PHYTOPLANKTON COMMUNITY STRUCTURE, SEASONAL DYNAMICS AND PHYSICO-CHEMICAL CHARACTERISTICS OF THE RADOINJA RESERVOIR (SERBIA)

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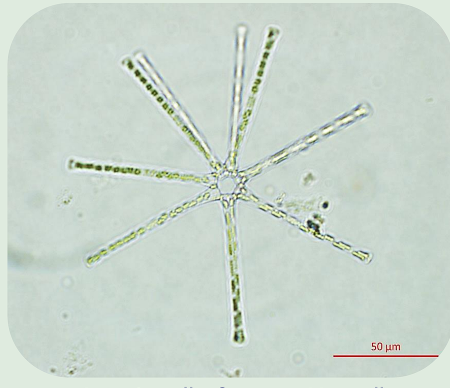
Introduction

The Radoinja Reservoir is situated in Southwestern Serbia. It represents a water filled canyon meandering between narrow and steep limestone shores and formed by constructing a dam across the Uvac River. The Radoinja Reservoir is 12 km long; it has a total volume of 7.6 x 10^6 m^3 and useful volume of 4.1 x 10^6 m^3. The mean altitude of the Radoinja Reservoir is 812 m a.s.l. The Radoinja Reservoir is a multi-purpose; it is used for electricity production and partially for water supply of the town of Priboj and its surrounding.

Cyclotella ocellata Pantocsek



Asterionella formosa Hassall

Materials and Methods

Field research of the Radoinja Reservoir was carried out in June, August and November 2014. The sampling was conducted at 3 sampling sites by depth (near the dam-A_1; central part of the reservoir-B_1 and at the entrance to the reservoir-C_1). By measuring water temperature at every 0.5 m depth, the layers of epilimnion, metalimnion (thermocline) and hypolimnion were determined.

The samples for basic physico-chemical parameters, primary nutrients and chlorophyll *a* were taken at each 1.5 m in epilimnion, at each 0.5 m in metallimnion, and then at every 1.5 m in hypolimnion to the depth of 15 m, and then at each 5 m (including 10% of the depth of bottom of the reservoir). Analysis of physico-chemical parameters was conducted using standard analytical procedures according to appropriate SRPS ISO methods.

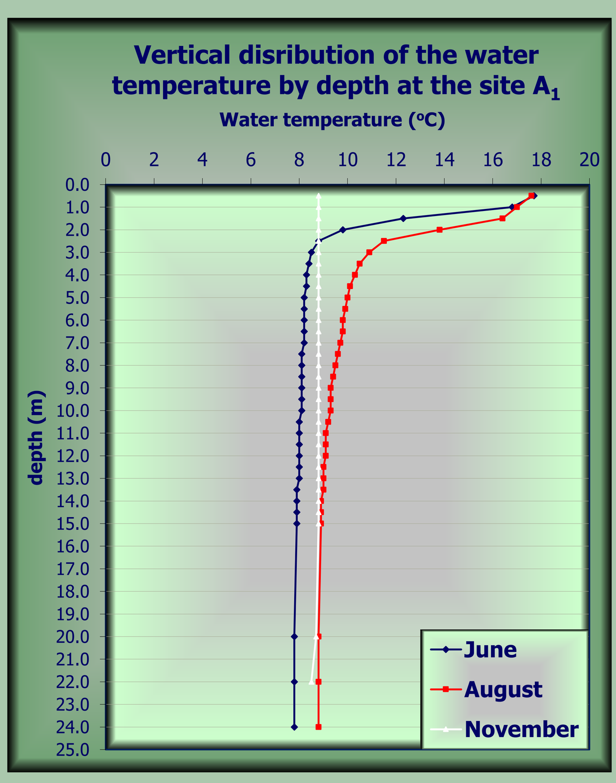
The algal material was collected using plankton nets (25 µm mesh size) and hydrobiological bottles. At three or four sampling sites by depth, two samples for quantitative analysis of phytoplankton were taken, and preserved with formaldehyde or Lugol's iodine. The phytoplankton analysis was done on inverted microscopes: Nikon TE-2000U with DS-5M camera and NIS-Elements D software and Zeiss Axiovert with AxioCam HRc camera and AxioVision 4.8 software. Quantitative analysis of phytoplankton was done using Utermöhl method (1958) according to the SRPS EN 15204: 2008.

