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PRODUCTION OF MACROZOOBENTHOS IN THE RAČA RIVER UPSTREAM AND DOWN STREAM FROM TROUT FARM

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PRODUKCIJA MAKROZOOBENTOSA U RECI RAČI UZVODNO I NIZVODNO OD PASTRMSKOG RIBNJAKA

Apstrakt

Biomasa (produkcija) makrozoobentosa je odabrana kao osnovni pokazatelj za praćenje promena kvantitativnog sastava naselja dna na lokalitetima uzvodno i nizvodno od pastrmskog ribnjaka u reci Rači.

Istraživanje sekundarne produkcije makrozoobentosa reke Rače sa sedam lokaliteta, obavljeno je u periodu 2011. (april, jun, septembar, oktobar, decembar) i 2012. godine (februar i maj). Dominantne grupe u biomasi makrozoobentosa su Hirudinea (Annelida), Mollusca, Gammaridae (Crustacea) i Trichoptera (Insecta).

Vrednosti biomase zoobentosa kretale su se u svim mesecima istraživanja u intervalu od 3,2001 g/m^2, na lokalitetu RČ2 (u februaru) ,do 216,7120 g/m^2, na lokalitetu RČ3 (u februaru).

Biomasa faune dna najveća je u svim mesecima istraživanja na lokalitetu RČ3, koji je lociran nizvodno od pastrmskog ribnjaka. Na ovom lokalitetu biomasa makroinvertebrata se kretala od 87,8643 g/m^2 (u aprilu 2011. godine) do 216,7120 g/m^2 (u februaru 2012. godine).

Ključne reči: makrozoobentos, biomasa, sekundarna produkcija, pastrmski ribnjak
Keywords: macrozoobenthos, biomass, secondary production, trout farm

INTRODUCTION

Freshwater ecosystems - rivers primarly - are one of the most important resource for mankind. By using this resource (for water supply, energy production, food source etc), man directly and indirectly makes an influence on the change of structure and function of aquatic ecosystems. Building a trout farms on rivers is definitely one of these activities.

Trout farming is increasing in Serbia. Trout farms cover approximately 14 ha in our country (Marković and Poleksić, 2011). Spring water (or water from streams and rivers) used for trout farm supply is often disposed into the environment after use without being treated by sedimentation or purification (Marković and Poleksić, 2011).

The negative influence of trout farms on such streams is mainly caused by the release of fish food remains and fecal matter (Liao, 1970), leading to deterioration of the water quality and changes in structure of the stream bottom.

Trout farms also influence the structure of macroinvertebrate communities. This is reflected through the level of secondary production of bottom fauna.

Zoobenthos biomass usually increases due to the greater amount of fish food remains, serving as food supply. On the other hand, wastewater from trout farms causes decline of diversity, replacement of more sensitive species by less sensitive ones, and changes of trophic structure due to increased abundance of collectors and reduced abundance of scrapers and shredders (Živić *et al.*, 2009).

Biomass is one of the basic parameters for quantification of the level of secondary production (Mason et al., 1985; Živić *et al*., 2000, 2008). This makes it very important for understanding the functioning of fresheater ecosystems, to establish a quantitative relationships between the number and activity of zoobenthic organisms (Zivić *et al.*, 2002) since they represent an essential link in the food webs of aquatic biocenoses (Cummins, 1973).

In this paper, macrozoobenthos biomass was used to monitor changes of quantitative composition of bottom fauna in the Rača River. Localities were seleceted upstream and downsteram from the Rača River trout farm.

MATERIAL AND METHODS

Description of the Study Area

The Rača River emerges on the slopes of Mt. Tara (Western Serbia, Figure 1). Rača River has several sources, best known is alkaline spring Lađevac at an elevation of 498 m a.s.l. (Marković, 1998). The basin of the Rača River is of a highland nature, building a deep canyon. It flows into the Drina River, a second order tributary of the Danube, near the town of Bajina Bašta.

