9.9 %]. It was also noticed that the molluscous presence of *Planorbidae* family but with a low frequency. For the first time, was met the *Glossiphoniidae* family of anelida but no with a low density and frequency. Despite the broad nutritive specter, this area does not present a very high number of species.

This station is listed as the last one considering the number of individuals gathered. A smallest family number of 6 was met here. From the other invertebrates only *Anelida*, *Oligochaeta* are met with *Haplotaxide* family. In this station are met 5 insect taxas: *Ephemeroptera*, *Trichoptera*, *Odonata*, *Diptera*, *Coleoptera*. Each

TABLE-1
AVERAGE DENSITY AND THE FREQUENCY OF MACRO INVERTEBRATES OF STATION 4

No	Taxon	Family	Average density	Average frequency [%]
1	Ephemeroptera	Ephemerelidae	3.3	9.9
		Baetidae	3.0	8.9
2	Trichoptera	Hydropsychidae	17.0	50.4
3	Diptera	Simuliidae	3.3	9.9
		Ceratopogonidae	0.3	0.9
4	Odonata	Gomphidae	4.3	12.9
		Corduliidae	0.3	0.9
		Cordulegasteridae	0.3	0.9
5	Anelida			
	Kl. Ligochaeta.	Haplotaxide	0.3	0.9
	Kl. Hirudinea	Glossiphoniidae	0.7	1.9
6	Molusque			
	Kl. Gastropoda	Planorbidae	0.3	0.9
	Not defined	–	0.3	0.9

TABLE-2
MACRO INVERTEBRATES' DENSITY AND FREQUENCY OF STATION 5

No.	Taxon	Family	Average density	Average frequency (%)
1	*Ephemeroptera*	*Ephemerelidae*	2.3	23.3
2	*Trichoptera*	*Hydropsychidae*	6.3	63.3
3	*Odonata*	*Gomphidae*	0.3	3.3
4	*Diptera*	*Tabanidae*	0.3	0.3
5	*Coleoptera*	*Dryopidae*	0.3	0.3
6	*Anelida*			
	Oligochaeta	*Haplotaxide*	0.3	0.3

of the above mentioned taxas are represented by a family. *Trichoptera* taxa with *Hydropsychidae* family has the highest average density of 6.3 individuals and a frequency of 63.3 %, followed by *Ephemeroptera* taxa with *Ephemerelidae* family with an average density of 2.3 individuals and frequency of 23.3 %. The other families have a lower frequency. In this station, are met also representatives of *Coleoptera* order. Even here as in station 4 is noticed the absence of *Plecoptera* sequence.

The characteristics of sand and gravel substratum, lack of flora along riverside, and perhaps the high level of urban flow in this part of river might affect the low values of species as well as the small number of bentic macro invertebrates. If we refer to the distance *Peqin* bridge to station 4, we shouldn't have such big differences in quantity and diversity, but lack of flora along riverside and substratum disadvantaged nature may justify at least the visible differences in quantity. In the sample carried out in station 4 were identified in total about 101 species at sequence/family level. From these, *Ephemeroptera-Plecoptera-Trichoptera* consitute about 69.3 % (n =

70) of all determinated individuals. The most dominant family as in third station was *Hydropsychidae* of about 50.4 % (n = 51) of the total, while *Ephemeroptera* sequence itself constitutes about 19 % of all the individuals.

Based on the data of each station respective parameters were calculated (Table-4).

As noticed from Tables 3 and 4, the calculated parameters resulted within the normal rates of "pure quality" water. The value 3.57 of EPT-biotic index showed that we had to do with an environment in which the water resulted to be clean. Referred to these two data identifications it results that this station is characterized by better water quality. From the biotic index calculation in taxa levels, we can say that its value (3.67) is higher than the value of 5th station (3.19), remaining on the margins of the group that shows a clean water quality.

TABLE-3
NUMBER OF FAMILIES EPT

Station No.	Total families	EPT- family	Bioclassification
4	11	3	Excellent
5	6	2	Good quality

TABLE-4
BIOLOGICAL PARAMETERS CALCULATION

Parameter	ST 4	ST 5
EPT Biotic index [Tvxd]:D	3.570	3.19
Biotic index[1]	3.670	2.80
Total biotic index	4.804	4.76

1: Index biotic calculated by Stroud water research center.

