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Impact of Urban Pollution on the Benthic Diatom Communities from Gjanica and Ishmi Rivers#

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Abstract: Albania is reach in water resources. In Western Adriatic Coastal Lowland area, where most of the rivers run, are situated the most inhabited and industrial centers (*i.e.* Tirana, Durresi, Berati, Fieri, *etc*.). Urban wastewater and other industrial wastes are collected directly by canals in rivers and transported to the sea. The effect of urban pollution from the inhabited centers on the benthic diatom communities of Gjanica and Ishmi rivers was studied in different occasions, during years 2002-2004. About 300 diatom taxa were found; scarce species number was found in each sample, which oscillated from 8 to 10 species. The most abundant taxa were *Nitzschia palea* var. *palea,* a saprotrophic species, *Navicula accomoda*, *Gomphonema parvulum*, *Navicula cryptotenella*, *Fragilaria ulna*, etc. Based on the phytobenthos composition (percentile of diatom taxa) and their ecological values, two indexes were applied to evaluate water quality, Trophic Index of Diatoms (TI_{DIA}) and Saprobic Index (SI); TI_{DIA} was always very high, up to 3.3 in Lana, showing polytrophic state of the waters, caused by the heavy contamination with nutrients (nitrogen and phosphorous); the same can be confirmed for the saprobic index, which was high, too, from 2.8 (α-mesosaprob) (Ishmi) up to 3.4 (α-meso-polysaprob) in Lana river (July 2003); the highest saprobic values correspond to the heavy organic pollutions in the rivers.

Keywords: Phytobenthos, Trophic Index of Diatoms (TI_{DIA}), Saprobic Index (SI); water pollution, biomonitoring, Albanian Rivers.

Introduction

Bio-monitoring techniques have been used in running waters to obtain information on the effects of pollution by waste waters or from the runoff from fertilized agricultural land on the biota. In rivers with varying impacts from agriculture, urban pollution, and with highly variable flow regime, the organic and inorganic substances often rapidly undergo massive fluctuations; thus, common planned physical and chemical monitoring will only show a momentary state of the water body and cannot reflect the current highly dynamic environmental situation, which strongly determines the water organisms present. Diatoms are abundant and the most species-rich primary producers in rivers, living in almost all habitats from the source to the mouth (John, 2003). They have a short life cycle and rapidly follow environmental changes. Due to their siliceous cell wall, they are easily sampled and preserved, hence providing a permanent record which allows the assessment of short or long term changes. Benthic diatoms and related water quality indexes are good measures to quantify the changes in saprobity or trophy along a river (Prygiel *et al*., 1999). Albania is rich in water resources which continue to be endangered. The Western Adriatic Lowland is the most inhabited area with industrial centers, intense agriculture and a developing tourism. Urban wastewater and industrial wastes are collected by canals, directed to the rivers and transported to the sea. In present paper, it is showed the assessment of water quality in diatom-based monitoring in the most polluted rivers of Albania, Ishmi and Gjanica, as a new experience. It describes the analyses of the diatom population from a two-year sampling period four years ago in the Western Adriatic Lowland to study the water quality within a relative short distance during the self-purification process. The variation of the diatom population between sites and seasons is quantified by calculating different indexes. A complete analysis of all rivers of Albanian Western Lowland is given by Miho *et al*. (2005) and Kupe, (2006).