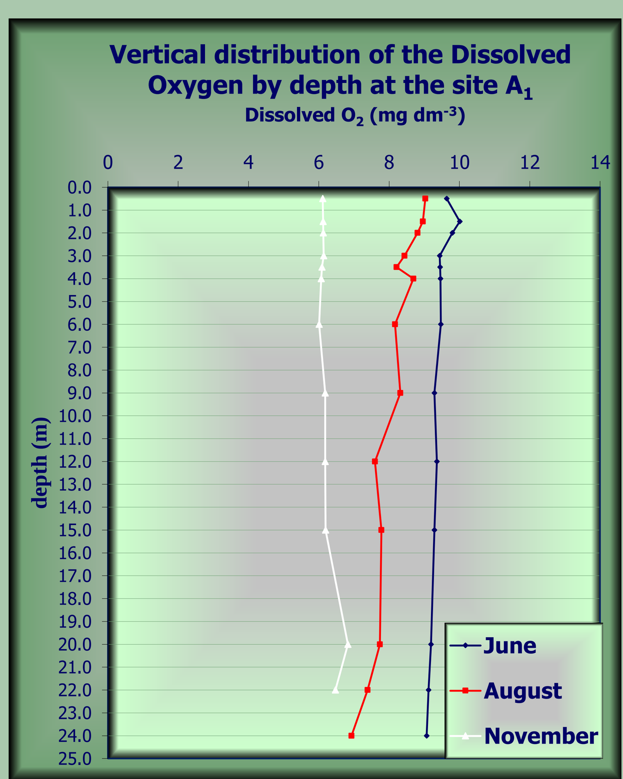
Phytoplankton taxa list of the Radoinja Reservoir in 2014