The study was conducted at seven localities on the Rača River (Figure 1) Locality RČ1 is situated at 353 m a.s.l., at the point where the canyon passes through dense forest complex. The river bottom consists mostly of larger and smaller stones, rarely rocks. Locality RČ2 – 10 m upstream from the intake of water for the fish farm, with coarse bottom substrate, mostly pebble and stones. Locality RČ3 – 10 m downstream from the trout farm effluent. It predominantly features gravel substrate type and aquatic macrophytes. Locality RČ4 and RČ4' are situated at about 340 m and 320 m a.s.l., downstream from the effluent, passing through a dense forest complex, with sharp and steep banks. The dominant substrate type is stone. Locality RČ5 – 1.5 km downstream from the trout farm, at 306 m a.s.l., with pebble and stones as substrate type. Locality RČ6 – 4 km downstream from the farm, at 245 m a.s.l. with coarse bottom substrate. Water from this locality is directed to another trout farm, situated 5m downstream.

The "Ihthos" trout farm is situated in the upper part of the Rača River (within the Rača Monastery), between second and third locality of the study (Figure 1). Fish farm consists of water intake and an open type main input channel. Its capacity is small, with two fish raceways for pre-consumer grade trout and two pools for consumer-grade trout nurturing.

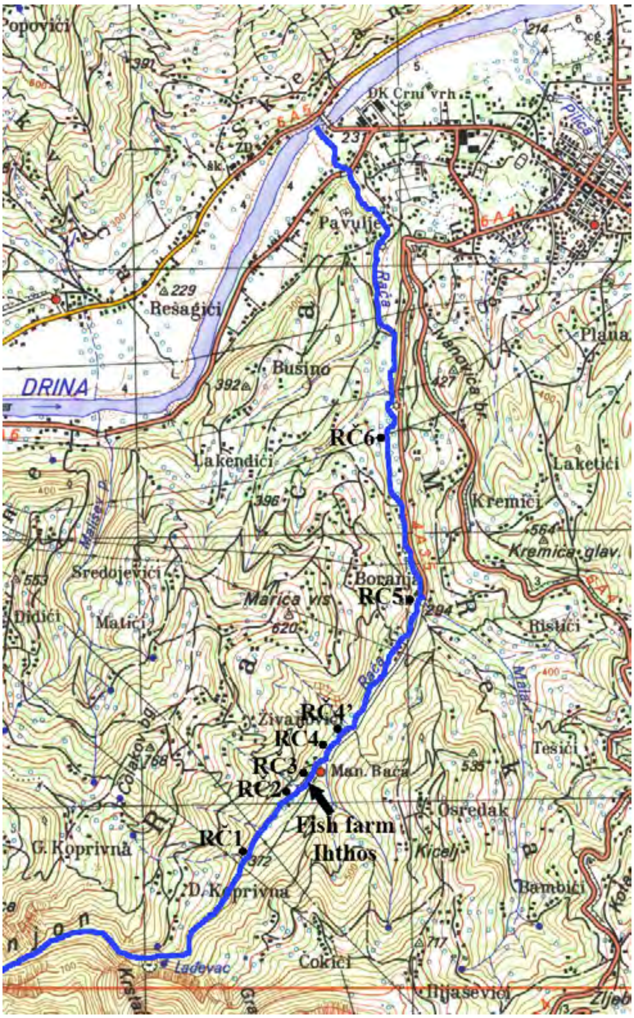

Figure 1. Studied localities in the Rača River and position of the "Ihthos" fish farm

Sampling

Macrozoobenthos samples were collected at seven localities on the Rača River, during 2011 and 2012 (April 4th 2011, June 20th 2011, 28 th September 2011, 16 th October

2011, 10 th December 2011, 26 th February 2012, 6 th May 2012). Samples were collected with a Surber net with the catchment area of 300 cm^2 and mesh size of 250 μm. The collected material was placed in plastic bottles and fixed with 96% alcohol. Three samples were taken with Surber net from every locality each month of the research. A sample is defined as material obtained from the river by a single sweep of the Surber net.

