ISIRR 2003

VIIth INTERNATIONAL SYMPOSIUM
INTERDISCIPLINARY REGIONAL RESEARCH - ISIRR 2003
HUNGARY – SERBIA & MONTENEGRO – ROMANIA
Hunedoara, ROMANIA
25th – 26th, September, 2003

Section III
– ECOLOGY AND ENVIRONMENTAL PROTECTION –

25th September, 2003 **12^{00} - 13^{00}**

25th September, 2003 **15^{00} - 19^{00}**

"BUSINESS CLUB" – "CORVIN CASTLE" HUNEDOARA

Doina Elena PETRE – President & Chairman
Adrian GAVANESCU – Member
Virginia Ana SOCALICI – Member

	Name of the Authors	Title of Presented Papers
0301.	SAVIC Radovan, LETIC Ljubomir - SERBIA & MONTENEGRO	Wind Erosion on Light Soils in Voivodina
0302.	SAVIC Radovan, PANTELIC Sanja, BELIC Andjelka, BELIC Sima - SERBIA & MONTENEGRO	Sediment Deposition Issues in the Irrigation / Drainage Canals in Vojvodina
0303.	Laura PITULICE, Mia ISACU, Delia ISAC, Adrian CHIRIAC – ROMANIA	Aspects of the Environment Pollution with Inorganic Substances
0304.	RADULOVIĆ, S., VUČKOVIĆ, M., PAJEVIĆ, S., PANJKOVIC, B. - SERBIA & MONTENEGRO	The Ecology in Distribution of Submerged Macrophytes in the Canal Network Danube – Tisza - Danube (S&Cg)
0305.	RADNOVIC Dragan, BORKOVIC Zorica, PETROVIC Olga, MATAVULY Milan, GAJIN Slavka, SIMEUNOVIC Jelica - SERBIA & MONTENEGRO	Evaluation of Faecal Pollution in the Bachka Region (Voivodina, Serbia) of Canal Waters According to Microbiological Parameters

0306.	*Cecilia HODÚR, Zsuzsa LÁSZLÓ – HUNGARY*	*Problems and MF Solutions of Thermal Water*
0307.	*VUKOV, D., ANACKOV, G., IGIC, R. - SERBIA & MONTENEGRO*	*Rare and Protected Plants in Zasavica River (Vojvodina, Serbia)*
0308.	*Marina ŠĆIBAN, Mile KLAŠNJA - SERBIA & MONTENEGRO*	*Optimisation of Usage of Wood Sawdust as Adsorbent of Heavy Metal Ions from Water*
0309.	*Ivana TEODOROVIC - SERBIA & MONTENEGRO*	*The Role of Density in Reproduction Strategy of Daphnia Magna – Implications for Chronic Ecotoxicity Tests*
0310.	*Victor – Viorel SAFTA – ROMANIA*	*Dimensioning Flows Determination Algorithm for Equipments and Installations of the Urban Waste Water Treatment Plants*
0311.	*PETROVICY Olga, MATAVULY Milan, BORKOVICY Zorica, RADNOVICY Dragan, GAYIN Slavka, SIMEUNOVICY Yelica - SERBIA & MONTENEGRO*	*Myxobacteria as Bio-indicators of Water Organic Load of The Bachka Region D-T-D Canal Network*
0312.	*Ivana IVANČEV-TUMBAS, Olivera JEVTIĆ, Srđan RONČEVIĆ, Miljana PRICA, Mile KLAŠNJA - SERBIA & MONTENEGRO*	*Degradation Kinetics of Total Hydrocarbons in the Bioremediated Soil Layer*
0313.	*D. STOJILJKOVIC - SERBIA & MONTENEGRO*	*Conditions of Artesian Aquifer Transformation into Sub-Artesian in Voivodina Part of Pannonian Basin*
0314.	*Ersilia ALEXA, Aurel LĂZUREANU, Liana CUC, Carmen GAL, Anca DRĂGUNESCU, Irina MATEI – ROMANIA*	*Researches Regarding Quality of Phreatic Water from West of Romania*
0315.	*DESI, I. NAGYMAJTÉNYI, L. - HUNGARY*	*Water Means Life - Global and Central and East European Problems in Clean Water Supply*

0316.	*Slobodanka PAJEVIĆ, Žarko KEVREŠAN, Snežana RADULOVIĆ, Dragan RADNOVIĆ, Mirjana VUČKOVIĆ, Milan MATAVULJ - SERBIA & MONTENEGRO*	*Aquatic Macrophytes – Role in Monitoring and Remediation of Nutrients and Heavy Metals*
0317.	*MATAVULY Milan, GAYIN Slavka, PETROVICY Olga, RADNOVICY Dragan, SIMEUNOVICY Yelica, BOKOROV Milosh - SERBIA & MONTENEGRO*	*Water Quality of the Zrenyanin – Banatska Palanka Stretch of the Major Canal of the Danube – Tisza – Danube Canal System According to Microbiological Parameters*
0318.	*GAYIN Slavka, MATAVULY Milan, RADNOVICY Dragan, PETROVICY Olga, SIMEUNOVICY Yelica, BORKOVICY Zorica, BOKOROV Milosh - SERBIA & MONTENEGRO*	*Microbiological and biochemical indicators of the Bachka region water organic load of the Danube – Tisza – Danube canal network (Bechey–Bezdan Stretch)*
0319.	*FRĂŢILĂ Eugeniu – Corneliu – ROMANIA*	*Researches Concerning the Mine Waste Dumps' Afforestation in The Forest Area from Banat*
0320.	*HEPUT Teodor, ARDELEAN Erika, KISS Imre, RATIU Sorin – ROMANIA*	*Accounting Possibilities of Ferrous Waste from Hunedoara Zone*
0321.	*Ester POPOVIĆ, Desanka KOSTIĆ, Olivera BJELIĆ-ČABRILO - SERBIA & MONTENEGRO*	*Endohelmints of Rana-complex as indicators of preservation of Natural Park-Begečka jama Pond and Special natural Reservation Koviljski Rit Marsh - Abstract*
0322.	*Olivera BJELIĆ-ČABRILO, Ester POPOVIĆ, Desanka KOSTIĆ - SERBIA & MONTENEGRO*	*Acanthocephalus Ranae (Palaeacanthocephala: Echinorhynchida) in Rana-complex from Petrovaradinski Rit Marsh (SCG) – Abstract*
0323.	*Miklós MOHL - HUNGARY*	*The Environmental and Ecological Quality of the River Maros - Abstract*
0324.	*VEZÉR, T., PAPP, A. - HUNGARY*	*Ill Effects of Inorganic Metal Pollutants – Abstract*

WIND EROSION ON LIGHT SOILS IN VOIVODINA

SAVIC Radovan [1)], LETIC Ljubomir [2)]

[1)] Faculty of Agriculture, Novi Sad, D.Obradovica 8, Serbia (rassa@polj.ns.ac.yu)
[2)] Faculty of Forestry, Belgrade, Kneza Viseslava 1, Serbia

Abstract:

The wind erosion process, appearing as a consequence of the application of intensive technologies in agriculture and global climatic changes, has already encompassed a significant part of Europe. The region of Voivodina, as a part of the large Pannonian plain, is not exempted from this process. Destructive effects of wind erosion are most visible in agriculture. In natural and anthropogenic conditions on territory of Voivodina deflation processes represent important factor of soil degradation and have also a negative effect on the other elements of the environment: water and air.

Keywords:
wind erosion, aeolian deposit, soil degradation, soil loss

1. INTRODUCTION

Both natural and anthropogenic conditions on the territory of Voivodina (2.15 mil. ha, northern part of Serbia) favour the occurrence of wind erosion. The continental climate of the Pannonian Plain with frequent strong winds, attaining the rates of even 40 m/s; annual precipitation sometimes even below 400 mm; large temperature amplitudes; markedly plain relief; more than 70% of the area being plow fields which are at a time without any vegetation cover and which under conditions of intensified agricultural production may be very erodible; insufficient (only about 6.5 %) and inappropriately located forest areas, are only some of the factors clearly indicating that the danger of wind erosion in Voivodina is potentially very

high, and if the forecast climatic changes are to become true, the situation may be even worsened.

Destructive effects of wind erosion in Voivodina are most visible in agriculture. Because of wind erosion, the soil - one of fundamental natural resources, is degraded. The wind carries the finest humus particles, and also the nutritive and protective matter, and the just sown crop grains, pulls out and breaks young plants, denudes the roots of perennial plants, causes excessive evaporation and soil drying, and the blows of wind-borne particles damage green parts and fruit of the grown crops. Besides, wind sediments are filling in the drainage canals and water reservoirs. The loss of nutrients and moisture from the soil, repeated sowing, lower and non-uniform yields can also bring into question the profitability of the agricultural production on the areas endangered by wind erosion, and especially at the present when the intensive agricultural production is very expensive. On the other hand, the attenuation of wind erosion processes can directly lead to lowering of the production costs, and enabling, even under unfavourable climatic conditions, high yields to be more probable, and thus the production more effective.

2. MATERIAL AND METHODS

The process of wind erosion is essentially a very complex problem which requires that all its stages (initiation of movement, transportation, and deposition) should be encompassed by the study and quantification, i.e. all the relevant factors have to be included. Because of the multitude and stochastic character of essential parameters of the process, as well as because of high costs of such experiments, only fragmentary investigations have been carried out, so that is not possible to define some universal relationships. Still, on the basis of such investigations, a number of models, empirical formulae and indicators (coefficients, indexes, etc.) have been established for a quantitative description of wind erosion processes, i.e. for assessing their intensity. However, a direct, non-critical application of such models, defined for particular locations, irrespective of all their complexity and effective mimicking of natural processes, may under the given conditions represent a certain risk, especially if the application is not followed by appropriate field investigations.

First concrete assessments and direct measurements of the intensity of wind erosion in Voivodina were carried out on the two sandy areas, which are potentially most endangered in this part of the Pannonian Plain. In the beginning of seventies, on a location in the Deliblato Sands ("European Sahara") based on measurements using a special rotating catcher of wind-borne particles [1]. Afterwards, in 1980, in the Subotica-Horgos Sands a special centre was founded to monitor wind erosion on the soils of lighter composition [2]. The investigations encompassed instrumental measurements of the intensity of wind erosion by monitoring relevant

climatic parameters and the state of the soil – the object of the wind action. These investigations have been carried out simultaneously at two measurement stations, one under the conditions of intensive agricultural production with no wind protection, and the other in the forest protection belt.

Because of the justified assumption that the process of wind erosion is involved and very significant, not only on sandy soils but also well-structured soils of the type of chernozem and meadow black soil, starting from 1995 the investigations and measurements of wind erosion intensity have been carried out on a location near Novi Sad [5], [6].

In this paper to point out the research of wind erosion on the soils of light mechanical composition on the Subotica-Horgos Sands (*Fig. 1.*). The Subotica-Horgos Sands are situated in the North part of Voivodina plain between the Danube and Tisza rivers, average length 50 km and diameter 5-10 km, area cca 24,000 ha. It is well-known orchard-grape vine region, with more then 33% under vineyards and orchards, cca 20% forests and woodlands, and over 34% under grassland.

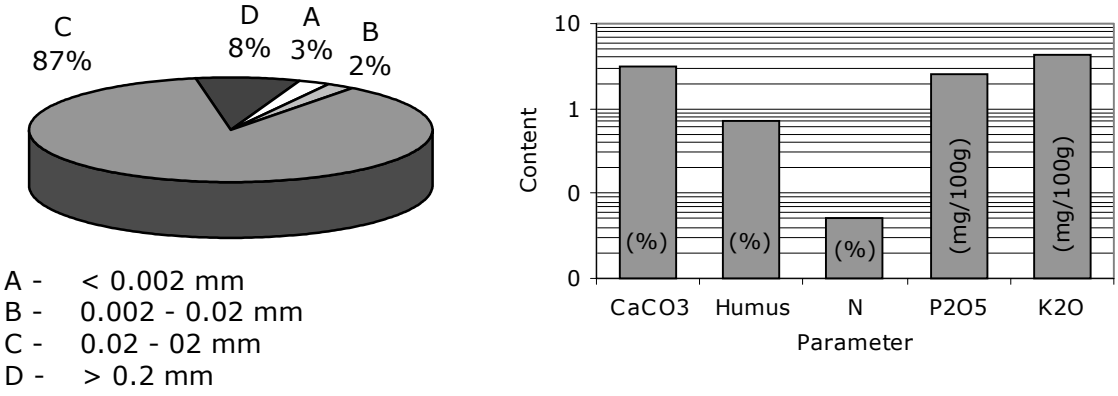


Fig. 1. *Mechanical composition and chemical characteristics of soil on the Subotica-Horgos Sands*

Experimental station record: quantity of aeolian deposition, wind frequency and velocity, air and soil temperatures, air and soil humidity etc. Field data are analysed in order to qualify and quantify the deflation processes, as well as to define the conditions of climate and residual soil in which they occur [3], [4].

3. RESULTS AND DISCUSSION

A comparative method of stationary observation by wind-gage stations has been applied on specially selected erosion plots, of which one, used for agriculture, has not been protected ("A"), while the other ("B") has been protected with forest plantings. The obtained results suggest the existence of

significant erosion processes outside the protective forest belt. On the basis of the measurements carried out during a number of years, an empirical relation has been derived for calculation of the wind erosion intensity on this and similar locations.

In the 1980-2000 period frequent variations in the wind erosion intensity and of some qualitative characteristics of the wind sediments were registered. The annual amounts of wind-borne sediments initiated in the Subotica-Horgos Sands are in the range from 0.63 to 35.87 kg/m on the unprotected area, and from 0.10 to 0.59 kg/m on protected areas (*Fig. 2.*).

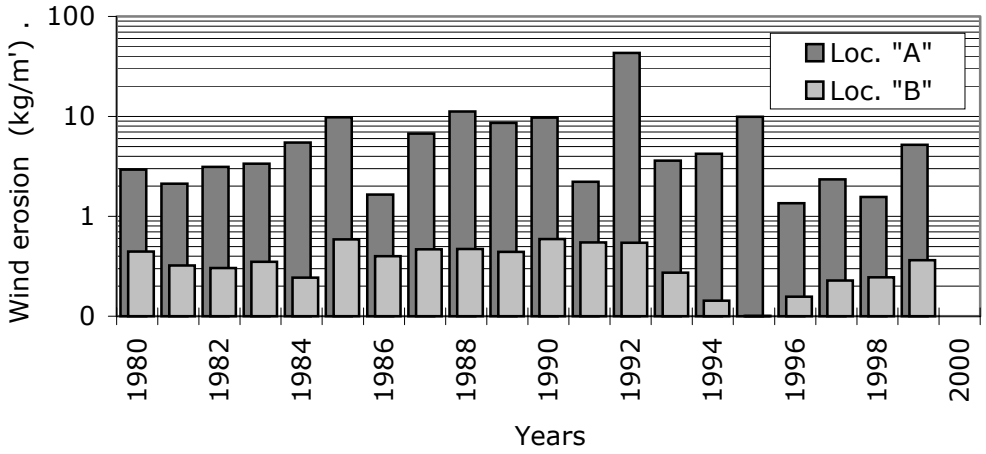


Fig. 2. *Annual wind erosion intensities in the Subotica-Horgos Sands: "A" – Plowed field with no wind protection; "B" – area in the protective forest belt.*

In addition to the quantification of deflation processes in the researched area, the analyses of quality have been made, i.e. physical and chemical properties of the aeolian deposition were defined and compared to the same characteristics of the residual, surrounding soil. This time to point out to the following nutrients which are removed from the soil complex of the Subotica-Horgos Sands: humus, total nitrogen, readily available phosphorus and potassium. [3]

Humus content in the aeolian deposition oscillated during the research period and ranged between 3.94-7.02 %, which is cca 5.7-18.1 (on the average 10.5) times higher content of organic matter then in the residual soil from which the particles were detached.

Total nitrogen content in the aeolian deposition ranges within the limits of 0.28-1.73 % which is 2.8-19.0 (on the average 11.1) times higher content than in the residual soil.

Readily available phosphorus content in the aeolian deposition ranges within the limits of 10.0-41.1 mg/100 g of soil, and that is cca 3.7-20.3 (on the average 9.3) times higher content of phosphorus than in the residual soil.

Readily available potassium content in the aeolian deposition oscillated within the limits of 15.7-40.0 mg/100 g of soil, and that is cca 5.8-14.3 (on the average 10.1) times higher content of potassium than in the residual soil.

The analysis of the relation of chemical characteristic of the aeolian deposition ("Ad") and the residual soil ("Rs") points to the very significant indication of soil fertilization loss affected by deflation processes. It is denoted by the "deflation coefficient" (η=Ad/Rs).

Also, by analysing the oscillations of the contents of humus and biogenic elements during the research period, it has been observed that the maximum and minimum of their concentration do not correspond to the maximal and minimal quantities of the aeolian deposition.

4. CONCLUSIONS

In natural and anthropogenic conditions on the territory of Voivodina deflation processes represent important factor of soil destruction and have also a negative effect on the other elements of the environment: water and air. Comparative researches on the protected and unprotected erosion fields and presented results pointing out the significant degree of the vegetative cover protective effect.

The processes of accelerated wind erosion are most frequently a consequence of anthropogenic factors, inappropriate use of the soil, vegetation destruction, etc. Modern measures of wind erosion control must be complex, all-inclusive, continuous, and systematic. At that, one should constantly bear in mind the fact that there is no absolute protection from wind erosion, that is, there is no possibility of complete elimination of wind erosion processes, one can only endeavour to reduce them to a rationally acceptable level. It would be highly desirable to establish a network of measuring stations to monitor the wind erosion in Voivodina under the different natural conditions (microclimate, soil, etc.), as well as under different crops. In this way, among other things, it would be possible to check the correctness of the applied empirical methods and achieve a more reliable estimation of the erodibility of particular types of soils, protecting effect of the crop covering in particular stages of crop development, effects of different modes of soil cultivation, humidity state of the soil, and like. It should be especially pointed out the importance of establishing the amount, characteristics, and composition of the wind erosion sediments, as of the crucial factor of degradation of all the elements of the environment.

Chemical analyses of sediments indicate its increased load of nutritive matter compared to the residual soil from which the sediment was originated: humus up to 18 times, nitrogen up to 19 times, phosphorus up to 20 times, and potassium up to 14 times, and even more.

5. REFERENCES

[1] Jevtic, Lj., Results of wind erosion deposit research on Deliblato Sands, Symposium Deliblato Sands III, pp. 128-134, Belgrade, 1975. (In Serbian)

[2] Letic, Lj., Research of wind intensity in the region of Subotica-Horgos Sands, Doctoral dissertation, Faculty of forestry, 307 p., Belgrade, 1989. (In Serbian)

[3] Letic, Lj., Savic, R., Bozinovic M. Moving Sand, monograph, pp. 164, Subotica. 2001. (In Serbian)

[4] Letic, Lj., Savic, R., Wind erosion in Voivodina, The Fifth International Conference on Aeolian Research, ICAR-5, p.164-167, Lubbock, Texas, USA, 2002.

[5] Savić, R., Letić, Lj., Božinović M. Wind erosion researches in Vojvodina, Fifth Congress Europian Society for Agronomy - ESA, Volume 1, pp. 201-202, Nitra, The Slovak Republic, 1998.

[6] Savic, R., Hazards from wind erosion of soil in Voivodina, Doctoral thesis, pp. 170, Faculty of agriculture, Novi Sad, 1999. (In Serbian)

SEDIMENT DEPOSITION ISSUES IN THE IRRIGATION/DRAINAGE CANALS IN VOJVODINA

SAVIC Radovan [1)], PANTELIC Sanja [2)], BELIC Andjelka [1)], BELIC Sima [1)]

[1)] Faculty of Agriculture, Novi Sad, D.Obradovica 8, Serbia (rassa@polj.ns.ac.yu)
[2)] Public Water Authority "Vode Vojvodine", Novi Sad, Serbia

Abstract:

The paper outlines the significance of studying and analysing sediment deposition issues in irrigation/drainage canals in Vojvodina. This problem needs to be properly addressed considering the total length of the canal network, that is, the total volume of sediment to be removed by dredging if the functional performance of the canal network is to be restored and maintained. Much of the effort needs to be focused to the polluted sediments with a severe risk for the environment. Sediment pollution is caused by the point and non-point sources of pollution. Taking one irrigation/drainage canal as the example, essential chemical properties of the sediment, heavy metals and hazardous and toxic substances contents are being analysed and presented in the paper.

Keywords:
sediments, mud, drainage/irrigation canals, disposal of muds

1. INTRODUCTION

Canal network in the territory of Vojvodina (the northern part of Serbia) is relatively dense, reaching total length of approximately 20.000 km (about 10 m/ha), with canals being in direct contact with agricultural arable land and without any protection whatsoever. Streamflow velocities and sediment transport regime in these canals cause deposition of fine sediments and silt generation at some specific sites along the canal network. Additionally, untreated or partially treated wastewaters are being directly discharged into

these canals by about 300 recorded polluters; while diffuse discharges from agriculture in general, and in the region of Vojvodina in particular, may substantially contribute to non-point surface water pollution [6]. Under the said circumstances, the quantity as well as the quality of sediment in some canal sections are the obvious areas of concern. That is, according to the standards set by the Public Water Authority in charge for regular canal network maintenance the total volume of about 2 million m^3 of sediment is to be dredged annually.

Deposition of sediment in the irrigation-drainage canal network is an undesirable, yet inevitable occurrence in the course of the use and operation of any canal network system. Apart from the sediment deposited in the bottom and consequently reducing the designed, basic purposes and the functional performance of the canal network as well as hydraulic works constructed on them, the physical, chemical and biological properties of these sediment deposits are becoming issues of more immediate concern. Nutrients contained in the sediments may adversely affect water quality and uses, intensify eutrophication and growth of vegetative cover in the canals, with no limitations regarding the disposal of dredged sediment in the surrounding areas, due to its favourable impact on soil properties and fertility. However, increased content of hazardous and toxic substances in the sediment, followed with further degradation of suspended solids due to accumulation of pollutants, raised concentration or synergic effects of the said substances, etc. can have serious impacts (toxic, pathogenic, carcinogenic, mutagenic, etc.) not only on the canal system but also on the environment in which dredging sediment is disposed and stored.

2. MATERIAL AND METHODS

Apart from the fact that almost no field investigation works and studies in regard to sediment suspended in irrigation/drainage canals in Vojvodina have been carried out [1], there are still no generally accepted criteria related to sludge and sediment quality evaluation and clearly defined conditions for the disposal and storage of dredged sediment in most of the European countries [2], [3], [4]. For the purpose of pollution prevention and control and environmental protection, stringent legislation in the form of standards, criteria, norms, etc. may (and must) be introduced, calling for the classification of sludge and sediment as per the content of hazardous substances. Given the content of hazardous and toxic substances is below established limit values, such sludge and sediment could be stored and used (deposited and spread on the land) without any limitation. If, on the contrary, sediment concentrations exceed threshold limits, they are to be classified as hazardous waste requiring specific rehabilitation procedure involving disposal of the dredged material in special containers with previous treatment, if applicable [7].

Physical and chemical properties usually taken into account in various classifications for evaluating sludge and sediment quality are the following: sieving, dry matter content, organic compounds, heavy metals, total hydrocarbons, polychlorinated biphenyls and pesticides. The existing criteria are more or less consistent with regard to the relevant substances and matters the presence of which is to be determined, with some differences, however, with regard to the maximum permissible levels (MPL), i.e. limit values for permitted concentrations in sediment.

3. RESULTS AND DISCUSSION

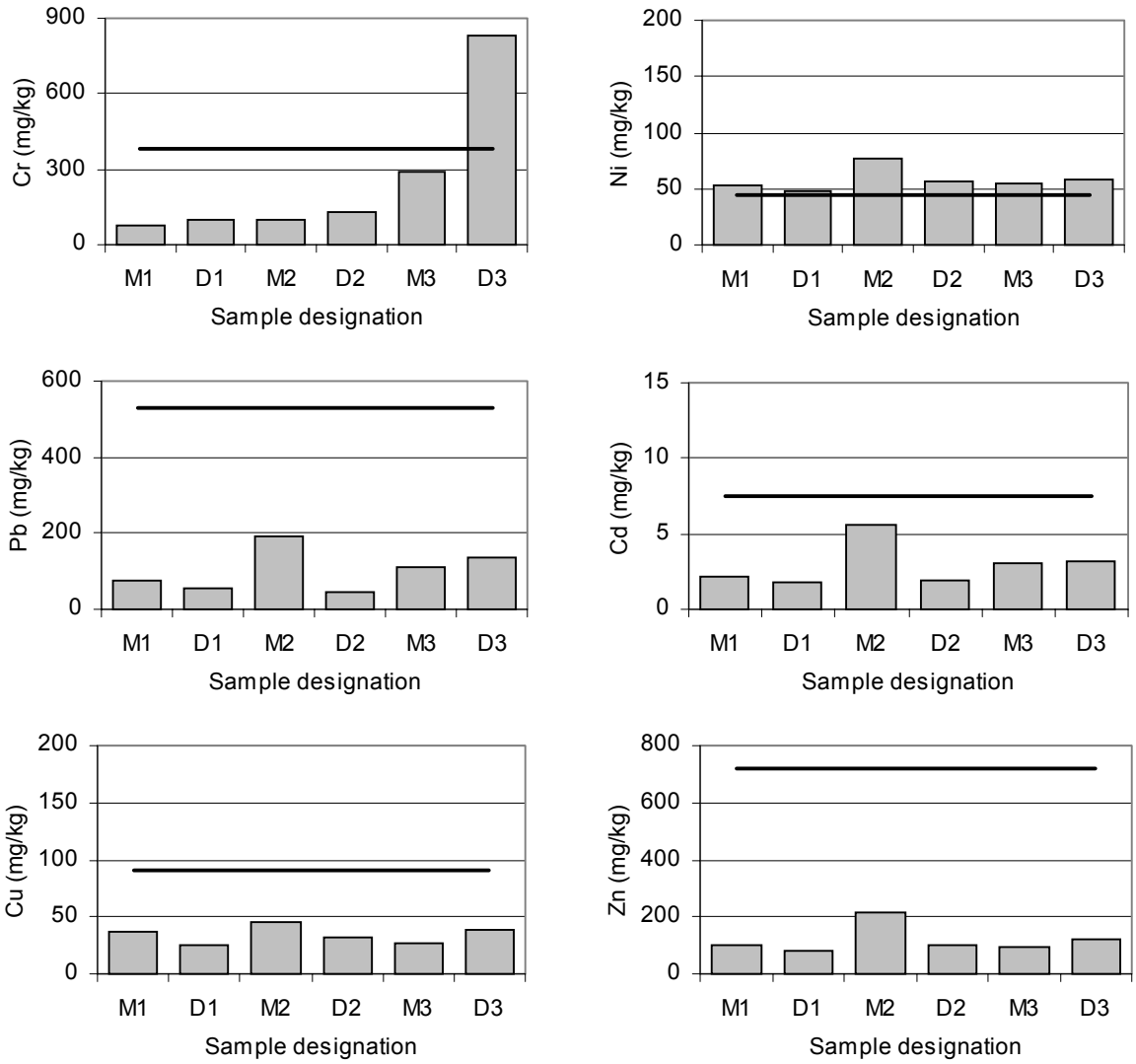
Suspended sediment in water bodies may contain, for the most part, necessary macro and micro nutrients, humus organic compounds and other ingredients improving properties of the soil onto which dredged sediment is to be deposited and spread. This referees particularly to the arable land, its texture and fertility, and consequently, to the yield and quality of the crops. Thus, reasons for the use of sediment on the land for agricultural purposes are more than obvious. It is clear that non-contaminated sediment may have positive impact on the land, and one of the basic principles calls for the incorporation of sediment in the land whenever possible. On the other hand, however, sediment may contain heavy loads of nutrients and other unwanted substances with harmful affects on the land, crops and public health. Great care and caution is, therefore, needed in handling and depositing sediment in the environment, as well as the introduction of restrictive measures in its application in agricultural sector, that is, in its spreading or injecting on the farmland.

Table 1. *Basic chemical properties of sediment samples taken from the characteristic points along the Aleksandar canal*

Sample designation	Humus %	N %	P_2O_5 mg/100g	K_2O mg/100g
M1	6.56	0.433	22.7	36.5
D1	4.66	0.307	42.5	120.0
M2	3.40	0.225	26.8	10.0
D2	1.13	0.075	12.7	13.5
M3	1.34	0.080	59.3	31.0
D3	2.77	0.183	147.0	50.0

For the illustration purposes follow the results of the studies conducted in the Aleksandar canal in the vicinity of the town of Zrenjanin with the purpose of determining sediment properties. This irrigation/drainage canal is 9,5 km long, with the drainage basin gravitating towards the canal covering the area of about 4,000 ha, average width of the canal bottom is 2.5 m, depth from

2.5 - 3.0 meters and flow of about 1 m^3/s. The basic purpose of the Aleksandar canal is to drain excess surface and ground waters from the agricultural fields. The canal, which is located adjacent to the municipal industrial zone, receives industrial and urban wastewaters of different origin and conveys and discharges them to the final receiving water body- the river Begej [5].



(M1, D1 - km 4+250; M2, D2 - km 1+850; M3, D3 - km 0+900)

Fig. 1. *Heavy metals content in sediment samples taken from the canal bottom (M), depots with stored sediment (D) in the Aleksanadar canal nearly Zrenjanin as compared to MPL from Regulation on permissible quantity of toxic and hazardous substances in the soil ..., Official Gazette of the Republic of Serbia, no. 23, 1994 [8]*

In the course of 2001, samples were taken and analysed to heavy metals content and other essential chemical parameters from one section of the said canal just before dredging, as well as from the old depots at which previously dredged sediment was stored. Microlocations of the taken samples are as follows: upstream before receiving water from the polluters (designated: M1 - sediment from canal, D1 - sediment from the depot; at km 4+250) - control sample, from the middle section just before municipal sewer system (M2, D2; km 1+850), and downstream after receiving water from the polluters (M3, D3; km 0+900).

Conducted chemical analyses of the sediment samples indicate to increased content of humus, nitrogen, phosphorous and potassium, with concentrations in the samples as shown in the *Table 1*.

The analysis results also showed that taken sediment samples from the canal itself and from the sediment depots contained heavy metals - classified as toxic and hazardous. Some of the examined parameters were found in the concentrations exceeding threshold limits for sediment disposal in the environment (*Fig. 1*).

4. CONCLUSIONS

Issues related to the sludge and sediment quality assessment, conditions under which suspended sediment may be dredged and stored or spread in the environment (particularly on the cropland) are to be treated and addressed as issues of immediate concern in our country, too (due both to the volume and the properties of sediments), with the trend of getting more prevailing in the coming period.

Sediment removal is an essential prerequisite for ensuring normal functional performance of the canal network as well as hydraulic works constructed on it; navigation and flowing capacity, etc.; and for enabling undisturbed operation of the municipal and industrial waste water treatment plants.

To this end, provisions and criteria under which sediment may be dredged and stored or used in agriculture are to be clearly defined and conformed. Special attention is to be devoted to the environmental, surface and ground waters protection, and before all, to the cropland, foodstuffs and food production protection. Plans and expectations in regard to sale and promotion of agricultural products from Vojvodina at the European marketplace could be implemented only if appropriate legislation governing this area is duly taken into account, such as EU Directive on the use of sludge in agriculture or the most recent document on sludge the implementation of which is to be expected soon.

Furthermore, it is to be noted that the issue of sediment suspended in the watercourses (particularly in irrigation and drainage canals) and

reservoirs stretching over the surrounding agricultural land for the maintenance purposes requires more research work and studying if adverse impacts on the environment, human, animal and plant health are to be avoided. Sediments of inadequate quality may negatively affect the properties and intended water uses of a water body in which they are formed and suspended. To this effect, an efficient and regular sediment monitoring system is to be established in the water bodies.

5. REFERENCES

[1] Božinović M. i sar.: Studiju uticaja otpadnih voda i muljeva na održavanje kanala za odvodnjavanje i objekata na melioracionom području "Gornji Dunav", Poljoprivredni fakultet, Institut za uređenje voda, Novi Sad, 2001.

[2] Dublin Port Company: Dublin Port Reclamation Environmental Impact Assessment, Sediment Quality Interpretive Report G5185/SC, Dublin, 2002.

[3] EEC: Working document on sludge, 3-rd draft, env.e3/lm, Bruseseles, 2000.

[4] Kelderman P.: Pollution sources and abatement measures for dredged sediments in the city of Delft (The Netherlands), European Water Management Online 2002-04, Official Publication of the European Water Association (EWA) © EWA 2002

[5] Pantelić S., Savić R., Božinović M.: Preliminarni rezultati istraživanja muljeva u Aleksandrovačkom kanalu kod Zrenjanina, Konferencija JDZV "Voda 2002", str. 233-238, Vrnjačka Banja, 2002.

[6] Savić R., Belić S, Belić A.: Poljoprivreda kao rasuti zagađivač voda, Konferencija JDZV "Voda 2002", str. 15-20, Vrnjačka Banja, 2002.