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Materials and Methods

Diatoms were sampled at 7 stations: Semani (Se4: Mbrostari) with its effluents Gjanica (Se3: Fieri) and Osumi (Se1: Berati and Se2: Ura-Vajgurore), Ishmi (Is3: Fushe-Kruja) with its effluents Tirana (Is1: Brari) and Lana (Is2: Kashari), during seven campaigns, respectively in dry and rainy season, (May and November 2002, May, July, September and November 2003, and March 2004). The stations were situated at sites of different levels of human impact; the numbering is downstream from the least to the most polluted parts of the rivers. In dry season water level was lower and influences of organic and inorganic matter on diatom community can be detected more easily. Diatoms were sampled by scraping the upper surface of selected rocks from riffle sections of the river with a toothbrush and the resulting suspensions collected and preserved in 4% formaldehyde [5; 6]. The cleaning of diatom frustules from organic and inorganic material was done by boiling the material in HCl_{conc} followed by boiling in H_2SO_{4conc} with addition of a few crystals of KNO_3 (Kelly et al., 1998). Microscopic slides were prepared using Naphrax and examined with a LEICA DML microscope (63x PL APO). Species determinations were made following the keys of Krammer & Lange-Bertalot (Krammer et al., 1986-2001). About 500 valves per slide were counted using 100 oil immersions, yielding a 95% confidence for the data on species composition (Kelly et al., 1998; Lund et al., 1958). To get relationship between diatom community and environmental factors, the trophic (TI_{DIA},) and saprobic (SI) index was calculated using the formula of Zelinka & Marvan (1961). Sigma Plot Programme and multivariate statistical package were applied. From the indicator value TW_i, S_i (not polluted to highly polluted water, or nutrient poor to high nutrient concentration), species specificity G_i and relative frequency H_i of each species i, (TI_{DIA},) and (SI) for a diatom community of a study site was calculated as:

$$TI_{DIA} = \frac{\sum_{i=1}^{n} TW_i G_i H_i}{\sum_{i=1}^{n} G_i H_i}$$

Where: TI_{DIA}, trophic index for diatoms; TW_i, trophic (saprobic) value of *i* species (1-3); G_i, indicative weight of *i* species (1-5); H_i, relative frequency of *i* species (%); *n*, total number of species. Respective values of TW_i and G_i, as well as trophic classes were taken after Rott *et al*., 1999.

$$SI = \frac{\sum_{i=1}^{n} S_i G_i p_i}{\sum_{i=1}^{n} G_i p_i}$$

Where: **SI** saprobic index for diatoms, S_i (saprobic) value of *i* species ***i* (**1-5**), G_i** indicative weight of *i* species (1-3), p_i relative frequency of *i* species (%), **n,** total number of species. Respective values of S_i and G_i, as well as saprobic classes were taken after Rott *et al*., 1997. In addition, the diversity index of Shannon & Weaver (1949) was calculated, too.

Results

The main data measured in 7 sampling station are shown in table 1. About 300 species of diatoms were determined, dominatet by pennate and only 15 belong to centric diatoms. *Achnanthes minutissima,* which is considered as a tolerant species (Hofmann, 1994), was found in all sampling stations and in all seasons; but higher density were observed during the warm season, spring and summer, and especially in non-polluted parts of river, (37.3% in Ura-Vajgurore station, May 02). It's accompanied frequently with *Cooconeis pediculus* (52% in Se1, May 03), *Gomphonema tergesinum* (43.4% in Se2, July 03).

A special composition of diatoms was observed in most polluted rivers, like Gjanica, Ishmi and Lana. *Nitzschia palea* var. *palea*, a saprotroph species, growing in polluted habitats, with high organic matter (polysaprob), (Rott et al., 1999), was very dense in Gjanica (73% in November 02; 65% in May 03; 59.8 % in July 03; 80.02% in September 03; 65.6% in November 03). The high relevance of N. *palea* with low number of species was the reason of low level of diversity index. *N. palea* accopmained with others saprotroph or tolerant species, like *Navicula accomoda*, *Gomphonema parvulum*, *Navicula cryptotenella, Fragilaria ulna* etc. Parts of rivers with lowest pollutions during winter period were populated mostly by *Diatoma moniliformis*, found in November 02, very dense in Osumi (65.8% in Se1; 86.5% in Se2), in Semani (84.3% in Se4).

