MICROBIOLOGICAL AND BIOCHEMICAL INDICATORS OF THE BACHKA REGION WATER ORGANIC LOAD OF THE DANUBE-TISZA-DANUBE CANAL NETWORK (BECHEY–BEZDAN STRETCH)

GAYIN Slavka, MATAVULY Milan, RADNOVICY Dragan,
PETROVICY Olga, SIMEUNOVICY Yelica,
BORKOVICY Zorica, BOKOROV Milosh

DEPARTMENT OF BIOLOGY AND ECOLOGY,
FACULTY OF SCIENCES, UNIVERSITY OF NOVI SAD,
D. Obradovicya square 2, Novi Sad, Serbia and Montenegro
E-mails: *gajins@im.ns.ac.yu; matavuly@im.ns.ac.yu*

ABSTRACT

In the frame of the Project No 1945, "Hydrobiological Investigations of the Danube-Tisza-Danube (DTD) Canal Network with the Aim of a Wise Use and the Sustainable Development of the Resources" supported by Ministry of Science and Technologies of the Republic of Serbia, microbiological and biochemical investigations of water quality of the Great Canal of Bachka (Voyvodina, Serbia) from the saprobiological point of view have been undertaken.

Results obtained in this investigation show that organic load of canal waters, estimated according to the number of heterotrophic, facultative oligotrophic, and certain physiological groups of bacteria (lypolytic, saccharolytic, proteolytic, naphta-degrading, phenol-oxidizing), during 2002 varied remarkably depending on season and on the sampling site. Using categorization system after Kohl (1975), quality of water ranged around II class (in some localities at the Great canal - near Bezdan, Sombor and upstream of the Vrbas town), over slightly and moderately polluted, to the range of extremely polluted water (III-IV and IV class) mainly downstream of Vrbas town wastewater discharge into canal as a recipient.

Culmination of organic load followed as a consequence of sugar beet campaigne in Vrbas sugar refinery. Chlorophyll a concentration also points to the disturbance of algal community downstream of Vrbas town wastewater discharge. As a bioindicator parameter, enzyme (phosphatase) activity correlated significantly with other microbiological and biochemical indicators of the water organic load.

Key words:

Bachka Region, DTD Canal network, Water quality,

1. INTRODUCTION

The Great Canal of Bachka, the main, magistral canal of Basic canal network of the Danube-Tisza-Danube hydrosystem of Voyvodina, with its construction finished around 200 years ago, became the biggest man-made flowing water in the South-Eastern Europe. One of the main properties of this Canal is the wery slow watercourse. The water supply of the upper stretch of the Canal (Vrbas-Bezdan stretch) has been provided by Bezdan water-pump, drawing water from the River Danube, and in favorable hydrological conditions, from the Baya Canal, entering the Great Canal near Shebesh Fok village. This part of Canal joins the Bechey-Bogoyevo Canal in the Vrbas town.

The upper stretch of the Great Canal of Bachka belongs to the most protected waters of Voyvodina, considering concentrated, pointed sources of water pollution, but, having in mind the huge basin collecting surface waters from the whole northern Bachka, and even from the southern part of Hungary, this water-flow has been subjected to the influence of number of spotted, dispersed pollution sources. The Bechey-Vrbas stretch has been suffering from the intensive anthropogenic influence (2; 3, 4, 10, 11, 13).

Primarily planned purpose of this canal (irrigation, watering, sport and recreation) in some sections has been endangered, and this canal has been gradually transformed into recipient water of municipal, and very often industrial wastewaters (4, 9, 10, 11, 13). After almost two decades of decreased industrial production, transportation and use of pesticides and fertilizers in the riparian agriculture zone, the significant increase of canal water quality have been recorded (4, 9, 11, 13). However, results of water quality study in the course of 2002 revealed the lack of measures with the aim of protection and improvement of the Canal water quality, becoming necessary with the revival and intensification of the industrial and agricultural production in the riparian area.

In this report the review of results of investigations of water quality of the main, Great Canal of Bachka, obtained in the course of 2002, in the frame of project No 1945, supported by Ministry for science, technologies and development of the Republic of Serbia, has been summarized. In order to get acquainted with the main causes and consequences of water pollution of huge canal net system in northern Serbian Autonomous Province of Voyvodina, long-term multidisciplinary biological investigations of Bachka part of canal net of Danube-Tisza-Danube (DTD) canal system have been undertaken. Obtained results were analysed seasonally (spring, summer, autumn, winter) comparing them with results of our earlier investigations. (4, 9, 10, 11, 13),

The main net of the irrigation and transportation DTD canal net, together with canal net of the Banat region, of the length of about 1000 km, consists of interconnected artificial canals and watercourses which, being regulated, have lost some of their original natural properties, and are subjected to the permanent anthropogenic influence. This canal net

has been of the great significance for the region, first of all for an agricultural artificial irrigation, for transportation too, and also for fish culture and water supply under the condition of satisfactory quality of water.

