ALGAE AS WATER QUALITY BIONIDICATORS OF THE RIVER DJETINJA

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ALGE KAO BIOINDIKATORI KVALITETA VODE REKE ĐETINJE

Apstrakt

U radu su prikazani rezultati algološke i saprobiološke analize reke Đetinje u periodu jun - septembar 2008. godine. Na odabranim lokalitetima uzvodno od Užica i u samom Užicu, kao i u Volijačkom potoku, identifikovano je 142 taksona iz 4 razdela algi. Voda reke Đetinje pre uliva Volujačkog potoka pripada II kategoriji, dok se neposredno po njegovom ulivu pogoršava kvalitet (III kategorija). Na lokalitetu „Plaža" u samom Užicu vrednosti koncentracije hlorofila *a* su niske, kao i ukupna brojnost individua/ćelija fitoplanktona po jedinici zapremine i ne ukazuju na značajniju primarnu produkciju fitoplanktona.

Ključne reči: fitoplankton, fitobentos, kvalitet vode, Đetinja
Keywords: phytoplankton, phytobenthos, water quality, river Djetinja

INTRODUCTION

In order to assess the quality of surface water it is usually necessary to take complex physico-chemical and biological examination to obtain the most complete review of the situation and events in the aquatic ecosystem. In most aquatic ecosystems algae are ecologically very important group of organisms as primary producers of organic matter and oxygen. It is possible to notice the first signs of environment degradation and their causes because algae react rapidly to the wide range of pollutants. The possibility of continuous monitoring through space and time and predicting changes in the ecosystem before the occurance of serious damages are criteria which gives advantage to algae as bioindicators over other organism indicators (McCormick & Cairns 1994).

The Djetinja River originates in the southwest of Mountain Tara, under the peak Runjeva Slavica at 1438m altitude. It is 75,4 km long and its catchment area is 1208 km^2. On its way to the city of Užice it partly runs through 8 km long and over 300m deep gorge

(partly canyon) valley (Marković 1980). It runs through the city of Užice, and near the town of Požega it connects with the Moravica River and creates the Zapadna Morava River on that way. There are 3 artificial lakes and 2 hydropower plants on the river. The Djetinja River has one large tributary (Skrapež) and several smaller. The relief of the Djetinja River's catchment makes very steep slopes of the mountain massifs, valley is narrow and expends only at the mouth of the Skrapež River and at the part where it meets the Moravica River. The Djetinja River has a character of fast-flowing mountain river and flow rate at the site where it meets the Moravica River is 11,8 m^3/s (Gavrilović, Dukić 2002).

The Djetinja River (at the site Gorobilja) is included in the monitoring program of surface water quality of RHMZ of Serbia (RHMS of Serbia 2008). Available data on the water quality from 1972 based on biological analysis indicate that the water of the Djetinja River was at the transition from α-mezosaprobic to polisaprobic water (Todić 1972). However, algae of the Djetinja River were not systematically studied. Available literature data indicate that there was detailed analysis of diatoms community only at the site Djetinja-Gorobilje (Tomašević 2000).

MATERIAL AND METHODS

The water samples for the qualitative analysis of phytoplankton were collected by plankton net (Ø 22 μm). Phytoplankton samples for quantitative analysis and determination the chlorophyll-*a* concentration were collected using a Rutner's bottle (1 l) from 1 m depth on the site Djetinja „Plaža". Phytobenthos samples were collected by scraping the stone surface or by taking a sample from the bottom surface of the Djetinja River with a pipette and from stone walls on the site „Plaža" as well as by collecting sludge and sand. Also, samples of macrophytes and macroscopic covers were collected from sludge and stones. All samples were immediately fixed with formalin solution to the final concentration of 4%. Qualitative analysis of phytoplankton and phytobenthos were performed with a Zeiss AxioImager.M1 light microscope with software AxioVision 4.8. Quantitative analysis of phytoplankton was done by using Utermöhl`s method (1958) with a Leica inverted microscope and is expressed as number of individuals/l and cells/l. Chlorophyll-*a* concentration was determined with spectrophotometric method according to ISO 10260:1992 (E).

Saprobiological analysis was performed using the Pantle-Buck (1955) and Zelinka, Marvan, Kubiček's (1959) method that is based on algae as indicators of the saprobity degree. Diatom pollution index (DAIpo) (Watanabe et al. 1986) is based on benthic diatoms as indicator and is used as an ecological indicator of organic pollution in aquatic ecosystems.

