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Using Insects as Bio-Indicators to Assess Water Quality of Albanian Rivers[#]

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Abstract: The communities of aquatic insects are affected by several factors related to water quality, stream morphology, food availability and quality. Among aquatic insects, Ephemeroptera, Plecoptera and Trichoptera (EPT) are very important in assessing water quality. As well as chemical indicators, bio-indicators are used in to define the water quality. EPT (Ephemeroptera, Plecoptera and Trichoptera) richness biotic index and TV are used to classify the water quality level of three Albanian rivers (Vjosa, Shkumbini and Buna-north center and south Albania). Our data prove that SEPT is 15 and Biotic Index 2.55 for Vjosa River; SEPT 13 Biotic Index 1.98 for Shkumbini River; SEPT 19 and Biotic Index 2.67 for Buna River. Related to these results we can conclude that the water quality of those rivers is still very good.
Key words: *EPT, TV, Biotic index, water quality.*

Introduction

Aquatic insects are important elements in the ecological dynamics of lotic environments (Hynes 1970) playing an important role in the cycle of materials and in trophic transfers (Cummins 1974; Vannote et al. 1980; Cummins et al. 1989). The communities of aquatic insects are affected by several factors related to water quality, stream morphology, food availability and quality (Richards et al. 1993; Usseglio-Polatera & Tachet 1994; Diniz-Filho et al. 1998). Among aquatic insects, Ephemeroptera, Plecoptera and Trichoptera (EPT) are very important in assessing water quality. These organisms are sensitive to environmental perturbations and occur in clean and well oxygenated waters. Therefore, EPT assemblages are frequently considered to be good indicators of water quality (Rosenberg & Resh 1993). The main objectives of this study are to complement the taxonomic knowledge of the EPT taxa; to compare the different study sites; to gain further information about the functional characteristics of the different taxa.

It is important to understand how these communities are structured and to identify the main environmental factors that determine their composition and in lotic environments, mainly because this provides information for biomonitoring and recovery of these environments when they are degraded (Petersen & Van Eeckhaute 1992; Richards et al. 1993; Zamora-Muñoz & Alba-Tercedor 1996). Related to this is needed a precise bioclassification of the Rivers and an efficient water quality assessment.

The sampling method of aquatic macro invertebrates is based on the methods according to Campaioli *et al*. (1994); Dowing & Rigler (1984); Barbour *et al*. (1999); Bailey *et al*. (2001); Bode et al. (1997). Benthic invertebrates were taken from the river bottom (40 - 60 cm) with a kick - net in order to gain sufficient samples from larger depths of water. The net is held upright on the stream bed by one individual, while the stream bottom upstream of the net is physically disrupted by a second individual. Kicking and turning over rocks and logs with the feet and hands dislodges organisms which are washed into the net by the current. The samples were collected from areas of differing current speed. In very small streams or in sandy areas lacking riffles, kicks are taken from root mats, snags or bank areas. All types of benthic macro invertebrates were collected by this sampling device, but method emphasizes species that live in fast flowing water. This technique gives consistent results (Horning & Pollard 1978; Armitage 1978). It was used to gather good results during the investigations in Buna, Vjosa & Shkumbini Rivers. The kick - net method also takes the quantitative aspect into account, if the necessary experience is present (Pollard 1981). In addition sampling plots were taken to be representative whereas within a station samples were taken randomly, along 2006 - 2007 years.

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Furthermore, the rivers, the stations and their respective codes are as following: Vjosa (1. Petran; 2. Mezhgoran; 3. Bridge of Memaliaj), Shkumbini (4. Hotolisht; 5. Labinot; 6. Bridge of Paper), Buna (7. The joint point between Buna River and Shkodra Lake; 8. The joint point between Buna and Drino River) (Figures 1 & 2). Additionally there have been analyzed two freshwater indicators that directly influence to the EPT and water quality: DO (Dissolved oxygen) and Conductivity, were measured in three stations for Vjosa and Shkumbini Rivers, and in two stations to the Buna River. The measurements were done with WTW handheld multi-parameter instrument Oxi 325 for DO pH/Cond. 340 i/SET for Conductivity. To take one sampling plot are needed 30 sec and per each field trip are taken 3 of them in different stations.