Since at the canal bank numerous settlements and industrial centers are situated, and also the agricultural production is being more and more intensive, the DTD canal water quality depends primarily on the degree of wastewater purification, not only in our country, but also in the states upstream of the River Danube, the River Tisza and other smaller flowing waters entering territory of Voyvodina from the neighbouring Hungary, Romania, and Croatia.

Bearing in mind that a very small percentage of regional wastewater has been treated before discharging into canal water as a recipient, and since the canal water turbulence and flow rate are almost irrelevant as a selfpurification factors, rather high water saprobity degree has been found, especially at the certain sections (4, 10, 13). Awareness of the importance of solving the problems of canal water pollution forced the regional water authorities to undertake numerous measures in order to improve a condition of surface waters in general, and especially in the regions where the water selfpurification has a reduced natural capacity.

Since several years ago a condition of canal waters of some section was found to be very bad (4, 9, 10, 11), the aim of our investigations was to determine a recent quality of water and sediment of the same object in order to compare the condition before and after all measures undertaken for the protection and improvement of natural surface flowing waters of DTD system, as well as other biological parameters, relevant for estimation of possible sustainable use of this natural resource.

2. MATERIAL AND METHODS

Sampling

Microbiological investigations included determination of qualitative and quantitative composition of bacterioplankton, from their bioindicative aspect. The samples for microbiological analyses were taken from the middle of the canal watercourse from the 1m depths.

Enumeration of bioindicating microorganisms

Viable psychrophylic heterotrophic bacteria count was determined on Torlak (Belgrade) nutrient agar. The facultative oligotrophic bacteria count as well as the number of physiological groups of bacteria (proteolytic, lipolytic, saccharolytic, amilolytic, phenol-degrading and naphtha-oxidizing) was determined as described in Petrovicy *et al.*'s manual (12).

Chlorophyll "*a*" concentration was determined according to standard method (1).

Enzymatic analyses

Water phosphatase activity was determined in original, untreated water sample on p-Nitrophenylphosphate as a substrate as described earlier (6, 8).

Assesment of water quality

The water quality estimation was carried out according to KOHL's classification (5) based on the number of heterotrophic bacteria, and also according to the water phosphatase activity index, PAI, reflecting water phosphatase activity level (7).

3. RESULTS AND DISCUSSION

Analyzing results of seasonal study of the Great Canal water in the course of 2002, the significant differences between quality of water of the Vrbas – Bezdan stretch and Bechey – Vrbas section have been recorded.

On the basis of sapromicrobiological, hydrobiological, and biochemical investigations, the categorization considering water quality of the most problematic stretch of DTD canal net, belonging to the Bachka Region, into classes of water quality has been done. The canal water at the most of sampling sites belonged to desired, II. Class according to KOHL's (5) categorization (Fig. 1,).

According to the sapromicrobiological investigations, canal waters belonged mainly to the moderately polluted, considering their biodegradable organics load. Some points with higher number of bioindicators of organic pollution directed to the location of acute or chronic load with organic pollutants. Nevertheless, the selfpurification capacity of investigated waters was conserved at the high level.