Table 1. Average value of physic-chemical, nutrient and biological indicators in rivers (from Miho *et al*., 2005)

River	**Tirana**	**Lana**	**Ishmi**	**Osumi**	**Osum**	**Gjanica**	**Semani**
Station Name	Brari	Kashari	Fushe-Kruja	Berati	Ura-Vajgurore	Fieri	Mbrostari
Station code	Is1	Is2	Is3	Se1	Se2	Se3	Se4
Temp, ˚C	15.8	17.9	19.0	16.3	16.8	20.0	19.2
pH	8.2	7.7	7.5	8.3	7.9	7.7	8.1
Cond., µS/cm	388	633	609	335	357	836	506
TDS, mg/L	198	330	316	156	193	455	249
DO, mg/L	9.0	3.0	2.2	8.7	8.3	3.2	8.1
DO, %	94.2	31.9	8	93.2	89.3	34.8	90
TSS, mg/l	73.2	117	84.9	141.7	142.8	111.5	286.2
NO_3, mg/L	6.0	5.2	3.8	2.5	2.2	10.6	7.1
NO_2, mg/L	0.1	1.6	1.1	0.1	0.1	1.1	0.1
NH_4.mg/L	0.3	18.1	7.2	0.3	0.4	2.8	0.2
PO_4. mg/L	0.05	2.78	1.014	0.02	0.032	0.514	0.027
Nr. of species	35	23	24	35	40	29	32
H'	2.81	1.57	1.97	2.86	2.65	2.16	2.83
TI_{DIA}	2.3	3.2	3.3	2.8	2.8	3	2.8
Trophic classes	Eutroph	Polytroph	Polytroph	Eu-Polytroph	Eu-Polytroph	Eu-Polytroph	Eu-Polytroph
SI	1.8	2.7	2.6	2	2.2	1.9	2
Saprobic classes	Oligosaprob-α-mesosaprob	β-mesosaprob	β-mesosaprob	α-mesosaprob	α-mesosaprob	α-mesosaprob	α-mesosaprob

