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MONITORING WATER QUALITY USING ZOOPLANKTON ORGANISMS AS BIOINDICATORS AT THE DUBICA FISH FARM, SERBIA

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Abstract – The quality of water at the Dubica Fish Farm was evaluated by the saprobiological method using the Pantle-Buck saprobity index, during one carp production cycle in the year 2000. By qualitative and quantitative analysis of the zooplankton community, bioindicator species were selected for evaluation of water quality. During the whole period of research, the saprobity index indicated class II water quality, which is suitable for rearing carp in a semi-intensive system as far as natural food is concerned. There was a general trend of decrease in the saprobity index from the beginning to end of the season, its values ranging from 2.05 do 1.77, and a gradual improvement of water quality towards the end of the season. This is partly a result of natural processes (terminated degradation of introduced organic matter as well as settlement of suspended matter introduced with the supply water) and partly a consequence of the application of ichthyological, agrotechnical, and hydrotechnical measures.

Key words: Water quality, monitoring, zooplankton, bioindicators, fish farm

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INTRODUCTION

Fish nutrition a semi-intensive system of rearing carp is based on natural food (zooplankton and bottom fauna) as the main source of proteins and additional feed as the main source of carbohydrates (M a r k o v i ć, 2003; M a r k o v i ć *et a*l., 1998, 2004, 2005). For this reason, it is more appropriate to supply carp farms water of quality class II, since it has higher productivity than class I water (V i d m a n i ć, 1993; M i t r o v i ć-T u t u n d ž i ć and B r k o v i ć-P o p o v i ć, 1995).

In this type of fish farm, organic production depends on several factors: productivity of the water body that supplies the fish farm; the type of fish pond bottom soil; total ichthyomass; appropriately prescribed quantity and quality of additional feed; and application of ichthyological, agrotechnical, and hydrotechnical measures (L i v o j e v i ć *et al.*, 1967).

When fish farms are supplied with water of quality class II, eutrophic water with a high content of dissolved nutrients (P and N) and appropriate levels of dissolved gases (O_2, CO_2) and favorable temperature is introduced, which improves secondary production and keeps the ecosystem in a state of dynamic balance (M i t r o v i ć-T u t u n d ž i ć *et al.*, 1988).

If the fish farm is supplied with water of bad quality, several negative processes will occur such as sedimentation and biodegradation of organic matter, which will increase the biological oxygen demand (J o n e s, 1990). Organic matter degradation can provoke oxygen depletion and appearance of intermediate products of degradation like NO_2, NH_3, and H_2S (M i t r o v i ć-T u t u n d ž i ć *et al.*, 1988).

However, considering the global problem of water pollution, the semi-intensive type of fish production recommends itself as the least polluting (B a u e r and T u r k, 1980; B a u e r, 1982; M i t r o v i ć-T u t u n d ž i ć and V i d m a n i ć, 1995). Complete dewatering of fish ponds into the recipient water body is carried out once a year, usually during the fish harvest. However, the water level in carp ponds is gradually lowered, so that mud with most of the waste discharge either stays in the pond or else flows into the receiving water in only small amounts. By this, the environment is protected against pollution from fish ponds during most of the year (P i l l a y, 2004).

MATERIAL AND METHODS

Research was carried out at the Dubica Fish Farm in Banatska Dubica during one rearing cycle of two-year old carp in the year 2000. Five points for sample collection were chosen on fish pond No. 4, with surface area of 112.25 ha. These points were chosen in such a way as to represent the whole pond (A p h a, 1998). Sampling transparent was carried our every two weeks, from May to October, using a narrow each plastic transparent 2 m long and 1 L in volume. Two samples of 2 L were taken at stored point. Water samples were filtered through No. 20 plankton mesh and stored with 4% formalin in glass bottles. Single samples were combined and analyzed as a summarized sample of the whole pond.