RESULTS AND DISCUSSION

In the examination of the algological samples, the total number of 142 taxa was identified from four divisions: Cyanobacteria, Chlorophyta, Euglenophyta and Bacillariophyta. From the total number of taxa, there are 81 present in the phytoplankton, and 131 in the phytobenthos. In both communities, the highest species diversity was observed within Bacillariophyta.

Quantitative analysis of phytoplankton

The total number of individuals in the phytoplankton at the site Djetinja „Plaža" ranged from 18.240 individual/l in July to 144.320 individual/l in June. Also, the maximum

number of cell/l was observed in June (1684.960 cell/l), and the minimum number in July (54.560 cell/l) (Fig. 1). Changes in the number of individuals/cells/l in phytoplankton do not indicate a significant level of primary production. In June, a significant difference was observed between the number of individuals and number of cells per unit volume which is caused by the greater presence of colonial and trichal algae. In the phytoplankton of the Djetinja River, during the first 3 months of examination, in all samples expressed as number of individual/l, diatom *Fragilaria vaucheriae* dominated. In September diatom *Stephanodiscus hantzchii* became dominant, while *F. vaucheriae* changed to subdominant.

Phytoplankton quantitative analysis expressed as number of cells per unit of volume indicates a different situation. In the samples significantly less individuals of trichal blue-green algae were present, but when it was recalculated to the number of cells these individuals took absolute dominance. During the whole studied period absolute dominance of trichal blue-green algae *Phormidium tergestinum* was recorded in phytoplankton. This algae was probably found in the phytoplankton at the site „Plaža" due to erosion of the Djetinja River's benthos, downstream from the mouth of Volujac Stream.

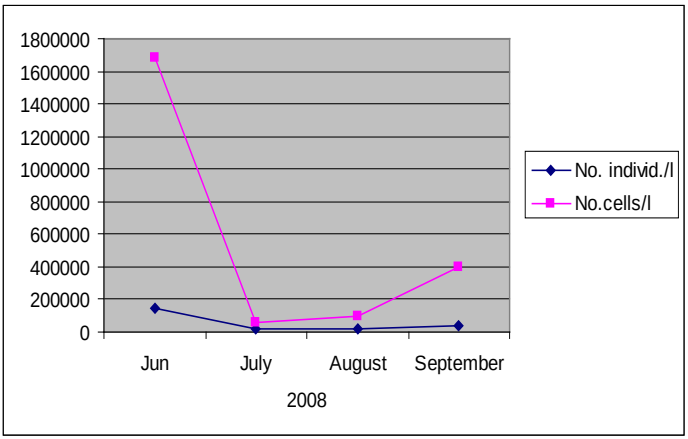

Figure 1. Abundance of phytoplankton community at the site Djetinja „Plaža"

Analysis of chlorophyll-a concentration

The highest chlorophyll-*a* concentration was recorded in July (6,6 µg/l), at 1 m depth, and the lowest in August (3 µg/l) (Fig. 2). The values of the chlorophyll-*a* concentration are low and do not indicate a significant phytoplankton production at the site Djetinja „Plaža" in the studied period.

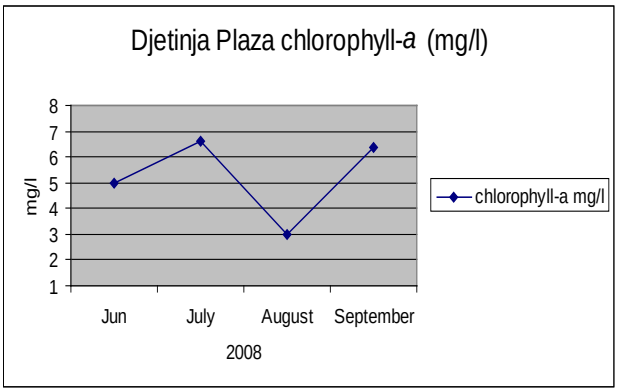

Figure 2. Chlorophyll-*a* concentration at the site Djetinja „Plaža" in the studied period

Water quality analysis of the Djetinja River based on diatom pollution index (DAIpo)

The values of DAIpo index at the first site Djetinja above Volujac Stream indicate that the water was β-mesosaprobic (category II) exept in September (α-mesosaprobic, category III). During the studied period there was a slight decrease in the value of DAIpo index at this site as well as decrease of water quality (Fig. 3). The second site Djetinja under Volujac Stream is only ten meters downstream from the first site. The values of DAIpo index indicate that the water was α-mesosaprobic (category III). At the third site Djetinja "Plaža" DAIpo index also indicate that the water is α-mesosaprobic (category III).