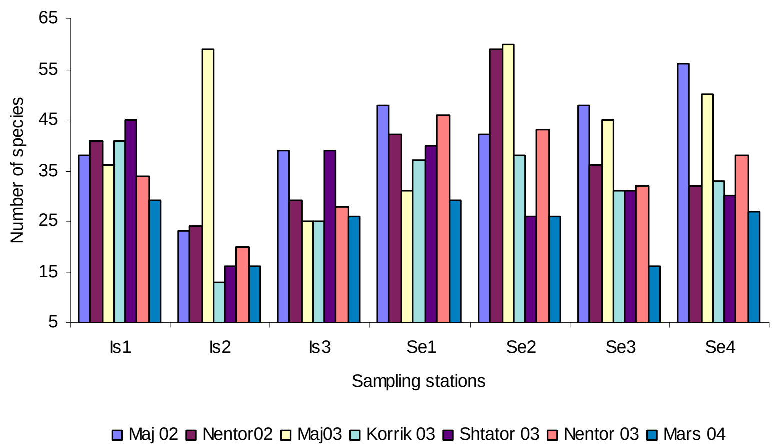

Figure 1. Average values of the number of species in Semani and Ishmi

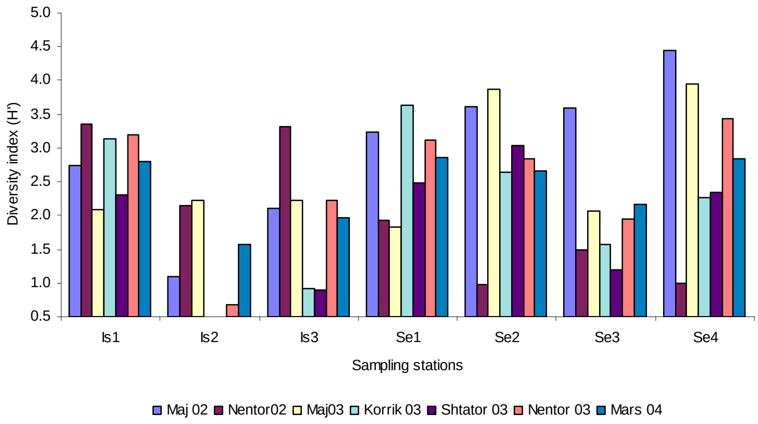

Figure 2. Average value of diversity index (H') in Semani and Ishmi

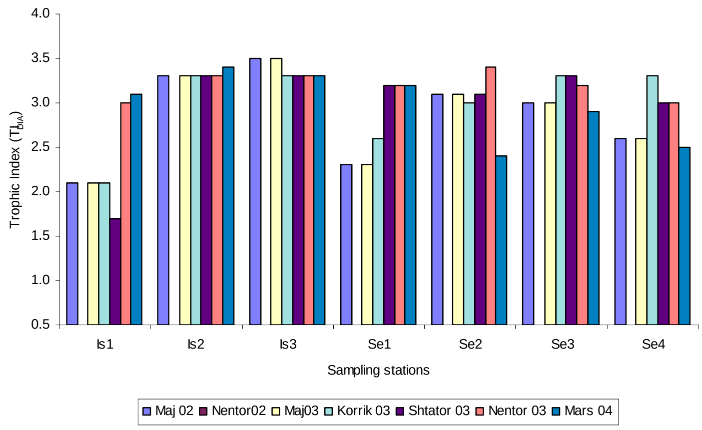

Figure 3. Average value of trophic index (TI_{DIA}) in Semani and Ishmi

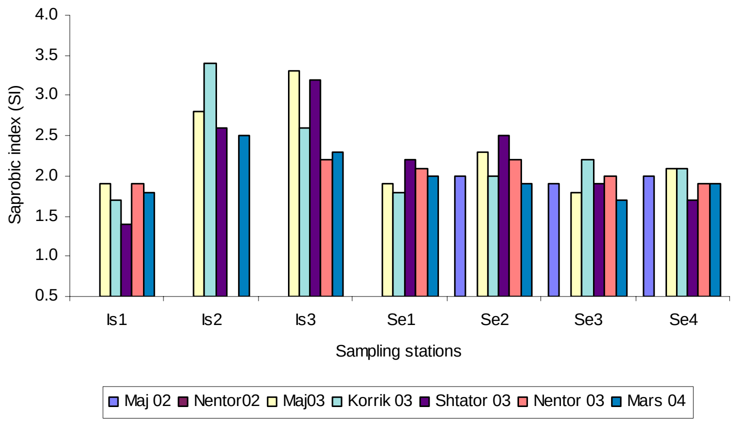

Figure 4. Average value of saprobic index (SI) in Semani and Ishmi

The number of species found in each tour oscillated from 100 species (November 03) to 160 (May 03), from 15 to 55 species in each samples; average number in each station oscillated from 15 (in Lana, July 03) to Se2, November 02, July 03) which is shown in figure 1. Lana (Is2) and Ishmi (Is3) were the poorest in number of species; only 8 species were found in Lana River in July 03 and 10 species in September 03. Mean value of diversity index oscillated from 1.57 and 3.16 (Figure 2). Diversity index was high (more than 3.5) in Osumi and Semani; the lowest values were calculated in Lana and Ishmi, 0.32 dhe 0.91, in July 03, and 0.38 and 0.89 in September 03, respectivly.
The average value of trophic diatoms index was very high (Fig. 3), from 3.3 in Tirana (Is1), that correspond to polytrophic class, up to 3.5 (eu-hypertrophic) in Lana, Osumi, Gjanica and Semani. It

evidences the high degree of pollution, especially with phosphates and nitrates; after Dell'Uomo (1996), the water quality corresponds to the third class.
The mean saprobic values oscillated from 1.4 (oligo- to β-mesosaprob), in Brari (Is1), to 3.4 β-mesosaprob-polisaprob), in Lana (Is2) and Ishmi (Is3). The lowest values of saprobic index was found in Brari (Is1, September 03), respectively 1.4 (oligo-β-mesosaprob), while the highest value was found in Lana (Is2, July 03), respectively 3.4 (α-meso-polisaprob), (Figure 4). As mentioned above the highest values belonged to Lana and Ishmi, in all seasons, showing permanent high pollution with organic matter, too.