The index value of 4.804 corresponds in the respective table to the bioclassification "good quality" water for the 4th station. In the sampling carried out in the 5th station were defined in total 30 organisms at sequence level. It was noticed here that, *Ephemeroptera-Plecoptera-Trichoptera* compound about 86 % of all the individuals found in the 5th station considering the small number of individuals. The most dominant families were *Hydropsychidae* with 63 %, *Ephemerelidae* with 23 %.

After we decided the tolerance value for each family based at the manual[20] and its density, we calculated the biotic index which resulted 3.19. As for family number, this index shows a good quality water in this station. Considering the calculations at sequence level and at the same time calculations of EPT-biotic index, it was noticed an accordance in water quality classification by determining it with an impact different from 2.8. In the Table-4, we see an index of 4.76 which corresponds at the respective classifying table with "good quality" water bioclassification in the 5th station being so in accordance to the classification of the previous parameters.

Water quality classification according to physico-chemical parameters: The physico-chemical parameters of water were measured by portable apparatus, while the content of nutrients in water was determined by chemical methods through SFUV-vis[21,22]. The obtained results are given in Table-5.

TABLE-5
CONTENT OF NUTRIENTS AND PHYSICO-CHEMICAL PARAMETERS OF THE STATIONS 4 AND 5 AT SHKUMBINI RIVER

Station	T (°C)	pH	NO_3-N[1]	NO_2-N[1]	NH_4-N[1]	PO_4-P[1]	DO[1]	DO [%]	TSS[1]	TDS[1]	Cond.[2]	N/P[3]
4	17.3	7.5	0.075	0.015	0.10	0.012	9.2	98.8	456	167.7	348	36
5	18.8	8.2	0.082	0.022	0.18	0.028	8.5	93.2	155.8	181.8	377	23

1: mg/L; 2: µs/cm; 3: N/P atoms ratio.

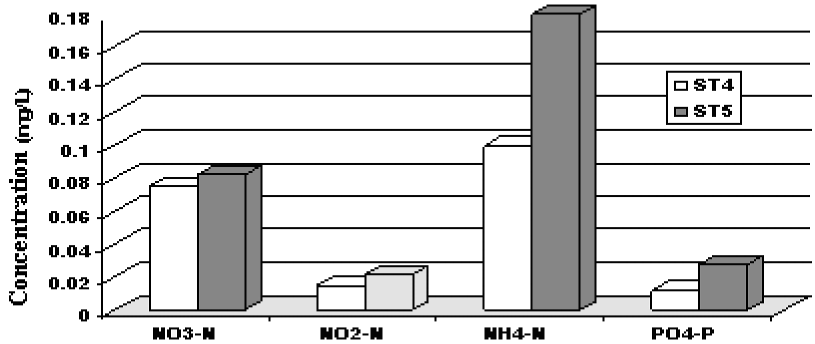


Fig. 2. Content of nutrients at stations 4 and 5

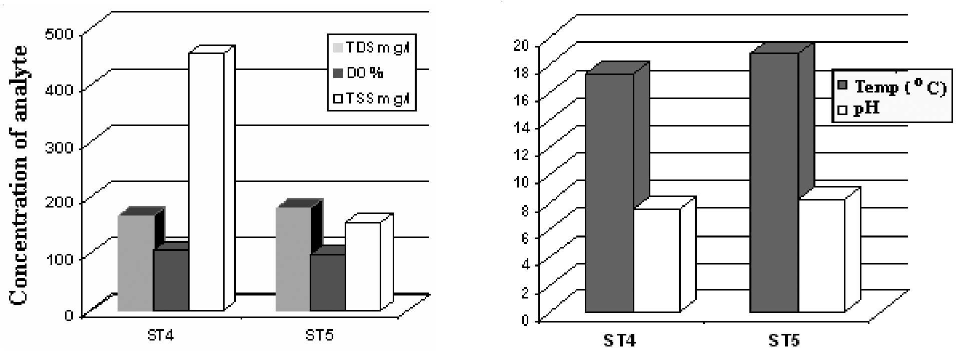


Fig. 3. Some physico-chemical parameters of stations 4 and 5

It is noticed in histograms (Figs. 2 and 3) that the parameters which affect the water quality, are nitrogen, phosphorus and dissolved oxygen, are different at stations 4 and 5. Regarding dissolved oxygen, which is an essential parameter for life of water species, and also an indicator of organic substance presence, station 4 contains more organic substances than station 5. Thus if we refer to this value the conditions for living species in this station are more favourable than those in station 5. This is as well reflected in nitrogen and phosphorous nutrients content that is related to the presence of organic substances which at station 4th with a higher amount of dissolved oxygen result at lower level compared to 5th station. The amount of rigid substances in suspension, a parameter related to the river flow or to the erosion of surrounding area, is presented higher at station four than at 5th station, while the contrary happens with other parameters.