[7] Savić R., Pantelić S., Belić A., Božinović M.: Kriterijumi za ocenu kvaliteta muljeva i sedimenata, Savetovanje Melioracije i poljoprivreda, Poljoprivredni fakultet, Departman za uređenje voda, str. 162-170, Novi Sad, 2002.

[8] . . . Pravilnik o dozvoljenim količinama opasnih i štetnih materija u zemljištu i vodi za navodnjavanje i metodama njihovog ispitivanja, Službeni glasnik Republike Srbije, br. 23, 1994

ASPECTS OF THE ENVIRONMENT POLLUTION WITH INORGANIC SUBSTANCES

Laura PITULICE, Mia ISACU, Delia ISAC, Adrian CHIRIAC

[1]West University of Timisoara, Faculty of Chemistry-Biology-Geography, Chemistry Department, Str. Pestalozzi Nr.16, Timisoara 1900

Abstract:

The purpose of this paper is to correlate aspects of chemical pollution of the air, water and soil with inorganic substances with ecological education to increase awareness regarding environmental issues among young people, entrepreneurs and others.

In the paper will be presented examples for all type of pollution mentioned. We will have in view some of the laboratory experiments provided in curriculum for high schools and universities.

In laboratory are uses, for experiments, substances that can pollute the environment. To protect it we must work at mini-scale, recycle residues and transform products in non-toxic forms. Much more, we have the possibility to simulate dangerous experiments using computer software.

Today, the society through social ideal commands an educational ideal, a type of personality with all these components of education: intellectual, moral, juridical, esthetical, physical, sanitary, and ecological.

Ecological education is the first step in the chain process of transmitting scientific and technological knowledge to all.

Keywords:

Chemical pollution, ecological education, laboratory experiments, de-pollution, simulation.

INTRODUCTION

We consider pollution to be a process consisting of a bad modification of the environment due, in principal, to human activities from a super industrialized society.

In this respect, environmental pollution can be classified using the following criteria:

- according to the origin of the factors, into:
  - natural pollution resulting from volcanoes, hurricanes, earth quakes, sand storms;
  - artificial pollution resulting from human activities: industry, agriculture, households;

- according to the type of the pollutants, into:
  - physical pollution: heavy sounds, radiations;
  - chemical pollution: combustion products (CO, CO_2, NO_x), sulphur compounds, nitrates, phosphates, heavy metals, etc.;
  - biological pollution: pathogenic microorganisms, death organic materials.
- according to the polluted medium, into:
  - air pollution resulting from gases, powders from factories, vehicles, stinks from farms;
  - soil pollution resulting from non-ecological tourism, waste grounds, car cemeteries, foams, insecticides;
  - water pollution resulting from oil, foams, discharges of industrial residues (tin, salts, etc.) [2].

Pollution with nitrogen oxides is correlated with reduction of stratospheric ozone, a problem which what we confront these days [4].

In this paper we gave our attention to chemical inorganic pollutants as following:

- gaseous pollutants: oxides (SO_2, NO_2, CO), compounds of hydrogen with non-metals (NH_3, H_2S, HCl, HF)
- solid pollutants: heavy metals, soluble salts (Table 1), [6,7].

Table 1 *Inorganic pollutants*

Pollutant	Sources of origin	Directly Polluted medium	Biological actions
SO_2	Volcanoes, industry, transports	air	Expectoration, spasms, respiratory difficulties, bronchitis
NO_2	Volcanoes, industry, transports	air	Metha-hemoglobin that restrains the transport of oxygen to the tissues,
CO	Transports,	air	Carboxyhemoglobin that generates dizziness, asphyxia due to oxygen deficiency
NH_3	Industry, agriculture	air, soil	Irritations of the nasal mucous
H_2S	Industry, anaerobic fermentations with sulpho-bacteria	soil, water	Troubles of the nervous system functions and of the sanguine circulation
HCl	Industry, transports	air	Respiratory diseases, cancerous effects
HF	Industry	air	Bleedings, loss of the visual acuity, vomit, cerebral diseases.
NH_4^+, NO_3^-, NO_2^-	Farms, factories that produce nitrogen	soil, water	Respiratory diseases, cancer
Pb	Heavy industry, transports	air	Intoxications, hemoglobin alteration, disturbances of the liver and kidney functions
Hg	Industry	soil, water	Caught, insomnia, hallucinations
Zn	Industry	air, water	Corrosive action on the tissues, muscular, cardiovascular and nervous systems diseases

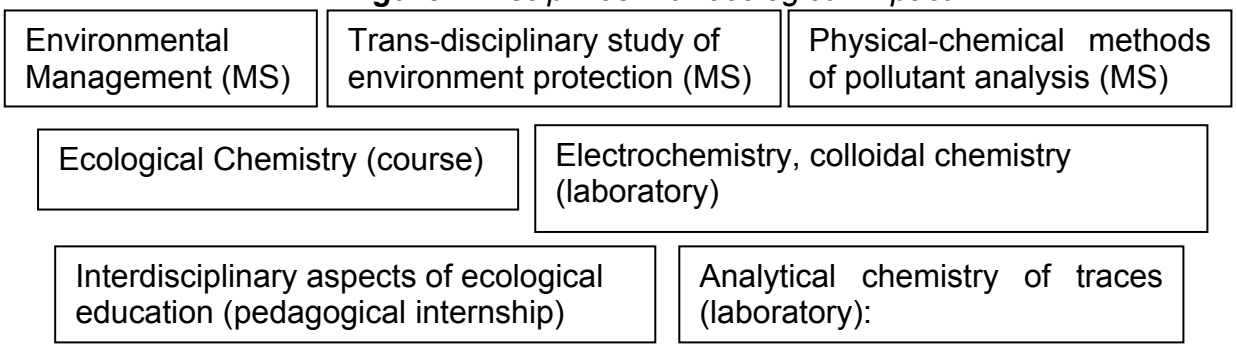
INVESTIGATIONS AND DISCUSSIONS

To make people aware of pollution's causes and effects is possible trough education at different levels.

It is the purpose of this paper to present aspects from our department's activities regarding the ecological education in the primary formation of the students, giving references of the methodical and scientific preparation with implications in the permanent formation of chemistry teachers.

Specialization is being done through courses, laboratories, and research themes as part of the MS program (examples in Figure 1)

Figure 1 *Disciplines with ecological impact*



The Ecological Chemistry course (taught in the IVth year of study) also implied research papers regarding the degree of pollution in the western part of the country, research conducted between 2000-2002. Here are a few titles:

- Pollution of Deva Caused by the Thermocentral of Mintia
- Air Pollution Sources in Resita
- Pollution of Arad Caused by Auto Transports
- Study on Air Pollution in Lugoj
- Pollution of the Town Baia Mare
- Environment Pollution of Marasesti
- Pollution Effects with Wastewater of the River Nadragel
- Pollution of the Rivers in Petrosani
- Risks of Pond Decantation in Baia Borsa [1,8]

The students were involved in research projects conducted all over the country, but mostly in the areas intensely polluted with inorganic substances: metals, oxide, acids, bases, salts.

At the same time, they are aware of the fact that this kind of pollutants can be transformed into non-toxic products.

The results of the research projects show the following:

Pollution with metals

Maximal values of the medium concentrations per 24 hours for specific pollutants are presented below (Table 2)

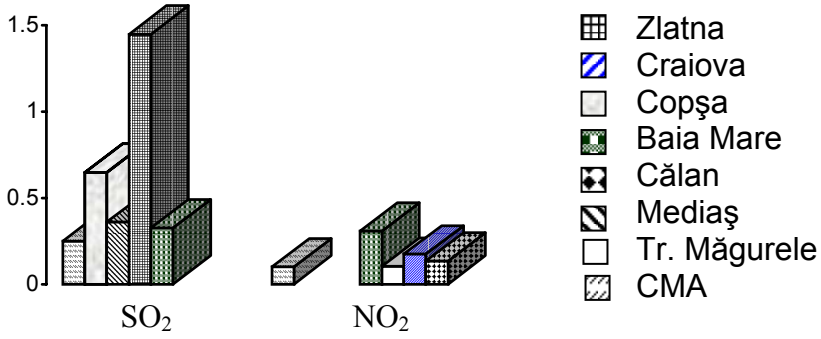
Table 2 *MAC for Cd and Pb*

• cadmium –MAC – 0,00002 mg/m³	Copşa Mică – 0,0008 mg/m³; Baia Mare – 0,0002 mg/m³; Mediaş – 0,0005 mg/m³; Zlatna – 0,0002 mg/m³
• lead –MAC – 0,0007 mg/m³	Baia Mare – 0,017 mg/m³; Copşa Mică – 0,020 mg/m³; Mediaş – 0,016 mg/m³; Zlatna – 0,0007 mg/m³

Pollution with oxides

Towns where exceeding values of MAC for SO_2 and NO_2 at 24 hours have been recorded (Figure 2):

Figure 2 *Towns polluted with SO_2 and NO_2*

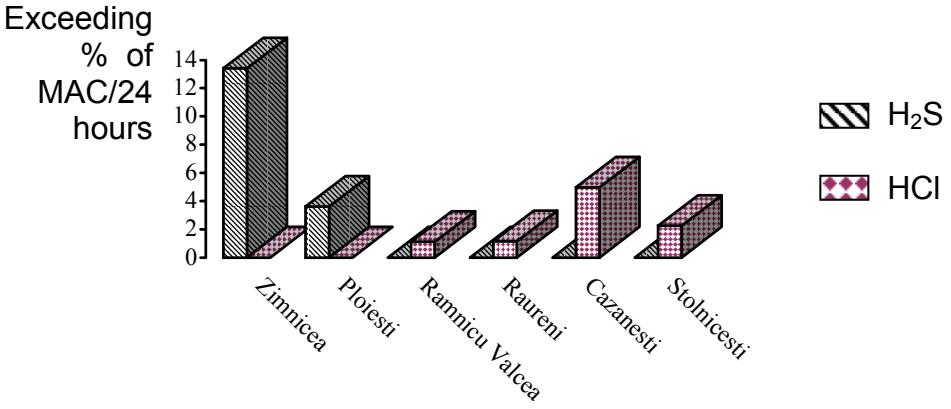


Pollution with acids (Table 3, Figure 3)

Table 3 *MAC for H_2S and HCl*

• hydrogen sulphide MAC - 0,05 mg/m³	Zimnicea – 0,059 mg/m³; Ploieşti – 0,056 mg/m³
• acid chloride MAC - 0,100 mg/m³	Rîmnicu Vîlcea – 0,140 mg/m³, Răureni – 0,160 mg/m³; Căzăneşti – 0,140 mg/m³; Stolniceni – 0,120 mg/m³

Figure 3 *Polluted zones with acids*



In general, exceeding values of MAC have been recorded over 24 hours for specific pollutants due to the fact that the monitoring points have been placed in areas where these pollutants are eliminated into the atmosphere.

Table 4 *Zone with intense acid precipitations*

Nr.	Zone	pH	Conductivity (µS/cm)
1	Arad	5,40	132,30
2	Brasov	5,0	149,50
3	Bucuresti	4,39	113,02
4	Medias	5,40	124,00
5	Zalau	4.41	258,00
6	Herculane	5,00	522,00
7	Baia Mare	5,15	503,50

Pollution with salts (Table 5)

Table 5 *Zones where precipitation with high loading of ions*

Nr.	Town	Pollutant	Maximal Concentration (mg/l)	Observations
1	Bistrița	Cl^-	24,82	The high concentrations of sulfates and chlorides determine acid water rains; concentrations of ammonia determine base water rains. Both processes have negative effects on the vegetation, water, soil and construction.
2	Bucureşti	NO_3^-	31,30	
3	Cluj	SO_4^{2-}	104,00	
		NO_3^-	57,74	
4	Copşa Mică	SO_4^{2-}	203,87	
5	Galați	SO_4^{2-}	51,18	
		NO_3^-	29,00	
6	Giurgiu	Cl^-	24,40	
7	Herculane	SO_4^{2-}	68,86	
		NO_3^-	18,76	
8	Jimbolia	NO_3^-	31,40	
9	Miercurea Ciuc	NH_4^+	22,63	
10	Semenic	SO_4^{2-}	100,49	
		NH_4^+	17,61	
11	Tulcea	NH_4^+	18,94	
12	Zalău	NO_3^-	16,68	
13	Baia Mare	SO_4^{2-}	151,20	

The students were studying the pH of the rain water by taking probes from 15 in 15 minutes. So, they observed the pH growth in time and made the correlations between the obtained pH values and the consumption of sulphur and nitrogen oxides.

The actual school curriculum for chemistry involves scientific experiments as a teaching and learning method.

Performing experiments students and teachers are often dealing with inorganic substances - reactants or products of reactions - that could be a source of pollution for the environment.

Thus, we were choosing some examples of obtaining pollutants:

- NO, NO_2 - reactions of some metals with HNO_3 conc.;
  - decompositions of some nitrates.
- SO_2 - reactions of some metals with H_2SO_4 conc.;
  - S and H_2S combustion;
  - reactions between sulphur and certain oxides.
- HF - from calcium fluoride and H_2SO_4;
  - silver fluoride and HNO_3;
  - the use of HF on glass writing.
- H_2S - reactions between some sulphides with strong acids;
  - using it at identification of cations from second analytical group.
- NH_3 - reactions of ammonium salts with alkaline oxides or bases.
- PH_3 - reactions between phosphorides and water or phosphorus with bases.

- AsH_3 - by reduction of arsenium trioxide.
- Hg - by decomposition of some oxides and salts.
- Pb, Sn, Ag - by their substitution from salts with heavy metals [3].

To prevent the environment pollution we consider that such experiments have to be conducted demonstratively by the professor. Sometimes we have the possibility to replace some substances with other much more harmless for the medium. Also, we can present movies or simulate these experiments using computer software.

As teachers we can spread scientific knowledge among students, entrepreneurs and others about what chemical methods are available to remedy the polluted air, water and soil.

For example: - the remediation at micro-scale of a simulated wastewater from a dye-house by electroflotocoagulation;

- the purification of a simulated contaminated soil (kaolin) by electrolysis (for pottering or cosmetic industry) [5].

CONCLUSIONS

The aim of our paper was to point out some aspects regarding the air, water and soil pollution with inorganic substances as a result of an interdisciplinary research.

The examples and models from this paper attest the implication at different levels of the educative factors, in actions made to reduce the pollution.

We presented some of the laboratory experiments made by our students in their initial formation as future chemistry teachers, partly for their educational value and partly for their relevance to scientific research.

REFERENCES

1. Ardelean, A.; Maior, C., *Management ecologic*, Editura Servo-Sat, Arad, 2000.
2. Chiriac, A.; Isac, Delia; Iagher, Rodica; Isacu, Mia; Pitulice, Laura, *Formare Initiala si Continua Chimie*, Ed. Universitatii de Vest, Timisoara, 2002
3. Chiriac, Veronica; Isac, Delia; Pitulice, Laura; Dascalu, Daniela, *Autoevaluare prin experimente de chimie anorganica*, Ed. Mirton, Timisoara, 2003
4. Fritz, H.G.; Kremer, M., *Die Ozonproblematik im Fa Cher Verbindenden Unterricht*, Typodruck Gagstatter, Tuttlingen, 1992
5. Ibanez, Jorge G., Singh, Mono M.; Szafran, Zvi, *Laboratory Experiments on the Electrochemical Remediation of Environment. Part 4: Color Removal of Simulated Wastewater by Electrocoagulation-Electroflotation*, J. Chem. Educ., nr.8, vol. 75, 1998
6. Kumar, H. D.; Häder, D. P., *Global Aquatic and Atmospheric Environment*, Spruger Velag, 1999.
7. Manahan, S., *Environmental Chemistry*, 7th Edition, Ed. Cole Parmer Int., 1999.
8. Ursoniu, S., *Medicina socială,* Editura Mirton, Timişoara, 1996.

THE ECOLOGY IN DISTRIBUTION OF SUBMERGED MACROPHYTES IN THE CANAL NETWORK DANUBE-TISZA-DANUBE (S&CG)

RADULOVIĆ, S., VUČKOVIĆ, M., PAJEVIĆ, S., PANJKOVIC, B.

University of Novi Sad, Faculty of Science,
Department of Biology and Ecology,
Trg Dositeja Obradovica 2, 21000 Novi Sad,
Voivodina
Serbia and Montenegro
e mail: snezar@im.ns.ac.yu

ABSTRACT

The first investigation of macrophytes vegetation in the the canal network Danube-Tisza-Danube (DTD, Voivodina, Serbia &Montenegro) were started several years ago. These investigation provided abundant data on the macrophytes communities, floristic composition, and ecological distribution in this anthropogenic ecosystem. The following submerged associations have been recorded: *Potamogetono - Ceratophylletum demersi (Hild eh Rehnelt 65) Pass. 95* and *Myriophyllo-Potametum Soó 34*. The results of these investigation could be used in the identification of the current and future condition of the canal network Danube-Tisza-Danube and indicating the necessity of bio monitoring of its ecosystems.

***Key words**: canal network, submerged , macrophytes, vegetation*

1. INTRODUCTION

Within secondary aquatic biotopes, being under distinct antropogenic influence and in its function, distribution and ecology monitoring for aquatic vegetation is a basis for estimation of ecological properties of habitat, as well as for proposal of protection and sanation measures for water streams of channel type, i.e. maintenance of ecological balance in these biotopes. Since these are very dynamic and fragile ecosystems, where aquatic plants have invaluable role in maintenance of necessary oxygen level, anti-erosive, phyto-filtration and phytosanation processes (absorption of phenol, trace metal ions, pesticides, crude oil, accumulation of trace metals) which under certain conditions could have weed properties (by their overexpansion waterflow is slowing, light and thermic regime are changing and

aquatic biotopes are overgrowing), which automatically brings disturbance of channels' basic function), it is clear that monitoring of ecological balance at vegetation level is the basis of maintainable development for channel-type biotopes.

2. METHODOLOGY

During three-month field investigations (at 19 localities*), standard floristical-phytocenological methods were used based on Swiss-France school principles [12]. Determination of plant taxons has been done using standard and classical determination keys according to international Code of Botanical Nomenclature][2][3][4][5].

Nomination and syntaxonomic overview of plant associations are given according to review of Europe vegetation [9] review of Serbian vegetation [6] and Hungarian one [7]. Elements of flora are given after Gajic [1].

Life forms are given after Flora Srbije and floristic similarity with previous vegetation investigations of this part of channel network HS DTD detecting level of changes within decade period [10], [11] are tested using Sorensen similarity index.

* SITES

1.Šebeš fok	2. Siget most	3.Sombor	4.Prigrevica	5. S. Miletić
6. Odžaci	7.Vrbas-uzvodno	8.Vrbas-nizvodno	9.Turija	10.B.Gradište
11.Bečej	12.B.Petrovac	13.R.Krstur uzvodno	14.R.Krstur – nizvodno	15.Kucura-uzvodno
16.Kucura nizvodno	17.Zmajevo	18.Žabalj	19.N.Sad	

3. RESULTS

Within investigations of aquatic and semiaquatic flora and vegetation 31 plant species were detected, belonging to different life forms of aquatic macrophyta by their biological and ecological characteristics (submerged, floating, emerging,) and in 19 investigated localities are present with specific phytocenological indices (Tab. 2).

Syntaxonic element SE 8.2 (Tab. 2), i.e. species characteristic for classis *Potametea* R. Tx. et Prsg. 1942, makes 42.8% of total taxons found in this aspect, with domination of SE 8.212, phytocenological elements of ordo *Potametalia* W.Koch 1926 and relation *Nymphaeion albae* Oberd. 1957, which point to sublitoral associations of submerged and floating plants in meso- and eutrophyc stagnant and slow-flowing waters. Phytocenological element 8.4 (species characteristic for classis *Phragmitetea* R. Tx. et Prsg 1942) has increased in comparison to previous period, and is present with somewhat lover percentage (37.5%) in comparison to previous vegetation group. Within this group edificators of associations *Phragmition communis* W. Koch 1926 are dominating - sublitoral, emerged vegetation of reed in stagnant and slow-flowing waters (8.4111), while characteristic species of eulitoral, submerged-emerged vegetation of smaller riverflows of association *Aparganio-Glicerion fluitantis* Br.-Bl. et Siss 1942 are present with only one taxon (3.57%).

Syntaxonomic element 8.1 (characteristic species from classis *Lemnetea* W.Koch et R. Tx. 1954, phytocenoses of free-floating flowering plants at water

surface) are present with 14.28% and with highest frequency of edificators from order *Lemnetalia* W. Koch et R. Tx. 1954, i.e. association of floating flowering plants in stagnant and slow-flowing waters rich in nutrients (meso- and eutrophic waters - 8.11).

Within accompanying species characteristic for these biotopes, in this stage of investigations presence of 15 plant taxons was found.

By analysis of syntaxonomical elements of taxons found in aquatic flora (SE-syntaxonomic - phytocenological elements, i.e. species characteristic for certain syntaxonomical categories - classes, ordi, relations and associations) presence of 3 classes of aquatic phytocenoses was found:

Potametea

Syntaxonic element SE 8.2, i.e. species characteristic for classis *Potametea* r. Tx. et Prsg. 1942, give more than 50% of total taxons found at investigated parts, with domination of SE 8.212, phytocenological elements from ordo *Potametalia* W.Koch 1926 and relation *Nymphaeion albae* Oberd. 1957, which detect sublitoral associations of submerged and floating plants.

Stands of plant associations in this classis are relatively rich (16 species, Tab. 1), where highest level of presence (V) has species *Ceratophyllum demersum*, an edification species of association *Ceratophyletum demersi*. Population of this plant species in its full development are the basic biomass in central parts of the channel, while in vertical profile they are distributed from the bottom to the surface of water, building so-called "underwater meadows" which directly disturbs water-economy function of the channel (slowing waterflow, decreasing currents, hindering navigation).

Somewhat lower but very significant level of presence of two endangered and protected species *Nymphaea alba* and *Nuphar lutea* (IV), edificators of association *Nymphaetum albo luteae*, having in mind relative oldness of this part of channel network, shows that these species, in situation when their autochthonous habitats are endangered, has found their secondary habitats in these human-caused biotopes.

The species with similar ecological demands, *Trapa longicarpa*, is expelled in certain measure and is present in lower presence level (III) and in smaller number of localities. This is to be expected in years of high peak of development for association *Nymphaetuym albo-luteae*.

With same presence level introduced (adventive) species *Elodea canadensis* (III) is present, but with a tendency of aggressive widening.

In life-forms specter, only hydrogeophyta are present (HydG 100%).

By review of ecological indices for characteristic species of these vegetation units, their ecological optimum is in moderately warm and light places (T 3-5, S 3-4), with neutral to slightly basic reaction (K 3-4), being characteristics for meso- and eutrophic waters (N 3-5)m except for two species: *Potamogeton gramineus* and *Nuphar lutea* (N2 - transition group towards indicators of oligotrophic waters). Having in mind high level of presence of *Nuphar lutea*, as well as even and stable distribution of this species in investigated localities, very favorable ecological conditions are indiced for hydrosystems of this type and purpose.

In specter of area types, highest percent participation have species of wide distribution, i.e. circumpolar groups of floristic elements - Eurasian, cosmopolitan,

circumpolar and subcircumpolar (75%), while adventive (12.5%), middle European (6.5%) and submiddle European (6.5%) species are much less present.

Testing indices of floristic similarity during several decades period (Tab. 3), for this vegetation group high level of floristic similarity is obtained in comparison to investigations in previous period (85-90%), which repeatedly confirms stable ecological conditions within channel network in the last period of several years.

Tab.1 Phytocenological elements from clases ***Potametea*** **R.Tx. et Prsg. 1942**

	PH. E	SE	BILJNA VRSTA	LIFE FORM	PRES. VALUE	ecological indices				
						V	K	N	S	T
Potametea **R.Tx. et Prsg. 1942**										
1	Subcirk.	8.2	*Myriophyllum spicatum* L.	rhiz sbmHydG	III	7	4	3	3	3
2	Adv.	8.2	*Elodea canadensis* L.	rhiz sbmHydG	III	7	-	-	-	-
3	Cirk.	8.2	*Potamogeton fluitans* Roth.	rhiznatHydG	II	7	3	3	3	3
4	Subcirk	8.2	*Polygonum amphibium* L.	rhiznatHydG	II	5	3	4	3	3
5	Cirk.	8.2	*Potamogeton gramineus* L.	rhiznatHydG	II	7	4	2	4	3
6	Cirk.	8.2	*Potamogeton lucens* L.	rhiz sbmHydG	II	7	4	4	3	3
7	Adv.	8.2	*Vallisneria spiralis* L.	rhiz sbmHydG	II	7	3	3	3	3
8	Kosm.	8.2	*Potamogeton perfoliatus* L.	rhiz sbmHydG	I	7	4	2	3	3
9	Kosm.	8.2	*Potamogeton pectinatus* L.	rhiz sbmHydG	I	7	4	4	3	3
Potametalia **W.Koch 1926**										
10	Kosm.	8.21	*Ceratophyllum demersum* L.	ersbmHydG	V	7	4	5	3	4
11	Evr.	8.21	*Ranunculus circinatus* Sibth.	radsbmHydG	II	6	3	3	3	3
12	Evr.	8.21	*Nymphoides flava* Hill.	rhiznatHydG	I	6	3	4	4	5
Nymphaeion albae **Oberd. 1957**										
13	Subse.	8.212	*Nymphaea alba* L.	rhiznatHydG	IV	6	3	3	4	4
14	Evr.	8.212	*Nuphar lutea* (L.) Sm.	rhiznatHydG	IV	6	2	2	4	3
15	Se.	8.212	*Trapa longicarapa* Jank.	stlnatHydG	III	6	3	4	4	4
Rupietalia J.Tx**. 1960**										
16	Kosm	8.22	*Zanichellia palustris* L	radsbmHydG	I	6	4	4	3	3

Tab.2 Aquatic macrophyta, their present, biological and ecological characteristics with specific phytocenological indices

PLANT SPECIES	LIFE FORM	SE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Submerzne																					
Ceratophyllum demersum L.	ersbmHydG	8.21	1-2	1-3	1-3	1-3	2-4	2-5	2-5	-	1-4	2-3	2-3	2-3	1-2	1-5	1-5	2-3	1-3	1-3	1-2
Myriophyllum spicatum L.	rhiz sbmHydG	8.2	1-3	1-2	1-1	1-2	-	-	-	-	-	1-1	1-1	-	1-3	1-1	-	-	1-1	1-1	1-3
Potamogeton lucens L.	rhiz sbmHydG	8.2	-	1-1	1-2	-	-	-	-	-	-	-	1-2	1-4	-	-	-	-	-	-	-
Potamogeton perfoliatus L.	rhiz sbmHydG	8.2	-	-	-	-	1-3	1-3	-	-	-	-	-	-	-	-	-	-	-	1-1	-
Potamogeton pectinatus L.	rhiz sbmHydG	8.2	-	-	-	-	-	1-2	1-2	-	-	-	-	1-3	-	-	-	-	-	-	-
Ranunculus circinatus Sibth.	radsbmHydG	8.21	-	-	1-2	1-1	1-3	-	-	-	-	1-2	-	1-1	-	-	-	-	-	-	-
Elodea canadensis L.	rhiz sbmHydG	8.2	-	-	1-3	1-2	1-5	1-3	-	-	-	1-1	-	1-2	1-3	-	-	2 - 3	-	-	-
Vallisneria spiralis L.	rhiz sbmHydG	8.2	-	-	-	1-2	1-1	-	-	-	-	1-2	-	-	1-2	-	1-1	-	-	-	-
Zanichellia palustris L	radsbmHydG	8.22	-	-	-	-	1-2	1-3	1-1	-	-	-	-	-	-	-	-	-	-	-	-
Flotantne																					
Spirodela polyrrhiza L.	ernatHydT	8.11	1-5	1-3	1-5	-	1-1	1-3	1-2	-	1-3	1-1	-	1-2	-	1-3	1-3	-	1-2	1-1	1-1
Lemna minor L.	ernatHydT	8.111	1-2	1-2	1-3	-	-	1-1	1-3	-	-	-	-	-	-	1-1	1-2	-	-	2-2	1-1
Lemna trisulca L.	ernatHydT	8.11	1-1	1-1	2-3	-	-	-	-	-	-	-	-	-	-	-	-	1-2	-	-	-
Hydrocharis morsus-ranae L.	erstlnatHydG	8.11	1-1	1-2	1-3	1-3	-	-	-	-	-	1-2	1-4	1-4	1-1	-	-	1-3	1-2	1-2	-
Nymphoides flava Hill.	rhiznatHydG	8.21	-	-	-	1-1	-	-	-	-	1-1	-	-	-	-	-	-	-	-	-	-
Nymphaea alba L.	rhiznatHydG	8.212	1-3	-	1-5	1-5	1-2	1-4	1-1	-	1-4	1-5	-	-	2-5	1-3	-	-	-	1-3	1-3
Nuphar lutea (L.) Sm.	rhiznatHydG	8.212	1-2	1-2	1-5	1-5	1-5	1-5	1-3	-	1-3	-	-	1-1	3-5	1-2	-	1-2	1-2	1-3	-
Trapa longicarapa Jank.	stlnatHydG	8.212	-	2-5	-	2-5	1-1	-	-	-	-	-	2-5	1-3	-	2-4	1-1	1-1	-	-	-
Potamogeton gramineus L.	rhiznatHydG	8.2	-	-	-	1-2	-	1-3	-	-	1-2	-	-	1-4	-	-	-	-	-	-	-
Potamogeton fluitans Roth.	rhiznatHydG	8.2	1-1	1-2	-	-	-	-	-	-	-	1-1	1-3	-	-	-	-	-	-	-	-
Polygonum amphibium L.	rhiznatHydG	8.2	1-1	1-2	1-1	-	-	-	1-2	-	-	-	-	-	-	-	-	-	-	-	-
Salvinia natans L.	ernatHydT	8.11	1-3	-	-	1-3	1-2	1-3	-	-	-	1-2	1-4	1-1	-	1-3	-	1-3	1-2	-	1-3
Emerzne																					
Phragmites communis Trin.	rhizemerHydG	8.411	2-5	2-3	1-5	1-4	1-5	2-3	1-4	1-3	2-3	1-3	3-4	2-3	2-4	2-3	2-3	1-3	1-3	1-5	1-1
Typha angustifolia L.	rhizemerHydG	8.411	1-1	-	1-1	-	-	-	1-1	-	1-1	1-2	-	-	-	-	-	1-1	-	1-2	1-1
Typha latifolia L.	rhizemerHydG	8.411	1-1	1-3	1-4	1-1	1-1	1-3	1-1	1-3	1-2	1-2	1-2	1-3	1-4	1-1	1-1	1-2	1-1	1-1	1-1
Butomus umbelatus L.	rhizemerHydG	8.411	-	-	-	-	-	-	-	-	-	1-2	1-1	-	-	-	-	-	-	-	-
Alisma plantago –aquatica L.	rhizemerHydG	8.41	1-1	1-1	-	-	-	1-1	1-1	-	-	-	-	-	-	1-1	-	-	-	-	-
Iris pseudoacorus L.	rhizemerHydG	8.41	-	-	1-2	1-2	-	-	-	-	-	1-2	-	-	-	-	-	1-1	1-3	-	-
Rumex hydrolapathum Huds.	rhizemerHydG	8.4	-	1-2	-	1-3	-	-	-	-	-	-	-	-	1-1	-	1-1	-	-	-	-
Sagittaria sagittifolia L.	rhizemerHydG	8.411	1-1	-	-	-	-	1-1	-	-	1-1	-	-	-	-	-	-	1-3	1-3	-	-
Sparganium ramosum L.	rhizemerHydG	8.41	1-2	1-1	-	-	-	1-1	-	-	-	1-4	-	-	-	-	1-1	1-3	-	-	-
Carex pseudocyperus L.	rhizemerHydG	5.1	-	-	1-3	-	1-2	-	-	-	1-2	-	-	-	-	-	-	-	-	-	-

Tab. 3 Floristic similarity

sites	Number of spesies	a	c
HS DTD, Kanal Vrbas-Bezdan, 1994, Stojanovic et al.	17	15	90%
HS DTD 1983, M.Vukoje	19	15	85%

Literatura:

1. Gajić, M. (1980): Pregled vrsta SR Srbije sa biljnogeografskim oznakama, Glasnik šumarskog fakulteta, ser. A 54,111-141, Beograd
2. Felfoldy.L.. (1990): Vizugyi hidrobiologija, 18. Hinar hatarozo. Kornyvezctvedelmi Teruletfejicsztesi Minizstorium, 1-114, Budapest.
3. Javorka, S., Csapody, V. (1975): Iconographia Florae Partis Austro - Orientalis Europa Centralis. Akademiai kiado. Budapest.
4. Josifovic, M. cd. (1970-1977): Flora SR Srbijc, I-IX, SANU, Beograd
5. Kojić, M., Popović, R., Karadžić, B.(1994): Fitoindikatori i njihov značaj u proceni ekoloških uslova staništa, Nauka, Beograd
6. Kojić, M., Popović, R., Karadžić, B.(1997): Vaskularne biljke kao indikatori staništa. Institut za istraživanja u poljoprivredi “Srbija”, Institut za biološka istraživanja Siniša Stanković, Beograd
7. [7]Kovacs, Attila (1995): Lagyszaru novenitarsulasaink rendszertani attekintese, Tilia, Vol.1:86-144. Budapest
8. Međunarodni botanički kodeks, Sveučilišna naklada “Liber”, Zagreb, 1987
9. Passarge, H. (1996): Pflanzengesellschaften Nordostdeutchlands I – Hydro und Therophytosa. J. Cramer in der Gebruder Borntraeger Verlagbuchhandlung. Berlin. Stutgart
10. Stojanovic, S., Vuckovic, M.,., Stankovic, Z., Zderic, M., Kilibarda, P., Radak, Lj., (1994): Biljni svet kanala Vrbas-Bezdan. Univerzitet u Novom Sadu, PMF, 1- 111, Novi Sad
11. Vukoje, M. (1983): Makrofitska flora osnovne kanalske mreže u Vojvodini, Čovek i biljka, Matica srpska, Novi Sad
12. Weshoff, V. (1987): The Braun-Blanquet approach.
13. Ordination and slasification of vegetation. The Hague 2 Aufl.1978:287-399

EVALUATION OF FAECAL POLLUTION IN THE BACHKA REGION (VOYVODINA, SERBIA) OF CANAL WATERS ACCORDING TO MICROBIOLOGICAL PARAMETERS

RADNOVIC Dragan, BORKOVIC Zorica, PETROVIC Olga, MATAVULY Milan, GAJIN Slavka, SIMEUNOVIC Jelica

Department of Biology, Faculty of Sciences, University of Novi Sad,
D. Obradovic square 2, Novi Sad, Serbia and Montenegro
e-mail: radnovic@im.ns.ac.yu

Abstract

For the assessment of water faecal pollution, bacterial indicators such as number of total coliforms and Escherichia coli, counted on Chromocult coliform agar, have been used. Our investigation has been done in the course of 2002/2003 and included 20 sampling sites of the DTD Canal network in the Bachka Region (Voyvodina, Serbia). Our results of faecal pollution of canal waters varied depending of season and of the sampling site, but in the most of cases, faecal pollution indicated low or moderate pollution of canal water. These results are important for watershed management activities in order to maintain safe waters for recreational and economic purposes.