Zooplankton identification was performed using appropriate identification keys (Š r a m e k - H r u s e k *et al*., 1962; D u s s a r t, 1969; K o s t e, 1978). Samples were analyzed in the Faculty of Agriculture's Laboratory of Zoology and Fisheries, using a Sedgwick-Rafter cell and a Carl Zeiss (Jena) compound microscope with 16x10 magnification. After qualitative analyses of zooplankton and estimation of their abundance, the Pantle-Buck saprobity index was determined (P a n t l e and B u c k, 1955). Ortendorfer and Hofrat's list of indicator species was used for determination of water quality (O r - t e n d o r f e r and H o f r a t, 1983).

RESULTS AND DISCUSSION

Twenty-five species of zooplankton were identified

Table 1. Qualitative and relative quantitative composition of zooplankton species with saprobic values («S») and saprobity index.

Zooplankton gruops	«S»	sampling dates								
		13.5.	31.5.	20.6.	4.7.	14.7.	1.8.	18.8.	5.9.	18.9.
Rotatoria										
Asplanchna brightwelli	2.3									1
Asplanchna priodonta	1.6		1	1	1	1	1	1	1	
Brachionus angularis	2.5		1	3	2	1	2	1	2	1
Brachionus budapestiensis	2.0				1					
Brachionus calyciflorus	2.5		1	1	3	1	1	2	2	1
Brachionus diversicornis	2.0			1	1		1	1	1	1
Brachionus falcatus	2.0				4	2	2	1	1	1
Brachionus quadridentatus	2.2		1	1		1	1			
Hexarthra mira	1.5				2	1	2	3		
Keratella cochlearis	1.9	1		1	1		2	5	1	1
Keratella quadrata	1.2			1			1			
Keratella valga	1.4		1		1	1	1	1	1	1
Philodina sp.	1.6					1				
Philodinidae					7					1
Polyarthra dolichoptera	1.3		2	2	1	2	1	1	7	2
Polyarthra vulgaris	2.1	1	1	1	1	1	1	4		1
Pomfolyx sulcata	1.7						1	1		
Trichocerca rattus	1.5									1
Cladocera										
Bosmina longirostris	1.6	1	5	9	5	3	5	7	7	5
Ceriodaphnia sp.	1.5						1	5	3	2
Chydorus sphaericus	1.8		1	1		1	1	1		
Daphnia longispina	2.0	1	1	1	1	1	1	1	2	1
Daphnia magna	3.4	1	1	1	1	1	1	2	1	1
Moina sp.	1.9				1		1	2	1	
Peracanta sp.								1		
Copepoda										
Cyclops sp.	1.8	3	3	3	5	3	2	3	3	4
Saprobity index		**2,05**	**1,87**	**1,87**	**1,58**	**1,88**	**1,86**	**1,82**	**1,77**	**1,78**

in the investigated fish pond (Table 1). The greatest diversity was observed among Rotifera, with 17 species and one family (Philodinidae), followed by Cladocera with seven species and Copepoda with one taxon. The sixth sampling yielded the greatest diversity of zooplankton (20 species), the first sampling the least (six species). It can be concluded that the pond's diversity is rather low. In any event, it is known that zooplankton diversity in aquatic ecosystems (including carp ponds) is lowered by increase of eutrophication (L a z z a r o, 1987).

Saprobiological analysis showed that the investigated fish pond had class II water quality, which is essential for good functioning of a carp pond (M i t r o v i ć-T u t u n d ž i ć and V i d m a n i ć, 1991; V i d m a n i ć, 1993). There were limited variations of saprobity index values during the investigation, but a general trend of decrease from the beginning to end of the season was noted. The highest index value (2.05) was at the beginning of the season (Fig.1). During most of the season, from May to the end of August, saprobity index values where rather stable, varying from 1.88 to 1.82, except at the beginning of July, when the saprobity index was 1.58 (Fig.1). During September, saprobity index values were lower than at the beginning and during most of the season of carp rearing (1.78 and 1.77).