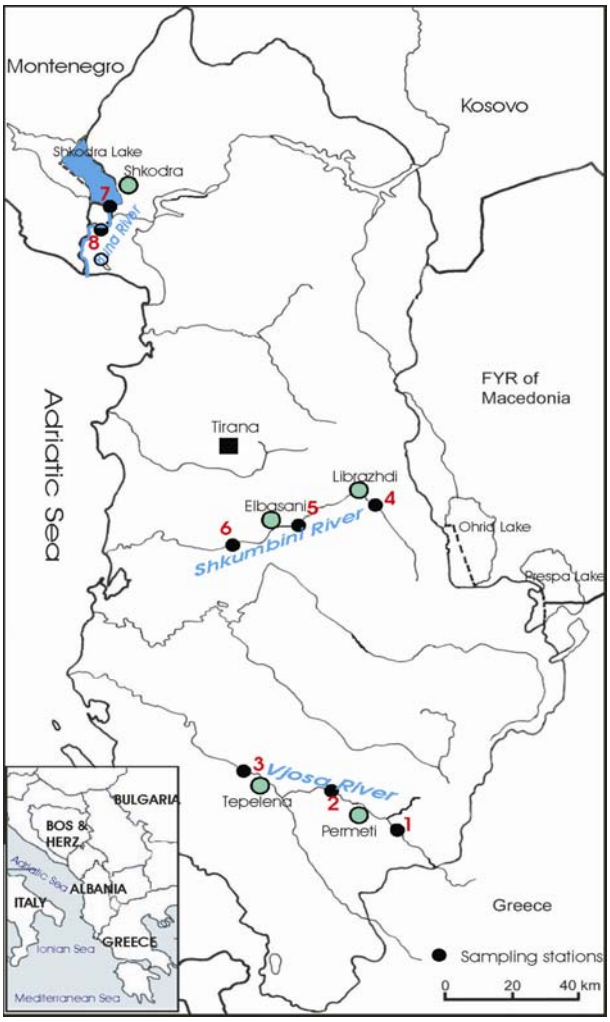

Figure 1. Study area map (Buna, Shkumbini, Vjosa River)

All benthic macro invertebrates are kept in 95% ethanol. Before mailing the jars are completely filled with alcohol to reduce damage to the specimen. They then are carefully packed with enough packing material to prevent breakage. Lab sheets and all the associated material is conserved in the laboratory. After the identification, the data is saved in the correct format, total taxa richness, EPT taxa richness, Tolerance value are automatically calculated.

The EPT values and Biotic Index for this paper are calculated based on the results taken from each station. They are presented grouped by rivers (Table 2, 3 and 4) because the differences between stations values where tested to be not significant.

***Investigated area*:** Vjosa River is located in southern part of Albania, in the center of this river raise the Permeti and Tepelena cities. It is 272 km long, with discharge rate in the Adriatic Sea (195 m^3/s). Vjosa River is shared between Albanian and Greece. It is one of the cleanest and the most important rivers of the country for its aquatic flora and fauna communities. Valley of the river (Albanian part)

extends in prolonged form (total surface of watershed is 6706 km^2), in the left side of national road Korça-Gjirokastra. The upper part of the Valley arises gradually from 170 a.s.l. (Valley level in Dragoti) to ca. 600 m (in Vavilikon, Greek part). The river is important for globally threatened species Lutra lutra, for a number of protected bat species, and for migratory fish species (*Salmo sp*.). The presence of biological indicator invertebrates in the river is of very much interest for assessing the pollution level of the water. Small-scale environmental heterogeneity and differences among species in their microhabitat preferences are thought to be important factors for the maintenance of local species diversity in forest-herb communities.

Figure 2. (A) Upper part of Vjosa Valley sampling station 1; (B) The place of sampling station 2, in Vjosa River; (C & D) The place of sampling station 4 and 5, in Shkumbini River; (D) The place of sampling station 8, in Buna River;

Shkumbini River is 181 km long; its watershed 2444 km^2 with mean altitude 753 m, totally extended within Albania territory. The annual discharge rate is 195m^3/s. The watershed contains high forest as well as coppice forest and shrubs influenced by Mediterranean climate. The Shkumbini watershed has three large urban areas (Librazhdi, Elbasani and Peqini) within its boundary and it traverses the country from east to west. Industrial pollution exists from past or activity and municipal wastes degrade water quality.