Key words: *Bachka Region, Canals, Water quality, Coliforms, E. coli*

1. INTRODUCTION

The Danube-Tisza-Danube (DTD) canal system is one of the great river engineering projects executed in Europe [1]. The whole hydrosystem is constructed in the Province of Voyvodina (Serbia) and it can be used for flood control and drainage, municipal water supply, irrigation and industrial water supply, fisheries and for recreational purposes. DTD system also taking, conveying and dilution of utilised waters from the industry, farms and settlings up to 3 billions cub meter per year [6]. With such activities pathogenic microorganisms can impact the microbiological water quality of the water of DTD system. 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, investigations of the faecal pollution using microbiological parameters have been undertaken.

2. MATERIAL AND METHODS

Sampling

The water samples, obtained from 20 sampling sites along the DTD Canal network in Bachka Region, in the course of 2002 and 2003, were collected seasonally (four times) during one year at the midsteram of canal water in 250 cm^3 sterile glass bottle, placed in 4^oC cooling boxes and processed within 6h of collection.

Enumeration of bioindicating microorganisms

For the determination of total coliforms (TC) water samples were inoculated onto endo agar plates. Total coliforms and *E. coli* were determined using Chromocult Coliform® agar (CCA, Merck). In both of cases the plates were incubated for 48 h on 37^oC. All blue colonies which developed on CCA agar were accounted as faecal coliforms and *E. coli* and with red is accounted as total coliforms [3]

Classification

To facilitate the interpretation of microbiological water qulity data, the results were classified according to EU-Bathing Water Quality Directive 76/160 EEC and new EU expert proposals [7].

3. RESULTS AND DISCUSSION

Fig. 1 shows results considering water quality of the main Canal from Bechey to Bezdan. The quality of water on the first four sampling sites was characterized by high concentrations of total coliforms especially in spring and during the summer season.

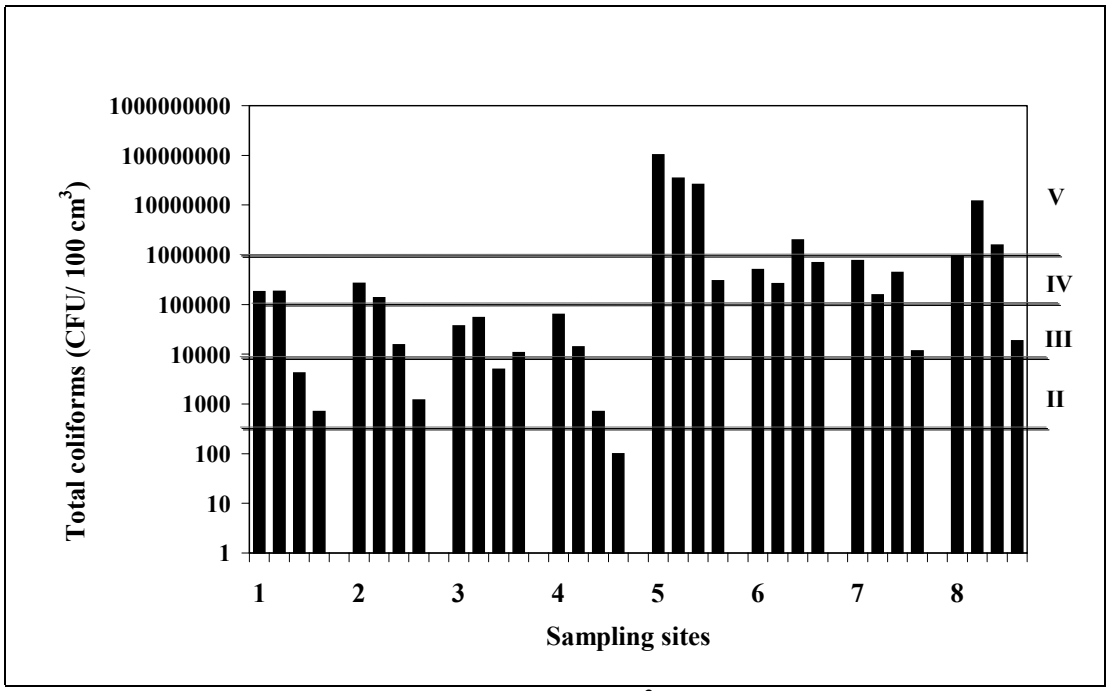


Fig. 1 *Seasonal fluctuation of total coliforms/100 cm^3 along the Bechey-Bezdan stretsh of the DTD canal network (classification system after Kavka, 2002);*
Sampling sites: (1-Shebesh Fok; 2-Bezdan; 3- Sombor; 4- Vrbas 1; 5- Vrbas 2; 6- Turiya; 7-Bachko Gradishte; 8- Bechey; from left: spring, summer, autumn, winter)

Recorded values of this parameter indicate critical and strong faecal pollution in this stretch of Canal (classes III and IV). However, durig autumn and winter season, total coliforms indicated moderate faecal pollution.

Results of the microbiological examinations of of the canal water quality of the Bechey-Vrbas stretch (sampling points 5-8) show remarkable fluctuations of the quantitative composition of investigated group of bacteria (Fig 1). According to considerable higher number of total coliforms, the canal water on this section could be categorized into V or IV class except on sampling sites 7 and 8 (Bachko Gradishte and Bechey) during winter season, when the water quality was qualified as III class. This canal section, especially between sampling sites 5 and 6, turned to be excessively polluted (hot spot) because of high influence of industrial and municipal wastewaters of three riparian towns (Crvenka, Kula and Vrbas). Besides coliform bacteria count, high degree of organic pollution were indicated by high number of organotrophic bacteria too [4,10].

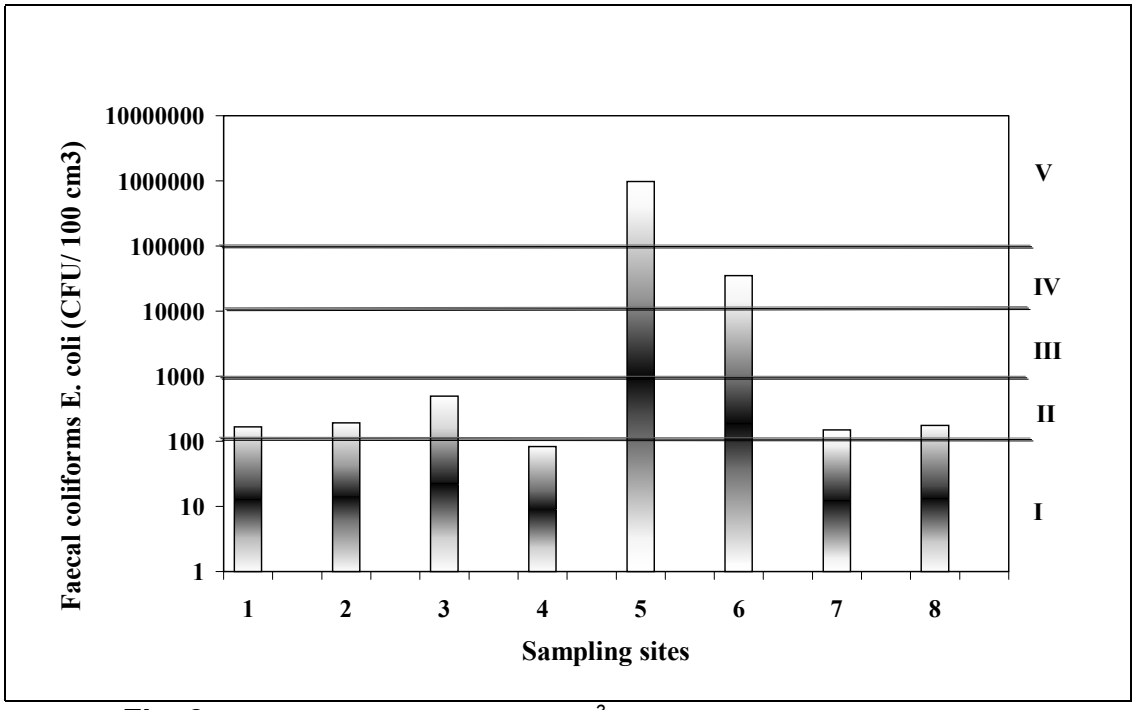


Fig. 2 *Mean values of E.coli/100 cm^3 along the Bezdan-Bechey stretch of the DTD canal (classification system after Kavka, 2002)*

It should, however, be noted that the presence of total coliforms and faecal coliforms in the water may not be a definitive and the only indicators of a faecal origin of the bacteria [9]. For this purpose in this experiment determination of *E. coli* count as one of the best means to evaluate degree of faecal pollution of water has been used. The chromogenic media Chromocult coliform® agar, recommended as viable alternative to the traditional MTF procedure for enumeration of *E. coli* [5] was used. Mean values of CFU/100 cm^3 of *E. coli* indicate second class or even first class or water with moderate faecal pollution on the stretch of the Canal upstream of Vrbas town (*Fig. 2*). Downstream of Vrbas town, number of CFU/100 cm^3 of *E. coli* shows very strong feacal pollution of the Canal water, as total coliforms did. This water could be characterized as V or IV class, indicating excessive and strong feacal pollution. More downstream of Vrbas town, towards to the Canal mouth into the Tisa

river, on sampling sites 7 and 8 (Bachko Gradishte and Bechey), canal water was moderately contaminated by faecal bacteria.

Another twelve sampling sites, situated on canal network around main canal Bechey-Bezdan, turned to be not subjected to the strong impact of big point sources of contamination. Number of total coliforms detected on both of used nutrient media shows that water in this area belonged mainly to the third class [7] of water quality, with exception of sampling sites 13, 15 and 18 (sampling sites: Kucura 2, Ruski Krstur 2, and Novi Sad 1) whose waters was contaminated with higher number of total coliforms (Table 1), probably due to the influence of municipal wastewater.

For better evaluation of faecal pollution, the number of faecal coliforms (*E. coli*) was also used in this experiment. This parameter indicated II class and moderate pollution of investigated waters (Table 1). Colony counts of *E.coli* (mean values) reflect mainly moderate feacal contamination of water (classes I-II).

***Table 1**. Microbiological indicators determined at the different sampling sites on the DTD canal (mean values) with classification system according to Kavka and Poetsch (2002).*

No of sampling site	Sampling site	TC (CFU/100cm^3)	TC (CC) (CFU/100 cm^3)	*E.coli* (CFU/100 cm^3)	Class	Pollution level	EC/TC	EC/TC (CC)
1	Bezdan 1	92675	67108	167	II	moderate	0.002	0.002
2	Bezdan 2	104550	17450	192	II	moderate	0.002	0.011
3	Sombor	26750	63354	492	II	moderate	0.018	0.008
4	Vrbas 1	19500	18908	83	I	moderate	0.004	0.004
5	Vrbas 2	$4.1*10^7$	$8.6*10^6$	$9.7*10^5$	V	excessive	0.024	0.112
6	Turiya	860992	916088	35100	IV	strong	0.041	0.038
7	B. Gradishte	342067	310275	150	I	moderate	0.000	0.000
8	Bechey	3657325	2550375	175	II	moderate	0.000	0.000
9	Prigrevica	135525	52958	246	II	moderate	0.002	0.005
10	Srp. Mileticy	58450	19888	338	II	moderate	0.006	0.017
11	Ojaci	26225	45069	100	II	moderate	0.004	0.002
12	Kucura 1	113900	55213	263	II	moderate	0.002	0.005
13	Kucura 2	$2.13*10^6$	$5.85*10^5$	125	II	moderate	0.000	0.000
14	R. Krstur 1	26817	14675	313	II	moderate	0.012	0.021
15	R. Krstur 2	257900	46200	96	I	low	0.000	0.002
16	B. Petrovac	42200	14875	1	I	low	0.000	0.000
17	Novi Sad 1	1393875	243338	1475	II	critical	0.001	0.006
18	Novi Sad 2	101350	41300	375	II	moderate	0.004	0.009
19	Zmayevo	128925	31708	125	II	moderate	0.001	0.004
20	Zhabaly	116350	48975	125	II	moderate	0.001	0.003

TC- total coliforms (endo agar); TC (CC) total coliforms on Chromocult Coliform® agar

In order to identify water faecal pollution of human origin we used the ratio of faecal coliforms (*E.coli*) to total coliforms count. In our case we used ratio of faecal coliforms to total coliforms (FC/TC) counted on endo agar and FC/TC (CC) counted on Chromocult agar (Table 1). According to obtained results, FC/TC ratio in almost all sampling sites did not exceed 0.1 (faecal coliforms participated with less than 10% in total coliforms number). Low water quality according to this parameter was found only at the sampling site 5 (Vrbas 2), where the FC/TC ratio was 0.112, indicating the presence of human faecal contamination [8].

4. CONCLUSIONS

Results of microbiological investigations the DTD canal network water show remarkable fluctuations of the number of TC and FC (*E.coli*), as well as significant differences of bioindicating values of these parameters. According to the number of TC, canal waters belong one or two classes of faecal pollution higher then when estimated according to the number of *E.coli*. Our results confirm that FC are better indicators of faecal pollution than TC. The FC/TC ratio indicates that faecal pollution of human origin generally was not found in investigated canal waters. Concentrations of bacterial faecal indicators (*E. coli*) indicated mainly moderate faecal pollution of canal waters of the Bachka Region, except for those locations downstream of Vrbas city being under the strong influence of municipal and industrial wastewater.

5. REFERENCES

[1] Braykovicy, M., Gavrilovicy, Z., Stefanovicy M. (1998): Creating Sustainable Conditions for Foreland Forestry Within Complex System of Trained Water Streams. Danubius No. 1-2.

[2] Council Directive 76/160/EEC concerning the quality of bathing water, Official Journal, L 31/1, December 8th 1975.

[3] Farnleitner, A.H., Hocke, L., Beiwl, C., Kavka, G.G., Zechmeister, T., Kirschner, A.K.T., and Mach, L.R. (2001) Rapid enzymatic detection of Escherichia coli contamination in polluted river water. Lett. Appl. Microbiol. 33:246-250

[4] Gayin S., Matavuly M., Petrovicy O., Kilibarda P., Radnovicy D., Simeunovicy Y. (2002): Water and sediment quality of the most polluted Vrbas – Srbobran section of the DTD canal net, according to sapromicrobiological parameters. IAD Limnological Reports, Proc. 34th IAD Conference, Tulcea, Romania: 34: 543-546.

[5] Geissler, K., Manafi., M., Amoros, I., Alonso., J.L. (2000):Quantitative determination of total coliforms and *Escherichia coli* in marine waters with chromogenic and fluorogenic media. Journal of Appl. Microbiol.,88:280-285.

[6] (http://www.srbijavode.com/ENGLISH_www/HsDTD_CANAL/

[7] Kavka, G. & E. Poetsch (2002): Joint Danube Survey: Microbiology.Technical Report of the Int. Commission for the Protection of the Danube River, 138-155

[8] Noble, R.T., Dorsey, J., Leecaster, M., Reid, D., Schiff, K., Weisberg, S. W. 2000. A regional survey of the microbiological water quality along Southern California Bight Shoreline. Environ. Monit. and Assess. 64: 435-447.

[9] Paul, JH., Rose, JB, Jiang, S, Kellog, C and Shinn, E., (1995): Occurrence of faecal indicator bacteria in surface water and the subsurface aquifer in Key Largo. Florida. Appl. Environ.Microbiol. 61 (6) 22352241.

[10] Petrovicy O., Matavuly M., Radnovicy D., Gayin S. (2002): The organic load of DTD canal water as a recipient of edible oil factory waste-water according to some microbiological parameters. IAD Limnological Reports, Proc 34th IAD Conference, Tulcea, Romania: 34: 435-442.

PROBLEMS AND MF SOLUTIONS OF THERMAL WATER

Cecilia HODÚR, Zsuzsa LÁSZLÓ

University of Szeged,
College Faculty of Food Engineering,
HUNGARY

Abstract:

The membrane separation was used to minimise or rather to remove the phenol contain of thermal water. PCI tubular UF/RO pilot-plan equipment with AFC99 and ES 209 membrane was used for separation at pressure of 0,6; 1,0 and 6,0 MPa. Its active filter area is 1,2 m^2.

HPLC method was used to determine the phenol contain of retentate and permeate and we used the standard water-analytical, methods (MSZ-1484-1:1992) as well. Ultrafiltration was applied to reduce the phenol contain of the samples below the admissive value, and the reverse osmosis was used to eliminate of total phenol.

Keywords:

Thermal water, phenol contamination, membrane separation.

1. INTRODUCTION

Water reserves of our Earth can be considered to be satisfactory in their totality, but the amount of water being suitable for human consumption is not meeting the demands presenting themselves. It can be well understood that the protection, defence of our potable waters should be an important task of our everyday life.

The purification by membrane separation techniques of the water being not for human consumption, coming from the thermal wells in the environs of Szeged, and thus making it applicable to be used for the heating of glass houses, have been the target of our study.

The wide exploitation of the heating energy content of the thermal water gained from the wells Im34, Im35 and Im36 in the neighbourhood of Szentmihálytelek is highly impeded compromised by its high phenolic and ionic contents. The company operating the wells is paying

considerable sums for wastewater penalties due to the higher than admissible phenolic content of the outlet water.

The aim of our experiments has been the reduction of the phenolic content being higher than admissible to below the limit value by help of membrane separation process.

2. LITERATURE SURVEY

The presence of organic compounds is a frequent and undesirable phenomenon in the surfacial and thermal waters and naturally in wastewaters, as well. It is a general problem in the whole world to purify the waters being contaminated with toxic components. The phenolic compounds are severe cell poisons that exert their effect by absorbtion through the skin or by their steams being inhaled.

In the professional literature studied by us, five basic methods were found for the decomposition i.e. the removal of phenol and of other contaminants [9,8,3,7,6,5,2]

- *photocatalytic decomposition*,
- *enzyme decomposition*
- *fermentation*
- *membrane separation*
- *adsorption*

According to the data published by the WHO, the maximal values of phenolic compounds in potable waters are the followings: from 2,4,6-trichlorophenol 200 µg/l, from pentachlorophenol 9 µg/l, from 2-chlorophenol 10 µg/l, 2,4-dichlorophenol 40 µg/l.

3. EXPERIMENTAL MATERIALS AND METHODS

The company FLORATOM LTD. out of its wells Im34 and Im36 provided the thermal water used for our experiments.

The membrane separation measurements were carried out on a semi-industrial membrane filter PC1 provided with tubular modul with a filtering surface area of 0,9 m². The membranes applied: ES209 and AFC99, the pressure values used: 0,6, 1,0, 6,0 MPa.

The amount of the permeate was determined every minute with help of an on-line computer-balance system.

During the investigations, the temperature was measured with an alcoholic rod-thermometer, the conductivity with an equipment type OK 102/1 made by RADELKIS, the absorbed energy by the help of a mobile equipment for capacity measurement.

From the values of flux, the equivalent permeability (NWP, i.e. Normalised Water Permeability; the flux (q_m) values referring to a surface (A) unit, a pressure difference (Δp) unit, a time unit and a temperature (f_t) of 20 C°) were determined with the following formula:

$$NWP = \frac{q_m \cdot f_t}{A \cdot \Delta p} \quad \left[\frac{kg}{m^2 h\ bar}\right] \qquad (1)$$

The phenol concentration was measured after a calibration with samples of known concentration by liquid chromatography (Merck-Hitachi pump type L-7100, and detector type L-4250 UV-Vis). In the testing laboratory accredited by the NAT under number 501/0714 of the Directory for Water Affairs the phenol index was measured according to the specifications fixed in the norm MSz 1484-1:1992 (Water testing, determination of phenol index) with the help of photometry determination based on 4-aminoantipyrine colour reaction, in mg/l.

4. RESULTS AND EVALUATION

With consideration of the fact, that our primary target has been the reduction of the phenol content of thermal water below the limiting values of the regulations i.e. below a value of 3 mg/l, an ultrafiltration technique, having a higher permeability and applicable with lower pressure values, with two different pressure values was used for our investigations

On **Figure 1**., the equivalent mass-current values belonging to two different pressure values were drawn up, on **Figure 2**., the changes of phenolic content measured for different samples were illustrated.

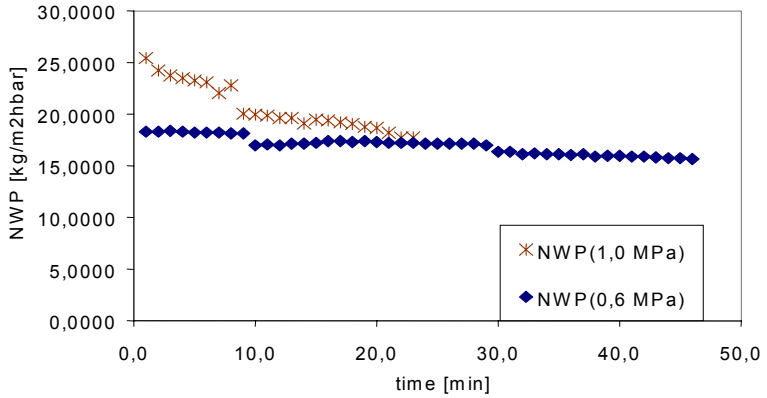


Fig.1.: UF Flux values

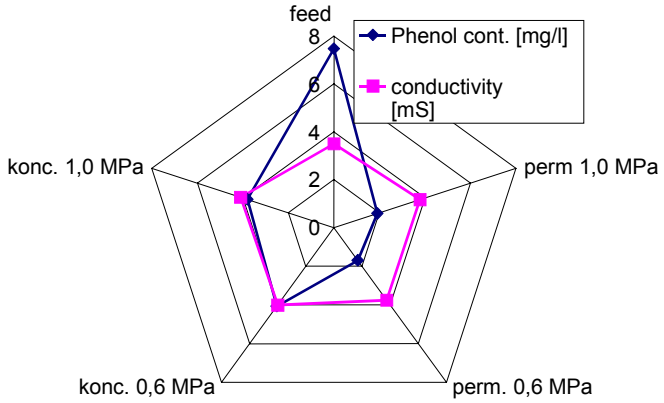
At an ultrafiltration with 6 and with 10 bar pressures, high flux values were measured being very favourable in case of an industrial realisation. After the first 20 minutes of the measuring, the values of equivalent flux of the two experiments made with two different pressures got similar and the 16 $kgm^{-2}\ h^{-1}\ bar^{-1}$ value that could be considered as the mean, set in.

At an ultrafiltration with 6 and with 10 bar pressures, high flux values were measured being very favourable in case of an industrial realisation. After the first 20 minutes of the measuring, the values of equivalent flux of the two experiments made with two different pressures got similar and the 16 $kgm^{-2}\ h^{-1}\ bar^{-1}$ value that could be considered as the mean, set in.

On the figure (**Figure 2**.) presenting the phenol content of the samples, it can be well seen that the water showing originally high (7,48 mg/l) phenol content could be reduced below the limiting value (3 mg/l)

with 0,6 MPa (1,69 mg/l) and with 1,0 MPa pressures (1,91 mg/l) by ultrafilter membranes.

It can be observed on the figure, that there is no significant difference neither in the conductivity nor in the ionic content determining mostly the conductivity in consideration of the permeate and the concentrate samples.



Our experiments have proved, that the reduction of phenolic content can be successfully achieved by help of ultra-filtration, but this separation technic does not cause any significant change in the equally high ionic content of the samples.

Fig.2.: Phenol content and conductivity of samples

In order to reduce the ionic components of the samples, the reverse osmose (RO) with an AFC 99 membrane, with 0,9 m² filtering area and a pressure of 6,0 MPa was applied. See **Figure.3**.

The equivalent mass-current values (NWP) measured at reverse osmosis are lower compared to the values measured at ultra-filtration due to the close pore structure of the membrane. The change of the mass-current in function of time is also significant. In the permeate obtained with reverse osmosis, the phenolic content i.e. the presence of phenolic compounds could not be detected.

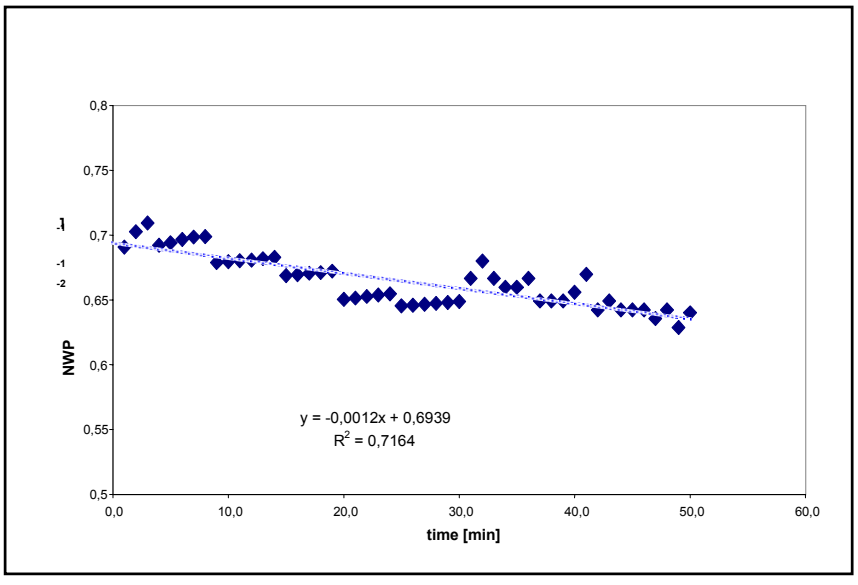


Fig.3.: Normalised Water Permeability during RO

The ionic content of the thermal water decreased in a considerable degree in the permeate samples obtained with reverse osmosis, as this has been presented in Figure 4.

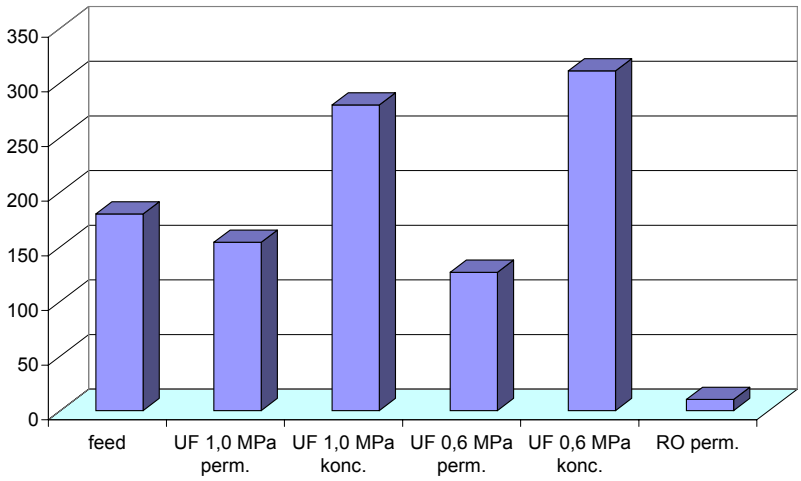


Fig.4.: Ions contain of samples

With the used HPLC method, the separation and exact determination of the ions were impossible, as they were eluated together with the solvent front. Nevertheless, from the size of their sign, the total ion content of the samples couild be deduced. The amount of ions is given in the figure in arbitrary relative units being proportionate with the area of the relative chromatographic peak

6. SUMMARY

The most important results of our experiments have been summarized in **Figure 5**. On base of this figure it can be found, that for the reduction of the phenolic content of the thermal water to below the limiting value of 3 mg/l, ultra-filtration (ES209 membrane, 0,5 and 1,0 MPa pressures) and also reverse osmose (APC99 membrane) can be applied as suitable separation technics.

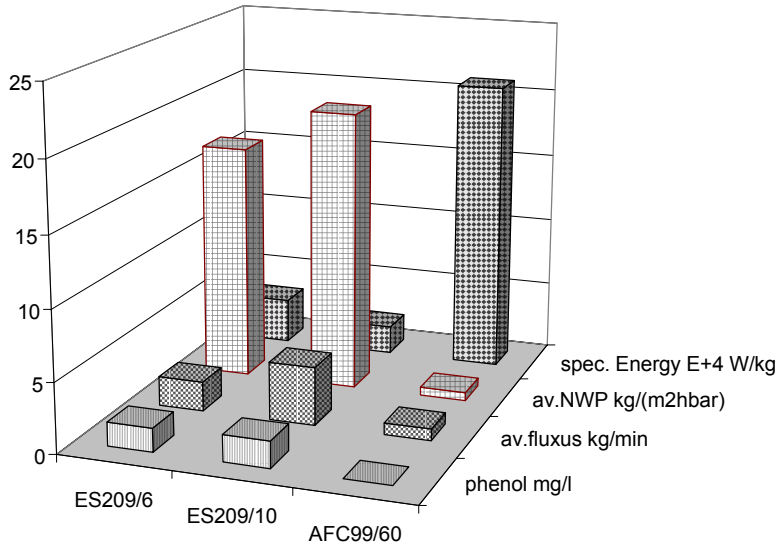


Fig.5.: Summary of results

However, for the removal of total phenolic content, only the reverse osmose can render possibility, further this technic of membrane separation is capable to reduce the high ionic content of the thermal water, while this effect could not be naturally demonstrated with ultra-filtration. In case of the values of mass-current and the equivalent mass-current, the ultra-filtration technic produces the most favourable higher values and thus, the specific energy consumption i.e. the amount of energy required for the removal of 1 kg permeate show highly more favourable values.

For the removal, decomposition of the phenol cumulated in the concentrate in case of the thermal wells of Szentmihálytelek, the highly effective oxidation and fermentation process seems to be hopeful.

7. REFERENCES

1. Barni B. Cavicchioli A. Riva E. Zanoni L. Bignoli F. and Bellobono R. I. (1995) Pilot-plant-scale photodegradation of phenol. Vol.30. No.10. pp.1861-1874.
2. Bélafi-B K. Gubicza L. (2000)Biocatalysts and Membranes, in Integration of Membrani Processes into Bioconversions. Kluwer Academic, London, pp.131-140
3. Davi L. M. Gnudi F. (1999) Phenolic compounds in surface water. Wat. Res. Vol.33. No.14. pp.3213-3219.
4. García G. I. Pena J. P. R. Venceslada Bonilla J. L. Martín M. A. Santos Martín M. A. Gómez R. E. (2000) Removal of phenol compounds from olive. Process Biochemistry. Vol.35. pp.751-758.
5. Lee SA. Choo KH. Lee CH. Lee HI. Hyeon T. Choi W. Kwon HH. (2001) Use of ultrafiltration membranes for the separation of TiO_2. Vol.40. (7). pp.1712-1719.
6. Masqué N. Marcé R. M. Borrull F. (1998) Comparasion of different sorbents for on-line solid-phase extraction of pesticides and phenolic compounds. Vol.793. pp.257-263.
7. Simonic M. Ozim V.(1998) Thermal water treatment with granular activated carbon. Journal of Hazardous Materials. Vol. 60. pp.205-210.
8. Vassilev N. Fenice M. Federici F. and Azcon R. (1997) Olive mill waste water treatment by immobilized cells of Asp. Niger and its enrichment with soluble phospate. Process Biochemistry. Volume 32. Issue 7. pp. 617-620.
9. Yamagishi T. Leite J. Ueda S. Yamaguchi F. Sawa Y. (2001) Simoltaneous removal of phenol and ammonia by an activated sluged process with crossflow filtration. Water Research. Vol.35. Issue 13. pp.3089-3096. 2001

This work was supported by the Hungarian Government "NKFP 4/0026" project.