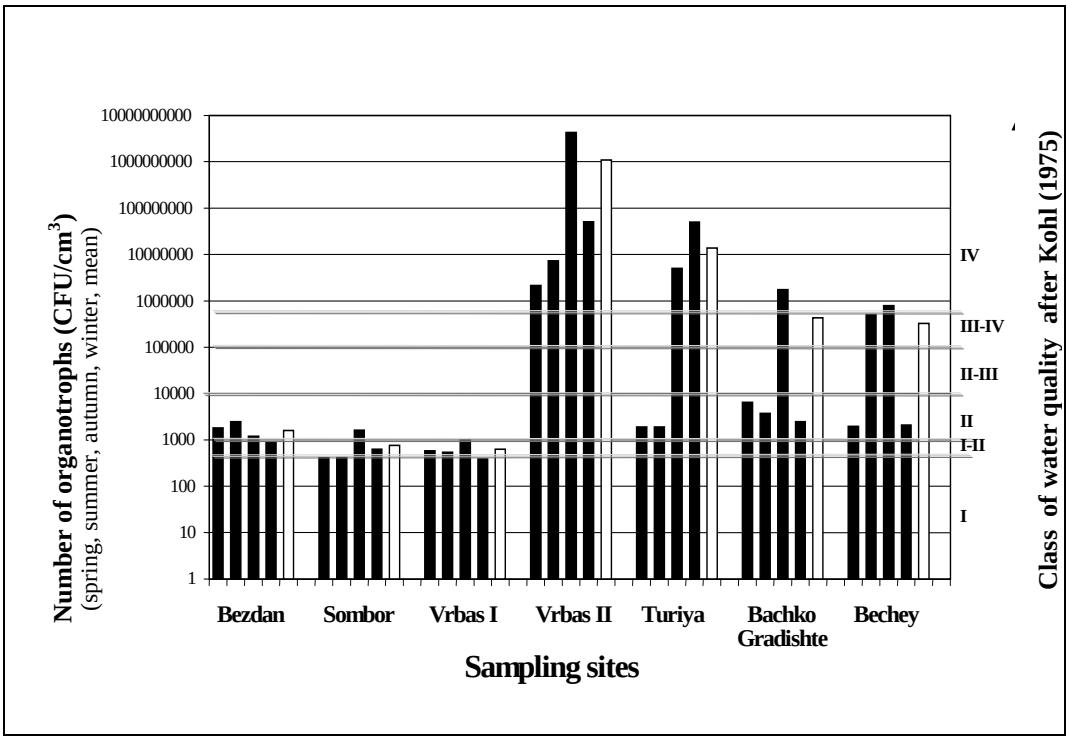

Fig. 1. Number of heterotrophic bacteria and water quality after Kohl (1975)

In the upstream stretch of the Bachka Great Canal, (Bezdan, Sombor and Vrbas I, upstream of the industrial wastewater discharge, sampling sites) in the course of the whole year water quality has been found to bee in the frame of classes of satisfactorily clean to slightly polluted (I-II or II class after Kohl, (5) (Fig 1.). Facultative oligotrophic bacteria in all of cases were much more numerous than heterotrophs, and the ratio between mostly autochthonous facultative oligotrophs and mostly allochthonous heterotrophs (FO/H), testifyes about good, sometimes very good autopurification capacity of water (12).

Water phosphatase activity index (PAI) correlated significanly with the bacterial water quality indicators, and testify to the comparatively good quality of water of this strech of Great Canal of Bachka. According to the water quality classification, based on the level of the water phosphatase activity, reflecting water heterotrophic biotransformation rate, proposed by Matavuly (7), Canal water of the Vrbas–Bezdan strech belonged to the class of water moderately polluted by organics (Fig. 2), what was in agreement with our earlier findings (3; 9, 10, 11). Water enzyme activity, implemented here as the new biochemical parameter of water quality assessment, turned to be precise, fast and reliable indicator in water condition assessment, what was in agreement with our previously reported findings (8, 10, 11).