Buna River is the only field and shortest river in Albania (44 km long). It flows from Shkodra Lake and near 1.5 km was joint with Drini River, extending along the Montenegro border until the Adriatic Sea. In contrast with two other rivers, the discharge rate of Buna from the lake is 320 m^3/s,

whereas the outflow is 680 m^3/s. Shkodra Lake has an important role in the water regime and water quality of Buna River (Kabo 1991; Troendle 2000). Buna River and Shkodra Lake are distinct for their diverse fauna which include more then 48 endemic invertebrate species. The lake and river are important habitats for many species of nesting, staging and wintering water birds, some of which are threatened (e.g. *Pelecanus crispus* and *Phalacrocorax pygmeus*).

EPT and Biotic Index: An index number called EPT Family Richness is often used to assess water and habitat quality. "E" represents the number of families of Ephmeroptera (mayflies), "P" represents the number of families of Plecoptera (stoneflies), and "T" is Trichoptera (caddisflies) (Wallace et al. 1996; Voelz et al. 2000). The association of good water quality with high species richness has been thoroughly documented. Increasing levels of ecosystem stress gradually eliminate the more sensitive species, leading to progressively lower species richness. Taxa richness for Ephemeroptera + Plecoptera + Trichoptera is calculated and SEPT is used to assign a biological classification of each river (Table 1). Bioclassification criteria for EPT taxa richness values for several major ecoregions have been developed, both for the standard qualitative sampling method and for the EPT method.

Table 1. Bioclassification of water quality based on SEPT (Charles R. Parker, Gregory K. Salansky, Protocol manual)

Bioclass	SEPT
Exellent	> 35
Good	28 – 35
Good – Fair	19 – 27
Fair	11 – 18
Poor	0 – 10

According to this assessing method, the data presented on the table 2 show that Vjosa and Buna Rivers are included in the Good – Fair bioclass, while Shkumbini River is included in Fair bioclass. In the collected samples 556 organisms were identified to at least the level of families and some of them to the level of genius. The *Ephemeroptera, Plecoptara* and *Trichoptera* made up for Vjosa River 78.2% (161 organisms) of the total sample; for Shkumbini River 93.7% (135 organisms) of the total sample; for Buna River 78.2% (161 organisms) of the total sample. The analyze of the family richness for all three rivers show that the order with the biggest number of families for Vjosa River is *Plecoptera*; for Shkumbini River is *Ephemeroptera* & *Plecoptera* and for Buna River is *Trichoptera*, those results indicate the generally good conditions of the water quality for the study rivers. According to the above classification Vjosa River is classified in Good – Fair bioclass, Shkumbini River in Fair bioclass and Buna River is classified in Good – Fair bioclass (Table 2). This biolclassification is proving that the good quality of river Albanian waters is still remaining.

Table 2. Bioclassification of Vjosa, Shkumbini, and Buna rivers water quality based on SEPT

Rivers	SEPT	Bioclass
Vjosa	15	Good - Fair
Shkumbini	13	Fair
Buna	19	Good - Fair

For bioclasifications of rivers water quality, we calculated also Biotic Index, based on the formula [Biotic Index = (TVxD) ÷ D] (Schmiedt et al. 1998) (Table 3, 4, 5). Each of the selected major taxonomic groups have a pollution tolerance value (TV) that ranges from 0 (most pollution sensitive) to 10 (most pollution tolerant). This number is multiplied by the density (number of critters found).

Our data show that Biotic Index is 1.98 in Shkumbini River, 2.55 in Vjosa River and 2.67 in Buna River. These values of Biotic Index indicate that the rivers are classified in the first bioclass (Table 6; Schmiedt et al. 1998), which means that no impairments are evident.