PROBLEMS AND MF SOLUTIONS OF THERMAL WATER

Cecilia HODÚR, Zsuzsa LÁSZLÓ

University of Szeged,
College Faculty of Food Engineering,
HUNGARY

Abstract:

The membrane separation was used to minimise or rather to remove the phenol contain of thermal water. PCI tubular UF/RO pilot-plan equipment with AFC99 and ES 209 membrane was used for separation at pressure of 0,6; 1,0 and 6,0 MPa. Its active filter area is 1,2 m^2.

HPLC method was used to determine the phenol contain of retentate and permeate and we used the standard water-analytical, methods (MSZ-1484-1:1992) as well. Ultrafiltration was applied to reduce the phenol contain of the samples below the admissive value, and the reverse osmosis was used to eliminate of total phenol.

Keywords:

Thermal water, phenol contamination, membrane separation.

1. INTRODUCTION

Water reserves of our Earth can be considered to be satisfactory in their totality, but the amount of water being suitable for human consumption is not meeting the demands presenting themselves. It can be well understood that the protection, defence of our potable waters should be an important task of our everyday life.

The purification by membrane separation techniques of the water being not for human consumption, coming from the thermal wells in the environs of Szeged, and thus making it applicable to be used for the heating of glass houses, have been the target of our study.

The wide exploitation of the heating energy content of the thermal water gained from the wells Im34, Im35 and Im36 in the neighbourhood of Szentmihálytelek is highly impeded compromised by its high phenolic and ionic contents. The company operating the wells is paying

considerable sums for wastewater penalties due to the higher than admissible phenolic content of the outlet water.

The aim of our experiments has been the reduction of the phenolic content being higher than admissible to below the limit value by help of membrane separation process.

2. LITERATURE SURVEY

The presence of organic compounds is a frequent and undesirable phenomenon in the surfacial and thermal waters and naturally in wastewaters, as well. It is a general problem in the whole world to purify the waters being contaminated with toxic components. The phenolic compounds are severe cell poisons that exert their effect by absorbtion through the skin or by their steams being inhaled.

In the professional literature studied by us, five basic methods were found for the decomposition i.e. the removal of phenol and of other contaminants [9,8,3,7,6,5,2]

- *photocatalytic decomposition*,
- *enzyme decomposition*
- *fermentation*
- *membrane separation*
- *adsorption*

According to the data published by the WHO, the maximal values of phenolic compounds in potable waters are the followings: from 2,4,6-trichlorophenol 200 µg/l, from pentachlorophenol 9 µg/l, from 2-chlorophenol 10 µg/l, 2,4-dichlorophenol 40 µg/l.

3. EXPERIMENTAL MATERIALS AND METHODS

The company FLORATOM LTD. out of its wells Im34 and Im36 provided the thermal water used for our experiments.

The membrane separation measurements were carried out on a semi-industrial membrane filter PC1 provided with tubular modul with a filtering surface area of 0,9 m². The membranes applied: ES209 and AFC99, the pressure values used: 0,6, 1,0, 6,0 MPa.

The amount of the permeate was determined every minute with help of an on-line computer-balance system.

During the investigations, the temperature was measured with an alcoholic rod-thermometer, the conductivity with an equipment type OK 102/1 made by RADELKIS, the absorbed energy by the help of a mobile equipment for capacity measurement.

From the values of flux, the equivalent permeability (NWP, i.e. Normalised Water Permeability; the flux (q_m) values referring to a surface (A) unit, a pressure difference (Δp) unit, a time unit and a temperature (f_t) of 20 C°) were determined with the following formula:

$$NWP = \frac{q_m \cdot f_t}{A \cdot \Delta p} \quad \left[\frac{kg}{m^2 h\ bar}\right] \qquad (1)$$

The phenol concentration was measured after a calibration with samples of known concentration by liquid chromatography (Merck-Hitachi pump type L-7100, and detector type L-4250 UV-Vis). In the testing laboratory accredited by the NAT under number 501/0714 of the Directory for Water Affairs the phenol index was measured according to the specifications fixed in the norm MSz 1484-1:1992 (Water testing, determination of phenol index) with the help of photometry determination based on 4-aminoantipyrine colour reaction, in mg/l.

4. RESULTS AND EVALUATION

With consideration of the fact, that our primary target has been the reduction of the phenol content of thermal water below the limiting values of the regulations i.e. below a value of 3 mg/l, an ultrafiltration technique, having a higher permeability and applicable with lower pressure values, with two different pressure values was used for our investigations

On **Figure 1**., the equivalent mass-current values belonging to two different pressure values were drawn up, on **Figure 2**., the changes of phenolic content measured for different samples were illustrated.

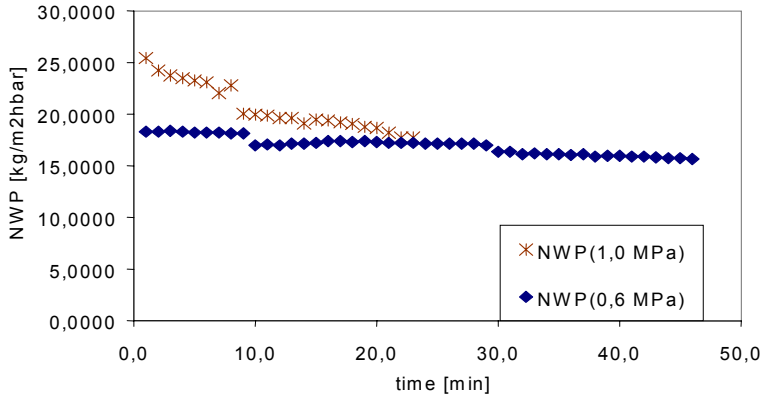


Fig.1.: UF Flux values

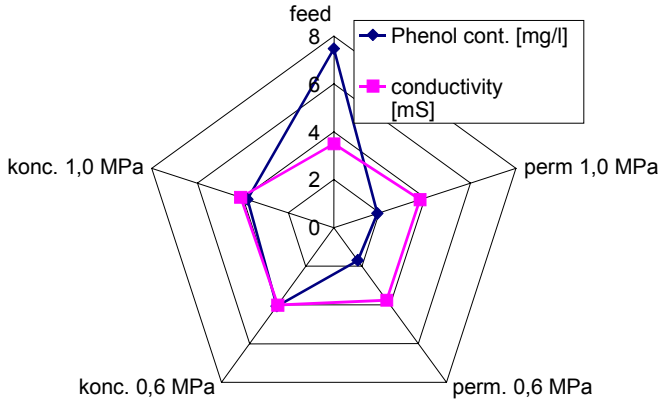
At an ultrafiltration with 6 and with 10 bar pressures, high flux values were measured being very favourable in case of an industrial realisation. After the first 20 minutes of the measuring, the values of equivalent flux of the two experiments made with two different pressures got similar and the 16 $kgm^{-2}\ h^{-1}\ bar^{-1}$ value that could be considered as the mean, set in.

At an ultrafiltration with 6 and with 10 bar pressures, high flux values were measured being very favourable in case of an industrial realisation. After the first 20 minutes of the measuring, the values of equivalent flux of the two experiments made with two different pressures got similar and the 16 $kgm^{-2}\ h^{-1}\ bar^{-1}$ value that could be considered as the mean, set in.

On the figure (**Figure 2**.) presenting the phenol content of the samples, it can be well seen that the water showing originally high (7,48 mg/l) phenol content could be reduced below the limiting value (3 mg/l)

with 0,6 MPa (1,69 mg/l) and with 1,0 MPa pressures (1,91 mg/l) by ultrafilter membranes.

It can be observed on the figure, that there is no significant difference neither in the conductivity nor in the ionic content determining mostly the conductivity in consideration of the permeate and the concentrate samples.



Our experiments have proved, that the reduction of phenolic content can be successfully achieved by help of ultra-filtration, but this separation technic does not cause any significant change in the equally high ionic content of the samples.

Fig.2.: Phenol content and conductivity of samples

In order to reduce the ionic components of the samples, the reverse osmose (RO) with an AFC 99 membrane, with 0,9 m² filtering area and a pressure of 6,0 MPa was applied. See **Figure.3**.

The equivalent mass-current values (NWP) measured at reverse osmosis are lower compared to the values measured at ultra-filtration due to the close pore structure of the membrane. The change of the mass-current in function of time is also significant. In the permeate obtained with reverse osmosis, the phenolic content i.e. the presence of phenolic compounds could not be detected.

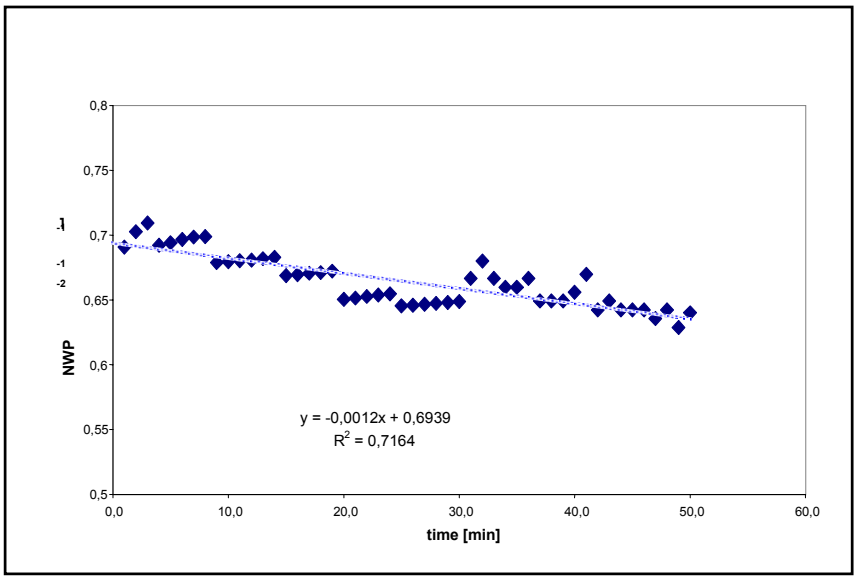


Fig.3.: Normalised Water Permeability during RO

The ionic content of the thermal water decreased in a considerable degree in the permeate samples obtained with reverse osmosis, as this has been presented in Figure 4.

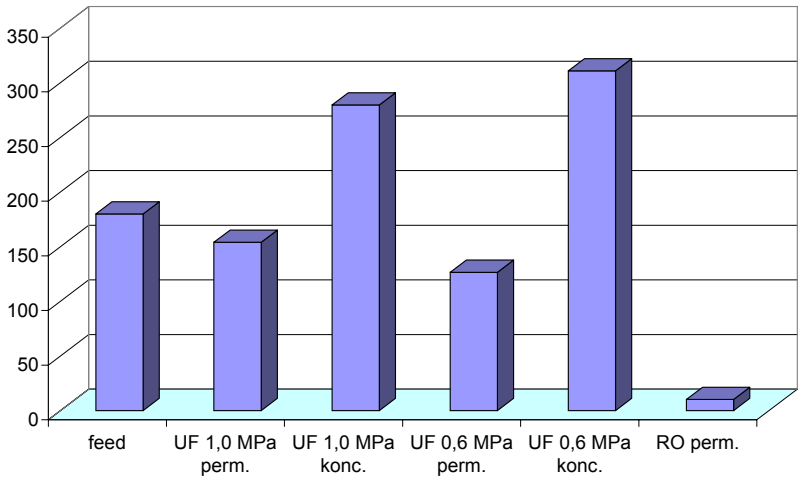


Fig.4.: Ions contain of samples

With the used HPLC method, the separation and exact determination of the ions were impossible, as they were eluated together with the solvent front. Nevertheless, from the size of their sign, the total ion content of the samples couild be deduced. The amount of ions is given in the figure in arbitrary relative units being proportionate with the area of the relative chromatographic peak

6. SUMMARY

The most important results of our experiments have been summarized in **Figure 5**. On base of this figure it can be found, that for the reduction of the phenolic content of the thermal water to below the limiting value of 3 mg/l, ultra-filtration (ES209 membrane, 0,5 and 1,0 MPa pressures) and also reverse osmose (APC99 membrane) can be applied as suitable separation technics.

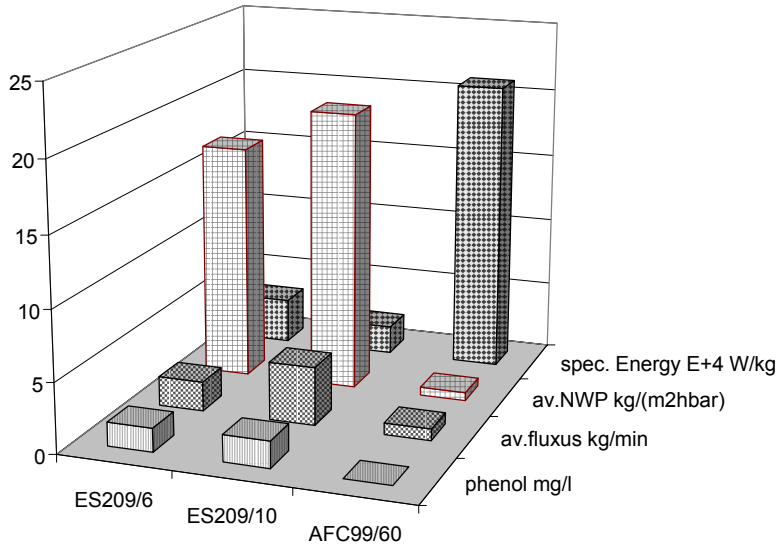


Fig.5.: Summary of results

However, for the removal of total phenolic content, only the reverse osmose can render possibility, further this technic of membrane separation is capable to reduce the high ionic content of the thermal water, while this effect could not be naturally demonstrated with ultra-filtration. In case of the values of mass-current and the equivalent mass-current, the ultra-filtration technic produces the most favourable higher values and thus, the specific energy consumption i.e. the amount of energy required for the removal of 1 kg permeate show highly more favourable values.

For the removal, decomposition of the phenol cumulated in the concentrate in case of the thermal wells of Szentmihálytelek, the highly effective oxidation and fermentation process seems to be hopeful.

7. REFERENCES

1. Barni B. Cavicchioli A. Riva E. Zanoni L. Bignoli F. and Bellobono R. I. (1995) Pilot-plant-scale photodegradation of phenol. Vol.30. No.10. pp.1861-1874.
2. Bélafi-B K. Gubicza L. (2000)Biocatalysts and Membranes, in Integration of Membrani Processes into Bioconversions. Kluwer Academic, London, pp.131-140
3. Davi L. M. Gnudi F. (1999) Phenolic compounds in surface water. Wat. Res. Vol.33. No.14. pp.3213-3219.
4. García G. I. Pena J. P. R. Venceslada Bonilla J. L. Martín M. A. Santos Martín M. A. Gómez R. E. (2000) Removal of phenol compounds from olive. Process Biochemistry. Vol.35. pp.751-758.
5. Lee SA. Choo KH. Lee CH. Lee HI. Hyeon T. Choi W. Kwon HH. (2001) Use of ultrafiltration membranes for the separation of TiO_2. Vol.40. (7). pp.1712-1719.
6. Masqué N. Marcé R. M. Borrull F. (1998) Comparasion of different sorbents for on-line solid-phase extraction of pesticides and phenolic compounds. Vol.793. pp.257-263.
7. Simonic M. Ozim V.(1998) Thermal water treatment with granular activated carbon. Journal of Hazardous Materials. Vol. 60. pp.205-210.
8. Vassilev N. Fenice M. Federici F. and Azcon R. (1997) Olive mill waste water treatment by immobilized cells of Asp. Niger and its enrichment with soluble phospate. Process Biochemistry. Volume 32. Issue 7. pp. 617-620.
9. Yamagishi T. Leite J. Ueda S. Yamaguchi F. Sawa Y. (2001) Simoltaneous removal of phenol and ammonia by an activated sluged process with crossflow filtration. Water Research. Vol.35. Issue 13. pp.3089-3096. 2001

This work was supported by the Hungarian Government "NKFP 4/0026" project.

RARE AND PROTECTED PLANTS IN ZASAVICA RIVER (VOJVODINA, SERBIA)

VUKOV, D., ANACKOV, G., IGIC, R.

Department of Biology and Ecology, Faculty of Natural Science and Mathematics, University of Novi Sad, Serbia and Montenegro

Abstract:

In 1997 Zasavica has been proclaimed as a special Reservation of Nature (I category), by the decision of the Government of the Republic of Serbia. One of the main characteristic of this reservation is its exceptional richness of plant and animal life. According to recent investigations, over 50 species of aquatic macrophytes have been recorded. These taxa are remnants of tertiary flora of Northern and Central Europe, and in Pannonian Plane region they have relict character. As a natural rarity protected by the Low, aquatic macrophytes had important role in valorization and protection of Zasavica. During the field investigation, species like Hippuris vulgaris, Hottonia palustris and Ranunculus lingua, rarest and therefore classified in volume I of the Red Book of Serbian Flora, have been recorded. Also, Nymphaea alba, Nuphar luteum, Stratiotes aloides and Utricularia australis have been found (they are on the Red List of Serbian flora). During the period from 1998 to 2001 quantity of these species has been changed, and two of them, Hippuris vulgaris and Hottonia palustris are extinct from investigated area. According to the Social Behavior Types, these two species are specialists, organisms that may be considered as the most sensitive indicators of the changes of the habitat. Their disappearance is undoubtedly an early sign of disturbance. It is important to choose the adequate measures of protection in Special Reservation of Nature Zasavica, also to prevail reintroduction of extinct species.

Keywords*: aquatic ecosystem, growth forms, quantitative analysis.*

1. INTRODUCTION

The Natural Reservation Zasavica extending over a 671 ha, covers southern part of Vojvodina and northern Macva (Yugoslavia), to the east of Drina. Due to legislative measures in 1997 it became Special Reservation. A very important role within Reservation plays river Zasavica with its high diversity and richness of plant and animal world. Two streams Prekopac and Jovaca joins together making 33.1 km long river that flows southwest-northeast, and runs into Sava near Macvanska Mitrovica. Numerous depression springs supply it with water during the whole year.

2. MATERIALS AND METHODS

The field work was performed in 1998-2001 period. Plant material was collected and preserved in the Herbarium of the Institute of Biology and Ecology, Novi Sad. Plant determination was done after Flora Europaea [17, 18], Hungarian flora [14] and Hínár határozó [4]. Social behavior types and relative ecological indicator values of recorded plant species are given according to BORHIDI [2]. Categorization of the endangerment degree is given by IUCN [15].

Aquatic macrophyte vegetation was surveyed in stretches of variable length. In each survey stretch the Plant Mass Estimate [8] was assessed on a five - level - scale (1=rare; 2=occasional; 3=frequent; 4=abundant; 5=very abundant). Species list contains: species name, author, species name abbreviation. Obtained data has been processed by standard methodology [6, 9, 12], adopted by Expert Group Macrophytes of the International Association for Danube Research (IAD).

The PME data form the base for mathematical model with: Relative Plant Mass (RPM) for each species, Mean Mass Index (MMI) of an individual species with respect to the survey stretches where it occurs (MMO) and with regard to full length of the river reach investigated (MMT) and Distribution Ratio (d) of each species. These data sets and respective graphics are used for describing quantitative relationships of aquatic macrophyte vegetation.

3. RESULTS AND DISCUSSION

Aquatic macrophytes survey, conducted in 1998, resulted with 57 registered plant species, while in 2001, number of recorded species was 55 (tab. 1).

The Relative Plant Mass (RPM, fig. 1, fig. 2) describes in detail the dominance pattern of the plant species. In Zasavica River, dominant plant species is *Stratiotes aloides*, followed by *Typha angustifolia* and *Phragmites australis*.

The Mean Mass Indices (MMT, MMO, fig. 3, fig. 4) and the Distribution Ratio (d, fig. 5, fig. 6) show the distribution pattern of each species found in river. Aside of species *Hippuris vulgaris* and *Hottonia palustris*, which have been not recorded in Zasavica in 2001, there have been no noticeable changes in distribution pattern of rare and protected species in Zasavica river. Only *Stratiotes aloides* showed the tendencies of retreat, possibly by human impact (clearing the way for boats, by cutting the water plants).

Rare and protected species have specific significance in this protected area (tab. 1). *Acorus calamus* is a remnant of old culture on European continent. Its rhizome has been used in pharmaceutical and cosmetic industry. Due to the irrational exploitation it is almost extinct, it is on The Red List of Serbian Flora, and it is protected as a natural rarity. In Zasavica it is present with relatively large population, but limited on a rather small area (fig. 3, fig. 4).

In time period between 1998 and 2001, two very valuable plant species *Hippuris vulgaris* and *Hottonia palustris* has been disappeared from the investigated area. Both of them are in The Red Book of Serbian Flora [3, 19]. According to BORHIDI [2] they belong to the social behavior type named “Specialists”. One of the main characteristics of these plants is their extreme sensitivity to environmental

conditions, specially their changes. Disappearance of such species is an early sign of habitat disturbance, while their reappearance is a signal of the habitat revitalization. In Zasavica, these species have been found only on locality Banovo Polje with very small populations.

Tab. 1: Total species list of Zasavica River

	Species	***1998***	***2001***	***Abbrevation***
1.	*Acorus calamus*L.			Aco cal
2.	*Alisma plantago-aquatica* L.			Ali pla
3.	*Butomus umbellatus*L.			But umb
4.	*Callitriche palustris* L.			Cal pal
5.	*Carex pseudocyperus* L.			Car pse
6.	*Carex vulpina* L.			Car vul
7.	*Ceratophyllum demersum* L.			Cer dem
8.	*Ceratophyllum submersum* L.			Cer sub
9.	*Glyceria maxima* (Hartman) Holomberg			Gly max
10.	*Hippuris vulgaris* L.			Hip vul
11.	*Hottonia palustris* L.			Hot pal
12.	*Hydrocharis morsus-ranae* L.			Hyd mor
13.	*Iris pseudacorus* L.			Iri pse
14.	*Juncus compressus* Jacq.			Jun com
15.	*Lemna gibba* L.			Lem gib
16.	*Lemna minor* L.			Lem min
17.	*Lemna trisulca* L.			Lem tri
18.	*Lycopus europaeus* L.			Lyc eur
19.	*Lysimachia nummularia* L.			Lys num
20.	*Lythrum salicaria*			Lyt sal
21.	*Mentha aquatica* L.			Men aqu
22.	*Myriophyllum spicatum* L.			Myr spi
23.	*Myriophyllum verticillatum* L.			Myr ver
24.	*Najas marina* L.			Naj mar
25.	*Najas minor* All.			Naj min
26.	*Nuphar lutea* (L.) Sibth. & Sm.			Nup lut
27.	*Nymphaea alba* L.			Nym alb
28.	*Nymphoides peltata* (S.G. Gmelin) O. Kuntze			Nym pel
29.	*Oenanthe aquatica* (L.) Poiret in Lam.			Oen aqu
30.	*Phragmites australis* (Cav.) Trin. ex Stendei			Phr aus
31.	*Polygonum amphibium* L.			Pol amp
32.	*Potamogeton acutifolius* Link in Roemer et Schultes			Pot acu
33.	*Potamogeton crispus* L.			Pot cri
34.	*Potamogeton lucens* L.			Pot luc
35.	*Potamogeton pectinatus* L.			Pot pec
36.	*Potamogeton pusillus* L.			Pot pus
37.	*Potamogeton trichoides* Cham. & Schlecht.			Pot tri
38.	*Ranunculus circinatus* Sibth.			Ran cir
39.	*Ranunculus lingua* L.			Ran lin
40.	*Riccia fluitans* L.			Ric flu
41.	*Rumex hydrolapathum* L.			Rum hyd
42.	*Sagittaria sagittifolia* L.			Sag sag
43.	*Salvinia natans* (L.) All.			Sal nat
44.	*Scirpus lacustris* L.			Sch lac
45.	*Sium latifolium* L.			Siu lat
46.	*Solanum dulcamara* L.			Sol dul
47.	*Sparganium emersum* Rehmann			Spa eme
48.	*Sparganium erectum* L.			Spa ere
49.	*Spirodella polyrhiza* (L.) Schleiden			Spi pol
50.	*Stratiotes aloides* L.			Str alo
51.	*Typha angustifolia* L.			Typ ang
52.	*Typha latifolia* L.			Typ lat
53.	*Urtica kioviensis* Rogow.			Urt kio
54.	*Utricularia australis* R. Br.			Utr kio
55.	*Utricularia vulgaris* L.			Utr vul
56.	*Wolffia arrhiza* (L.) Horkel ex Wimer			Wol arr
57.	*Zannichelia palustris* L.			Zan pal

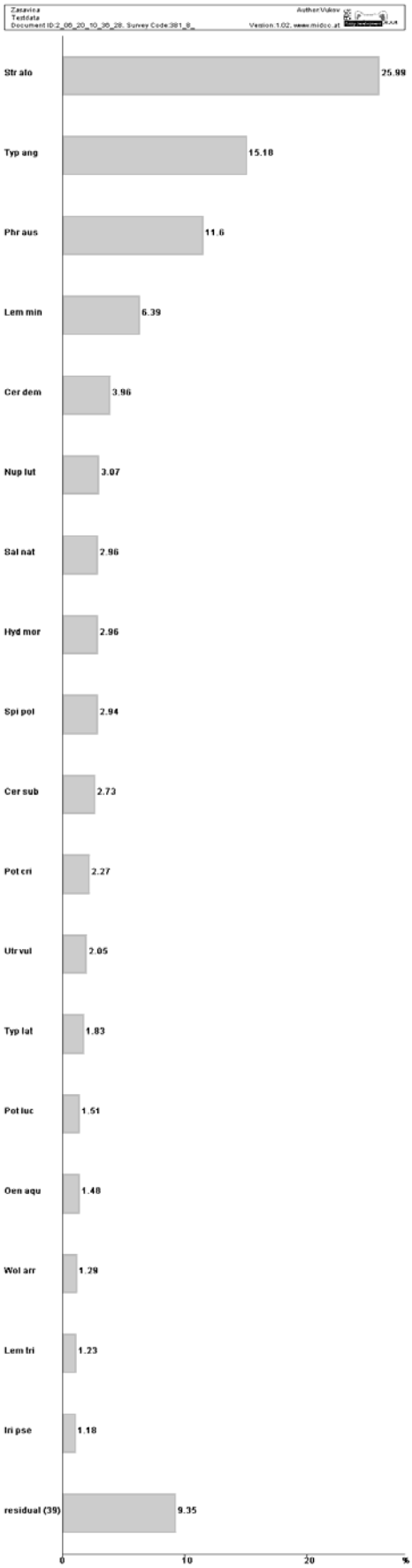


Fig. 1: RPM (%) values in 1998

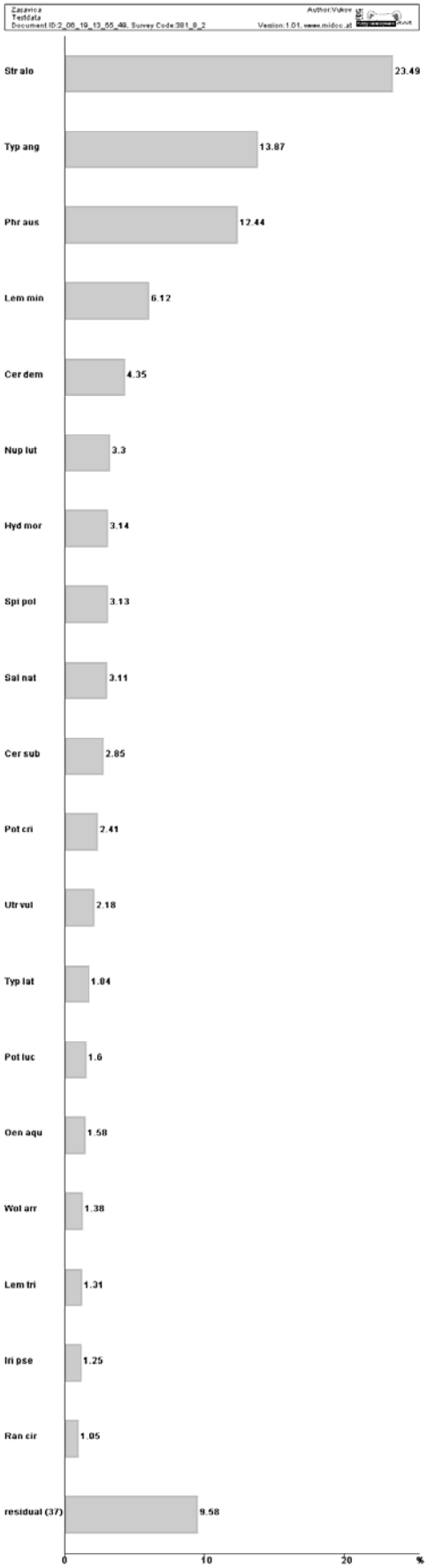


Fig. 2: RPM (%) values in 2001

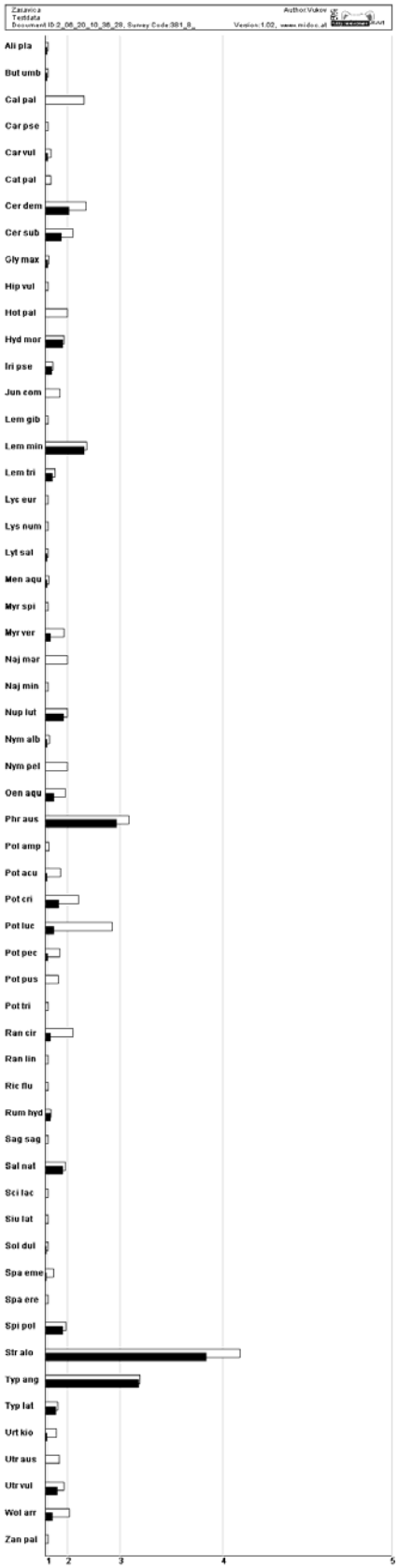


Fig. 3: MMT(black) and MMO (white) values in 1998

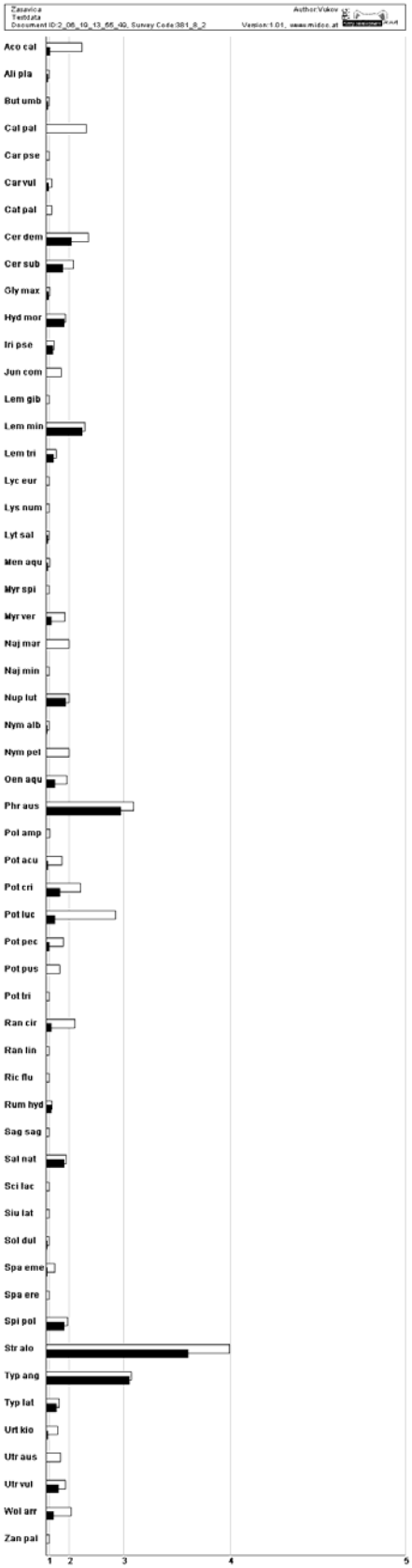


Fig. 4: MMT (black) and MMO (white) values in 2001

Fig. 5: d values in 1998

Fig. 6: d values in 2001

Anchored floating plants *Nuphar luteum* and *Nymphaea alba* could be considered as remnants of tertiary period of Northern and Central Europe, and in Pannonian plane they have relict character. In Zasavica *Nuphar luteum* is more

frequent and its populations are large. *Nymphoides peltata* could be considered as a rare species in investigated area.