The fresh weight of macroinvertebrates was measured with a KERN ABS 80-4:ABS/ABJ analytical balance with a percision of 0.0001 gr, in order to estimate the total biomass of macrozoobenthos at localities above and below the trout farm.

Chemical parameters

The dissolved oxygen concentration, water temeperature, pH and conductivity were measured using PCE-PHD device (Germany). Measurements were performed each month, at each locality. Also, water was taken for chemical analysis of total phosphorus, orthophosphates and ammonia.

RESULTS AND DISCUSSION

Freshwater ecosystems of the temperate zone are characterized by relatively constant biomass of macroinvertebrates, in which aquatic insects are dominant, together with molluscs, annelids and crustaceans (Cummins, 1973). It is possible to notice certain seasonal variation in zoobenthic biomass (Hynes, 1970), resulting from different adaptations of the life cycle of aquatic insects (egg laying-emergence) to environmental factors, primarily water temperature.

Macrozoobenthos biomass varied annualy in the Rača River, in the interval from 3.2001 g/m^2 at locality RČ2 (February) to 216.7120 g/m^2 at locality RČ3 (February) The greatest mean value of biomass was recorded in June (108.1430 g/m^2), while the second part of the year was characterized by decline of secondary production from 55.2918 g/m^2 in September and 61.5764 g/m^2 in October (Figure 2).

The reason of this production can be explained by the increasing number of major groups of macrozoobenthos, but also by the fact that emergence of larger forms of Ephemeroptera and Diptera has not occurred. Also, increased abundance of Hirudinea was recorded. There was a decrease in abundance and biomass of benthic organisms in August, due to emergence of insect groups. Caused by abiotic factors of the environment (especially decrease in temperature), the development cycle of bottom organisms enters a phase of slow biochemical processes, resulting in reduction of seconadary production (September and October, Figure 2). The lowest production of macrozoobenthos was registered during the winter (56.3485 g/m^2 in February) and early spring (56.9956 g/m^2 in April). Unexpectedly high level of bottom fauna biomass was recorded in December (103.6084 g/m^2). Result of such growth is related to RČ3, RČ4 i RČ4' localities. Great abundance of trichopteran larvae were registered at locality RČ4 and RČ4', like *Hydropsyche, Rhyacophila* and *Sericostoma* genera, which overall contribute to the increase in biomass at these localities. The increase in biomass at RČ3 locality (208.2071 g/m^2) was connected with a great abudance of taxa less sensitive to organic pollution, overall Hirudinea and *Gammarus* genus.

