The impact of sewage effluents in water quality and benthic macroinvertebrate diversity of the Prishtina river (Kosova)

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Abstract

From December 2004 until November 2005 macrozoobenthos specimens were collected every month with Surber net in six selected stations of the Prishtina River . The Hilsenhoff Family Biotic Index (FBI) and Shannon Weaver Index of Diversity on family level were used to indicate organic and nutrient pollution.

In total 7 947 specimens belonging to 56 families of macrozoobenthos groups were found, mainly consisting of aquatic insects. The FBI results during the one-year period show that station P3 has the lowest value (4.6) and thus the best quality of water, while the highest value of this index was registered in station P5 (8.1) where the impact from sewage input is huge and obvious. The lowest value of Shannon Weaver Diversity Index was registered in station P5 (0.33) while the highest value was found in station P3 (4.04).

These results show that biodiversity of aquatic insects (and macrozoobenthos in general) is seriously threatened in the last three stations of Prishtina river because of the direct discharge of sewage waters.

Keywords: Benthic macroinvertebrates, sewageeffluents, Prishtina river

Introduction

Pollution of Prishtina River is enormous due to continuous increased amount of organic and biogenic substances (solids, nutrients, chemicals etc) getting directly into the river through sewage waters that cause direct impact on presence and abundance of benthic macroinvertebrates. Freshwater macroinvertebrates, mainly consisting of aquatic insects, have been frequently used in water quality studies because they provide both a facility for examining temporal changes and integrating the effects of prolonged exposure to intermittent discharges or variable concentration of pollutants (Hellawell, 1986).

The objectives of this study were to analyse the structure of macroinvertebrate communities in different segments of Prishtina River by contrasting sites with relatively good water quality with those affected by domestic sewage pollution along its length from the area where the river springs up to Sitnica River where it flows. Prishtina river is a left tributary of Sitnica river and belongs to Black Sea water basin.

Material and methods

Macrozoobenthos specimens were collected once a month from December 2004 to November 2005 with Surber net of 30 x 20 cm (600 cm2) diameter, in six selected stations of Prishtina River. The collected material was fixed in 4 % formaldehyde. In the laboratory, the material was sorted out and the specimens were identified and preserved in 75% ethanol.

The criteria for choosing sampling stations were: type and slope of the river ground, altitude, vegetation structure, and especially the selection of stations was subject to different intensity of domestic sewage input and vicinity of human settlements.

Metrics used to characterize the aquatic macroinvertebrate communities are: density (Plafkin et al, 1989), Family Biotic Index (Hilsenhoff, 1988) and Shannon-Weaver Index of Diversity on family level (Shannon-Weaver, 1949).

Results

During the one-year period of investigation a total of 7 947 macroinvertebrate specimens were collected distributed in 56 families, 44 of them belonging to aquatic insects while the rest is composed by members of Oligochaeta, Hirudinea, Mollusca, Isopoda and Amphipoda (Table 1).

Table 1

Distribution of benthic faunae in six selected stations of Prishtina River (December 2004 – November 2005)

	Stations					
	P1	**P2**	**P3**	**P4**	**P5**	**P6**
GASTROPODA						
Lymnaeidae	30	33	47	24		
Planorbidae	5	38	1	4		
Ancylidae		23	11			
Neritidae			3			
LAMELIBRANCHIATA						
Sphaeriidae	13		29			
OLIGOCHAETA						
Tubificidae	108	21	37	113	198	319
Lumbriculidae	12					10
Lumbricidae	4	12	20	4		
HIRUDINEA						
Erpobdellidae	80	111	16	216		
Hirudidae		7				
Glossiphoniidae			1	2		
ISOPODA						
Asellidae			6	16		
AMPHIPODA						
Gammaridae	483	686	733	109		
EPHEMEROPTERA						
Baetidae	83	103	195	358		
Heptagenidae	103	82	171	2		
Siphlonuridae	7		1	5		
Ephemeridae	31	166	142	3		
Caenidae	1	43	20	5		
Ephemerellidae		18	60	40		
Leptophlebiidae		6	3			
PLECOPTERA						
Nemouridae	84	2	15			
Capniidae	98	93	32	4		
Perlodidae	36	48	24			
Taeniopterygidae	12	10				
Leuctridae	31	7	8			
Perlidae	11	19	21			
Chloroperlidae		31	2			
TRICHOPTERA						
Hydropsychidae	28	227	171	1		
Limnephilidae	51	125	49	3		
Sericostomatidae	4	5	3			
Goeridae	17	7				
Leptoceridae		2	3			
Psychomyiidae		6	2			
Rhyacophylidae		10	18			
Polycentropodidae		9	3			
ODONATA						
Gomphidae	5	8	13			
Calopterygidae		7		1		
Coenagrionidae		5				
Corduliidae		2				
Cordulegastridae		2	8			
Libellulidae			1			

