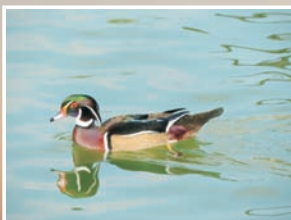


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## WATER QUALITY ASSESSMENT OF VRUTCI RESERVOIR TRIBUTARIES BASED ON DIATOM INDICES

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### ANALIZA KVALITETA VODE PRITOKA VRUTCI AKUMULACIJE POMOĆU DIATOMNIH INDEKSA

#### *Apstrakt*

Silikatne alge su važna grupa akvatičnih organizama osjetljivih na promene u svojoj životnoj sredini. Međutim, njihova praktična upotreba kao bioindikatora je relativno nova u Srbiji. U ovom istraživanju sakupljeni su epilitski uzorci iz 14 pritoka akumulacije Vrutci u toku septembra i oktobra 2014. godine. Identifikovano je ukupno 84 taksona silikatnih algi. Najveće populacije u okviru epilitske zajednice silikatnih algi u većini pritoka grade *Cocconeis placentula* var. *lineata* i *Achnanthydium minutissimum* var. *minutissimum*. Rezultati izračunavanja diatomnih indeksa, uz pomoć softverskog paketa OMNIDIA, ukazuju da je ekološki status vode većine ispitivanih pritoka odličan do dobar. Samo rezultati diatomnih indeksa za pritoke Simića potok, Konjski potok, Bioštanska Banja i neimenovanu pritoku 13 pokazuju prisustvo umerene antropogene eutrofikacije.

*Ključne reči: biomonitoring, silikatne alge, diatomni indeksi, akumulacija Vrutci*  
*Keywords: biomonitoring, diatoms, diatom indices, Vrutci reservoir*

#### INTRODUCTION

Algae are essential components of primary production in aquatic ecosystems. Diatoms are so ecologically important that they are used as bioindicators in environmental monitoring of waters. They form a large part of the benthos communities and therefore they could become an important part of water quality monitoring (Ács et al. 2004). Diatoms have been used in a number of countries as bioindicators of river pollution (Kelly and Whitton 1995,

Ziller and Montesanto 2004, Ács et al. 2006, Blanco et al. 2004, Gosselain et al. 2005, Solak et al. 2012). However, in Serbia it is still a new topic (Andrejić 2012, Krizmanić et al. 2013, Vidaković 2013, Jakovljević et al. 2014).

Catchment area of Vrutci reservoir represents a part of Starovlaško-Raških mountains, which are part of the Dinarides. Altitude in the area is mainly within the interval from 570 to 1250 meters above sea level (KRO" Bioktoš" 1986). Average altitude of the catchment area of reservoir „Vrutci” of 915 m.a.s.l. (area of 127 km<sup>2</sup>) indicates an area of particularly mountainous and hilly terrain (mountain massifs of Tara, Zlatibor and Mokra Gora). Geologically, catchment of reservoir „Vrutci” is predominantly built from limestone. The dominant tributary of reservoir is the Đetinja River, at which a dam was built. The catchment area of reservoir is abundant in streams which have a torrential character.

## MATERIAL AND METHODS

The material used in the present study was collected in autumn 2014, from 15 tributaries of the Vrutci reservoir. Epilithic samples were scraped from the surface of gravel and boulders by using scalpel blade and brush. Samples were fixed immediately with formaldehyde to a final concentration of 4%. In the laboratory samples were prepared using the standard method with cold acid (Krammer and Lange-Bertalot 1986). After this process the material was airdried on coverglasses and mounted in Naphrax<sup>®</sup>. Light microscope observations and micrographs were made using a Zeiss AxioImager.M1 microscope with DIC optics and AxioVision4.8 software. The relative abundance of taxa within the diatom community in the samples was determined by the valve percentage representation of each taxon relative to 400 numbered valve at every permanent slide. The biological assessment of water quality was performed using 17 diatom indices calculating by OMNIDIA 5.3 software (Lecointe, Coste & Prygiel 1993). The ranges of diatom indices were used together with the water quality classes and ecological status according to the regulation of the Ministry of Agriculture and Environmen (Sl. Glasnik 74/2011).