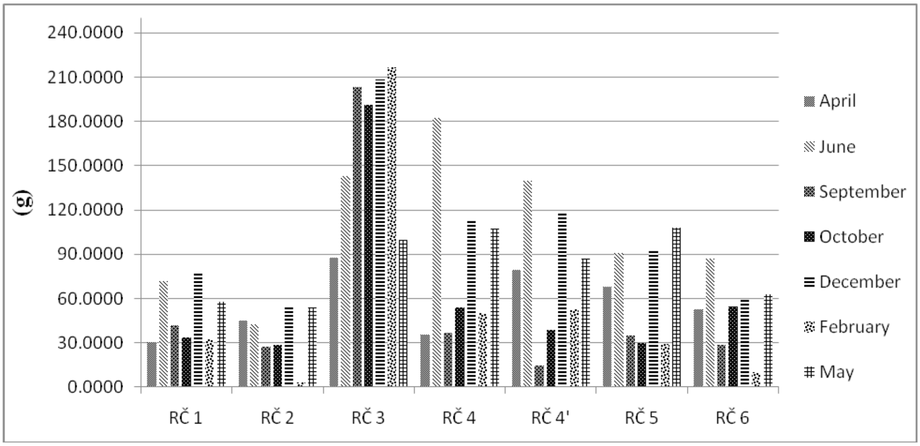

Figure 2. Macrozoobenthos biomass (g/m^2) at seven localities in the Rača River

According to the results of bottom fauna biomass, rapid growth trend can be seen at locality RČ3, right below the trout farm, relative to localities RČ1 and RČ3 situated above the farm. Macrozoobenthos biomass was in the interval from 87.8643 g/m^2 (in April 4th 2011) to 216.7120 g/m^2 (26th February 2012) at RČ3 locality. Comparing the average macrozoobenthos biomass between localities upstream from the trout farm (RČ1 - 49.3482 g/m^2; RČ2 - 36.5903 g/m^2) and downstream from the farm (RČ3 - 164.3381 g/m^2) it is evident they are significantly lower.

The maximum values of zoobenthos biomass at RČ3 locality can be explained by the high inflow of fish food remains in the recipient used by bottom organisms as food source. Due to deterioration of water quality (also because of the wastewater influx from the trout farm) only tolerant macroinvertebrate groups were found, which are larger and therefore contributed to the biomass of the community. Dominant groups collected at this locality were Hirudinea (Annelida), Mollusca (*Lymnea* sp.), Gammaridae (Crustacea) and Trichoptera (Insecta).

Figure 3 and 4 represents mean values (mean ± standard error) of chemical paremeters measured at localities. It is evident that temperature increases from the first to the sixth locality, while the concentration of oxygen decreases from the first to the third locality, in order to increase again from the fourth locality (Figure 3). However, these changes in oxygen concentration were not drastic, as its concentrations remained high (10.3-10.0 mg/l). The consequence – high oxygen concentration during the entire study period - was probably due to good river aeration and field configuration (steep banks). Conductivity and pH were more constant throughout the study period (Figure 3). Their higher values indicate that substrate type of the Rača River is primarily limestone. Concentration of total phosphorus and orthophosphates stayed below the recommended upper limit (Figure 4), although their higher concentrations were expected at the localities below the trout farm. Mean value of orthophoshates in the Rača River reached up to 0.017 mg/l and the recommended level of 0.02 mg/l (Dulić, 2010) are characteristic for salmonid waters. The exception was the concetration of orthophosphates at the RČ 4' locality with the highest concentarion of 0.0317 mg/l. The maximal permissible concentration of total phosphorus is 0.2 mg/l for salmonid waters (TPECD, 2006) and its highest value was observed at the RČ4' locality (0.072 mg/l) in February. Ammonia concentrations varied considerably during the research period (Figure 4), especially at the locality below the trout farm (RČ3) where the highest mean concentartion was observed (0.18 mg/l). Taking into account the parameters that were measured at all studied localities, we can conclude that only high concentration of ammonia at the third locality made an imact on zoobenthos biomass, in terms of the presence of taxa less sensitive to such changes. Those taxa, especially Mollusca and Hirudinea, have the lagrest single biomass.