Growing only on four localities in Serbia, European species *Ranunculus lingua* is in category of critically endangered species in the Red Book of Serbian Flora [16]. In Zasavica its distribution is limited only on two, rather small populations on locality Sumareva Cuprija.

Distribution of *Stratiotes aloides* is in Serbia limited only on the lowland area of Pannonian Plane. According to old records, it had been growing in rivers Mostonga and Jegricka [1], in Petrovaradinski Rit [10], and the newest data for Koviljski Rit is taken from the literature [20]. This plant is frequent in Obedska Bara [7, 5] it has been discovered in side arm of the upper part of the Danube River near Bezdan (VUKOV, oral information). In Zasavica it is dominant plant species, with very large populations, often covering large areas, and it is present almost in whole reach of the river.

Urtica kioviensis is relict species of the postglacial period. It has been recorded near Celarevo village on the Danube bank, in Koviljski Rit, Kovinski Rit, and in Obedska Bara near Kupinovo [11]. In Zasavica it was found near village Zasavica, on locality Vrbovac, Sumareva Cuprija, and in part of the river called Stari Tok.

Utricularia australis is very rare in flora of Vojvodina. It has been recorded in Obedska Bara [13]. In Zasavica it grows only on locality Valjevac.

4. ACKNOWLEDGEMENTS

Investigations have been supported by the Austrian Government, through the MIDCC Project.

5. REFERENCES

1. ATANACKOVIC, N. (1958): Prilog flori Backe. Zbornik Matice Srpske, serija za prirodne nauke, 14: 143-149 pp.
2. BORHIDI, A. (1993): Social behaviour types of the Hungarian flora, its naturalness and relativ ecological indicator values. Környezetvédelmi és területfejlesztési Minisztérium és a Janus Pannonius Tudományegytem kiadványa, Pécs.
3. BUTORAC, B. (1999): *Hottonia palustris.* In: Stevanovic, V. (ed.): Crvena knjiga flore Srbije I (iscezli i krajnje ugrozeni taksoni). Ministarstvo za zastitu sredine Republike Srbije, Bioloski fakultet u Beogradu, Zavod za zastitu prirode Srbije, Beograd.
4. FELFÖLDY, L. (1990): Hínár határozó. Vízügyi hidrobiológia, 18. kötet. Környezetvédelmi és területfejlesztési Minisztérium, Budapest, 1-144 pp.
5. GAJIC, M., KARADZIC, D. (1991): Flora ravnog Srema sa posebnim osvrtom na Obedsku Baru. Sumarski fakultet Beograd i Sumsko gazdinstvo Sremska Mitrovica, Beograd.
6. JANAUER, G. A., Zoufal, R., Christoff-Dirry, P., Englmaier, P. (1993): Neue Aspekte der Charakterisierung und vergleichenden Beurteilung der Gewässervegetation. Ber. Inst. Landschaft-Pflanzenökologie, Univ. Hohenheim, 2: 59-70 pp.
7. JANKOVIC, M. (1974): Vodena i mocvarna vegetacija Obedske Bare. Zbornik radova Republickog zavoda za zastitu prirode, SANU, knj. 1, br. 4: 1-81 pp.
8. KOHLER, A. (1978): Methoden der Kartierung von Flora und Vegetation von Süßwasserbiotopen. Landschaft+Stadt 10: 23-85 pp.
9. KOHLER, G. A., JANAUER, G. A. (1995): Zur Methodik der Unterschung von aquatischen Makrophyten in Fließgewassern. p. 1-22. In: Steinberg, Ch., Bernhardt,

H., Klapper, H. (eds.): Handbuch Angewandte Limnologie VIII-1.1.3, Ecomed Verlag, Landsberg/Lech.
10. OBRADOVIC, M. (1966): Biljnogeografska analiza flore Fruske Gore. Matica Srpska.
11. OBRADOVIC, M., PANJKOVIC-MATANOVIC, V., IGIC, R. (1991): Cetiri nove biljke za Floru SR Srbije. Zbornik radova PMF-a, br. 5: 179-206.
12. PALL, K., JANAUER, G. A. (1995): Die Makrophytenvegetation von Flußstauten am Beispiel der Donau zwischen Fluß-km 2552.0 und 2511.8 in der Bundesrepublik Deutschland. Arch. Hydrobiol. Suppl. 101 (Large Rivers 9), 91-109 pp.
13. SLAVNIC, Z. (1956): Vodena i barska vegetacija Vojvodine. Zbornik Matice Srpske, ser. prirodnih nauka, 10: 5-73.
14. SOÓ, R. (1964-1973): A magyar flóra és vegetàció rendszertani – növényföldrajzi kézikönyve I-V (Sistematic-geobotanical manual of Hungarian flora and vegetation). Akadémiai Könyvkiado, Budapest.
15. STEVANOVIC, V., JOVANOVIC, S., LAKUSIC, D., NIKETIC, M. (1995): Diverzitet vaskularne flore Jugoslavije, sa pregledom vrsta od medjunarodnog znacaja. Bioloski fakultet, Ecolibri, Beograd.
16. STOJSIC, V., PANJKOVIC, B. (1999): *Ranunculus lingua*. In: Stevanovic, V. (ed.): Crvena knjiga flore Srbije I (iscezli i krajnje ugrozeni taksoni). Ministarstvo za zastitu sredine Republike Srbije, Bioloski fakultet u Beogradu, Zavod za zastitu prirode Srbije, Beograd.
17. TUTIN, T. G., HEYWOOD, V. H., BURGES, N. A., MOORE, D. M., VALENTINE, D. H., WALTERS, S. M., WEBB, D. A. eds. (1968-1980): Flora Europaea II-V. Cambridge University Press, Cambridge.
18. TUTIN, T. G., HEYWOOD, V. H., BURGES, N. A., VALENTINE, D. H., WALTERS, S. M., WEBB, D. A. ed. (1964): Flora Europaea I. Cambridge University Press, Cambridge.
19. VUCKOVIC, M., PANJKOVIC, B. (1999): *Hippuris vulgaris*. In: Stevanovic, V. (ed.): Crvena knjiga flore Srbije I (iscezli i krajnje ugrozeni taksoni). Ministarstvo za zastitu sredine Republike Srbije, Bioloski fakultet u Beogradu, Zavod za zastitu prirode Srbije, Beograd.
20. ZORKÓCZY, L. (1896): Újvidék és környékének flórája. Újvidék

OPTIMIZATION OF USAGE OF WOOD SAWDUST AS ADSORBENT OF HEAVY METAL IONS FROM WATER

Marina ŠĆIBAN, Mile KLAŠNJA

Faculty of Technology, Novi Sad, Serbia and Montenegro

Abstract: *The wood sawdust is a potentially useful adsorbent for heavy metals. The aim of this work was optimization of usage of wood sawdust as heavy metal adsorbent. It was examinated influence of wood sawdust quantity on adsorption capacity and efficiency, and feasibility of multistage batch adsorption processes. Experiments were carried out with poplar sawdust and model water. For better adsorption efficiency it was recommended to apply larger amounts of sawdust, if it is not cause problems with delaying of used adsorbents. Smaller amounts of adsorbent were better utilized in two or three stage adsorption processes.*

Keywords: *water, heavy metals, adsorption, wood sawdust*

1. INTRODUCTION

The contamination of wastewater by toxic heavy metal ions is a world-wide environmental problem. They can be removed from wastewater by several methods, including basic precipitation, ion exchange, adsorption and so on. The removal of heavy metals by adsorption onto low-cost waste materials has recently become the subject of considerable interest. Natural materials that are availble in large quantities, or certain waste products from industrial or agricultural operations, may have potential as inexpensive adsorbents. Due to their low cost, after these materials have been expended, they can be disposed of without expensive regeneration.

Our previous studies have shown that the wood sawdust is a potentially useful biosorbents for treating wastewaters contaminated with heavy metals[2,3,4]. In these experiments it was determinated adsorption capacities of sawdust of different kinds of wood, at optimum pH, and with sufficient contact time. The aim of this work was further optimization of usage of wood sawdust as heavy metal adsorbent. It was examinated influence of wood sawdust quantity on adsorption capacity and efficiency, and feasibility of multistage batch adsorption processes.

2. MATERIAL AND METHODS

The sawdust of deciduous soft wood – poplar was used as adsorbent in copper(II) removal from water. Wood sawdust was sieved, and the fraction with particle size between 0.5 and 1.0 mm was used for experiments.

The stock solution of copper(II) (0.25 M) was prepared by dissolving $CuSO_4 \cdot 5H_2O$ in distilled water and its pH was adjusted to a desired value by adding 0.5 M CH_3COOH. All chemicals used were of analytical reagent grade.

Batch adsorption experiments were carried out by shaking different quantity of wood sawdust with aqueous solution of copper(II) of desired concentration at pH 4. After 3 hours of shaking, the adsorbent was separated by vacuum filtration through the gooch G3, and filtrate was analyzed. Coplexometric method was used for determination of copper(II) concentration before and after adsorption [1].

To determine the adsorption capacity of adsorbent for the removal of copper(II) from water, the Langmuir and Freundlich models were used, as

$$q = \frac{q_m \cdot K_L \cdot C}{1 + K_L \cdot C} \qquad (1)$$

$$q = K_F \cdot C^{1/n} \qquad (2)$$

where is: q – amount of Cu(II) adsorbed per specific amount of adsorbent (mg/g), C – equilibrium concentration (mg/l), q_m – amount of Cu(II) required to form a monolayer (mg/g), K_L – Langmuir equilibrium constant, and K_F and n – Freundlich equilibrium constants. Computer simulation technique was applied to fit the Langmuir and Freundlich equations for the adsorption data. The correlation coefficients (R^2) were computed, too.

3. RESULTS AND DISSCUSION

To investigate the effects of the initial copper(II) concentrations and amount of poplar sawdust on the uptake of this metal, the process was carried out with initial copper(II) concentrations between 5 and 200 mg/l and warious poplar sawdust concentrations: 1, 2.5, 5, 7.5, 10 and 15 g/l. Fig. 1 shows that the amount of adsorbed copper ions by the adsorbent increased with the increase of initial copper concentration in the solution, and with the decrease of adsorbent quantity. The data presented in Fig. 1 were used to determine the adsorption constants in Langmuir and Freundlich adsorption equations, displayed in Table 1.

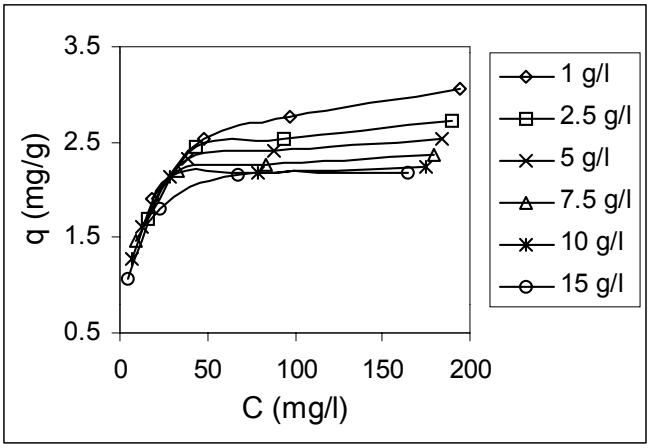


Fig. 1. *Adsorption isotherms of copper(II) at different quantity of poplar sawdust as adsorbent*

Table 1. *Adsorption constants for adsorption of copper(II) by poplar sawdust*

Amount of adsorbent (g/l)	Langmuir constants			Freundlich konstants		
	K_L (l/mg)	q_m (mg/g)	R^2	K_F (l/g)	1/n	R^2
1	0.0715	3.241	0.999	0.0177	0.19	0.949
2.5	0.1045	2.860	0.999	0.0172	0.18	0.843
5	0.1469	2.605	0.999	0.0180	0.16	0.842
7.5	0.1890	2.415	0.999	0.0183	0.16	0.825
10	0.2357	2.288	0.999	0.0157	0.17	0.768
15	0.2231	2.224	0.999	0.0134	0.20	0.900

It can be noted that the maximum adsorption capacity (q_m) increased with a decrease in the adsorbent concentration, since the availble surface area was smaller, and the adsorption intensity (K_L) decreased. Therefore, for determination of maximum capacity of some adsorbent, lower adsorbent quantity is recommended. However, the total amount of the metal removed decreased with an decrease in adsorbent concentration, as seen in Fig. 2. In practise, for good removal of metal ions from water the larger quantity of adsorbent is recommended. Because of that it is important of knowledge of adsorbent maximum capacity when is larger adsorbent quantity is applied. In cases presented in Figures 1 and 2, adsorption efficiency were increased for 8.5 to 10.5 times (in dependence of initial copper(II) concentration) when was adsorbent quantity increased for 15 times (since 1 g/l to 15 g/l). At the same time q_m was decreased for 45 to 25 %.

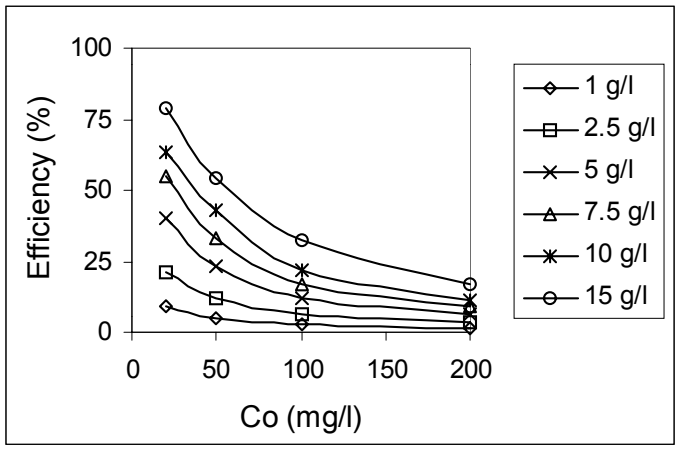
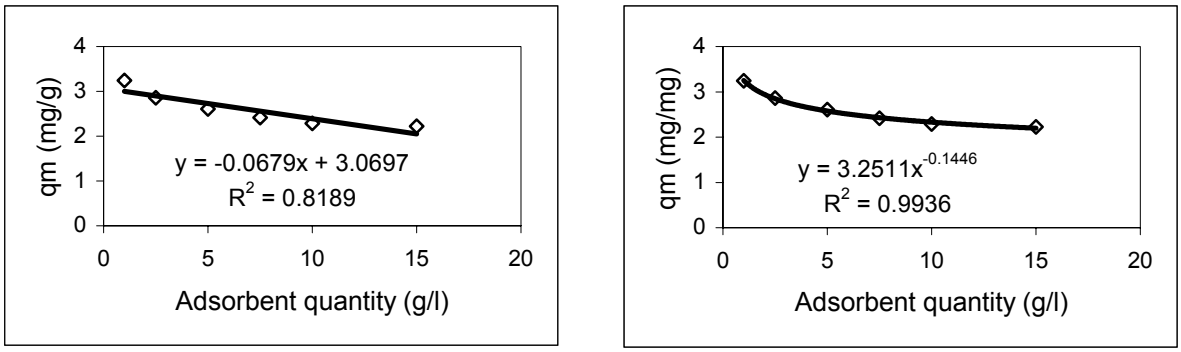


Fig. 2. *Adsorption efficieny of copper(II) by different adsorbent quantity*

In Fig. 3 is present dependence of maximum capacity (Langmuir constant q_m) on adsorbent quantity. According to regresion analysis (in Excel program), it is evident that the dependence q_m vs adsorbent quantity is not linear (Fig. 3a) than power (Fig. 3b). Similar relation exist between Langmuir constant K_L and adsorbent quantity (not show). However, Freundlich constants vs adsorbent quantity shows polynomial dependence (also not show).



a) b)

Fig. 3. *Dependence of maximum capacity (Langmuir constant q_m) on adsorbent quantity: a) linear, b) power*

From efficasy removal of copper ions from water it is recommended application of higher adsorbent concentration. It is necessary to have sufficiently, local available wood sawdust as adsorbent and to have solution for further treatment and disposal of used adsorbent.

In a batch adsorption process is better to apply multistage countercurrent operation. What results is possible to realize in this case it was investigated by following experiments. As first it was investigated ability to reutilize poplar sawdust as adsorbent, without regeneration. The tests were performed using an initial copper(II) concentration of 50 mg/l, at pH 5, in a 5 g/l sawdust suspension. Adsorption was carried out for 3 hours and then the sawdust was separated, rinsed with double disstilate water and trasferred to another portion of solution. The process was repeated for three times. Each time the sawdust was able to adsorb some copper(II). The largest amount of copper(II) was adsorb in first cycle and with each of its subsequent reutilization the sawdust performance was lower (Fig. 4).

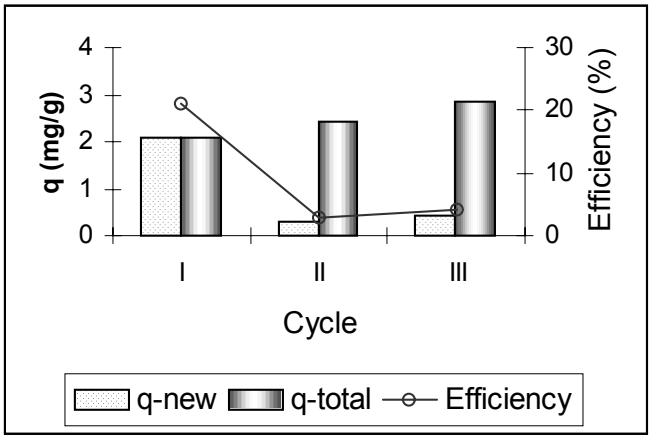


Fig. 4. *Reutilization of poplar sawdust for copper(II) adsorption*

After first cycle adsorbent have a certain number of active sites. In second cycle adsorbent bind still 15% from firstly adsorbed copper(II), and in third cycle still 18%. Amount of adsorbed copper(II) – q, after third cycle is still lower from corresponding q_m presented in Table 1. It is mean that the adsorbent after third cycle, still have a some free active sites for adsorption.

Influence of adding of fresh adsorbent in treated water on amount of adsorbed copper ions was tested too. In this experimens, after first cycle (like above) in treated water was added a fresh poplar sawdust. The process was repeated for three times. Results is present on Fig.5.

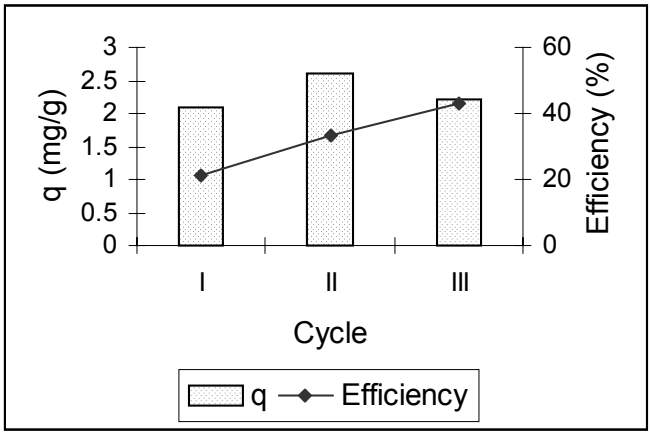


Fig. 5. *Efficiency of copper(II) adsorption by fresh poplar sawdust in three cycle*

If sawdust added immediately in quantity of 10 g/l, instead 5 g/l in twice, adsorption efficiency will be lower for about 10%. If sawdust was added immediately in quantity of 15 g/l, instead three times by 5 g/l, adsorption efficiency will be lower for about 20%.

On the base of the results presented on Fig. 4 and Fig. 5 it was concluded that the adsorbents like wood sawdust can be applied in multistage countercurrent adsorption operation. Sawdust separation from water is easy, what represent one more advantage of this materials as adsorbents for heavy metal ions from water.

4. CONCLUSION

Inexpensive, readily available materials like wood sawdust can be used for the removal of heavy metal ions from water. Numerous parameters have influence to adsorption phenomenon, and it is necessary to find a optimum operation conditions for application of some adsorbent. On the base of the presented results it was recommended to apply larger amounts of sawdust, e.g. 10-15 kg/m^3 for adsorption of copper(II) from water, if it is not cause problems with delaying of used adsorbents. Smaller amounts of adsorbent were better utilized in two or three stage adsorption processes. The results suggest that already used sawdust could be applied to fresh heavy metal solution, whereas used metal solutions that still contain residual metal ions could be treated with a fresh sawdust.

5. REFERENCES

1. Sajo I., Komplexometria, Muszaki konykiado, Budapest, 1973
2. Sciban M. and M. Klasnja, Adsorption of heavy metals from water and wastewater with some lignocellulosic materials, 1st International Conference “Chemical Sciences and Industry”, Halkidiki, Greece, Book of abstracts, Vol. I, PO 124, 1998

3. Sciban M. and M. Klasnja, Adsorpcija jona bakra iz vode na piljevini drveta u dinamickim uslovima, 28th Conference “Zastita voda ’99”, Soko Banja, Yugoslavia, Proceedings, 429-434, 1999
4. Sciban M. and M. Klasnja, Coniferous wood sawdust as adsorbent of heavy metal ions from water, 6th ISIRR, Novi Sad, Yugoslavia, Proceedings, S1, 0139, 1-4, 2002

THE ROLE OF DENSITY IN REPRODUCTION STRATEGY OF *DAPHNIA MAGNA* – IMPLICATIONS FOR CHRONIC ECOTOXICITY TESTS

Ivana TEODOROVIC

Faculty of Science and Mathematics, Department of Biology and Ecology,
Trg Dositeja Obradovica 2, 21000 Novi Sad, Serbia and Montenegro

Abstract:

We examined the possible influence of the parental culturing pattern on offspring reproductive strategy, as an implication for chronic toxicity tests. Clutch sizes of F_0 daphnids living in groups were smaller than those of living singly. Clutch sizes of F_1 daphnids living singly were bigger then those of living in groups. However, the clutch size of F_2 daphnids living alone were not significantly different from the clutch sizes of F_1 daphnids living singly. Neonates intended for chronic toxicity tests should be F_1 deriving from the daphnids (F_0) taken out of the batch cultures as neonates, living singly.

Key words

Daphnia magna, toxicity tests, maternal effect, intraspecific interaction

1. INTRODUCTION

Ecotoxicologists use a suite of acute and chronic toxicity tests to predict the effect of chemicals in the environment. Those results have been and will be used for setting EQS (environmental quality standards) under the current EU legislation [3]. Additionally, whole effluent toxicity testing is a common method for effluent quality monitoring [14]. *Daphnia magna* is, by far, the most often used test species for either purposes [1,6,7,11,12,14,15,16], while reduction in fecundity, as measured by the production of juveniles by parental Daphnia is the most commonly used end-point to estimate the chronic toxicity of substances and mixtures. All standardised testing methods set the minimum number of neonates in control treatments to declare a test as a valid one, and one of the important issues of intercalibration process of chronic tests with daphnids had been standardisation of control reproduction [11,12,13,]. It has been, so far, well documented that reproduction of *D. magna* is obviously related to food rations [8,10], since at low food levels small broods of

large neonates were produced, whereas at high food levels many tiny young were born. Yet, no unequivocal relationship was found between maternal food level and the sensitivity of the young [4]. However, the aim of this paper was to examine the possible influence of the parental culturing pattern on offspring reproductive strategy as an implication for chronic toxicity tests.

2. MATERIALS AND METHODS

The daphnids (*Daphnia magna*, laboratory clone NSV) were bred and experiments were run according to standard method [14], in static-renewal conditions. Animals used for experiments were kept in 50 ml beakers, in 30 ml culture medium and fed with 0.1 ml of YCT mixture and 0.1 ml of *Selenastrum capricornutum* concentrate per animal three times a week, 2 h before the renewal of culture medium.

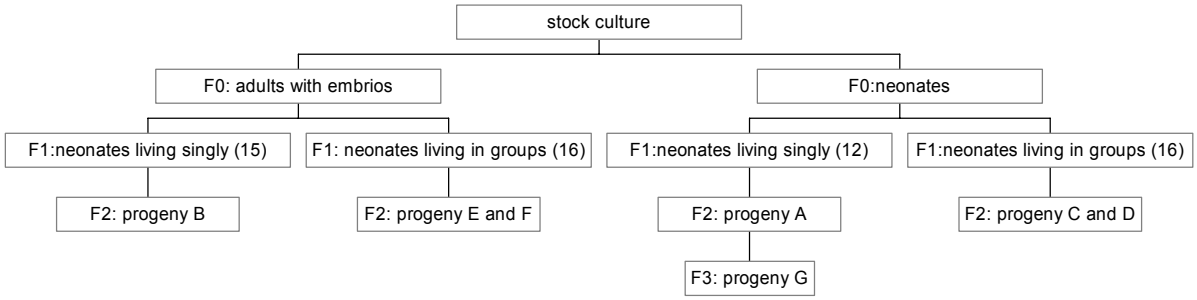


Fig. 1. *Schema of experiments on the role of density in reproduction strategy of Daphnia magna*

Progeny A represents the offspring (F2) of neonates living singly, born form parental Daphnids living also singly (F1), as they were taken from stock culture (F0) as neonates. Progenies C and D are neonates (F2) of daphnids (F1) living in groups (5), although they have been taken out of stock culture as neonates. Progeny B represents the neonates (F2) of singly living daphnids (F1) born from the parents living in groups. Progeny E and F are the neonates (F2) of daphnids (F1) living in groups (5) in two successive generations. Additionally, progeny G (F3) represents the neonates born from daphnids living singly in three successive generations. Differences between progeny E and F as well as between C and D originates from expression of the average number of neonates: C and E, are expressed as average number of neonates of all animals in the test chamber (5), regardless of their survival until the end of test, while D and F are expressed as average number of neonates born from parents surviving to the end of test, till day 21 (fig.1).

3. RESULTS AND DISCUSSION

The highest mean number of neonates (30.58 ±8.72, range 18-44) after 14 days was recorded in progeny G (offspring of progeny A) – singly living animals during 3 successive generations, while the lowest number (8.78 ±4.3, range 1.8-16.2) occurred in progeny C – animals living in groups, born from singly living parents, but the mean number expressed as average number from the test chamber (5), regardless of the survival of the animal (fig. 2).

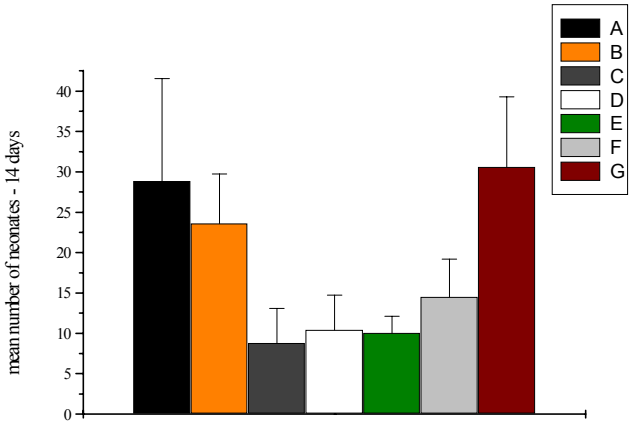


***Fig 2**. The role of density in reproduction strategy of D. magna –14 days*

However, detail analysis (table 1) indicates that the mean number of neonates in progeny G, although higher, does not significantly differ from progeny A. Also, the average number of neonates from progeny C (although the lowest of all) does not significantly differ from progenies D and E. The mean numbers of neonates from progeny A and B also do not significantly differ each other, in spite of the unlike origin of the animals used in experiment (fig. 1).

The highest mean number of neonates (84.45±23.71, range 49-119) after 21 days was again recorded in progeny G (offspring of progeny A) – singly living animals during 3 successive generations, while the lowest number (18.05 ±8.73, range 4-32-16.2) occurred in progeny C – animals living in groups, born from singly living parents, but the mean number expressed as average number from the test chamber (5), regardless of the survival of the animal (fig. 3), as it was the case after 14 days.

***Table 2**. Detailed analysis of reproduction patterns – 14 days*

	A	B	C	D	E	F
B	**p=0.17**	-				
C	p=0.00002*****	p=9x10^{-8}*****	-			
D	p=0.00005*****	p=7x10^{-7}*****	**p=0.34**	-		
E	p=3x10^{-6} *****	p=3x10^{-9}*****	**p=0.32**	**p=0.74**	-	
F	p=0.0003*****	p=0.00007*****	p=0.002*****	p=0.02*****	p=0.001*	-
G	**p=0.7**	p=0.002*****	p=4x10^{-8}*****	p=1.2x10^{-7}*****	p=3x10^{-9}*	p=1.1x10^{-6} *

** statistically significant (one - way ANOVA, p ≤ 0.05)*

Also, detail analysis (table 2) indicates that the mean number of neonates in progeny G, although higher, does not significantly differ from progeny A, while the average number of neonates from progeny C (although the lowest of all) does not significantly differ from progeny E. However, after 21 days, neither mean number of neonates from progenies B and F nor A and F significantly differed. Yet, average offspring of E and F, as well as A and B, differed significantly.

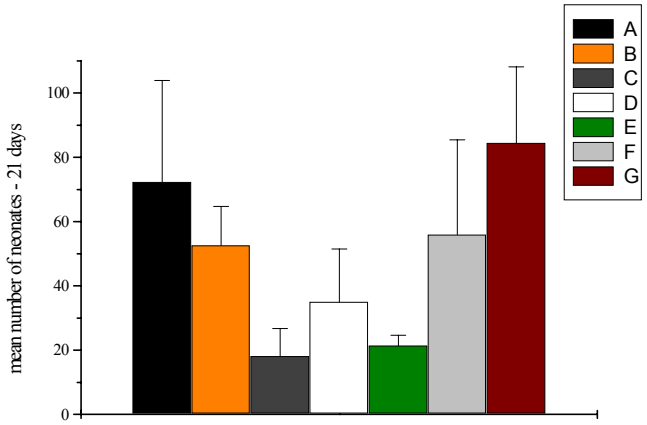


***Fig 3**. The role of density in reproduction strategy of D. magna – 21 days*

In *D. magna,* high animal density, even when sufficient and equal food levels are available to all test animals, unquestionably causes a mutual intraspecific influence called life-strategy shift by intraspecific interaction, as suggested earlier [2,9]. The mean number of neonates in progenies A, B and C (singly living animals) was significantly higher than the average offspring of animals living in groups (C, E, D and E), in spite of the equal food levels available to all test animals. Summarising, but without the intention of going deeply into complex biology and ecology of species, at present there is no evidence to counter the chemical hypothesis [5] that chemical substances, which release might be stimulated by mechanical interaction, are responsible for eliciting life-strategy shift by intraspecific interaction.

Table 2. Detailed analysis of reproduction patterns – 21 days

	A	B	C	D	E	F
B	p=0.04*	-				
C	$p=4x10^{-6}$*	$p=5x10^{-9}$ *	-			
D	p=0.001*	p=0.003 *	p=0.003*	-		
E	$p=8x10^{-7}$ *	$p=8x10^{-11}$ *	**p=0.17**	p=0.03*	-	
F	**p=0.17**	**p=0.69**	p=0.0001 *	p=0.03 *	p=0.00006 *	-
G	**p=0.31**	p=0.0001 *	$p=3x10^{-9}$ *	$p=5x10^{-6}$ *	$p=1x10^{-10}$ *	p=0.01 *

* statistically significant (one - way ANOVA, $p \leq 0.05$)

However, our concern were only the implications such reproduction pattern might have on chronic toxicity testing. To avoid any possible influence of culturing patterns on offspring, the animals intended for chronic toxicity testing should be derived from singly-living parents, cultured and kept during the experiments in separate test vessels. The reason is very simple – in mass cultures it is virtually impossible to distinguish between over-crowding and test substance's impact on reproduction pattern, while the purpose of laboratory tests basically is to provide such conditions that environmental factors need not be taken as co-variables when evaluating the possible effect of test substances or mixtures.

Therefore, the old test design - to keep test animals in groups, 10 per tests vessel, in 4 replicates per each test concentration (total of 40 animals) was changed [11]: the new method uses 10 animals housed individually. Apart from the fact that the results of the tests conducted according to old method are under direct influence of over-crowding, it was extremely difficult to accurately evaluate reproduction status. Although the animals used in tests derive from the same clone, it virtually never happens that all animals in tests release clutches simultaneously, the offspring usually appear in 2-3 days intervals and overlap, so it is impossible to tell between the offspring of test animals housed in groups. Therefore, the whole set of valuable information on clutch size and timing are lost. Besides, the new experimental design uses 10 real replicates instead of pseudoreplicates used in old method, and therefore, provides more information from the test: the exact size of the clutch, the timing of the distinctive clutches, the exact number of possibly aborted embryos or dead neonates per parent animal, the time intervals between two successive clutches etc. Contrary to expectations, 1 x 10 practice, although requires less animals per treatment, results in same statistical power of the test as 4 x 10, as the experimental unit is the test vessel, not the animal, and there are more vessels in each treatment in new design than in the old one (10 as opposed to 4), which will tend to increase the power [13].