	Stations					
	P1	**P2**	**P3**	**P4**	**P5**	**P6**
DIPTERA						
Chironomidae	259	11	13	360	72	143
Simulidae	33	8	11	322		11
Limoniidae				4		
Tabanidae	3	10	5	1		
Dixidae	4					
Stratiomyiidae						
Tipulidae		1	3	4		
COLEOPTERA						
Helodidae			1	1		
Haliplidae			3			
Dytiscidae	1		1	4		
Gyrinidae	1					
Hygrobiidae				1		
MEGALOPTERA						
Sialidae		1	2			
HETEROPTERA						
Nepidae	2	11	1	1		
Corixidae	3					
Dolichopodidae	1					

Apart from Amphipoda who dominate in first four stations regarding density, Ephemeroptera and Diptera are the most numerous orders of macrozoobenthos in Prishtina River. The only taxon of Amphipoda, Gammarus balcanicus Schaferna, 1922 sometimes comprises more than a half of total sampled specimens (for example during April Gammarus balcanicus represented 60.7 % of total sampled individuals in station P1). Diptera is the only order of aquatic insects that is present in all 6 stations. In last two stations are present only Diptera and Oligochaeta, even those lacking completely sometimes during the period of investigation in station P5. Ephemeroptera are present in first four stations with relatively high number of specimens (1648) and the most widespread families of this order are: Baetidae, Heptagenidae and Ephemeridae. The most dense taxons of mayflies are Baetis rhodani Pictet, 1843 and Ecdyonurus venosus Fabricius, 1775. Seven families of Plecoptera are randomly found in first three stations, sometimes only once during the period of investigation. Capnia vidua Klapálek, 1904 of Capniidae family is the most representative taxon of Plecoptera and is the only taxon present in station P4 with four individuals in total during the one-year period. Trichoptera are present with 8 families in first four stations and the most widespread families are: Hydropsychidae, Rhyacophilidae and Limnephilidae. Six families of Odonata are mostly found in stations 2 and 3 with low number of individuals. Diptera are mostly concentrated in stations 1, 4 and 6 with high number of specimensims. Other orders of aquatic insects are found in small number of specimens in first four stations of Prishtina River during the one-year period of investigations.

Macrozoobenthos families tolerant to pollution are mainly concentrated in last two stations and also in station P1 during the last half of the year. Station P3 has the lowest medium FBI value for the one-year period of investigation (4.63) while station 5 has the highest (8.17) (Table 2).

Table 2

Values of Family Biotic Index, Hilsenhoff 1988 for six selected stations of Prishtina River.

Months / Stations	**P 1**	**P2**	**P3**	**P4**	**P5**	**P6**
December	5.03	4.5	5.13	5.8	7.85	8.12
January	5.38	4.94	4.42	6.57	8.81	8.14
February	4.32	4.35	4.23	5.9	-	8
Mart	3.079	3.47	5.31	6.06	9	8
April	5.15	5.32	4.56	6.43	-	7.2
May	4.27	4.46	5.44	7.25	9	8.02

Months / Stations	P 1	P2	P3	P4	P5	P6
June	6.46	5.4	3.69	6.5	8.02	7.36
Jule	5.9	5.36	4.32	5.98	-	8.15
August	6.2	5.7	5.18	6.66	8	8.46
September	7.12	4.42	4.83	5.98	6.61	7.8
October	7.57	5.3	4.57	6.2	7.74	7.77
November	7.32	4.7	3.9	6.06	8.52	7.28
Medium values	5.64	4.82	4.63	6.28	8.17	7.85

The lowest value of Shanon Weaver Index of diversity was registered in station P5 (0.33) during January 2005 while the highest value was registered in station P3 (4.04) during June. Station P2 is characterized with highest medium value (2.93) for one-year period of investigation and station P5 with the lowest value during this period (0.54) (Table 3).