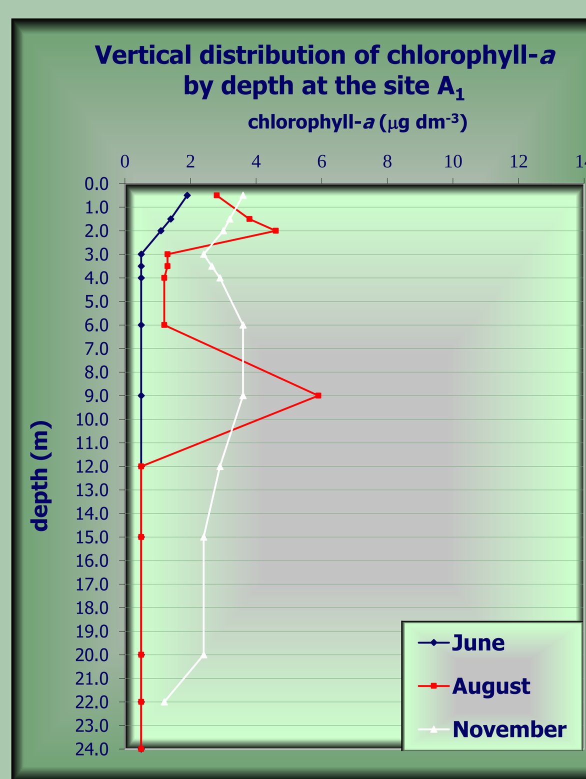
Cyanobacteria	*Rhoicosphaenia abbreviata* (C. Agardh) Lange-Bertalot
Aphanocapsa incerta (Lemm.) Cronberg & Kom.	*Rhopalodia gibba* (Ehrenberg) Otto Müller
Cuspidothrix issatschenkoi (Usachev) P.Rajaniemi, Komárek, R.Willame, P. Hrouzek, K.Kastovská	*Staurosira construens* Ehrenberg
Gleotrichia echinullata P.G.Rihter	*Staurosira venter* (Ehrenberg) Cleve & J.D.Möller
Kamptonema formosum (Bory de Saint-Vincent ex Gomont) Strunecký, Komárek & J.Smarda	*Stephanodiscus minutulus* (Kützing) Cleve & Möller
Merismopedia elegans A. Braun in Kützing	*Surirella brebissonii* Krammer & Lange-Bertalot
Oscillatoria limosa Agardh ex Gomont	**Cryptophyta**
Phormidium terebriforme (Agard&Gom) Anagnostidis & Komarek	*Cryptomonas* Ehrenberg sp.
Planktothrix rubescens (DeCand. ex Gom.) Anagn.& Kom.	*Plagioselmis nannoplanctica* (H.Skuja) G.Novarino, I.A.N.Lucas & S.Morrall
Pseudoanabaena limnetica (Lemm.) Kom.	*Rhodomonas lacustris* Pascher & Ruttner
Snowella lacustris (Chodat) Kom. & Hindák	**Dinophyta**
Chrysophyta	*Ceratium hirundinella* (O.F.Müller) Dujardin
Chrysococcus biporus Skuja	*Gymnodinium* Stein sp.
Dinobryon divergens Imhof	*Parvodinium inconspicuum* (Lemmermann) S.Carty
Dinobryon sertularia Ehrenberg	*Peridinium* Ehrenberg sp.
Bacillaryophyta	*Peridinium cinctum* Ehrenberg
Achnanthidium catenatum Bily & Marvan	**Euglenophyta**
Achnanthidium minutissimum Kützing	*Euglena* Ehrenberg sp.
Amphora ovalis (Kützing) Kützing	*Lepocinclis acus* (O.F.Müller) Marin & Melkonian
Amphora pediculus (Kützing) Grunow	*Monomorphina pyrum* (Ehrenberg) Mereschkowsky
Asterionella formosa Hassall	*Strombomonas acuminata* (Schmarda) Deflandre
Campylodiscus hibernicus (Ehrenberg)	*Trachelomonas hispida* (Perty) Stein em. Deflandre
Caloneis silicula (Ehrenberg) Cleve	*Trachelomonas volvocina* Ehrenberg
Cocconeis placentula Ehrenberg	**Chlorophyta**
Cyclotella ocellata Pantocsek	*Acutodesmus acuminatus* (Lagerheim) Tsarenko
Cymatopleura solea (Brébisson) W. Smith	*Acutodesmus obliquus* (Turpin) Hegewald & Hanagata
Cyclotella radiosa (Ehrenberg) Kützing	*Trachelomonas volvocina* Ehrenberg
Cyclotella (Kützing) Brébisson sp.	*Chlamydomonas* Ehrenberg sp.
Cymbella cistula (Ehrenberg) Kirchner	*Chlorococcales* sp.
Cymbella affinis Kützing	*Closterium aciculare* West
Cymbella C.Agardh sp.	*Closterium acutum* Bréb. var. *variabile* (Lemm.) Krieg.