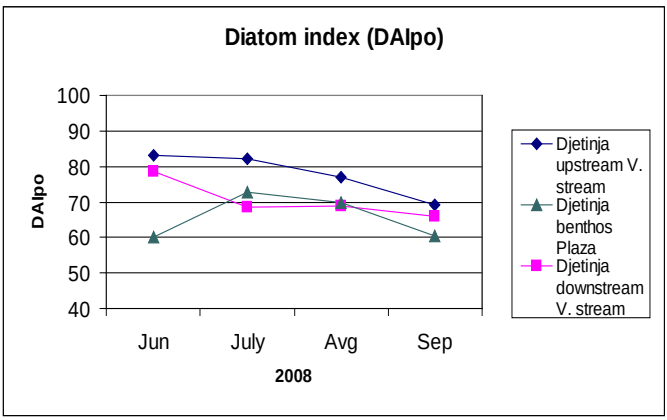

Figure 3. Diatom pollution index (DAIpo) of the Djetinja River at the studied sites

The data from DAIpo index clearly show deterioration of water quality and organic load of the Djetinja River during the studied period, immediately after the influx of Volujac Stream. Also, general decrease in the water quality of the Djetinja River is observed in the study.

Saprobiological analysis of the Djetinja River

Saprobity index according to Pantle-Buck (S) at all studied sites during the whole study was in the β-mezosaprobic zone (shows that the water of the Djetinja River is in category II, fig 4.). However, it is clear that the water of Djetinja River above Volujac Stream has slightly lower saprobity (better quality then downstream part of the river).

The resulting saprobic valence of saprobity index in June at the studied sites based on 43 indicator taxa are in β-mesosaprobic zone. The Djetinja River's site above Volujac Stream has the best quality. Immediately after the influx of Volujac Stream it has the lowest quality with a high α-mesosaprobic value (Fig. 5).

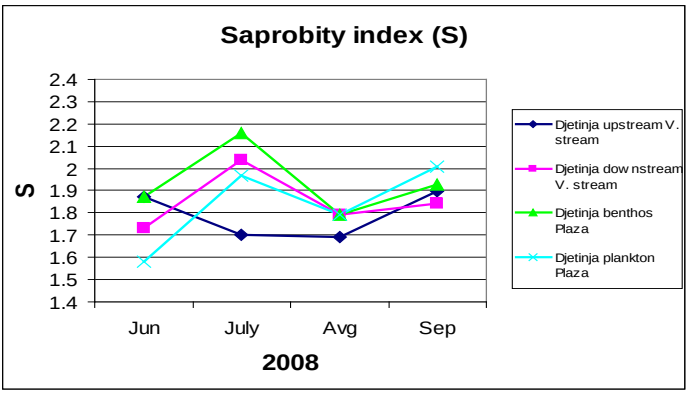

Figure 4. Saprobity index (S) of the Djetinja River at studied sites

Forty indicator taxa were determined at the studied sites in July 2008. The water above Volujac Stream has the best quality (β-mesosaprobic zone, category II of water) with the highest ratio of oligosaprobic value. The Djetinja River's water has significantly lower quality just after the influx of Volujac Stream with an almost equal ratios of α-mesosaprobic and β-mesosaprobic values. Benthos analysis at the site „Plaža" (Fig. 5) shows low water quality (α-mesosaprobic). This confirms the results of quality and quantitative analysis from the site Djetinja "Plaža". These results show that erosion from the benthos of Djetinja (downstream from the influx of Volujac Stream) leads to precipitation of large amount of sludge and creation of favorable conditions (water temperature and nutrients) for the development of blue-green algae and diatom community. Eventually, these organisms reach the surface where they decompose and form a scum on the water sufrace.

Forty-seven indicator taxa were determined at the studied sites in August 2008. The resulting saprobic valence at all studied sites were in β-mesosaprobic zone. Figure 5 shows that the lowest quality was recorded at the site placed immediately after the influx of Volujac Stream.