In chronic toxicity tests, particularly those based on reproduction strategy of test animals, the influence of status, reproduction potential, test design and parental culturing method (especially crowding) could not be easily excluded. Mean number of neonates in offspring of individually housed animals (series A and B) differs significantly after 21 day, being 72 and 52, respectively. The situation in offspring derived form parental animals cultured in groups is rather vague, so the direct connection between parental crowding and offspring reproduction potential couldn't be found. One of the possible explanations of higher number of neonates in individually housed animals definitely is the higher rate of adult and pre-mature death in animals housed in groups.

However, the mean number of neonates in series A and G do not differ significantly, although the average number of offspring in series G

was higher that any other, including A, after 14 as well as after 21 days. Basically, it could be concluded that it is not necessary to keep animals intended for chronic tests individually till F3 generation, but it is not advisable to take adult animals (with embryos) out of mass cultures and use their offspring in reproduction tests, either. Optimal design would be to use animals as series A, in other word, it is ideal to take neonates from mass cultures, house them individually, and to use their offspring (third clutch) in chronic toxicity tests.

4. REFERENCES:

1. APHA, AWWA, WPCF. *Standard Methods for Examination of Water and Wastewater*, 19th ed., Washington, DC, 1995.
2. Cleuvers, M., Goser, B., Ratte, H. T. Life-strategy shift by intraspecific interaction in *Daphnia magna*: change in reproduction from quantity to quality. *Oecologia*, **110**, 337-345, 1997.
3. Council Directive 2000/60/EC of 23 October 2000 establishing a framework for Community action in the field of water policy Official Journal L 327/1, P. 0001 – 0072, 22.12.2000.
4. Enserink, L., de la Haye, M., Maas, H. Reproductive strategy of *Daphnia magna*: implications for chronic toxicity tests. *Aquatic Toxicology*, **25**, 111-124, 1993.
5. Goser, B. and Ratte, H. T. Experimental evidence of negative interference in *Daphnia magna* Strauss. *Oecologia* 98: 354-361, 1994.
6. ISO. Determination of the inhibition of mobility of *Daphnia magna* Straus (Cladocera, Crustacea)–Acute toxicity test. ISO 6341-1996.
7. ISO. Determination of long term toxicity of substances to *Daphnia magna* Straus (Cladocera, Crustacea). ISO 10706:2000.
8. Kluttgen, B., Ratte, H. T. Effect of different food doses on cadmium toxicity to Daphnia magna. *Environ. Toxicol. Chem.,* **13** (10), 1619-1627, 1994.
9. Matveev, V. An investigation of allelopathic effects of *Daphnia*. *Freshwat. Biol.* **29**, 99-105, 1993.
10. Norberg – King, T., J., Schmidt, S. Comparison of effluent toxicity results using *Ceriodaphnia dubia* cultured on several diets. *Environ. Toxicol. Chem.,* **12**, 1945-1955, 1993.
11. OECD. Draft Guideline 202, part II on *Daphnia magna* Reproduction Test. Organisation for Economic Co-operation and Development, Paris, 1994.
12. OECD. Report of the Final Ring Test of the *Daphnia magna* Reproduction Test, OECD, Series on Testing and Assessment, No. 6, Paris, 1997.
13. Sims, I., van Dijk, P. The statistical power and biological information of two *Daphnia* juvenile production test design. *Water Research*, **30**, (4), 1030-1035, 1996.

14. US EPA. Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, 4th ed., EPA/600/4-90/027F, 1993.
15. US EPA. Aquatic invertebrate acute toxicity test, freshwater daphnids. EPA 712-C-96-120, 1996.
16. US EPA. Daphnid chronic toxicity test. EPA 712-C-96-121, 1996.

DIMENSIONING FLOWS DETERMINATION ALGORITHM FOR EQUIPMENTS AND INSTALLATIONS OF THE URBAN WASTE WATER TREATMENT PLANTS

Lect. Eng. Victor – Viorel SAFTA, Dr.Es.Sc.

POLITEHNICA University of Bucharest

Abstract: *At the designing of a locality waste water treatment plant, the waste water characteristic flows of the locality constitute the main dimensioning input data of the technological objects of the plant.*

In the paper, a calculus algorithm for the analytic estimation of the water demand and waste water characteristic flows of a locality is presented.

Keywords: *waste water treatment plant, designing, waste water characteristic flows, water demand characteristic flows, calculus algorithm.*

1. INTRODUCTION

At the designing of the equipments and installations of a locality waste water treatment plant, the main data, which the designing is based on, are the processed waste water flows. That is why the problem of correct determination of waste water characteristic flows of the localities is extremely important in the designing field of the waste water treatment plants.

The waste water characteristic flows of a locality are:

- waste water average daily flow $Q_{u\ zi\ med}$ [m^3/day or m^3/s];
- waste water maximum daily flow $Q_{u\ zi\ max}$ [m^3/day or m^3/s];
- waste water maximum hourly flow $Q_{u\ orar\ max}$ [m^3/h or m^3/s];
- waste water minimum hourly flow $Q_{u\ orar\ min}$ [m^3/h or m^3/s];

For the determination of a locality waste water characteristic flows it is necessary to know its water demand characteristic flows, because it is considered that waste water characteristic flows of a locality represent 80% of its water demand characteristic flows [2,3].

The water demand characteristic flows of a locality can be determined in the two following ways:

- the practical way is to sum the water demands of all the locality consumers; in this case it is necessary to detain detailed data about the locative structure of the locality and the manner that this is endowed with water and sewage utilities, the number and nature of industrial enterprises and live stock units of the locality and their specific water demands and the fire extinction water network of the locality;

- the analytic way is to estimate the water demand of the locality following the prescriptions of the Romanian national normative and standards [2,3,4,5,6,7] which settle the water supply quantities for populated centres, industrial enterprises and live stock units and indicate the calculus methodology of the locality water demand characteristic flows.

In this paper a specialised calculus algorithm for estimating the locality water demand and waste water characteristic flows is presented.

2. CALCULUS ALGORITHM OF A LOCALITY WATER DEMAND AND WASTE WATER CHARACTERISTIC FLOWS

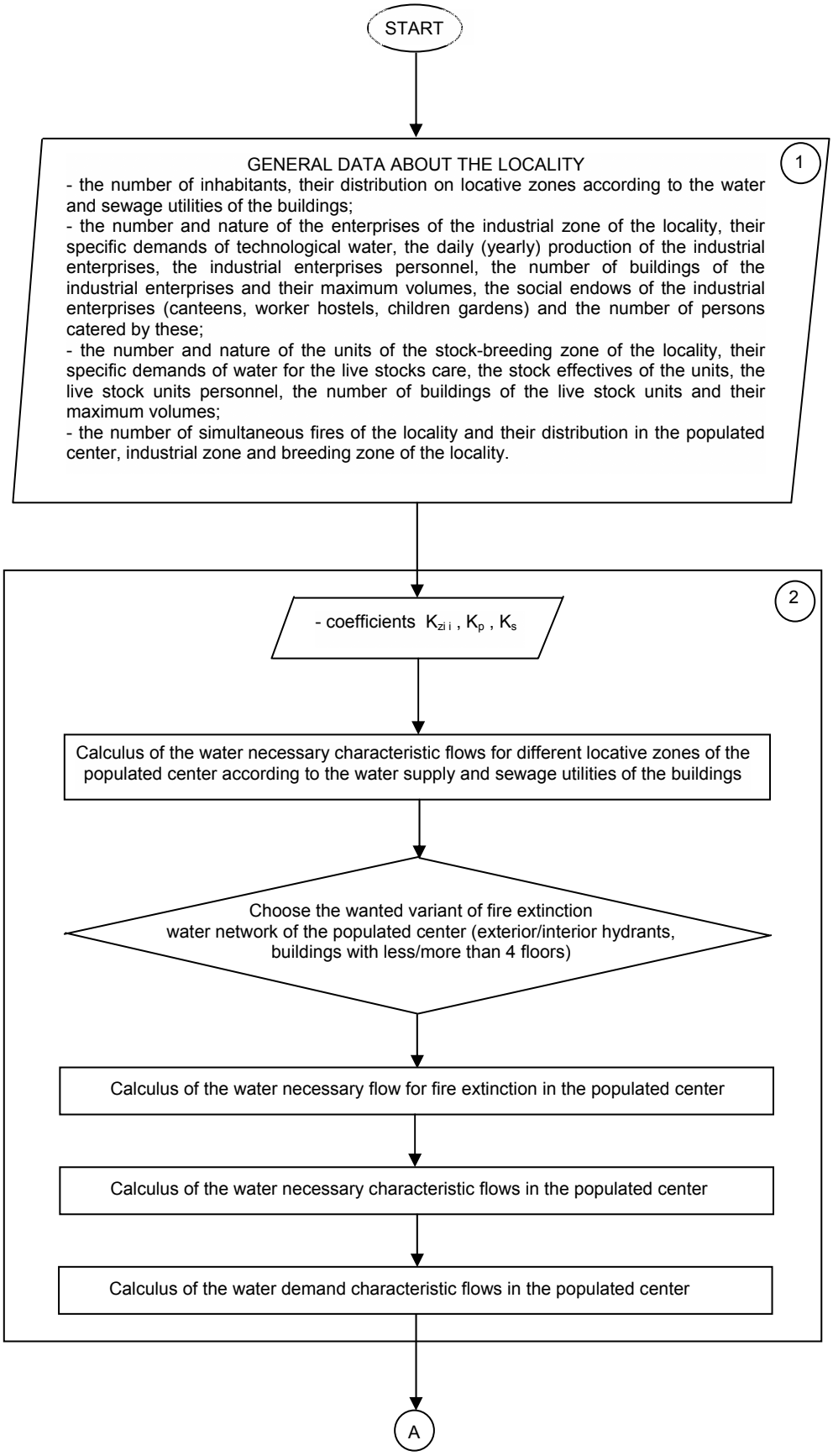
The calculus algorithm of a locality water demand and waste water characteristic flows is structured on the following main modules (the logical schema of the algorithm is presented in the paper):

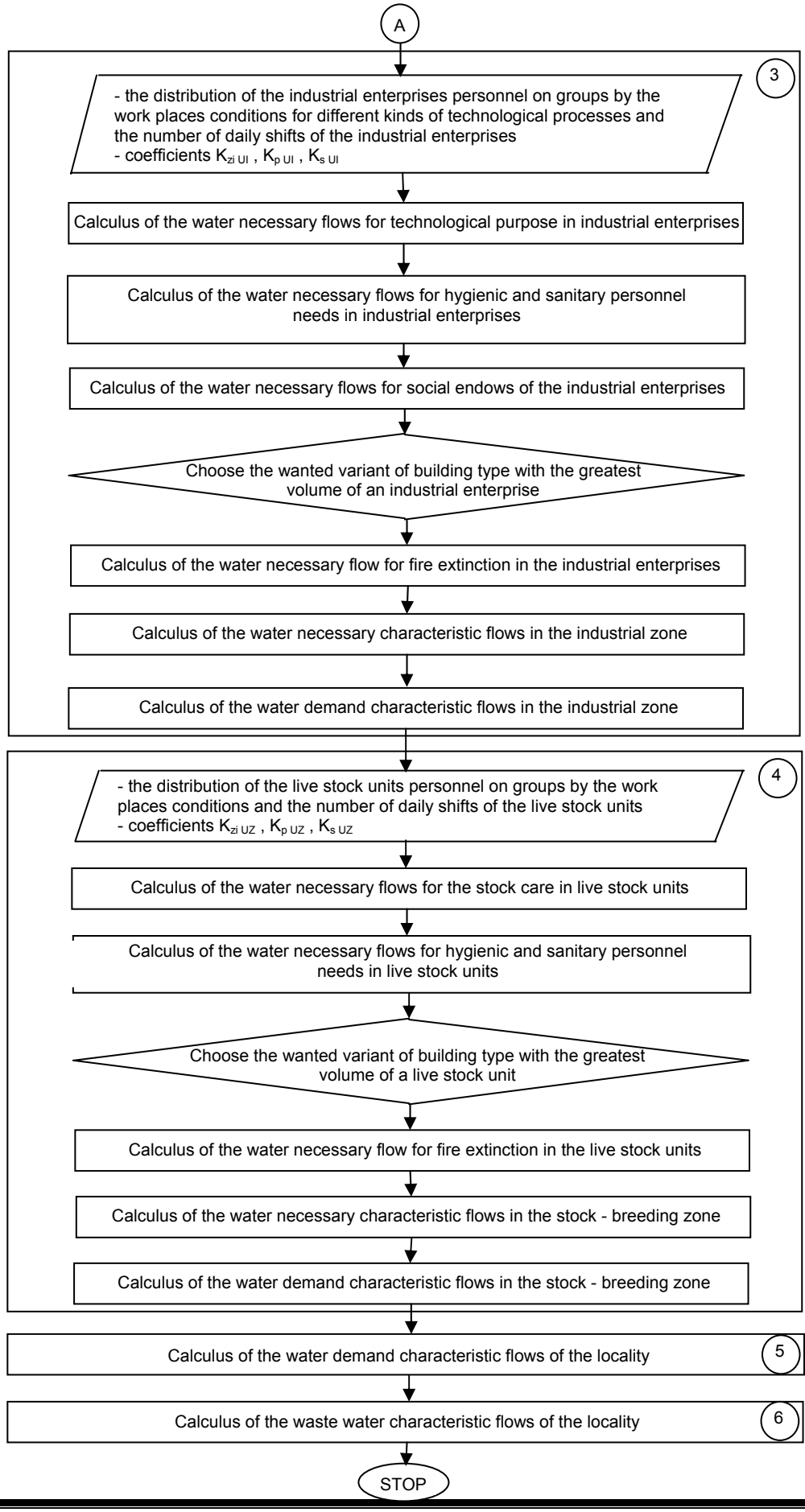
1. General data about the locality.
2. Calculus of the populated centre water demand characteristic flows.
3. Calculus of the industrial zone water demand characteristic flows.
4. Calculus of the stock-breeding zone water demand characteristic flows.
5. Calculus of the locality water demand characteristic flows.
6. Calculus of the locality waste water characteristic flows.

In the module “General data about the locality” there are introduced in the algorithm the following data about the locality: the number of inhabitants, their distribution on locative zones according to the water and sewage utilities of the buildings, the number and nature of the enterprises from the industrial zone of the locality, their specific demands of technological water [1], the daily (yearly) production of the industrial enterprises, the industrial enterprises personnel, the number of buildings of the industrial enterprises and their maximum volumes, the social endows of industrial enterprises (canteens, worker hostels, children gardens) and the number of persons catered by these, the number and nature of the units from the stock-breeding zone of the locality, their specific demands of water for live stock care, the stock effectives of the units, the live stock units personnel, the number of buildings of the live stock units and their maximum volumes, the number of simultaneous fires in the locality and their distribution in the populated centre, industrial zone and stock-breeding zone of the locality.

In the module “Calculus of the populated centre water demand characteristic flows” can be chosen the wanted variant of locality by its climate (modifying the value of the coefficient $K_{zi\,i}$ of variation of the daily flows) or by its water supply and sewage installation structures (modifying the values of the coefficient K_p of water looses in adduction and distribution network and of the coefficient K_s of the technological demands of the water supply and sewage system)[4] and the wanted variant of fire extinction water network (exterior / interior hydrants, buildings with less / more than 4 floors) and result the values for the water demand characteristic flows of the populated centre in the chosen variant.

In the module “Calculus of the industrial zone water demand characteristic flows” must be introduced the distribution of the industrial enterprises personnel on groups by the work places conditions for different kinds of technological processes [5] and the number of daily shifts of the industrial enterprises and can be chosen the wanted variant of industrial zone by its climate (modifying the value of the coefficient


START
GENERAL DATA ABOUT THE LOCALITY
- the number of inhabitants, their distribution on locative zones according to the water and sewage utilities of the buildings;
- the number and nature of the enterprises of the industrial zone of the locality, their specific demands of technological water, the daily (yearly) production of the industrial enterprises, the industrial enterprises personnel, the number of buildings of the industrial enterprises and their maximum volumes, the social endows of the industrial enterprises (canteens, worker hostels, children gardens) and the number of persons catered by these;
- the number and nature of the units of the stock-breeding zone of the locality, their specific demands of water for the live stocks care, the stock effectives of the units, the live stock units personnel, the number of buildings of the live stock units and their maximum volumes;
- the number of simultaneous fires of the locality and their distribution in the populated center, industrial zone and breeding zone of the locality.
1
2
- coefficients $K_{zi\,i}$, K_p , K_s
Calculus of the water necessary characteristic flows for different locative zones of the populated center according to the water supply and sewage utilities of the buildings
Choose the wanted variant of fire extinction water network of the populated center (exterior/interior hydrants, buildings with less/more than 4 floors)
Calculus of the water necessary flow for fire extinction in the populated center
Calculus of the water necessary characteristic flows in the populated center
Calculus of the water demand characteristic flows in the populated center
A


A
3
- the distribution of the industrial enterprises personnel on groups by the work places conditions for different kinds of technological processes and the number of daily shifts of the industrial enterprises
- coefficients $K_{zi\ UI}$, $K_{p\ UI}$, $K_{s\ UI}$
Calculus of the water necessary flows for technological purpose in industrial enterprises
Calculus of the water necessary flows for hygienic and sanitary personnel needs in industrial enterprises
Calculus of the water necessary flows for social endows of the industrial enterprises
Choose the wanted variant of building type with the greatest volume of an industrial enterprise
Calculus of the water necessary flow for fire extinction in the industrial enterprises
Calculus of the water necessary characteristic flows in the industrial zone
Calculus of the water demand characteristic flows in the industrial zone
4
- the distribution of the live stock units personnel on groups by the work places conditions and the number of daily shifts of the live stock units
- coefficients $K_{zi\ UZ}$, $K_{p\ UZ}$, $K_{s\ UZ}$
Calculus of the water necessary flows for the stock care in live stock units
Calculus of the water necessary flows for hygienic and sanitary personnel needs in live stock units
Choose the wanted variant of building type with the greatest volume of a live stock unit
Calculus of the water necessary flow for fire extinction in the live stock units
Calculus of the water necessary characteristic flows in the stock - breeding zone
Calculus of the water demand characteristic flows in the stock - breeding zone
Calculus of the water demand characteristic flows of the locality
5
Calculus of the waste water characteristic flows of the locality
6
STOP

$K_{zi\ UI}$ of variation of the daily flows) or by its water supply and sewage installation structures (modifying the values of the coefficient $K_{p\ UI}$ of water looses in adduction and distribution network and of the coefficient $K_{s\ UI}$ of the technological demands of the water supply and sewage system)[6] and also the variant of building type with the greatest volume of an industrial enterprise, randomize chosen, for fire extinction flow determination and result the industrial zone water demand characteristic flows.

In the module "Calculus of the stock-breeding zone water demand characteristic flows" must be introduced the distribution of live stock units personnel on groups by the work places conditions [5] and the number of daily shifts of the live stock units and can be chosen the wanted variant of stock-breeding zone by its climate (modifying the value of the coefficient $K_{zi\ UZ}$ of the daily flows variation) or by its water supply and sewage installation structures (modifying the value of the coefficient $K_{p\ UZ}$ of water looses in adduction and distribution network and of the coefficient $K_{s\ UZ}$ of the technological demands of the water supply and sewage system)[7] and also the variant of building type with the greatest volume of a live stock unit, randomize chosen, for fire extinction flow determination and result the stock-breeding zone water demand characteristic flows.

In the module "Calculus of the locality water demand characteristic flows" there are determined the locality water demand characteristic flows by summing the correspondent water demand characteristic flows from the populated centre, the industrial zone and the stock-breeding zone.

In the module "Calculus of the locality waste water characteristic flows" there are determined the locality waste water characteristic flows from the locality water demand characteristic flows.

Based on the presented calculus algorithm it was made an interactive program which aloud to determine rapidly and comfortably the values of water demand, respectively of waste water characteristic flows. The program was conceived in a matricidal structure and can be easily adapted to every locality, with all kinds of water supply and sewage utilities in the populated centre zones, with a desired number of industrial enterprises which can be chosen from a multitude of types (in order of their technological processes) and with a desired number of live stock units which can be chosen from all kinds of stock-breeding units.

3. CONCLUSIONS

The estimation of a locality waste water characteristic flows is extremely important for the designing phase of the waste water treatment plant which the locality will be endowed with, because the dimensioning of all the equipments and installations of the waste water treatment plant is based on the values of the waste water characteristic flows.

In this paper a specialised calculus algorithm for analytical estimation of the locality water demand characteristic flows, respectively waste water characteristic flows, based on the Romanian national normative and standards prescriptions, is presented.

Based on the presented calculus algorithm it was made an interactive program which aloud to determine rapidly and comfortably the values of water demand, respectively of waste water characteristic flows. The program was conceived in a matricidal structure and can be easily adapted to every locality, with all kinds of water supply and sewage utilities in the populated centre zones, with a desired number of industrial enterprises which can be chosen from a multitude of types (in order of their

technological processes) and with a desired number of live stock units which can be chosen from all kinds of stock-breeding units.

BIBLIOGRAPHY

1. Pîslăraşu I., Rotaru N., Tigoianu V. – *Sewages* - Editura Tehnică, Bucharest, 1965

2. *** *Normative for urban waste water treatment constructions and installations – First Part: Mechanical Level* – Fore project - Technical University of Civil Engineering Bucharest, Faculty of Hydrotechnics, Bucharest, January 1998

3. *** STAS 1846-90 – *Determinations of sewage water discharges. Design specifications.*

4. *** SR 1343/1 – 1995 – *Determination of drinking water supply quantities for settlements.*

5. *** STAS 1478-90 – *Water supply for civil and industrial buildings. Main specifications.*

6. *** STAS 1342/2-89 – *Determination of supply water quantities for industries.*

7. *** STAS 1343/3-86 – *Determination of supply water quantities for live stock units.*

MYXOBACTERIA AS BIOINDICATORS OF WATER ORGANIC LOAD OF THE BACHKA REGION D-T-D CANAL NETWORK

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

Department of Biology and Ecology, Faculty of Sciences,
University of Novi Sad, D. Obradovicya square 2,
YU-21000 Novi Sad, Serbia and Montenegro
e-mail: petrovico@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, investigations of myxobacteria as a new microbiological indicator of water organic load have been undertaken. Due to their multienzymatic nature, myxobacteria are considered as a good bioindicators of organic pollution of water.

Results obtained in this investigation show that organic load of canal waters, estimated according to the number of this sampling site. Using categorization system after Lecianova (4), quality of water ranged between almost pure water, over slightly and moderately polluted, to the range of extremely polluted water. As a bioindicators parameter, myxobacteria quantitative composition correlated significantly with other classical microbiological indicators of the water organic load.

***KEY WORDS**: myxobacteria, organic load, canal water quality, Bachka*

1. INTRODUCTION

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 watercourses coming from the neighboring Hungary and Croatia.

Since during the last decade a condition of canal waters of the Vrbas-Srbobran section was very bad with a very low quality of water (1, 2, 5, 6, 10) the aim of our investigations was to determine a recent quality of water of the same object in order to compare the condition before and after measures undertaken for the protection and conservation of natural surface watercourses of DTD system and to campare with other canal waters.

The efficient water quality control consider today introduction new methods and parameters indicating the level and the nature of water contamination. One of the most exploited parameters today is the enumeration of organotrophic bacteria, indicating the presence of easy-to-degrade organics and enabling the categorization of water into the classes of bonity (9). Also, myxobacteria, due to their multienzyme complexes, are considered as relevant and good indicators of the water organic load (3, 4, 7, 8, 11).

2. MATERIAL AND METHODS

In the course of 2002, the samples of canal waters of the Bachka Region have been analyzed. Besides other microbiological analyses, quantitative composition of specific group of aerobic saprophytic bacteria has been determined champignon-agar (4, 9).

The estimation of water organic load has been done according to the scale adjusted for the surface freshwaters, after the same autor (4).

3. RESULTS AND DISCUSSION

After publishing our results regarding investigation of Bezdan – Vrbas section of the DTD canal system (1,2,5,6) these investigations were continued at several sections of the Bachka canal network. Besides other microbiological analyses, the quantitative composition of mixobacteria, specific aerobic saprophytic group of bacteria, has been recorded. Also, heterogeneous quality of the same canal water sample reflects the dynamic of complexity of seasonal ecological factors.

Generally could be stated that, in the course of summer and autumn od 2002 June, August, and November) myxobacterea were found to be present in all samples of canal waters. At some localities dominated typical bacteriolytic forms, mainly with visible fruting bodies. In some other samples typical cellulolytic forms were abundant. Domination of different groups of myxobacteria in different samples was caused probably by specific complex conditions of specific locality.

The count of myxobacteria in investigated water samples fluctuated considerably too, depending on season as well as according to sample. In the most of cases, in allmost all of samples, the higher numerical values in the summer season (July) have been recorded.

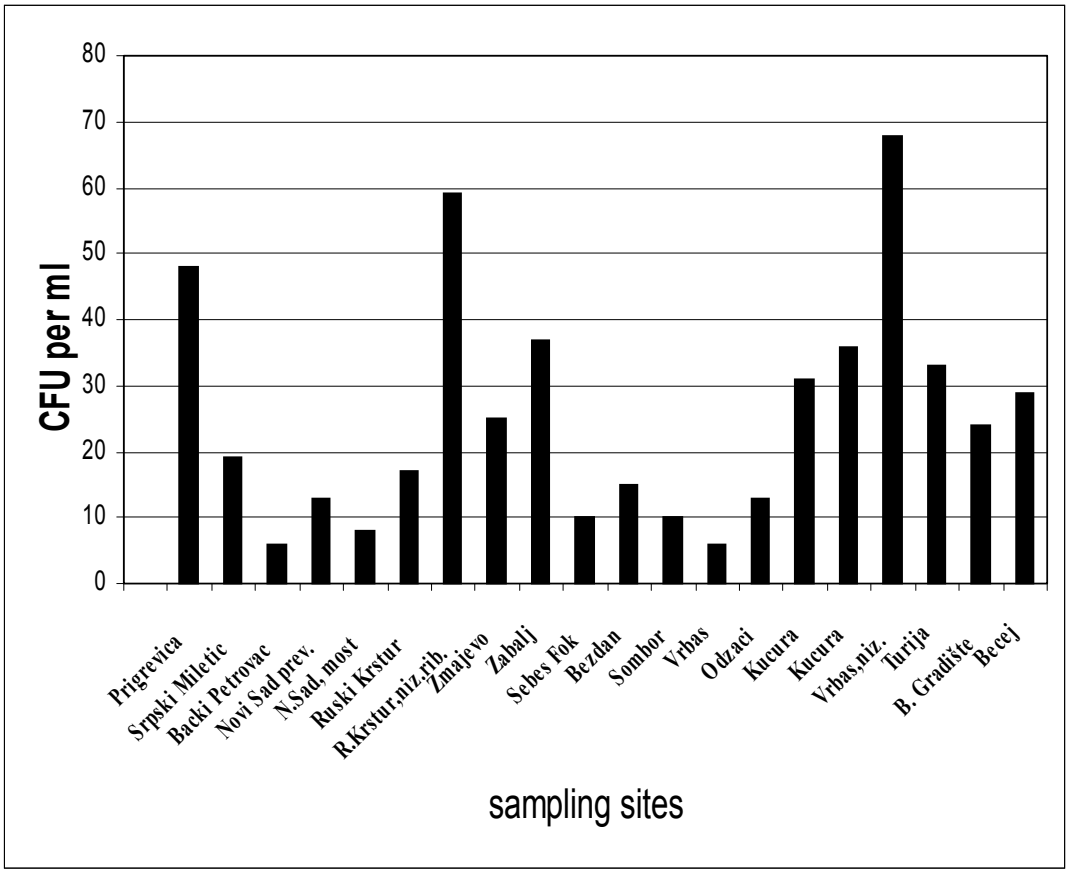


Fig. 1 *The myxobacteria abundance in canal waters (mean values)*

Analyzing the mean values of the myxobacteria abundance in canal waters (Fig. 1) the differences in number of this group of bacteria could be noticed, indicating various quality of water. According to the Lecianova categorization (4), the water quality ranged from clean, over slightly and moderately polluted, to the exceptionally polluted waters. Out of 20 samples, only three turned to have clean waters (sampling sites: Bachki Petrovac, Novi Sad – Kacyki most, and Vrbas, upstream of the industrial wastewater discharge). On the basis of the categorization after Lecianova (4), according to the myxobacteria abundance, the most of waters (10 out of 20 samples analyzed) of the Bachka Region canal waters belonged to the slightly polluted by organic matter (Criterion 10-30 CFU/cm^3). Six others belonged to the moderately polluted (Criterion 30-60 CFU/cm^3) (Fig. 1).

Unlike to these sampling sites, one sampling site was characterized with exceptionally polluted water. The high number of this group of bacteria, downstream of the Vrbas town wastewater discharge into canal as a recipient (Fig. 1), indicate the high organic load of this water, in comparison with the low organic load of the same water upstream of wastewater discharge (Fig. 2). Our earlier published results of investigation of impact of edible oil factory wastewater discharge revealed (10) dizasterous influence of industrial wastewaterson the canal recipient waters, with number of myxobacteria reaching enormous quantities of several thousands per cm^3.

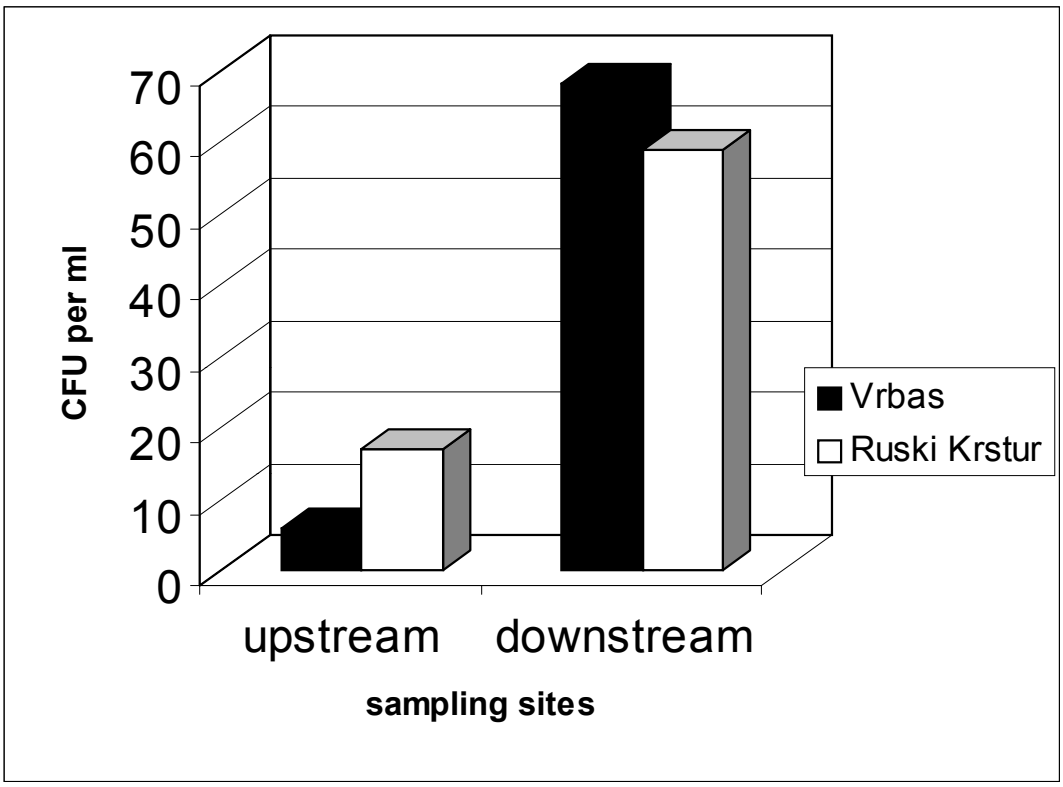


Fig. 2 *Quantitative composition of myxobacteria, indicating water organic load upstream and downstream of wastewater discharge.*

The similar situation was noticed in the course of 2002 at the Kosanchicy-Mali Stapar canal strech, at the Ruski Krstur sampling site (Fig. 1, and Fig. 2). Obviously, the canal water quality was determined by the presence of cage fish aquaculture. Canal water upstream of the fish cages wass found to belong to category of slightly to moderately polluted, but, downstream of the cages, turned to belong to moderately polluted category after Lecianova (4).

3. CONCLUSION

Results of microbiological examinations of the quality of DTD canal water shows remarkable fluctuations of number of investigated group of bacteria, what reflect the fluctuations in water organic load. Heterogeneous quality of the same canal water sample reflects the dynamic of wastewater discharge, as well as complexity of seasonal ecological factors.

According to the myxobacteria count most of water samples could be classified as slightly or moderately loaded by organics, only waters downstream of the Vrbas town iindustrial wastewater discharge into canal as the recipient was found to be exceptionally polluted by organic matter, testifying about high and permanent influx of organic contaminants.