Cymbella helvetica Kützing	*Coelastrum astroideum* De Notaris
Denticula tenuis Kützing	*Coelastrum microporum* Nägeli
Diatoma ehrenbergii Kützing	*Cosmarium* Corda ex Ralfs sp.
Diatoma moniliformis Kützing	*Cosmarium depressum* (Nägeli) Lundell var. *planctonicum* Reverdin
Diatoma vulgaris Bory	*Crucigenia tetrapedia* (Kirch.) W. West & G. S. West
Diploneis elliptica (Kützing) Cleve	*Desmodesmus bicaudatus* (Dedusenko) P.M.Tsarenko
Encyonema minutum (Hilse) D.G.Mann	*Desmodesmus opoliensis* (P.G.Richter) E.Hegewald
Encyonema silesiacum (Bleisch) D.G.Mann	*Dictyosphaerium ehrenbergianum* Nägeli
Encyonopsis subminuta Krammer & E.Reichardt	*Golenkinia radiata* Chodat
Ellerbeckia arenaria (Moore & Ralfs) R.M.Crawford	*Hariotina reticulata* P.A.Dangeard
Fragilaria acus sensu Krammer&Lange-Bertalot	*Hindakia tetrachotoma* (Printz) C.Bock, Pröschold & Krienitz
Fragilaria dilatata (Brébisson) Lange-Bertalot	*Hyaloraphidium contortum* Pascher
Fragilaria capucina Desmazières	*Kirchneriella lunaris* (Kirchn.) Moeb.
Fragilaria crotonensis Kitton	*Koliella planctonica* Hindák
Fragilaria acus sensu Krammer&	*Lagerheimia ciliata* (Lagerh.) Chodat
Fragilaria ulna sensu Krammer&Lange-Bertalot	*Lagerheimia genevensis* (Chodat) Chodat
Gomphonema olivaceum (Hornemann) Kützing	*Monactinus simplex* (Meyen) Corda
Gomphonema parvulum (Kützing) Kützing	*Monactinus simplex* var. *echinulatum* (Wittrock) Pérez, Maidana & Comas
Gomphonema pumilum (Grunow) E.Reichardt & Lange-Bertalot	*Monoraphidium contortum* (Thurs.) Komarkova-Legn.
Gyrosigma acuminatum (Kützing) Rabenhorst	*Monoraphidium griffithii* (Berkeley) Komarkova-Legn.
Gyrosigma attenuatum (Kützing) Rabenhorst	*Monoraphidium komarkovae* Nygaard
Melosira varians Agardh	*Oocystis lacustris* Chodat
Navicula Bory de St. Vincent sp.	*Pandorina morum* (O.F.Müller) Bory
Navicula capitatoradiata Germain	*Pediastrum duplex* Meyen
Navicula cryptotenella Lange-Bertalot	*Pseudopediastrum boryanum* (Turpin) E.Hegewald
Navicula gregaria Donkin	*Scenedesmus grahneisii* (Heynig) Fott
Navicula lanceolata (Agardh) Ehrenberg	*Scenedesmus quadricauda* (Turp.) Brébisson
Navicula radiosa Kützing	*Staurastrum chaetoceros* (Schröder) G. M. Smith
Nitzschia Hassall sp.	*Staurastrum gracile* Ralfs ex Ralfs
Nitzschia denticula Grunow	*Tetraedron minimum* (A. Braun) Hansgirg
Pleurosira laevis (Ehrenberg)Kom.	*Tetrastrum staurogeniaeforme* (Schröder) Lemm.