## RESULTS AND DISCUSSION

In this study, a total of 84 diatom taxa were identified. The most numerous were taxa of genus: *Navicula*, *Gomphonema* and *Nitzschia*. Seven taxa were defined as dominant in all tributaries, those whose percentage participation at a given site was 10% or more. The biggest populations were consisting of *Cocconeis placentula* var. *lineata* (Ehr.) van Heurck and *Achnantheidium minutissimum* var. *minutissimum* (Kütz.) Czarnecki, which dominated in almost all tributaries. These two taxa dominated in all tributaries alternately or in combination with some of the other dominant taxa (Tab. 1). These are some of the most common diatoms, with a wide ecological range. They prefer waters from oligo- to eutrophic, and develop numerously in mountain streams with no anthropogenic impact (van Damm et al. 1994, Krammer and Lange-Bertalot 2004, Hofman et al. 2013).

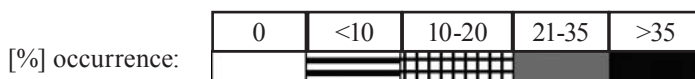
Dominant and frequent species identified in the epilithic communities of the Vrutci reservoir tributaries, such as: *Cocconeis placentula* var. *pseudolineata* (Geitler) Lange-Bertalot, *Amphora pediculus* (Kütz.) Grunow ex A.Schmidt, *Planothidium frequentissimum* (Lange-Bertalot) Lange-Bertalot, *Planothidium lanceolatum* (Brébisson ex Kützing)

Lange-Bertalot, *Achnanthydium pyrenaicum* (Hust.) Kobayasi, were also found in other aquatic ecosystems with a good water quality, e.g. Baryczka stream (Noga et al. 2013).

Rivers and streams with water characterized by a low level of pollution are also characterized by higher species diversity (Kwandrans et al. 1998; Rakowska and Szczepocka 2011), which is the case with tributaries of the Vrutci reservoir. Further, a substantial part of the diatom species identified in these tributaries are species that prefer water with low level of pollution,  $\beta$ -mesosaprobic zones, according to indicator values after the OMNIDIA 5.3 database.

**Table 1.** Dominance in diatom communities in tributaries of the Vrutci reservoir in September and October 2014

Tributaries	2	4	5	6	7	8	9	10	11	12	13	14	15
<b>Taxon</b>	oct	oct	sep	oct	sep	oct	sep	oct	sep	oct	sep	oct	sep
<i>Achnanthydium minutissimum</i>													
<i>Achnanthydium pyrenaicum</i>													
<i>Amphora pediculus</i>													
<i>Cocconeis placentula</i> var. <i>lineata</i>													
<i>Cocconeis pseudolineata</i>													
<i>Cyclotella ocellata</i>													
<i>Cymbella excisa</i>													
<i>Diademsis perpusilla</i>													
<i>Fragilaria crotonensis</i>													
<i>Planothidium frequentissimum</i>													
<i>Planothidium lanceolatum</i>													



### Diatom indices

In order to determine the water quality of Vrutci reservoir tributaries 17 diatom indices were counted with OMNIDIA software. IPS and CEE were taken into consideration as legally obliged indices in the assessment of ecological status of small rivers and their water quality in Serbia.

The results of the diatom indices analysis show an excellent ecological status of the tributaries Krnda 2 and Cvetića bay stream in the investigated period, with the absence of organic pollution and anthropogenic eutrophication.

Ecological status of tributaries Simića stream and Konjski stream, based on the analysis of phytobenthos community, could be classified as moderate to good, with moderate anthropogenic eutrophication.

The tributaries Jasik, Jovac, Bioštanska Banja and nameless tributary marked with 10 in the investigated period showed good to moderate ecological status accompanied by the absence of organic pollution and anthropogenic eutrophication. These tributaries in October changed their composition of phytobenthos community, which was manifested by the dominance of typical planktonic algae from the Vrutci reservoir *Fragilaria crotonensis* and



*Cyclotella ocellata*. This was due to changes of the water level in the reservoir, when the water from the reservoir spilled over into these tributaries.

Ecological status of the tributary Ročnjak and two unnamed tributaries marked with 12 and 13 in the investigated period, can be classified as excellent to good, along with moderate anthropogenic eutrophication in September.

The tributaries Đetinja and nameless tributary marked with 15 in the investigated period showed good to moderate ecological status accompanied by the absence of organic pollution and anthropogenic eutrophication.

## CONCLUSIONS

Collected samples of benthic communities consisted of 84 diatom taxa. The most dominant in all tributaries were *Cocconeis placentula* var. *lineata* and *Achnanthyidium minutissimum* var. *minutissimum*.

Based on the obtained values of diatom indices it can be concluded that all tributaries of the reservoir Vrutci had no major variations of water quality during the observed period. The water had mostly excellent to good ecological status. Moderate anthropogenic eutrophication can be noticed based on the results from Simića stream, Konjski stream, Bioštanska Banja and unnamed tributary 13.

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