4. REFERENCES

1. Dalmaciya, B., Tamash, Z., Karlovicy, E., Ivanchev-Tumbas, I., Davidovicy, R., Kilibarda, P., Bugarski, R., Berkovicy, M. (1996): The importance of the data bank.

2. Karlovicy E., Dalmaciya B., Karlovicy DY., Turkulov Y. (1996): Znachay tretmana otpadnih voda koye nastayu u procesu prerade ulyarica i ulya na ukupno smanyenye zagadyivanya voda na teritoriyi Voyvodine", Zbornik radova "Zashtita voda 96", p.184-188.
3. Lecianova L. (1978): Myxobakterien im Wasser, ein neuer indikator in der Hydromikrobiologie. Wasser und Abwasser, Wien, 21:43-65.
4. Lecianova L. (1981): Einfluss Okologischer faktoren Auf das Vorkommen von Myxobakterien im Wasser. III Intern. Hydromikrob. Symp., Smolenice, 1980- Verlag der SAV, Bratislava, 1981.:99-106.
5. Matavuly, M., Gayin, S., Petrovicy, O., Svirchev, Z., Radnovicy, D., Bokorov, M., Tamash, I. (1996): Water Quality of the Danube-Theiss-Danube canal at the Bezdan - Vrbas section according to microbiological and enzymological parameters. IAD Limnological Reports: 29-34.
6. Matavuly, M., Gayin, S., Petrovicy, O., Svirchev, Z., Radnovicy, D., Bokorov, M., Tamash, I. (1996): Water Quality of the Danube-Tisa-Danube channel at the Bezdan - Vrbas section according to microbiological and enzymological parameters. IAD Limnological Reports, 31: 29-34.
7. Miklošovičova L. (1981): Die Anwesenheit von Myxobakterien im Wasserbiotop. III Intern. Hydromikrob. Symp., Smolenice, 1980- Verlag der SAV, Bratislava, 1981.:107-113.
8. Petrovicy, O., Radnovicy, D., Galonya, T., Matavuly, M. (1997): Miksobakteriye i fosfatazna aktivnost kao indikator organskog zagadyenya vode Dunava kod Novog Sada. Zbornik radova "Eko-konferenciya 97", Novi Sad, p.121-124.
9. Petrovicy O., Gayin S., Matavuly M., Radnovicy D., Svirchev Z. (1998): Microbiological investigations of surface freshwaters. Manual. University of Novi Sad, 1998.
10. Petrovicy, O., Matavuly, M., Radnovicy, D., Gayin, S. (2002): The Organic Load of the DTD Canal water as a Recipient of Edible Oil Factory Wastewater According to Some Microbiological Parameters. IAD Limnological Reports, 34: 435-442.
11. Zhivanovicy, B. (1990): Myxobacteria – specific ecological indicators. Proc. Sec. Yugosl. Microb. Ecol., Zagreb, 1990, pp: 383-392.

DEGRADATION KINETICS OF TOTAL HYDROCARBONS IN THE BIOREMEDIATED SOIL LAYER

Ivana IVANČEV-TUMBAS[1], Olivera JEVTIĆ[1], Srđan RONČEVIĆ[1], Miljana PRICA[2], Mile KLAŠNJA[3]

[1]Institute of Chemistry, Faculty of Sciences, University of Novi Sad, 21000 Novi Sad, Trg Dositeja Obradovića 3
[2]Faculty of Technical Sciences, Trg D. Obradovića 6, 21000, Novi Sad
[3]Faculty of Technology, Bulevar Cara Lazara 1,21000 Novi Sad

Abstract:

The work presents kinetic parameters of the removal of the components with hydrocarbon functionalities and polar components in the course of bioremediation of the soil contaminated with crude and oil derivatives. In the course of a laboratory experiment that lasted 325 days it was found that content of the components with hydrocarbon functionalities decreased from 125 g/kg to 40-75 g/kg, depending on the mode of recirculation of water phase and sampling site (top, middle, or bottom of the bioreactor). A slower degradation process was observed compared to that of mineral oils along with the accumulation of polar components in the course of the bioremediation process.

Keywords:

bioremediation, hydrocarbons, soil, kinetics

1. INTRODUCTION

Hydrocarbons represent an extremely important and heterogeneous group of compounds that reach the environment by natural and anthropogenic ways. Among hydrocarbons, there are several groups of compounds that exhibit high toxicity (polycyclic aromatic hydrocarbons, PAHs, BTEX components, etc.). In the environmental samples, the majority of these compounds are analyzed by specific gas or liquid chromatography methods. In addition to the information about so specific sort of pollutants, the analyses of contaminated areas often contain also data obtained by IR spectrometric measurements, indicating total hydrocarbon content. According to Standard Methods, these measurements are carried out in the extracts (carbon tetrachloride or freon) after removal of polar components by adsorption on alumina or silica gel [2]. Kind of total petroleum hydrocarbons data can be obtained by gas-chromatographic measurments, also. The aim of this work was to determine kinetic parameters of degradation of the components with hydrocarbon functional groups, encompassing also polar structures that are not determined in routine analyses. It is known that the biodegradation of hydrocarbons yields formation of

polar products of metabolism [5] that can still have a high proportion of hydrocarbon structures, so that a better insight is thus obtained into the degree of degradation, i.e. persistence of hydrocarbon molecules.

2. MATERIALS AND METHODS

The experiments were carried out on samples of the contaminated soil brought from the internal dump of the Oil Refinery Novi Sad, where it was deposited immediately after the bombing in June 1999. Soil was directly contaminated with various petroleum products (gasoline, crude oil, kerosene, diesel fuel, black oil etc.) and products of their combustion due to frequent fires [1]. Real composite samples of the soil were put in two laborotory scale bioreactors (with continuous and discontinuous recirculation) [4]. Microorganisms previously adapted to specific pollution were applied on the soil together with nutrients. During the experiment (325 days) content of substances with hydrocarbon moieties was monitored at different heights of the bioreactors. IR spectrofotometric procedure was applied [2] with and without removal of polar compounds on Al_2O_3.

3. RESULTS AND DISCUSSION

Changes in the concentration of total hydrocarbons in soil with time are presented in Fig. 1.

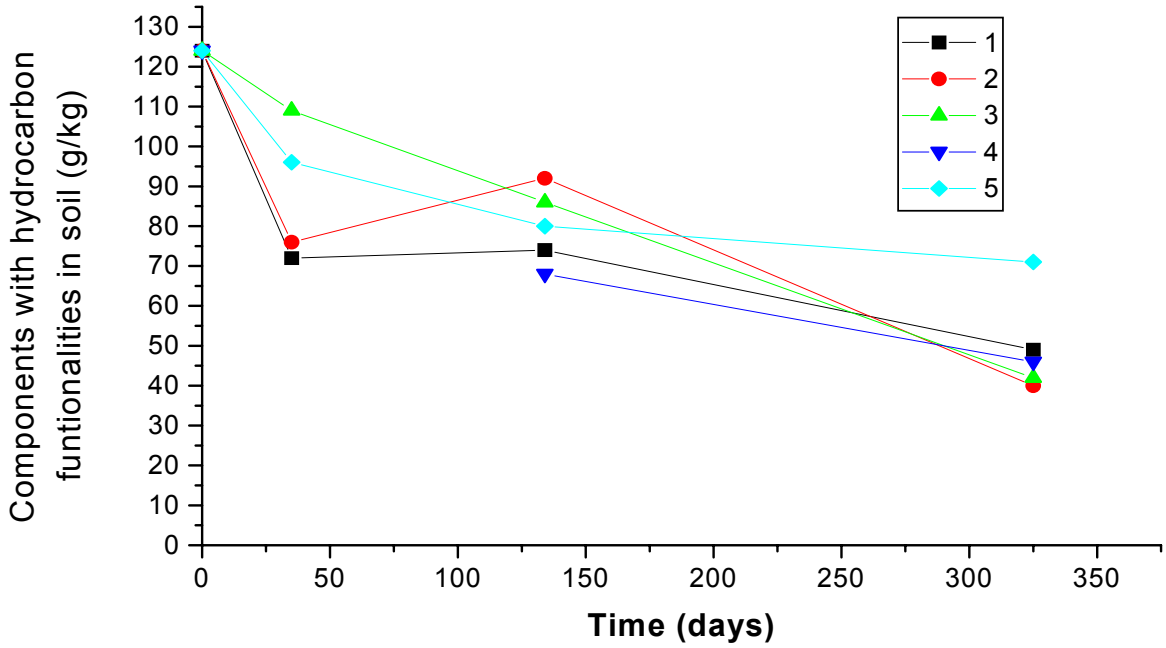


Fig. 1*.Concentration change of matter containing hydrocarbon functionalities in soil in the course of 325 days; 1-top of the reactor with continuous recirculation, 2-bottom of the reactor with continuous recirculation, 3-top of the reactor with discontinuous recirculation, 4-middle of the reactor with discontinuous recirculation, 5- bottom of the reactor with discontinuous recirculation*

Functional dependence of the concentration change with time can be described by the following equation:

$$\ln Y = A + B*X^{0.5} \qquad (1)$$

with the correlation coefficients from 0.9330 to 0.9995 (depending on the measured parameter and sampling site), where :

Y - concentration of total hydrocarbons in g/kg of dry soil,
X - time (in days) needed to reduce the concentrations of components with hydrocarbon groups to the natural level (25 mg/kg),
A – ordinate intercept,
B – rate coefficient of the change of total hydrocarbon content in soil ($day^{-1/2}$) .

The values of the slope (B) and correlation coefficient (R), as well as the time (x) needed to achieve the reduction of the concentration of hydrocarbons to natural level are presented in Table 1. The estimated time needed for removal of hydrocarbon components from the soil, i.e to reduce their contents to the natural level, is from 44 to 184 years, which is significantly longer than the estimated value for mineral oils (32 to 59 years) [3], depending on the wetting conditions and site of sampling.

Table 1. *Kinetic parameters of hydrocarbon degradation*

Constant	Content of components with hydrocarbon functionalities			
	1	**2**	**4**	**5**
A	4.8	4.8	4.8	4.8
-B ($day^{-1/2}$)	0.050	0.067	0.054	0.033
R	0.9330	0.9925	0.9995	0.9856
X (year)	79	44	69	184

The rate of removal of components with hydrocarbon functionalities is the lowest at bottom of the reactor with discontinuous recirculation, it is eqaul at the top of the reactor with continuous recirculation and in the middle of the reactor with discontinuous recirculation, whereas it is highest at the bottom of the reactor with continuous recirculation. Changes in the concentration of hydrocarbons adsorbed on alumina (polar compounds) in soil with time are presented in Figure 2. The concentration of polar components shows first a decrease except for the anaerobic bottom, where it constantly increases (probably because of migration), and then increases everywhere, and after 150 days a decreasing trend is observed. On the basis of the rate of removal of components with hydrocarbon functionalities and mineral oils, as well as trends of the changes of polar components concentration, it can be concluded that polar groups that can represent degradation products of hydrocarbon pollutants decelarate significantly the process of their complete removal.

4. CONCLUSION

In the course of the laboratory experiment lasting 325 days it was found that contents of the components with hydrocarbon functionalities decreased from 125 g/kg to 40-75 g/kg, depending on the mode of water recirculation and sampling site (top, middle or bottom of the bioreactor). It was found that the rate of biodegradation is slower compared to that observed for mineral oils and that the components accumulate in the process of biodegradation. In both bioreactors, biodegradation can be described by equation: $\ln y = a + bx^{0.5}$ with high correlation cefficient r^2=0.93-0.99.

Using this equation it was calculated that the level of pollution could reach background value of the area (25 mg/kg) in 44-184 years, depending on the conditions involved. It can be supposed that this is a consequence of accumulation hydrocarbon components with polar groups, as the experiment showed they can also accumulate in soil. Such a result indicates at the same time that once contaminated with hydrocarbons, the soil can be very slowly brought to the previous state, and only under the condition that no new contamination occurred.

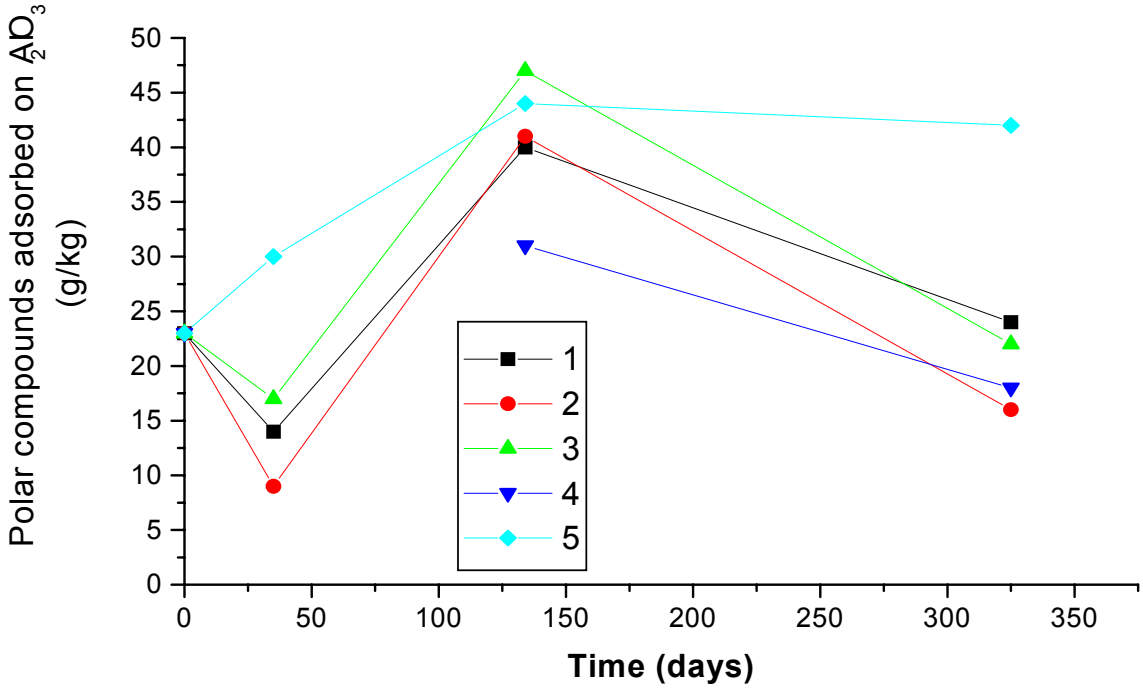


Fig. 2. *Changes in polar compounds concentration during experiment*

Acknowledgement: This work was supported by the Ministry of Science, Technology and Development of the Republic of Serbia (Grant No. 1937).

5. REFERENCES

1. Anon. Protection of Water Supply Source ”Ratno Ostrvo” in Novi Sad, Institute for Water ”Jaroslav Cerni”, Belgrade, 1999.
2. Anon. Standard Methods for the Examination of Drinking Water, Federal Institute of Public Health, (Skunca-Milovanovic, S., Feliks, R., Djurovic B., Eds) Belgrade, 1990.
3. Dalmacija B., Ivančev-Tumbas I., Rončević S., Petrović O. Bioremediation of polluted soil after NATO bombing in Novi Sad, Yugoslavia in Abstract Book from 12th International Biodeterioration and Biodegradation Symposium, Prague, Czech Republic, 14-18 July, 2002.
4. Roncevic S. Kinetics of bioremediation processes in soil polluted with oil and oil derivatives, Master thesis, Faculty of Sciences and Mathematics, Novi Sad, 2002.
5. Watkinson R.J. Developments in Biodegradation of Hydrocarbons. Applied Science Publishers, London, 1974.

CONDITIONS OF ARTESIAN AQUIFER TRANSFORMATION INTO SUB-ARTESIAN IN VOJVODINA PART OF PANNONIAN BASIN

D. STOJILJKOVIC

University of Novi Sad, Agricultural Faculty, Institute for Water Management,

Abstract

As a consequence of an intensive exploitation of ground waters to provide drinking and industrial water supply the artesian waters in the region of Vojvodina. Accumulated in the sand strata at a depth of 60.0-140.0 m, have been transformed into subartesian ones, with a tendency of a further slow decrease of their static level.

Keywords: *Intensive exploitation, drinking water, hydroisolines*

1. INTRODUCTION

Numerous artesian wells in the territory of Vojvodina (Northern Serbia, Yugoslavia) reduce artesian aquifers only small part of that amount is used for drinking, while greatest part disappears forever, forming marshes in depression. Drilling is carried out without any control, particularly by private contractors, producting undesired consequences. Case of artesian well in the northern side of Fruska gora mountain, where huge eruption of artesian aquifer happened, causing occurrence of landslide, which was hardly reclaimed, warns us. There are no regulations to protect so significant source of unpolluted groundwater. The resources are not inexhaustible, which is documented through decrease of piesometric pressure and self-discharge of some artesian wells in the settlements. Self-discharge prevention is possible by some technical procedures, which should be regulated. But, it is much more difficult problem of concentrated exploitation of a great number of wells supplying towns in Vojvodina and produced ecological consequences. Through the example of Becej town water supply, it is shown in this paper.

2. PRESURE LOWERING BECAUSE OF SELF-DISHARGE

Pressure measuring-piezometric levels and capacities of self-dishrag of artesian wells were made periodically, with continual three-five years period. Unfortunately, there are no continual observations for longer period. They were impossible to be made because of lack of financial resources.

Analysis of acquired data presented that, within edge parts of large Pannonian basin (including Macva, part of Srem and SE Banat, near to Yugoslav - Romanian border), static reserves are restorable. Dynamic reserves are reflected by increase or decrease of pressure and self-discharge capacity in dependence of time, closeness of recharge zone and precipitation regime.

Artesian aquifers are not endangered by artesian wells self-dishrag. However, it doesn't mean that they should not be protected against useless consumption by uncontrolled outflow (Stojsic 1988).

In the major part of large Vojvodina plain, resources of artesian aquifers are almost unrestorable. During exploitation, static reserves are consumed, which is noticeable at each well in the area. In dependence of locality, distribution of artesian wells or closeness of the source where the same aquifers are exploited, trend of pressure lowering and self-discharge capacity is different, but with constant decrease.

In order to illustrate the decrease, on well in endangered zones in the territory of Vojvodina (Table 1) in presented.

Table 1. *Changes of piezometric pressure at artesian wells*

Location	Year	Capacity Q (l/s)	Piezometric WTL (m)
Vlajkovac (1)	1985	-	+ 0,70
	1986	0,423	+ 0,60
	1987	0,348	+ 0,40
	1988	0,276	+ 0,38
Novi Sad (2)	1986	0,875	+ 0,69
	1987	0,820	+ 0,63
	1988	0,770	+ 0,51

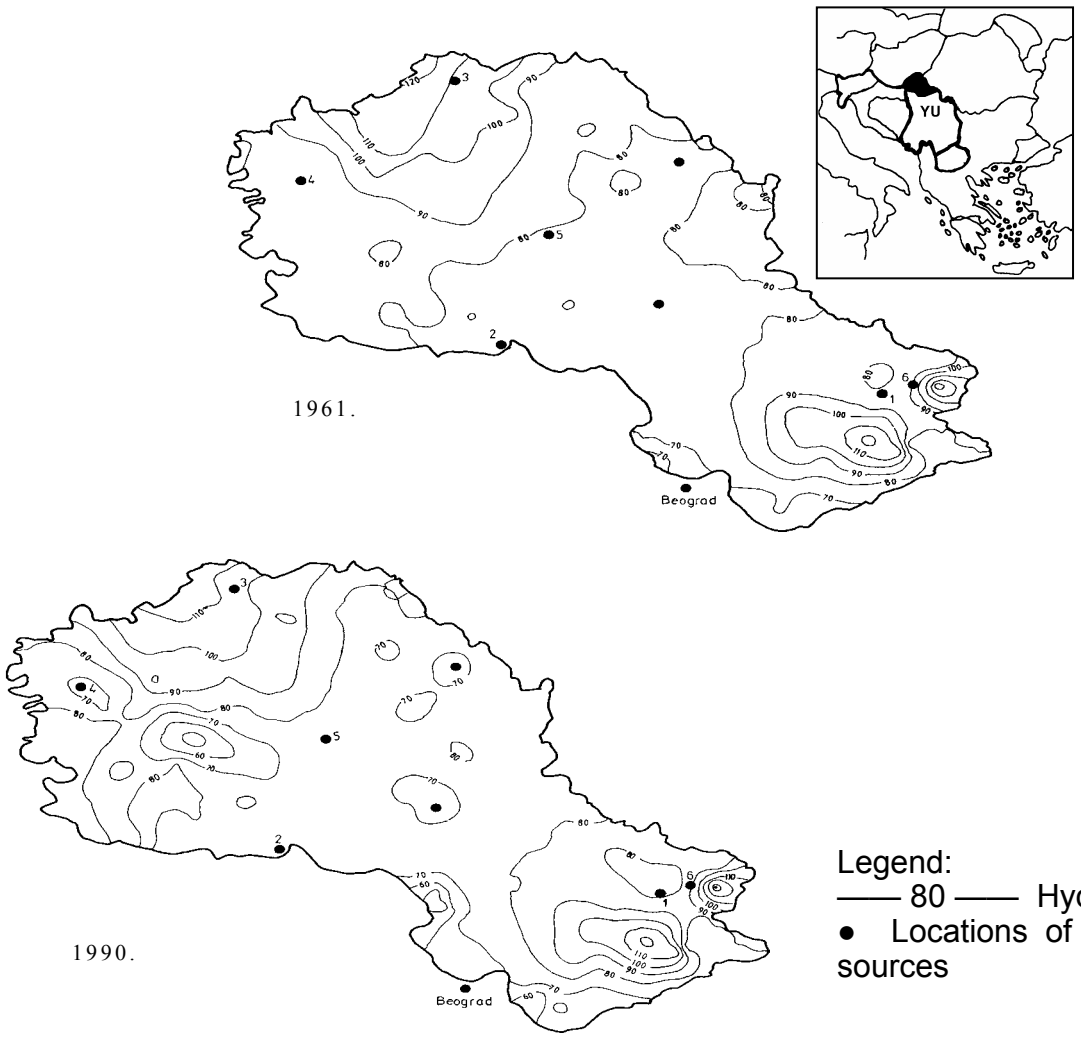


Fig. 1. *Schematized maps of hydroisolines of artesian aquifer in 1961. and 1990.*

Artesian wells working in zones with settlements far from centralized sources where the same catched aquifers are exploitated.

Lowering of pressure and outflow capacity of some artesian wells in the settlements far from the edge of Panonian basin is noticeable. With time, trend of lowering increases, by transforming artesian pressure into subartesian and tendency of further decrease. There are several examples that several wells have become dry by stopping of self-discharge, although it was caused particularly because of intensive exploitation of present sources in these towns, because of uncontrolled long-term self-discharge.

Protection measures of artesian aquifers

Uncontrolled useless discharge of artesian aquifers over wells self-discharge should be stopped. Problem is not easy to be solved, because it is impossible to close easily and to regulative the self-discharge.

It is known that during pressure measuring by the manometer and self-discharge closing, capacity decrease, even outflow stopping, occurred. By closing, contra-pressures balance at contact of screen envelope and catched sand layers was disturbed. The envelope is caving, filling with fine grains, causing self-discharge capacity decrease. In Banovo Polje village (Macva), after measuring with manometer and self-discharge closing, outflow was permanently reduced from 0.6 to 0.15 l/s.

Self-discharge can be similarly controlled if piezometric levels-pressures are 3-4 m. that height is possible for mounting pipes ∅128 mm over the well, fixing by concrete. One meter over the terrain surface, drainpipe with valve is put, so-by closing opening, level in the pipe ∅128 mm oscillates freely.

For higher pressure, a technical solution should be found. Regarding a number of artesian wells in the territory of Vojvodina, by measures of self-discharge control, part of static reserves. Will be protected (Stojiljkovic 1997).

3. CONSEQUENCES OF INTENSIVE EXPLOITATION OF ARTESIAN AQIFERS

By urbanization of towns in Vojvodina and development of industry, needs for water increased from year to years. Present sources for water supply were enlarged by drilling new wells or forming new ones. But, it was not taken care of potential of catched aquifers. Consequences of irrational water consumption and more intensive exploitation had influence onto:

pressure lowering (piezometric level),

water quality changes,

changes within aquifers,

which was noticed during the last decade at the territory of Vojvodina (Fig. 1, Table 2).

Table 2. *Level changes of artesian aquifer caused by exploitation at greater sources*

Location Depth wells (m)	Year	Pumping rate in the course of year Q (m^3/s)	Piezometric level STL (m)
Subotica (3) 130.00	1958	0.010	- 1.04
	1962	0.015	- 2.20
	1967	0.068	- 2.90
	1968	0.110	- 4.30
	1972	0.140	- 8.60
	1975	0.186	- 1.53
	1977	0.186	- 15.40
	1980	0.235	- 19.50
	1995	0.438	- 30.00
Sombor (4) 160.00	1957	0.005	- 1.16
	1963	0.010	- 2.50
	1965	0.015	- 3.43
	1968	0.020	- 6.15
	1975	0.030	- 8.30
	1977	0.040	- 12.00
	1980	0.040	- 14.03
	1995	0.240	- 38.00
Becej (5) 80.00	1955	0.007	- 1.05
	1963	0.010	- 0.80
	1965	0.010	- 1.50
	1968	0.015	- 3.07
	1970	0.020	- 4.20
	1975	0.025	- 6.50
	1980	0.030	- 7.80
	1995	0.145	-15.05
Vrsac (6) 65,00	1961	-	+ 2.85
	1993	0.021	- 3.90
	1997	0.021	- 5.10
	1998	0.021	- 8.00

However, thanks to hydrogeological conditions, Becej is famous after the solution of water supply of industry and irrigation systems separated from water supply of settlements and part of food industry.

Area of the town and vicinity is made of Quaternary and Neogene sediments.

Quaternary sediments, 30-40 m thick are presented by loam, sand dust, clay and sand. Fine-grain to medium-grain sand thick 5.0-14.0 m occur at the terrain surface along left coast of the Tisa river, and, at the right one, under Varoska Terase to 30 m depth.

In sands, accumulated groundwater is with double hydraulic mechanism - unconfined and subartesian. Content of ammonia and iron is higher than permitted (according to regulation for drinking water), but they can be eliminated by aeration and activeted charcoal. By groundwater catchig in Quetarenary sands for irrigation systems and industrial water supply, intensity of exploitation at Becej plumbing source. Neogene sediments to 140 m depth are made of clay with sand intervals:

58.0 - 64.0 m
69.0 - 74.0 m
94.0 - 103.0 m
112.0 - 136.0 m.

Fine-grained to coarse-grained sand change grain-size characteristics in horizontal and vertical direction. From place to place, there is more or less clay content. Loosing characteristics of aquifer.

Calculated filtration coefficient are 3.1×10^{-5} - 2.7×10^{-4} m/s. from fifties, aquifers were catched by all drilled wells in depth range 50.0 - 140.0 m. long-term, particularly perforated exploitation of the aquifer caused undesirable consequences.

Consequence of pressure drop is end of self-discharge of artesian wells in becej, used as public drinking fountains.

During the end of sixties, old source was formed in the town, by drilling several wells. From 1975, in the town and in vicinity, 30 exploitation wells are existent.

Small number of exploitation artesian wells drilled before sixties for supply of industry, at first, became “dry”, transforming artesian aquifer into the subartesian, and titen, caused level drop: 1,5 m underthe terrain surface. Between 1960 and 1975, byexploitation of 30 wells, statistic level droppes: from 3.20 to 4.50 m.

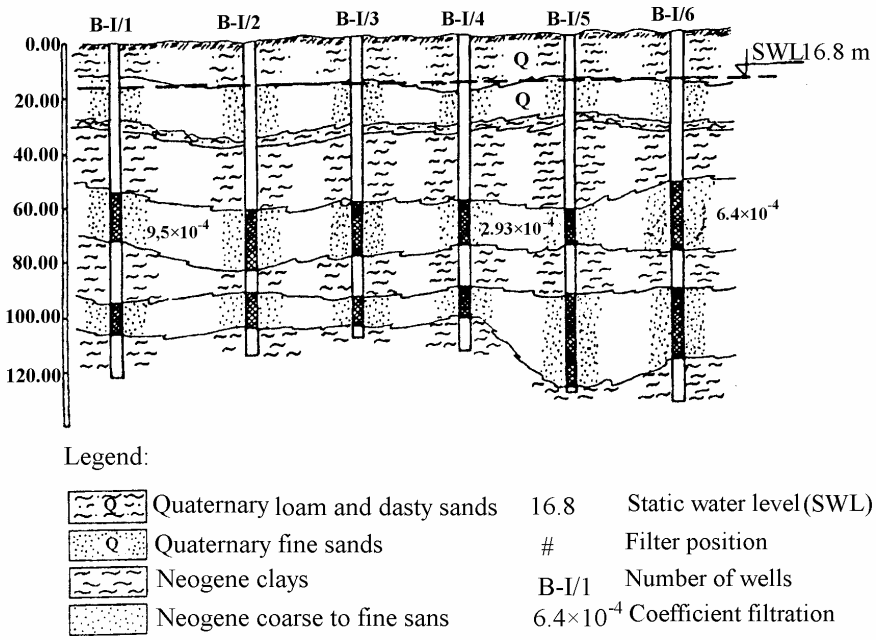


Figure 2. *Hydrogeological profile along of the trace of exploitation wells (water - supply source of Becej)*

Old source in the town was not sufficient for the requirements of the town and industry. From 1980, hydrogeological exploitation of the area right from Becej - Srbobran way (Fig.2), started. Just five years later, level in the exploratory boreholes was: 4.17-7.00 m.

Between 1980 and 1990, at the new source, 15 exploitation wells were made. Because of perforated exploitation, static level became to dropmore intensively, and from 1995 it was: 11.4-16.8 m.

This trend of droping worries us, because it is consequence of the well exploitation at the source with total capacity: □Q = 135 l/s.

With planned increase of capacity in 2000. to over 200 l/s, trend of dropping will be more drastic. Ecological consequences are difficult to be predicted, because they are present even now (Stojiljkovic & Pavlovic 1997).

4. CONCLUSION

Discharge of groundwater resources over the self-discharge of artesian wells should be prevented by piezometric level stabilizing over the terrain surface in ∅128 mm pipe, with mounted valve for closing. However, it is much more difficult to solve problem of pressure drop by static reserves total consuming because of intensive exploitation. At the territory of Vojvodina, it is necessary to carry out integrated groundwater resources management, control of well drilling and constructing industry with high water consumption.

Besides, some parts of industry can use water of the first aquifer formed in Quaternary sands water from water flows which could be conditioned. By this, exploitation at sources of greater towns could be rationalized and negative effects as a consequence of perforated well pumping, prevented. First of all, slowing down of global trend in piezometric pressure drop, but also water quality aggravating, degradation of catched aquifers by iron and manganese depositing, and short life of the well.

REFERENCES / BIBLIOGRAPHY

[1.] Stojiljkovic, D. & Pavlovic, P. 1997. The consequence of intensive exploitation of groundwaters in the region of Becej. *100 years of hydrogeology in Yugoslavia, Belgrade.* 275-280, Univ. of Belgrade, Yugoslavia.

[2.] Stojiljkovic, D. et all. 1997. Danger presence of methane in water supply system of Backa *Proc. 100 years of hydrogeology in Yugoslavia, Belgrade.* 353-359, Univ. of Belgrade, Yugoslavia.

[3.] Stojsic, M. & Stojiljkovic, D. 1988. Pijezometarski nivoi i hemizam podzemnih voda dubljih izdani u uslovima dugotrajne eksploatacije na teritoriji SAP Vojvodine. *Vode Vojvodine J.* 16, 95-107, Novi Sad, Yugoslavia, (in Serbian).

RESEARCES REGARDING QUALITY OF PHREATIC WATER FROM WEST OF ROMANIA

Ersilia ALEXA[1], Aurel LĂZUREANU[1], Liana CUC[1], Carmen GAL[2], Anca DRĂGUNESCU[1], Irina MATEI[1]

[1]U.S.A.M.V.B. Timişoara
[2]AQUATIM Timisoara

ABSTRACT

Agriculture has a great importance in the west of Romania. In order to obtain a lucrative production, it is necessary to use the fertilizer and the use of pesticides, which assure the best results regarding the quality level of agricultural production and lucrative results, but also being the cause of contamination and danger over the people and natural environment.

The scope of this paper is the monitoring of nitrates, nitrites, and ammonium content as well as the pesticides content in surface and underground phreatic water from private fountains in the Timis and Arad districts.

Keywords:
nitrate, nitrite, ammonium, organochlorinated pesticides, water

INTRODUCTION

Because of using the fertilizers and the pesticides in the agriculture, it has been found that the natural underground water resources are seriously polluted with chemical substances, which include nitrates, nitrites, ammonium, or pesticides. The infiltration of the residues in the agricultural terrain represents a source of contamination especially in the areas where the agriculture is intensively practiced. A large amount of nitrate is formed during the microbiological processes, which take place in the organic compounds with nitrogen and ammonium; these are coming from household fertilizer (household refuse), commercial fertilizer, purifying mud (filtration), residues from harvesting, residues from radiculaceae (root crops) and humus components.