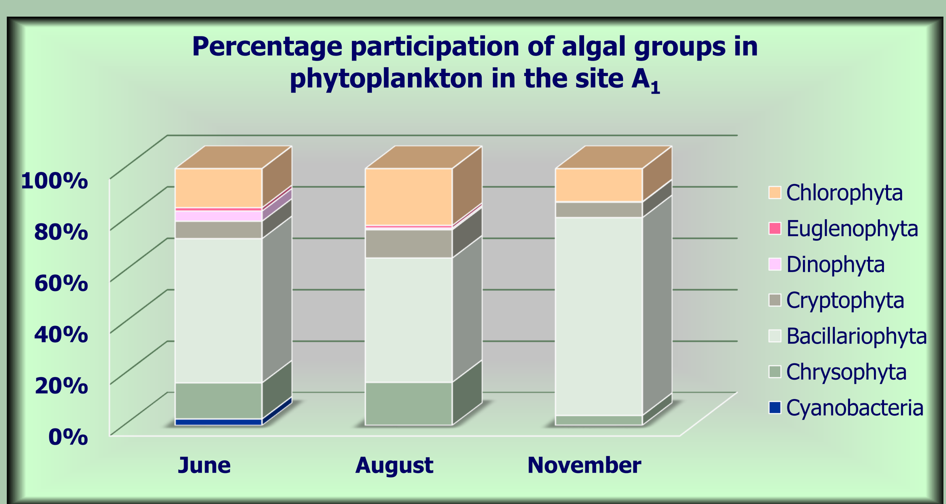
Results and Discussion

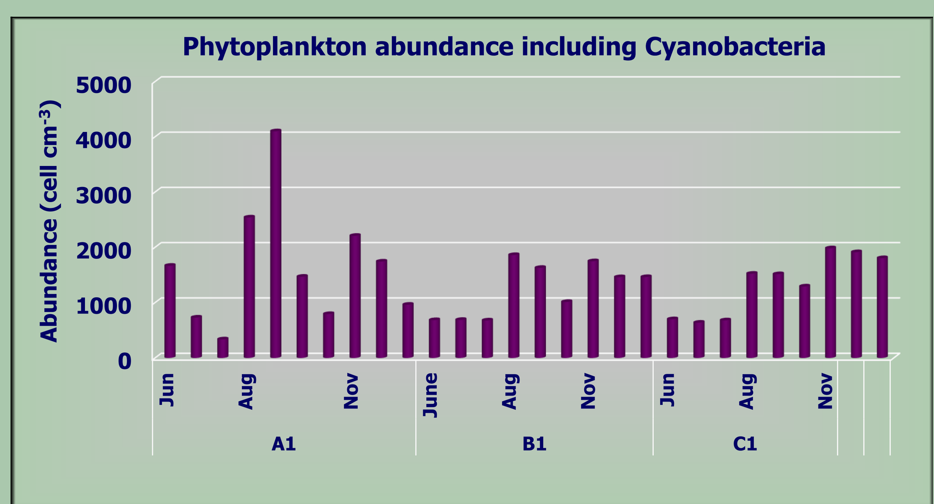
The first two field research is charaterised by thermal stratification whilst the third by total circulation of the reservoir. During all year the Dissolved Oxygen (DO) concentration was high in all water layers; there was not the DO deficit in the hypolimnion. The investigation showed that the phosphorus concentration is a limit factor for phytoplankton growth due to the TP:TN ratio > 17:1 and the Dissolved Inorganic Nitrogen (DIN):Soluble Reactive Phosphorus (SRP) mass ratio > 10:1. By qualitative phytoplankton analysis a total of 117 taxa were identified from 6 algal divisions: Chrysophyta (3 taxa), Bacillariophyta (52 taxa), Dinophyta (5 taxa), Cryptophyta (3 taxa), Euglenophyta (6 taxa), Chlorophyta (38 taxa) and Cyanobacteria (10 taxa). Quantitatively, the diatoms were dominant. Besides typical planktonic forms, the benthic diatoms were numerous. The highest phytoplankton abundance was recorded in August 2014, at the deepest sampling point, near the dam at 2.0 m depth, and it was 4100 cell cm^{-3} whilst the lowest phytoplankton abundance was in June 2014, near the dam, too, at the 24 m depth (336 cell cm^{-3}). The dominant species in phytoplankton community was *Cyclotella ocellata*. The Radoinja Reservoir belongs to oligo-mesotrophic reservoirs characterised by relatively uniform phytoplankton community composition and low productivity as well. In the summer period, a maximum of phytoplankton growth was observed, with poorly expressed peak below the thermocline (the highest chlorophyll *a* concentration was at 9.0 m depth and it was 5,9 µg dm^{-3}). Due to low phytoplankton productivity a water transparency was high (over 7 meters).