This trend (Fig. 1) can be attributed to a great quantity of suspended solids, which usually contain an increased amount of organic matter, the indicated solids having introduced into the fish pond from the supply water body (in this case the DTD Bečej-Banatska Palanka Canal) during filling of the pond.

The increased amount of degradable organic matter introduced at the beginning of the season (when the saprobity index was the highest), provokes increase of oxygen demand in the water and general aggravation of the environment for the zooplankton community. Species that are more tolerant of environmental changes, ones which have a higher saprobity value, become the most frequent, and this results in greater total value of the saprobity index. As a consequence of sedimentation organic matter in still aquatic ecosystems such as carp ponds and correct application of ichthyological, agrotechnical and hydrotechnical measures, gradual decrease of saprobity index values can be expected. A greater decrease of the index (1.58) was noted at the beginning of July, when the hydrotechnical measure of pond water refreshment was carried out by introducing fresh water from the water supply (the DTD Canal), whose quality has improved of late (Fig 1).

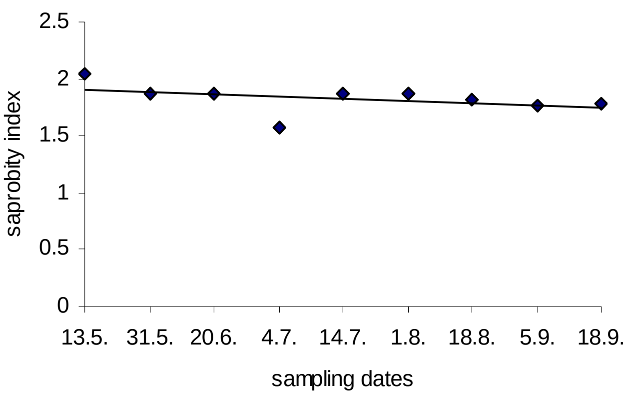

Fig. 1. Dynamics of saprobity index during research period.

CONCLUSION

The quality of water at the the Dubica Fish Pond in Banatska Dubica (112.25 ha of water surface) was monitored using zooplankton as bioindicator organisms during one production cycle of two-year old carp in the year 2000.

The obtained results showed a general trend of decrease of saprobity index values from the beginning to end of the season. Gradual improvement of water quality is partly a result of natural processes in aquatic ecosystems (sedimentation of suspended solids and terminated degradation of introduced organic matter) and partly an effect of proper application of ichthyological, agrotechnical, and hydrotechnical measures.

The determined beta mesosaprobic water quality is optimal for carp ponds with the semi-intensive type of rearing because such water contains appropriate amounts of dissolved nutrients (phosphorus and nitrogen) and dissolved gases (oxygen, carbon dioxide, etc.), which improve productivity of the pond and lead to a better rate of growth of the reared fish.

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ПРАЋЕЊЕ КВАЛИТЕТА ВОДЕ КОРИШЋЕЊЕМ ЗООПЛАНКТОНСКИХ ОРГАНИЗАМА КАО БИОИНДИКАТОРА НА ШАРАНСКОМ РИБЊАКУ "ДУБИЦА", СРБИЈА

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Током производне сезоне гајења шарана у 2000. години на рибњаку "Дубица", у циљу праћења квалитета воде примењена је биолошка метода израчунавања индекса сапробности по Pantle-Buck-у. Квалитативном и квантитативном анализом заједнице зоопланктона издвојени су биоиндикатори на основу којих је одређен квалитет воде у испитиваном рибњачком језеру. Током целог периода истраживања, индекс сапробности је био у границама II класе квалитета воде, што је за шаранске рибњаке са полуинтензивним системом гајења пожељно са становишта продукције природне хране. Вредности индекса сапробности су имале и генерални тренд опадања од почетка према крају сезоне, од 2,05 до 1,77, односно дошло је до постепеног побољшања квалитета воде језера у другом делу сезоне. Овај процес је до извесне мере резултат природних процеса (завршене разградње унетих органских материја водом, као и таложења суспендованих материја унетих свежом водом), а делом примене агротехничких и хидротехничких мера.