Table 3

Values of Shanon Weaver index of diveristy for six selected stations of Prishtina River.

Months / Stations	P 1	P2	P3	P4	P5	P6
December	2.727	3.016	1.631	2.193	0.95	0.866
January	2.554	2.915	2.597	2.424	0.33	0.938
February	2.9	3.521	2.626	3.146	0	0.924
Mart	2.91	2.482	2.338	2.208	0	0.924
April	2.106	3.102	2.612	2.453	-	1.356
May	2.683	3.074	2.569	2.554	0	0.895
June	2.092	3.059	4.04	2.655	0.9	1.457
Jule	2.987	2.785	3.752	2.482	-	1.025
August	1.818	3.059	2.9	2.583	0.9	0.678
September	1.919	2.958	1.934	2.367	0.89	0.967
October	2.063	2.41	2.554	2.511	0.86	1.284
November	1.76	2.843	2.496	2.468	0.62	0.981
Medium values	**2.376**	**2.935**	**2.6707**	**2.503**	**0.545**	**1.024**

Discussion

Due to variable environmental conditions and different level of anthropogenic impact through sewage input, the composition of macrozoobenthic organisms, the structure and abundance of their communities in six different stations of Prishtina River were different. The sewage input may act as an energy source or a stress factor for an ecosystem, altering its productivity and community development. In this regard the highest number of macrozoobenthos families was found in station 2 (45) where was found the greatest number of individuals as well (2016), while the smallest number of macrozoobenthos families and individuals was found in station 5 (2 families and 270 individuals).

Although not far away from the place where one of the branches of Prishtina River springs, the village in which is located station P1 contributes to relative degree of sewage pollution at this point. The Family Biotic Index values show good quality of water with some organic pollution in station P1 during the period December 2004 – May 2005 and starting from May and up the end of the investigation period water quality declined sharply. Drastic change in composition of macrozoobenthos and decrease in number of taxons occurred because of decrease in the amount of stream water in this station and dominance of waters of sewage origine. Station P2 is located in the stream that represents the main branch of the Prishtina River and together with station P3 (located after the connection of two previous and some other small streams) is relatively out of anthropogenic impact and in these two stations was found the greatest number of taxa and individuals. The FBI values show constant good quality of water in these two stations during all seasons with some improvements during the months with higher rainfalls (February, March, May and September). As pollution intolerant EPT taxa declined, tolerant Chironomidae species influence on the Family Bi-

otic Index values in station P4 and especially in last two stations. Station P4 is in the middle of a village composed by approximately 2 000 inhabitants. The FBI classifies station P4 into the fair quality of water with fairly significant organic pollution while for stations P5 and P6 FBI suggests poor quality of water with very significant organic pollution. Station P5 is located after the river collects urban sewage waters of more than 400 000 inhabitants. The sewage input dominates against the small amount of stream water causing sometimes total absence of macrozoobenthos community (February, April and July) in station P5. There is a light improvement in station 6 (medium FBI value decreases from 8.17 as it was in previous station to 7.85) which can be concluded by appearance of a greater number of taxons. Autopurification processes that are taking place after pollution input from Prishtina town give an opportunity for developing in station P6 of some other macrozoobenthos taxons which are not present in station P5, however the distance between these two stations is not sufficient for any substantial autopurification and much more the sewage input from surrounding villages continues to manifest an obstacle for development of the majority of macrozoobenthos taxons in this fragment of the river.

Station P6 is located just before the Prishtina River flows into Sitnica River and thus contributes to further pollution of Sitnica River which is classified amongst the most polluted rivers in Kosovo (Zhushi Etemi, 2005). Values of Shannon Weaver index of Diversity show similar results, suggesting highest diversity in stations 2 and 3 and the worst conditions in last two stations. However values of this index do not reflect any strict direct link between organic pollution and species diversity in circumstances prevailing in stations P1 and P4. The season when the specimens are sampled and other influences apart of organic pollution affect in values of this index as it was shown in other similar studies where this index was used (Trožic-Borovac, 2001).

Results of one-year investigation in Prishtina river show that the rich fauna of this river is under continuous threat from anthropogenic sources and especially the problem of sewage waters is lethal for this fauna causing total absence of several macrozoobenthos groups in lower flow of Prishtina River.

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