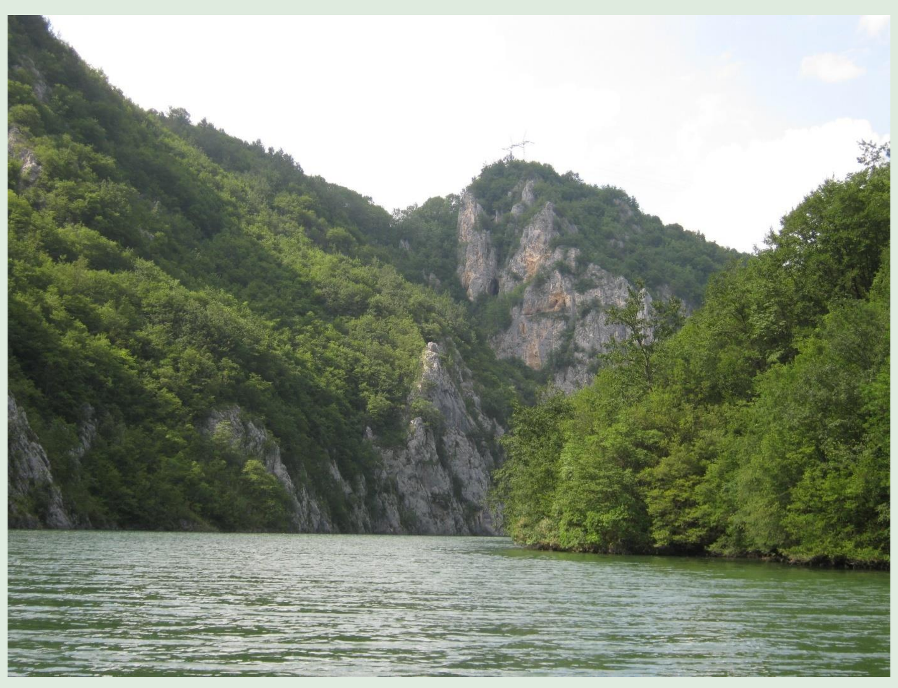


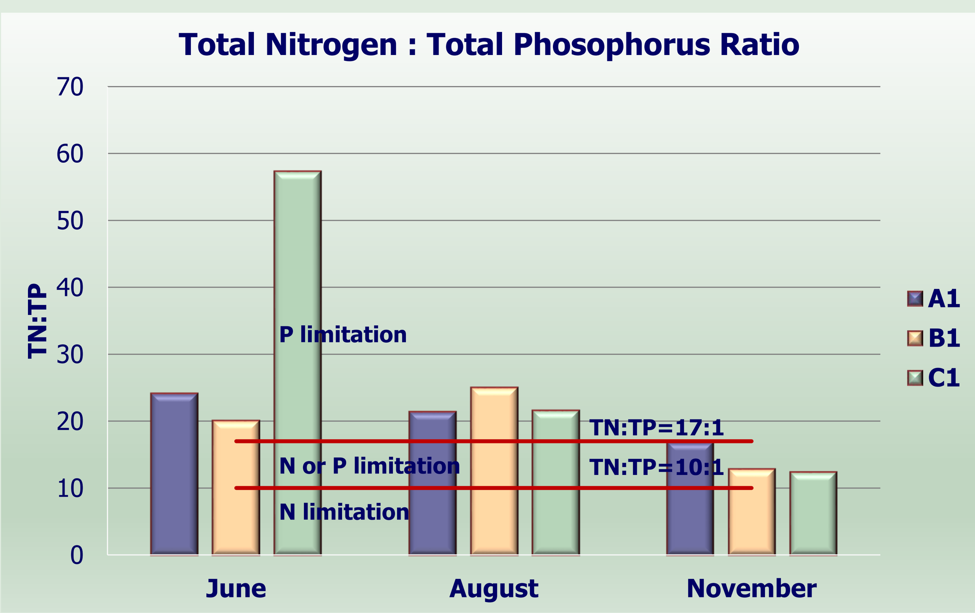












Conclusion

In summer period in oligotrophic lakes the available primary nutrient content which controls productivity is suddenly decreased in surface water layer "suppressing" the phytoplankton populations to some kind of a refuge in the zone below thermocline. In surface water layer only a small amount of renewable primary nutrients remains enabling the survival of poor summer plankton community. Such conditions were noted in the Radoinja Reservoir, which belongs to oligo-mesotrophic type, and its phytoplankton community was characterised by uniform composition and low productivity.