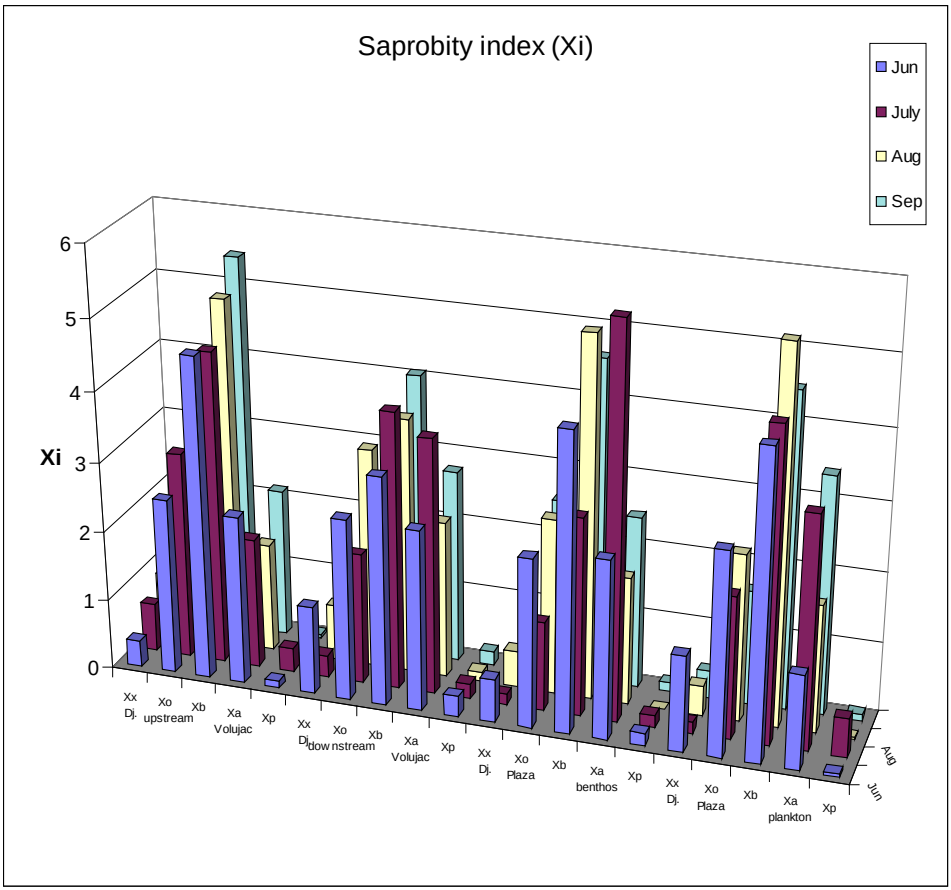

Figure 5. Saprobity index (Xi) of the Djetinja River.

Forty indicator taxa were determined at the studied sites in September 2008. The resulting saprobic valence at all studied sites were in β-mesosaprobic zone. Figure 5 shows that the lowest quality was recorded at the site placed just after the influx of Volujac Stream in the Djetinja River.

CONCLUSION

According to the obtained algological and saprobiological water analysis of the Djetinja River and Volujac Stream in the period from June to September 2008 at the studied sites, it can be concluded that the water of the Djetinja River is in II category just before the influx of Volujac Stream. Hydrological conditions (widened and deepened bottom and a significant deceleration of flow) enable widespread development of macrophytes and epiphytic community, which further contribues to the polution load of the river. The water quality of the Djetinja River immediately after the influx of the Volujac Stream has a deteriorating status and is in the transition from category II to III according to S and Xi, category III according to DAIpo. The Volujac Stream brings a large amount

of suspended particles (sludge) to the Djetinja River which leads to the blurring of the water and the creation of thick layers of sludge at the river bottom. Blue-green cover is made by blue-green algae *Phormidium tergestinum* and green algae *Cladophora glomerata* and it is found in the suspended material of the Djetinja River, which completely covers the bottom and enables the development of epiphytic community. The chlorophyll-*a* concentration level indicates a low primary production of phytoplankton at the site „Plaža" in the studied period. The total number of phytoplankton individuals/cells per unit volume at the site „Plaža" does not indicate a significant level of production. The occurrence of dominant benthic forms in the upper parts of the river, indicates a significant influence of upper flow on water quality at the site „Plaža". Macroscopic floating formations at the site „Plaža", consist of the communities of blue-green algae, diatoms and suspended sludge particles which are generated by lifting from the bottom as a consequence of algae over- reproduction.

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