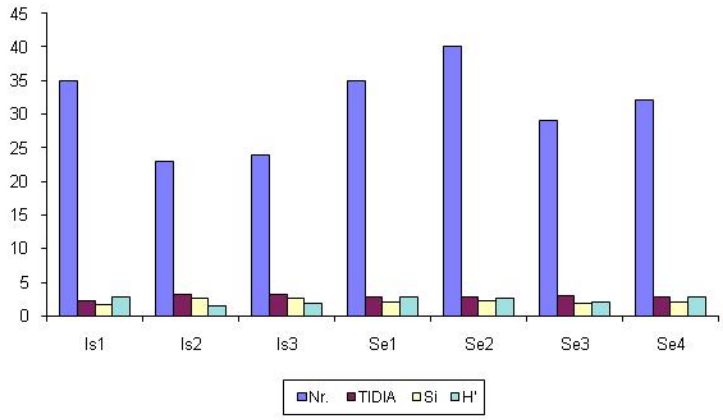

Figure 5. Average values of diversity, trophic, saprobic index and number of species.

Discussion

Monitoring of water quality was performed in the most impacted rivers of the Coastal Adriatic Lowland (7 stations), seven trips during May 2002 - March 2004 (Miho et al., 2005) & (Kupe, 2006). The water quality can be graded based either on the presence of the main inorganic and organic nutrients which indicated by trophic and saprobic level (Prygiel et al., 1999); (Whitton et al., 1991); (Kelly, 2002). Based on value of trophic diatoms index, Osumi, Gjanica and Semani were eu-polytrophic (Table 1). It reflect the high pollution with organic matter mainly phosphates and nitrates, from urban, petrol and agricultural discharge, of nearby cities: Berati, Kuçova and Ura Vajgurore. High values of trophic and saprobic indexes were calculated in Gjanica, corresponding to eu-polytrophic and polytrophic classes, indicating high organic and inorganic pollution. Furthermore, bad smell was easy seen from rives, showing high concentration of organic matter, like phenols. Also, suspended solids along the river, besides the water pollution, reduce the beauty of the river landscape.
High values of dissolve matter, as well as the highest values of conductivity, were measured in Ishmi and Semani, representing the high content of dissolved matter. Moreover, the suspended solids (TSS) were higher than value of European Directive (lower 25 mg/L). High content of suspended solids and turbidity of water reduce the photosynthesis, decrease oxygen, with negative impact on aquatic flora, fauna and human health.
Regarding to oxygen value, the waters of Gjanica, belong to fifth classes (very polluted), as confirmed also by Bratli (2000). Semani station belonged to the third classes (moderately polluted). Waters of Osumi in Berati and Ura-Vajgurore allow the living of cyprinids, but not in Gjanica. Oxygen decrease was caused from urban pollution. Compared to limits of EU 2006/44/EC Fish Directive, waters of Osumi, Gjanica, Lana and Semani represented higher nitrite concentration than guide values. It is the main cause of their extreme trophic degree, enhancing few species of algae and decomposition process; it causes the decrease the oxygen, making the life difficult in water. Main sources of phosphates and nitrites for sure are the detergents and fertilizer phosphates.

Conclusions

Even considering the diatom structure, it can be concluded that some river parts like Ishmi (Tirana) and Gjanica (Fieri) are really polluted, unhealthy for the aquatic living, like fishes, and for the man itself. Only few species of diatoms can survive in the periphyton of those rivers. Moreover, their turbidity and high content with nitrogen and phosphorous increase the eutrophication risk of the nearby coastal area, with negative impact in the aquatic living on the sea and tourist development, as well.

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