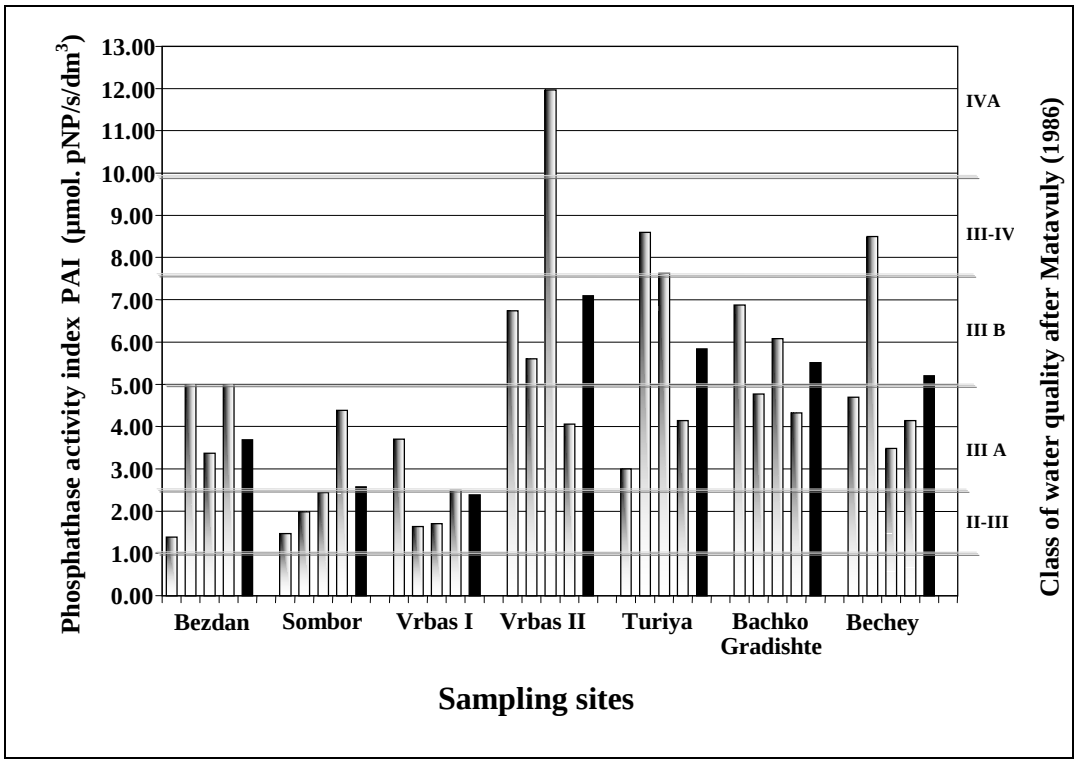

Fig. 2 Water enzyme phosphatase activity and water quality after Matavuly, 1986)

Lower stretch of the Great Canal, downstream of the Vrbas town wastewater discharge into Canal water (Bechey–Vrbas section), has been subjected to the long-term anthropogenous pollution. Consequently, the considerable fluctuations of the water quality in the course of 2002 have been recorded. Estimated on the basis of the heterotrophic bacteria count, water quality downstream of Vrbas turned to belong to IV class after Kohl (5) in the course of the whole year, pointing to the harmful effect of industrial water discharge into Canal water (Fig. 2, Tab. 1). The same findings we have published earlier (2, 4; 9, 10, 11, 13).

Sampling sites, downstream of Vrbas town (Turiya, Bachko Gradishte, and Bechey) were characterized with wery changeable water quality, belonging mostly in the dirty water class, and only in the spring season, but not always, reached the desidered, moderately polluted class of quality. The wors quality of Canal water was recorded in the autumn season, caused the most probably by the sugar beet campaigne. The oxidation of high concentration of waste organic matter in water, causing the water anoxy, resulted in high rate of fish mortality in September 2002).

The FO/H ratio in the water of this strech varied considerably, indicating poor or satisfactory water selfpurification capacity. The water phosphatase activity downstream of Vrbas town varried too, calssifying Canal water into category of very pollyted to dirty water (7).

The results obtained in this investigations point that the measures of water protection were insufficient or completely lacking, especially considering the Vrbas town industrial zone (4, 9, 11). Being not pretreated, biologically treated or even subjected to the secondary and tertiarry treatment, industrial wastewaters are going to aggravate the alarming situation concerning the water quality of the Bechey–Vrbas strech of the Bachka Great Canal, especially downstream of the Vrbas town industrial zone.

Having in mind that water of Bechey–Vrbas strech of the Bachka Great Canal belonges to the exceptionally polluted waters (IV. class), what is caused by intensive industrial production in the Canal riparian zone, as well as by heavy transportation along the Canal, force the conclusion about the necessity of conservation of recent water quality upstream of Vrbas tovn, nevertheless the water quality increase came as a result of implemented measures of protection of our water authorities, or by decreased industrial production and transportation caused by economical depression.

This conservation of recent quality status of canal waters, nevertheless the very high water selfpurification power was found, we see as a prerequisite and a condition for the wise use and sustainable development of the canal bank region as a whole. Anticipated increased industrial production and transportation will certainly lead to the canal water quality decrease and we suggest permanent monitoring and strict sanctions against the ecological crime.

4. CONCLUSIONS

Investigations of the Bachka Great Canal water quality revealed the difference of the water quality upstream of Vrbas town (Vrbas – Bezdan strech) having the desired water quality at the most of sampling sites, and the water quality downstream of the Vrbas town wastewater discharge, where waters belonging to exceptionally polluted and even to the category of dirty water were recorded.

Such a situation emphasizes the necessity of conservation of actual water quality, at least at the sectors where water quality still reach desired standards. This conservation of recent quality status of canal waters, nevertheless the satisfactory water selfpurification potential was recorded, should be defined as a prerequisite and a condition for the wise use and sustainable development of the canal riparian area as a whole. Anticipated increased industrial production and transportation will certainly lead to the canal water quality decrease and obtained results direct to the necesity of permanent monitoring and strict sanctions against the ecological crime.

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