Table 3. Vjosa River Biotic Index (TV= Tolerance Value, D = Density)

Selected Major Taxa	Order/Family	TV (based of RWN manual)	Density (#)	TxD
Mayflies	**Ephemeroptera**	2	56	112
Stoneflies	*Plecoptera*	1	57	57
Caddisflies	*Trichoptera*	3	48	144
Midges - White	*Chironomidae, Diptera*	6	7	42
Midges - Red	*Chironomidae, Diptera*	8	0	0
Beetles	*Coleoptera*	4	13	52
Crane Flies	*Tipulidae, Diptera*	3	4	12
Other Flies	*Diptera*	6	1	6
Dragonflies	*Odonata*	5	20	100
	Density Total		**206**	
	TxD Total			**525**
	Biotic Index (TxD)/ Density	**2.55**		

Table 4. Shkumbini River Biotic Index (TV= Tolerance Value, D = Density)

Selected Major Taxa	Order/Family	TV (based of RWN manual)	Density (#)	TxD
Mayflies	**Ephemeroptera**	**2**	**65**	**130**
Stoneflies	*Plecoptera*	1	57	57
Caddisflies	*Trichoptera*	3	13	39
Midges - White	*Chironomidae, Diptera*	6	0	0
Midges - Red	*Chironomidae, Diptera*	8	0	0
Beetles	*Coleoptera*	4	0	0
Crane Flies	*Tipulidae, Diptera*	3	0	0
Other Flies	*Diptera*	6	9	54
Dragonflies	*Odonata*	5	2	10
	Density Total		**146**	
	TxD Total			**290**
	Biotic Index (TxD)/ Density	**1.98**		

Table 5. Buna River Biotic Index (TV= Tolerance Value, D = Density)

Selected Major Taxa	Order/Family	TV (based of RWN manual)	Density (#)	TxD
Mayflies	*Ephemeroptera*	2	47	94
Stoneflies	*Plecoptera*	1	51	51
Caddisflies	*Trichoptera*	3	63	189
Midges - White	*Chironomidae, Diptera*	6	6	36
Midges - Red	*Chironomidae, Diptera*	8	0	0
Beetles	*Coleoptera*	4	15	60
Crane Flies	*Tipulidae, Diptera*	3	0	0
Other Flies	*Diptera*	6	0	0
Dragonflies	*Odonata*	5	24	120
	Density Total		**206**	
	TxD Total			**550**
	Biotic Index (TxD) ÷ Density	**2.67**		

Table 6. Bioclasification based on Biotic Index (Schmiedt et al. 1998)

Data interpretation (Based on River Watch Network Manual)
0 – 3.75 = No Impairment Evident
3.75 – 6.50 = Moderate Impairment
>6.5 = Severe Impairment

This data interpretation is also complementing the bioclassification based on EPT taxa richness. The higher number of species (SEPT) indicates no evident deterioration in the water quality level. This definition means that the river water quality is still good (Table 7).

Table 7. Bioclassification based on SEPT and Biotic Index

River	**Condition**	**Water quality**
Vjosa	Non – Impaired	Good – Fair
Shkumbini	Non – Impaired	Fair
Buna	Non - Impaired	Good - Fair

All data are in accordance with other biological (trophic index, phytoplankton, benthic diatoms (Miho et al. 2005) and chemical indicators (DO & Conductivity) (Table 8), based on which these rivers are classified as oligotrophic.

Table 8. Mean annual values of DO and Conductivity in three River stations

Stations	1	2	3	4	5	6	7	8
Indicators	Petran	Mezhgoran	Memaliaj	Hotolisht	Labinot	Paper	Buna	Buna
DO (mg/L)	8.88	8.5	8.4	9.9	9.6	9.76	8.71	216.66
Conductivity (µS/cm)	405	420	514	317	345	396	7.5	213.5

Both bioclassifications based on EPT Taxa Richness and Biotic Index; indicate the good quality of Albanian Rivers and also confirm the classification as oligotrophic waters related to chemical indicators (DO & Conductivity).

Conclusions

- Application of EPT and Biotic Index in fresh water monitoring, provides a promising perspective to assess water quality properties.
- These assessing methods have low costs and the same results like other biological and chemical methods.
- High frequency of flooding and the negative impacts of sediment deposition have not influenced the Biotic Index or EPT taxa richness.
- Evaluation of the effect of land use practices, decrease of the cover vegetation that appears in the rivers watershed and industrial pollution and require a long and continuously monitoring program.

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