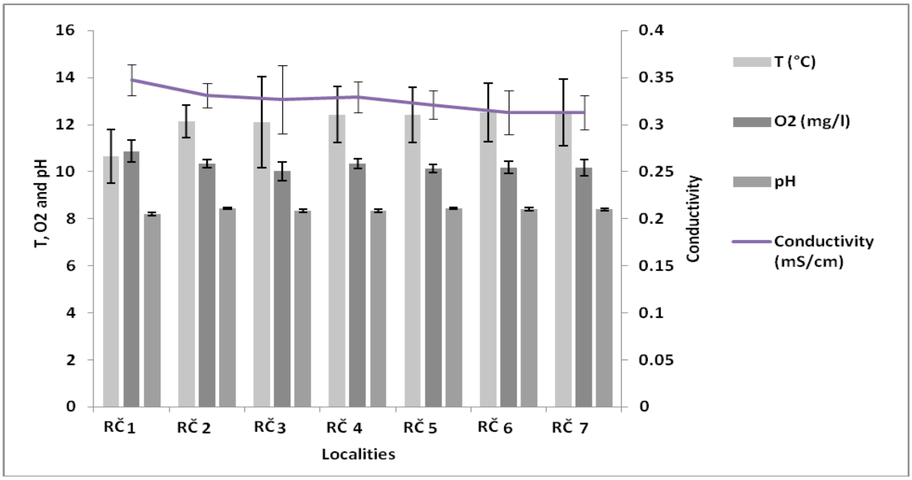

Figure 3. Mean values (with standard error) of temperature, dissolved oxygen, pH and conductivity

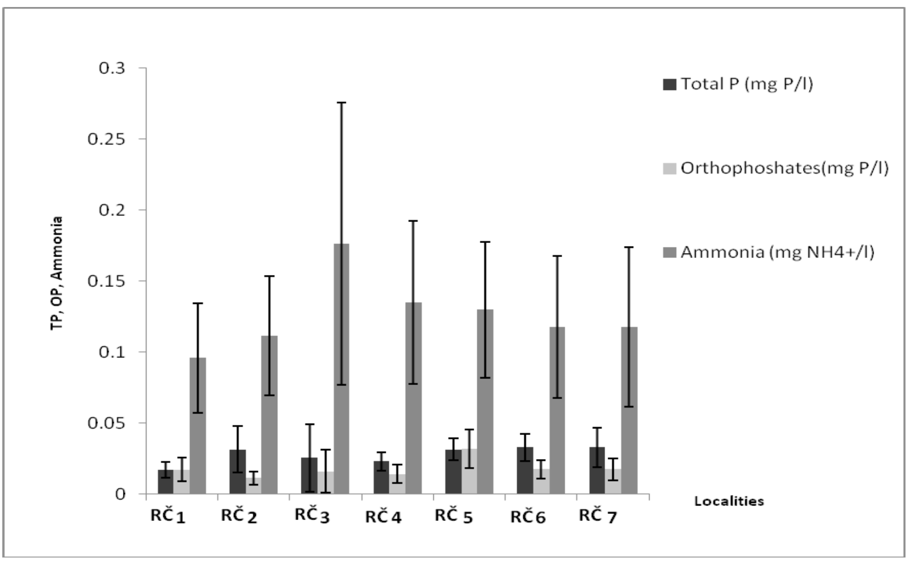

Figure 4. Mean values (with standard error) of total phosphorus, orthophosphates and ammonia

CONCLUSIONS

The research of macrozoobenthos secondary production was conducted during 2011 and 2012 in the Rača River (in a length of 4 km), upstream and downstream from the trout farm.

The greatest mean value of biomass was recorded in June (108.1430 g/m^2). The second part of the year was characterized by decline of secondary production, except in November, with the lowest biomass of organisms during the winter (56.3485 g/m^2 in February) and early spring (56.9956 g/m^2 in April).

Macrozoobenthos biomass varied annualy in the Rača River, in the interval from 3.2001 g/m^2 at locality RČ2 (February) to 216.7120 g/m^2 at locality RČ3 (February).

Locality RČ3, situated downstream from the trout farm, was characterized by the greatest bottom fauna biomass. At this locality macrozoobenthos biomass was in the interval from 87.8643 g/m^2 (in April 4th 2011) to 216.7120 g/m^2 (26th February 2012).

Mean values of chemical parameters remained below the recommended upper limit for salmonid waters. Concentration of total phosphorus and orthophosphates were higher than recommended level at RČ4' locality.

Ammonia concentrations varied considerably during the research period. The highest mean concentartion was observed at the locality below the trout farm (0.18 mg/l). High concentration of ammonia at the third locality made an imact on zoobenthos biomass, in terms of the presence of taxa less sensitive to such changes, who also have the largest single biomass.

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