TABLE-6
CLASSIFICATION OF NATURAL WATER QUALITY

	Oligotrophic	*Mesotrophic*	*Eutrophic*	*Hypertrophic*
P total (mg/L)	< 0.013	< 0.040	< 0.100	> 0.100
N total (mg/L)	< 0.300	< 0.400	< 1.000	> 1.000

TABLE-7
CLASSIFICATION OF FORTH AND FIFTH STATIONS' SITUATION ACCORDING TO WATER QUALITY

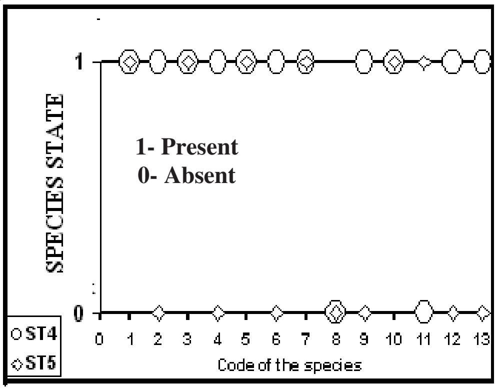
Parameter	Station 4	Station 5	Oligotrophic situation
N total	0.190	0.285	0.300
P total [mg/L]	0.012	0.028	0.013

According to the trophic situation classification of fresh water by OECD, it results as follows: considering the content level of two main nutrients, nitrogen and phosphorous, station 4 presents an almost pure oligotrophic situation, whereas 5th station has a tendency of shifting from an oligotrophic situation to a mezotrophic one, being so closer to mezotrophic situation than to oligotrophic one. The proportion nitrogen atoms to phosphorous atoms is present[23,24].

In both settings it is N/P = 36/1 for station 4 and N/P = 23/1 for station 5, which signifies that increasing speed of green mass is monitored [limited] by the phosphorous content, whilst at 5th station, this proportion in water is closer to the optimal values for increasing green mass [N/P = 15 ÷ 20/1], thus as a result, it has shifted to mezotrophic situation.

It is well known that phosphorous is a neccessary element for organisms' growth and usually it is the main nutrient that restricts primary productivity (phytoplankton) at a water setting.

This results from the relation of this element with carbon C at living organisms, through photosynthesis process. In a schematic way it is presented by the following reaction: Regarding the three above mentioned factors and the presence of dissolved oxygen in water setting of stations 4 and 5, it is likely suggested that the species present in station 4 are larger in number compared to those in station 5. This hypothesis is in accordance to our observations (Fig. 4), in which it is noticed that the essential distinctions between station 4 and 5 regarding the presence of different species.



TAKSONI	
EPHEMERELIDAE	1
BAETIDAE	2
HYDROPSYCHIDAE	3
CORDULEGASTERIDAE	4
GOMPHIDAE	5
CORDULIIDAE	6
TABANIDAE	7
CERATOPOGONIDAE	8
SIMULIIDAE	9
DRYOPIDAE	10
HAPLOTAXIDE	11
GLOSSIPHONIIDAE	12
PLANORBIDAE	13

Fig. 4. Presence of different species at stations 4 and 5 [value 1-present, value 0- absent]

Thus, at 4th station all the species are present [with the exception of No. 7-tabanidae and No. 10-dryopidae] mentioned in the table next to the figure, whilst at 5 th station it is noticed the absence of almost half of the species given in the table.

Findings: More than 17 families (*Ephemerelidae*, *Baetidae*, *Hydropsychidae*, *Simuliidae*, *Cerapotogonidae*, *Gomphidae*, *Corduliidae*, *Cordulegasteridae*, *etc.*) dominated by species of *Trichoptera*, order *Ephemeroptera* and followed by *Odonata* order families were found to be present in both stations under investigation of Shkumbni river. From EPT-biotic index and biotic index of family/sequence level, as well as biotic index parameter [Stroud water research center] used for water quality bioclassification water quality of station 4 results better than of station 5.

The water quality assessment based on chemical-physical parameters and nutrients content according NIVA classification[25] and the European community directive[26] on "quality of fresh waters supporting fish life" also concludes that water quality of station 4 results better than of station 5. The same class purity was found using both methods and the conclusions from the chemical analyses are in good accordance to those obtained from biological parameters.

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