The loss of nitrogen from washed soil with water coming from rainfalls or irrigation, is due in special by the levigation of nitrates. The levigation of nitrates represents a source of pollution, as the effect of accumulation of the nitrates in phreatic water, which could represent a possible source of drinking water [6].

Nitrites appear in the second stage of the mineralizing process of organic substances. That is why the presence of nitrites in the water is the sign of an old

polluting process. Because the nitrites are toxic, the water standards do not allow the presence of nitrites in water.

The presence of higher concentration of nitrates, nitrites, and ammonium in water is driving the situation on negative influence over the human body. Nitrates are causing irritant effects, congestive effects over the gastric mucous as well as nephro-toxicity. Reducing the nitrates by the microbial flora, the nitrites appear at the level of digestive tube. These have the capacity of oxidizing hemoglobin. The effect is reducing the oxygen fixing capacity, the decreasing of tissual perspiration and the modifying of mucous color in brown-grey. These symptoms are typically for cyanosis disease [1].

Another risk factor over the human health, which derives from water pollution, is the contamination with pesticides of underground and surface water sources.

The intoxication with pesticides using contaminated water, could be discovered rarely in acute stages, because of the low solubility of pesticides in water, but mostly by modifying the water characteristics (smell, taste, color) which coul rapidly alert people.

In water, the pesticides suffer a biodegradation process, rapidly or slowly, depending on their composition. The organochlorurated pesticides (HCH, DDT, Aldrine, Dieldrine) are slowly degraded having a higher remanence, fact that driving the situation for withdrawal the product from manufacturing [3].

The contamination of underground and surface water with nitrates, nitrites, ammonium, and pesticides, in Banat's area represents a problem of present interest.

Since 1994, the Banat's University of Agricultural Science and Veterinary Medicine together with the Federal Department for Plants Protection in Stuttgart, had been analysed the contamination with nitrites and pesticides of phreatic and drinking water, from the west part of Romania [2,4, 5].

This paper is a continuation of the studies, made in the program of romanian-german research. The scope is the monitoring of nitrates, nitrites, and ammonium content as well as the pesticides content in surface and underground phreatic water from private and public fountains in Timis and Arad districts.

MATERIALS AND METHODS

The nitrate, nitrite and ammonium content had been examinated by spectrophotometric method using Merck Test. The pesticides content (DDT, DDD, DDE, Aldrine, Dieldrine, Endrine, Heptachlor, Heptachlor epoxide) had been examinated by gas-chromatographic method.

Chromatographic conditions: ECD detector, SE-30 column, Tdetector 250^0C, T column 200^0C, mobile phase N_2, 40 ml/min.

The drawing points of samples from Timis district: Giarmata Vii, Becicherec, Birda, and Gataia.

The drawing points of samples from Arad district: Beliu, Tagadau, Berindia, Barsa, Aldesti.

The samples was preleveted in january, april and iulie 2002. The description of natural environment of the researched areas is presented in tabel 1.

The maximal admitted limits and the minimal detection limits for nitrate, nitrite and ammonium are presented in table 2.

RESULTS AND DISCUSSIONS

The results are shown in table 3.

The experimentally results indicate that in the case of surface phreatic water from Gataia place, there a higher pollution with nitrates (10 times higher than the maximum admissible limit). The source of this contamination was the storehouse of the fertilizers, which during the period of 1960 – 1989 used in an inappropriate way, being left uncovered at a distance of 60 m from a fountain nearby Gataia railway station. The nitrogen had been infiltrated in phreatic water, causing the contamination. A highest level of ammonium in phreatic water (hundreds of mg/l) indicates a sever contamination of the water in that area.

In the case of surface phreatic water from Birda and Becicherec place, there a higher pollution with nitrates but lowers comparing with the case of phreatic water from Gataia.

The experimentally results indicate a higher content of nitrates in the surface phreatic water from Giarmata Vii (fountain with depth of 5 m).

In Arad district the contain of the nitrate, ammonium and nitrite in the phreatic water, it doesn't outrun the maximum admitted level.

After an analysis of contamination causes with nitrate of surface phreatic water, in Banat's area, it was found out that the cause is the existence of porcine farms from COMTIM center. So, in Banat's area, the integration of porcine' residues for using them as manure, is still zero. Financial sources are missing for Banat's animal farms, for a modern proceeding of porcine residues, as in the Western Europe countries, in the scope of minimizing the contamination of natural environment and decreasing of commercializing of the manure. In the same time the unlimited discharge of these residues around the porcine farms generate a higher content of nitrates in the surface phreatic water, which represents the most important source of drinking water for Banat's village area.

In the place of Giarmata Vii, there is an increasing of nitrates in phreatic water because of the intensive agriculture. Another cause of higher content of nitrates in surface phreatic water on Giarmata Vii area, is the position of the territory nearby the International Airport of Timisoara. For defrosting of the flight strip in wintertime, it was used for 20 years fertilizers based on nitrogen. Because of using this method, the nitrogen was infiltrated in the phreatic water, having an important influence over the nitrate content.

The experimentally results obtained on the fountain from Giarmata Vii, having a depth of 75 m and public fountain from Gataia, show that there is an important potential of phreatic water in Romania, which could be use in the future.

Content of nitrites and ammonium from analyzed water does not indicate a contamination of that source of water, excepting fountain of Gataia. The presence of nitrites and ammonium in the water is the sign of an old polluting process.

The increasing of the nitrate level in the surface phreatic water draw from Becicherec area is represented by the farms with a numerous effective of animals. In farms don't have a station for water epuration, deject are collected in Surduc channel. This channel collects also the worn out water from the village cross the neighborhood of the analyzed fountain.

Regarding the contain of the ammonium and nitrite in the freatic water from Becicherecul Mic, it doesn't outrun the maximum admitted level.

A very important fact is that the results of the analyzed samples of water, in over 60 m depth fountains, semnalates a high quality of the potable water from freatic

water situated in depth. This shows that in Banat`s zone the filtration capacity of the covered stratification situated over the depth freatic water, is intact. The specific tips of soil in Banat`s are mud's, which filtrate the inferiors substances and in the same time favor the bearing capacity of soils. The nitrate contains of the freatic water situated in depth are about 0.1 mg/nitrate/liter.

In the same fountains situated in Becicherecul Mic, Gataia and Birda, had been examinated the contamination of phreatic water with pesticides.

The results of the studies showed that not exist a contamination of the surface phreatic water because of the low mobility of these pesticides in soil.

Tabel 1. The description of natural environment of the researched areas

Rural space	Natural environment
Timiş district	
Birda Adâncime fântână 5 m	Private fountain nearby of porcine farms from COMTIM
Gătaia Adâncime fântână 5 m	Private fountain at a distance of 60 m from Gataia railway station, which during the period of 1960 – 1989 used in an appropriate way storehouse of the fertilizers
Becicherecul Mic Adâncime fântână 6 m	Private fountain nearby farms with a numerous effective of animals
Giarmata Vii Adâncime fântână 6 m	Private fountain nearby the International Airport of Timisoara
Giarmata Vii Adâncime fântână 100 m	Private fountain nearby the International Airport of Timisoara
Arad district	
Berindia	Private fountain nearby intensive agriculture
Craiva	Private fountain nearby farms with animals
Tăgădău	Private fountain nearby intensive agriculture
Bârsa	Private fountain nearby intensive agriculture
Beliu	Private fountain nearby intensive agriculture

Table 2. The maximum admited levels (LMA) and the minimal detection limits (LMD) for nitrate, nitrite and ammonium

	NO_3 (mg/L)	**NO_2 (mg/L)**	**NH_4 (mg/L)**
LMA (mg/L)	45	0	0
LMD (mg/L)	0.1	0,02	0,01

Tabel 3. The water contamination with nitrate, nitrite and ammonium of the researched areas (medium values)

Rural space	NO_3 (mg/L)	NO_2 (mg/L)	NH_4 (mg/L)
Becicherec	225	<0,02	<0,01
Gătaia	3300	20	321
Gătaia (public fountain)	<0.1	<0,02	<0,01
Birda	410	<0,02	<0,01
Giarmata Vii (5m)	<0.1	<0,02	<0,01
Giarmata Vii (75 m)	210	<0,02	<0,01
Berindia	54.6	0.136	<0,01
Craiva	22.1	0.012	<0,01
Tagadau	19	0.5	<0,01
Barsa	44	<0,02	<0,01
Beliu	2.6	<0,02	<0,01

CONCLUSIONS AND RECOMMENDATIONS

1. Contain of nitrate in freatic surface water in rural zone is very high and made by the pigs combine works, in which is missing the dejection's removal system, in one side and at the other side by the unpropal administration of chemical fertilizers and by the practice of intensive agriculture.
2. By the analyzes of pesticides contain in water result that in west of Romania, the contain of the organochlorinated pesticides it doesn't outrun the maximum admitted level (0.1 μg pesticides/liter water), indicated by CE.
3. Researches of depth phreatic water show a high quality of it, Romania has in great resources.

There is a need of supervision and control programs, which include these aspects:

- growth of the number of quality measuring places for surface and depth phreatic water;
- practice of an agriculture with a proper rotation of cultures and an optimal choosing of the soil working type (immediately after culture, the soil must be ploughed then sowed, so the ground to be covered and the plant to restrain the nitrogen);
- sowing without lacks of the ground and introduction of alternative cultures between harvests represent a way of prevention the lost of these substances in freatic water. The roots and parts of plants, which give humus, improve the capacity of maintenance and change of ground, a protector strait, decrease the foundation of mud, improve the passing of air and water as regarding the biological activity, every strait

of plants gives upkeep for living being, speed up degradation of organic substances (pesticides), regulate nitrogen exchanges;
- Administration of fertilizers which may avoid draining of nitrogen. Administration may be executed when plant needs it;
- A proper working of the ground. On sandy land, rich in humus, a deep plunging made in autumn may speed up the nitrate mineralization, will be levigated. There, where is possible, it must be effectuated a plan working. That is possible in spring, not autumn. Organic soils must be cultivated with vegetable. These lands are situated a little in top of surface freatic water level. In these parts there exist big amounts of nitrate in freatic and drinking water;
- As regard the animal rise system, the maintenance of a proper conditions supposes introduction of a remove system for dejection on a hydraulic way. The mixture of fecal, pass water is diluted by the washing water who became used water and is collected.

REFERENCES

1. Cotrău, M., Popa, L., Stan, T., "*Toxicologie*", Ed. Did. Ped., Bucureşti, 1991
2. Cuc, L., *Contaminarea apei freatice de suprafata si adancime cu nitrati, nitriti, amoniu si pesticide in zona de vest a Romaniei,* Teza de doctorat, USAMVB Timisoara, 2002;
3. Häfner, M., *Trinkwasserqualität als Spiegelbild von Wasserwirtschaft und Pflanzenschutzmittelanwendungen in der Landwirtschaft*, Rev. Gesunde Pflanzen, 5/1996
4. Häfner, M., Lauer, K.F., Alexa, E., Cuc, L., *Untersuchungen uber Belastungen und Gefahrdungen des westrumanischen Grund und Trinkwasser durch die Landwirtschaft*, Lucrari Ştiințifice seria I, vol. II, Management Agricol, Ed. Agroprint Timişoara, 2000
5. Häfner, M., Lauer, K.F., Alexa, E., Cuc, L*., "Baden Wurttemberg Initiert Projekt fur Umweltschanende Landwirtschaftliche Produktion in Rumanien"*Pflanziche Erzeugung Landinfo, 8/2000
6. Rădulescu, Goian, "*Poluarea nitrică a alimentelor*", Ed. Mirton, Timişoara, 1999;

WATER MEANS LIFE
GLOBAL AND CENTRAL AND EAST EUROPEAN PROBLEMS IN CLEAN WATER SUPPLY

Prof. DÉSI, I. MD, PhD, DSc, Prof. NAGYMAJTÉNYI, L. MD, PhD

WORKING-GROUP OF ENVIRONMENTAL HEALTH,
SZEGED BRANCH OF THE HUNGARIAN ACADEMY OF SCIENCE
DEPARTMENT OF PUBLIC HEALTH, UNIVERSITY OF SZEGED

OFFICIAL PRESENTATION

According to UNO estimates by 2025 about 3.5 billion (miliard) men will face clean water scarcity around the world. The UNO declared 2003 the year of clean water. For us, for the Central and East European (CCE) countries the need to address the water problems is as urgent and necessary as everywhere in the world. Sanitation and wastewater treatment are pressing issues in this region. Ecosystems in CEE are at risk due to land conversions, changes in hydrological regimes, pollution by inadequately controlled agricultural discharges and the low level of wastewater collection and treatment. All these contaminate the surface waters, disintegrate the water quality.

In some CCE countries as for example in the Ukraine and Moldavia there are regions where there are shortages in safe drinking water, the microbiological contamination of drinking waters and consequently waterborne epidemics do appear. The faecal colioform numbers exceeded the national standards in the communal water suppliers by 5-12% in the Czech Republic, Hungary, Croatia, Slovakia, Lithuania. Water quality improvement and pollution control are urgent tasks.

In Hungary nowadays 99.4% of the settlements are provided with network of drinking water pipes. This numbered only 80% by 1980.

In about six hundred little settlements in Hungary the nitrate concentration in drinking water is too high because of exceedingly use of fertilizers, causing methmoglobinaemia in babies. In these places safe water is handled them in pharmacies by medical prescription.

In some of our counties, near to the Romanian border the As quantity was high in the drinking water, up to 300 microg/L. This was because geological reasons, but for the population it is quite the same. It

succeeded by now to diminish the Arsenic content to 50 microg/L. The WHO standard is 10 microg/L.

Unfortunately the sewage water conducting and cleaning in Hungary is still an unsolved problem. In about 50% of the settlements is sewage water drained off. 39% of those is properly cleaned, 28% partly by mechanical cleaning only, the others are not cleaned at all. According government plans by the year 2015 at every settlement sewage water drainage and proper cleaning would be solved.

It is a highly important task of our region to improve the water conditions, to diminish their contamination, to defend the quality of the surface and underground waters.

Another group of problems is the handling of the floods and droughts. Floods caused enormous damages in the region during the Summer of 2002, they were created in great part by human activities, because humans induced climate changing, created more severe weather; the clearing of forests and the riverside vegetation reduced the natural barriers to floodings. Because rivers of the region are flowing through many CEE countries, international solution is needed. The Hungarian prime minister, Mr. Medgyessy proposed regional collaboration for the countries of the Danube, Tisa, Oder and Elbe basin, it seems this would be effectively working. The CEE countries agreed on a package of measures to strenghten cooperation for sustainable flood management.

Human activities can also help. In the long by decreasing the air pollution that causes the climatic changes, in the short by building dykes, channels, and reservoirs to prepare for floods.

Hungary is in the worst situation among the CEE countries, as we are on the bottom of the basin of the great rivers. We re endangered by the floods of the Danube as well by that of the Tisa. 63% of the Hungarian flood barriers because of their lowness and thinness are insufficient. Unfortunately floodwalls do not solve the flood problems. After the great Danube floods in northern Hungary in 1954 and 1965 high and strong flood barriers were built there. They worked properly during the flood of 2002 but the whole flow was sustained in the levee system downstream and caused a very high flood in South Hungary in the Gemenc nature conservation area suffocating the protected animals living there. It is proposed now in the frame of the so-called Vásárhelyi plan to build together with dams cesspools and reservoirs where to conduct and maintain great quantities of floodwaters.

Ironically, great droughts are problem in the same areas where floods. Because of the evaporation from the ground and plant transpiration of the vegetation the loss of water in some parts of the Danube and Tisa basins exceed the volume of the rains.

The water management in the majority of CEE countries is too complicated, and financially not self-supporting.

Great help has been provided to the Danube basin countries through the Danube Regional Project, launched in December 2002 by the UN Development Programme. It aims to do its work by strengthening existing structures and activities throughout the Danube basin. Over the next four

years USD 1.5 million is intended to clean up the world most international watershed. The project has allocated the funds to non governmental organisations working at national and regional levels. The first round of USD 725 000 is available to 11 CEE countries: Bosnia-Herzegovina, Bulgaria, Croatia, the Czerch Republic, Hungary, Moldavia, Romania, Serbia, Slovakia, Slovenia and Ukraine. The grant will help to reduce sources of pollution, contribute to improvement of the monitoring systems, addresses trans-boundry environmental hotspots.

Hopefully the situation will improve as the CEE countries align with the European Union and its Water Framework Directive. But cooping with EU regulations will be costly, as investment needs are enormous. It is estimated that it would require between 500 and 1000 USD per capita.

An important international effort affecting CEE countries is the new EU Water Initiative a partnership between the EU, Africa and 12 countries from CEE, Caucasus and Central Asia to create a higher efficiency of water related developments.

CEE countries will have to build their capacity to handle together integrated water resources supervision, environmental water economics organisation and wastewater management.

REFERENCES

1. DÉSI I. Környezet-egészségtan (Environmental health) in Hungarian. JGYF. Kiadó Szeged 2003 pp. 287
2. THE BULLETIN, Quarterly Magazine of the Regional Environmental Center for Central and Eastern Europe 11. 2002.

AQUATIC MACROPHYTES – ROLE IN MONITORING AND REMEDIATION OF NUTRIENTS AND HEAVY METALS

Slobodanka PAJEVIĆ[1], Žarko KEVREŠAN[2], Snežana RADULOVIĆ[1], Dragan RADNOVIĆ[1], Mirjana VUČKOVIĆ[1], Milan MATAVULJ[1]

[1]Faculty of Sciences, Department of Biology and Ecology, University of Novi Sad, Novi Sad
[2]Faculty of Technology, University of Novi Sad, Novi Sad

Abstract:

Monitoring of the aquatic environment by chemical analyses of dominant aquatic macrophytes from DTD (Danube-Tisza-Danube) canal indicating possible chemical contamination of water and littoral zone were surveyed. Although significant variations of concentrations as related to plant species and surveyed site were found the highest accumulations of nutrients and heavy metals, especially Fe, Mn, Ni, Zn and Cu were obtained in submerged plant C. demersum and P. communis rizome. An extremely high P accumulation was obtained in P. communis rhizome at site 6 (1.83%) showing that the Krivaja river loads DTD canal complex with remarkable amounts of organic matter. Concentrations of Pb in plant tissues were below 10 μg ·g^{-1} and concentrations of Hg in C. demersum from the localities nearly Novi Sad were all but 40 μg · g^{-1}. The significant increase in Ni, Zn and Cu concentrations in plant tissues from Canal section nearly Vrbas were also recorded indicating a strong human impact reflecting in the presence of wastes discharged by factories and agricultural areas.

Key words:

Aquatic macrophytes, DTD canal system, nutrients, heavy metals, accumulation

1. INTRODUCTION

Aquatic macrophytes define the ecology of water ecosystems by integrating their role in the primary production (and decomposition) of organic matter, in food chains, light regime (shading), oxygen producing. They influence nutrient, heavy metal, and pollutant cycling, sediment stability, and characteristically determine the eutrophication degree [4, 13]. Monitoring the structure (species abundance, diversity) of macrophytic communities can provide indications of environmental impacts upon aquatic ecosystems [8]. Aquatic macrophytes have no mechanisms regulating the uptake of nutrients and heavy metals. Therefore, their impact upon environment is demonstrated through the process of chemical bioconcentration and excretion while increased nutrient and metal accumulation in their tissues may be the result of increased concentrations in aquatic environment [20]. Biomonitoring of aquatic

environments by plants hyperaccumulators of pollutants is based upon the relationship between concentration of pollutants in plant tissue and in environment. A precise expression of obtained results requires precise definition of factors significantly determining the absorption and accumulation of pollutants in plant tissue like their concentration in environment, temperature, pH, physico-chemical properties of pollutants, solubility, antagonism and synergism of ions taken up, and physiological and biochemical properties of plants (permeability of cell membranes and enzyme activity during absorption) [12, 18]. Rooted submersed and floating, as well as emergent macrophytes exhibit their role in bioaccumulation and filtration mostly in shallow water, namely littoral zone of rivers, canals, and lakes, and in slow streams [3]. An evident nutrient and heavy metal bioconcentration ability significantly enlarges the possibilities of utilization of aquatic plants not only for bioindication, but, also, for the purification of water, substratum, and littoral zone. Due to rapid industrial development and urbanization, with respect to the ecological problems caused by chemical contaminants, pollution reinforces studies of the possibility of utilization of macrophytic vegetation to remediate pollutants from environment, namely water detoxification [5]. Utilization of aquatic plants for a biological clean-up technique in various polluted ecosystems is highly acceptable due to their high biomass production resulting in a high uptake of macronutrients (N, P, K, S) and heavy metals. In addition, the ability of most of aquatic plants to highly tolerate a specific metal is of a great importance [14].

By determining nutrient and heavy metal concentrations in tissues of dominant aquatic macrophytes of certain sites along the DTD canal section Novi Sad – Bezdan undergoing a strong human impact, the aim of the survey was to show the ecological status, namely chemical contamination of water and its littoral zone. The obtained results should also point out the role of macrophytic vegetation in pollutant phytoremediation.

2. MATERIAL AND METHODS

Plant sampling was done by using a randomized block system at 9 sites of the DTD canal section Novi Sad – Bezdan during 2002 summer. Sampling sites were chosen according to plant abundance. For a more accurate result comparison, wherever it was possible, the same plant species from different sites were sampled. In the laboratory, plants were rinsed several times in tap water to remove the adherent periphyton and detritus. After the final rinsing in distilled water, material was dried and prepared for analyses following Standard methods for the examination of water and wastewater APHA [1]. Total N concentration in the dry matter was determined by standard microkjeldahl method [15]. After dry ashing at 450 °C and treatment with HCl, concentrations of heavy metals (Cu, Pb, and Cd) were determined by atomic absorption spectrophotometry (AAS). Concentrations of P, K, Ca, Mg, Na, Cl, Fe, Mn, Zn, Co, Sr, V, and Hg were determined in the Institute of Nuclear Research, Dubna, Russia, in dry plant material by neutron activation analysis (NAA).

Study area: The DTD canal complex includes canals connecting the Danube and the Tisza with Vojvodina canal network totaling 960 km. The Novi Sad – Bezdan section is undergoing a strong human impact due to wastewaters of food industry and fertilizer factories and also oil refinery wastewaters empting into this section. The chosen sites include Bezdan – canal empting into the Danube (1), Sombor –

surrounding municipal area (2), Prigrevica – arable land (3), Vrbas – upstream (small impact of food industry wastes) (4), Vrbas – downstream (strong impact of food industry wastewaters (5), Turija – Krivaja river mouth (6), Backi Petrovac (7), Novi Sad – lock (8), and Novi Sad - fertilizer factory and oil refinery (9).

3. RESULTS AND DISCUSSION

Unlike terrestrial species, aquatic plants absorb macro (N, P, K, Ca, Mg, S) and micronutrients (Fe, Mn, Cu, Zn, Mo, Co, B) from water through their leaves while from sediments through roots and rhizomes. Although indispensable for plant life cycle, greater amounts of nutrients, N, P, and K, in particular, provoke a high primary production, namely, eutrophication of aquatic ecosystems. Such a high primary production affects all the remaining physico-chemical water and sediment properties, oxygen content in particular. When present in higher concentrations and as free ions, metals – micronutrients may cause toxification of plants. The content of nutrients and heavy metals in sediments rely upon the rate of organic matter decomposition while an important role in detoxification of bottom and littoral zone belongs to rooted submersed, floating, and emergent species due to their roots and rhizomes taking up significant amounts of these elements in soluble form [16].

Test plants in this investigation were the species *C. demersum* and *P. communis*. Species *C. demersum* occurred in all surveyed sites except site 5 where no individual was found due to an extremely high water and bottom pollution (Tab. 1). The lowest N accumulation (1.83%) was recorded in tissue of this species at site 7 while a rather high N concentration (4.03 and 4.21%) was found at sites 6 and 9, respectively. Concentrations exceeding 3% were recorded at sites 8 and 3. Such N content distribution points out an elevated organic load of site 8 polluted with industrial wastewaters and site 6 where the Krivaja river empties significant amounts of this nutrient from surrounding arable land. The site 3 where also a higher N accumulation in *C. demersum* tissue was recorded confirms that arable land areas are remarkable pollutants of streams.

Table 1. Concentrations of nutrients in Ceratophyllum demersum tissue (%)

Locality	N	P	K	Ca	Mg	Na	Cl
1	2.791	0.062	8.05	1.03	0.589	0.642	3.18
2	2.847	0.044	6.93	0.55	0.430	0.633	2.18
3	3.182	0.618	5.36	1.48	0.603	0.745	1.97
4	2.205	0.034	5.74	0.69	0.572	0.735	2.13
6	4.033	0.445	4.90	2.49	0.768	0.712	1.63
7	1.828	0.084	5.44	1.40	0.729	0.689	2.53
8	3.098	0.053	6.88	1.17	0.603	0.843	3.06
9	4.214	0.317	6.89	1.63	0.536	0.868	1.83

N concentration in the emergent species *P. communis* was lower than in submersed species *C. demersum*, amounting up to 2.46% (emergent part at site 2) (Tab. 2). A specific distribution of this element by organs was evident, namely N content in rhizome was smaller than in emergent part, on the average. The smallest values were recorded at site 6 and 7. Lower N concentrations concurrent with elevated P content in rhizome tissue of the species *P. communis* at site 6 and 7 show an antagonism between these ions. In other words, concentration of Cl^-, K^+, SO_4^{2-}, and PO_4^{3-} significantly influences N uptake by plants [10]. Concentration ratio of N to

P has a great impact upon plant metabolism, sometimes greater than absolute concentrations [2].

Table 2. Concentrations of nutrients in Phragmites communis tissue (%)

Locality		N	P	K	Ca	Mg	Na	Cl
1	ag.	2.20	0.021	2.84	0.195	0.076	0.045	0.919
2	ag.	2.46	0.016	2.92	0.194	0.052	0.013	0.746
4	ag.	1.56	0.036	2.03	0.313	0.139	0.046	0.827
4	rhiz.	1.45	0.186	1.19	0.442	0.135	0.139	0.454
5	ag.	2.27	0.027	3.02	0.228	0.110	0.161	0.788
5	rhiz.	1.94	0.043	3.00	0.067	0.020	0.298	0.993
6	ag.	1.52	0.028	1.74	0.207	0.111	0.031	0.662
6	rhiz.	1.00	1.830	1.43	1.75	0.751	0.380	0.262
7	ag.	1.46	0.025	1.88	0.116	0.063	0.042	0.760
7	rhiz.	0.93	0.967	1.29	0.387	0.353	0.141	0.412

ag.– aboveground part
rhiz. - rhizome

Although tissue N concentration is ten times as high as P concentration, diagnostic studies of water ecosystems indicate phosphorus as a limiting nutrient for plant growth. Generally, rooted aquatics satisfy their demands for P from sediments, thus interfering biomonitoring due to nutrient concentration, water depth, light regime, and pH limiting their distribution. Despite that, P is often chosen as a critical element to control nutrient loading rate [19]. Aquatic plants play an important role in taking out excessive P from wastewaters, which cause pollution when present in greater amounts. P amounts taken out rely upon plant species and P from water and substratum while, frequently, a main P source for macrophytes is the surface mud layer [11]. For that reason P accumulation is higher in rhizome than in emergent part and by comparing P content relying upon plant species, one may conclude that submersed species *C. demersum* accumulated few times higher P in its tissue than emergent part of *P. communis*. An extremely high P accumulation was obtained with *P. communis* rhizome at site 6 (1.83%) showing that the Krivaja river loads DTD canal complex with remarkable amounts of organic matter. Also, littoral zone of site 7 showed organic pollution.

Potassium (K) also assembles the group of main macronutrients responsible for plant growth, namely primary production where higher K and N accumulation is reported [6, 7]. Recorded K concentrations at site 1 were extremely high, amounting even up to 8%. Also high K concentrations were recorded at site 8 and 9.

Calcium (Ca) enters aquatic environment primarily from the sediment, because it is mineral that dissolves easily in water. As a result of extensive use of calcium-containing chemicals in agriculture and industry, Ca can be deposited in water environment in excessive levels and influence the growth of aquatic plants and animals. Submersed aquatic macrophytes accumulate higher Ca concentrations than emergent due to the CO_2 exchange in the processes of photosynthesis and dark respiration in aquatic environment concurrent with $CaCO_3$ deposition on plant surface. This is also confirmed by our results clearly showing the hyperaccumulation ability of submersed species *C. demersum*. Recorded concentrations of Ca in *C. demersum* are significantly lower than those already reported elsewhere [17]. The highest Ca concentrations in both analyzed aquatics were recorded at site 6 – Turija (Tabs. 1 and 2).

Concentrations of Na and Cl in *C. demersum* were also few times as high as those of *P. communis* (Tabs. 1 and 2). Higher concentrations of these two elements frequently defined as useful nutrients, were recorded at Novi Sad and Vrbas sites after wastewater loading.

Plants require trace amounts of some heavy metals, as Fe, Mn, Ni, Zn, Cu, Co, Mo, V and Sr, which are essential micronutrients. Non-essential heavy metals being of particular importance when ecosystem pollution is discussed are Pb, Cd, Hg, and Cr. Excessive levels of heavy metals in environment, and consequently in plant tissues can be detrimental to the development of vegetation. However, many species developed special physiological mechanisms that allow their survival in contamined conditions. Nutrient uptake and tissue storage of nutrients as well as heavy metals are major issues that have been identified in utilization of macrophytes as clean-up techniques of polluted water ecosystems [9]. Our results showed that purification efficiency and nutrient assimilation depended on plant species. With respect to the investigated heavy metal accumulation, *C. demersum* showed significantly the highest concentration values of almost all the surveyed elements except some elements in *P. communis* rhizome. From the heavy metal concentrations which were measured, Fe showed the highest values followed by Mn, Zn, Cu, Sr, and so on. Sites that might be distinguished due to their highest heavy metal load in aquatic macrophytes are Prigrevica, Turija and Novi Sad – nearby fertilizer factory and oil refinery. Also chemical contamination of littoral zone of these sites was recorded judging by the highest concentrations of metals recorded in rhizome of *P. communis*. In addition, rather high concentrations of mercury (Hg) (11.2 and 36.8 $\mu g \cdot g^{-1}$) were found in tissues of *C. demersum* in the surroundings of Novi Sad – lock, fertilizer factory and oil refinery.

High concentrations of heavy metals recorded in plant species of the surveyed sites additionally favor the conclusion that the canal water of these sites was remarkably loaded with the analyzed pollutants, so Turija, Novi Sad and Vrbas may be distinguished as potentially highly threatened regions.

Pb was recorded in *C. demersum* and in rhizome of *P. communis* at all the surveyed sites. Although the recorded concentrations were below 10 $\mu g \cdot g^{-1}$, it may be concluded again that the canal water was loaded with the heavy metals.

Our results clearly show that biomonitoring enforcement as the analysis of chemical composition of test – species might be essential for the protection of areas experiencing a strong human impact.

3. REFERENCES

[1] APHA - Standard Methods for Examination of Water and Wastewater. In: M.H. Franson (Ed.), 19th Editrion. American Public Health Association, Washington, DC 20005, 1995.

[2] Babalonas, D., Papastergiadou, E. The water fern *Salvinia natans* (L.) All. in the Kerkini Lake (North Greece). Arch. Hydrobiol. 116 (4): 487-498, 1989.

[3] Bunn, S.E., Davies, P.M., Kellaway, D.M. and Prosser, I.P. Influence of invasive macrophytes on channel morphology and hydrology in an open tropical lowland stream, and potential control by riparian shading. Frashwater Biol. 39: 171-178, 1998.

[4] Chambers, P.A., Prepas, E.E. Nutrient dynamics in riverbeds: The impact of sewage effluent and aquatic macrophytes. Water Res. 28, (2): 453-464, 1994.

[5] DeBusk, T. A., Dierberg, F.E., Reddy, K.R. The use of macrophyte-based systems for phosphorus removal: an overview of 25 years of research and operational results in Florida. Water Science and Technology 44 (11-12): 39-46, 2001.
[6] Hwang, Y-H., Fan, C-W., Yin, M-H. Primari production and chemical composition of emergent aquatic macrophytes, Schoenoplectus mucronatus ssp. robustus and Sparganium fallax, in Lake Yuan-Yang, Taiwan. Bot. Bull. Acad. Sin. 37 (4): 265-273, 1996.
[7] Hwang, Y-H., Lou, C-F., Weng, I-S. Nutrient dynamics of two aquatic angiosperms in an alpine lake, Taiwan. Bot. Bull. Acad. Sin. 41: 275-282, 2000.
[8] Janauer, G.A. Is what has been measured of any direct relevance to the success of the macrophyte in its particular environment? Scientific and legal aspects of biological monitoring in freshwater. O. Ravera (Ed.), J.Limnol. 60 (1): 33-38, 2001.
[9] Karpiscak, M.M., Whiteaker, L.R., Artiola, J.F., Foster, K.E. Nutrient and heavy metal uptake and storage in constructed wetland systems in Arizona. Water Science and Technology 44 (11-12): 455-462, 2001.
[10] Kastori, R. Mineralna ishrana. U: Fiziologija biljaka, Feljton, Novi Sad, p.p. 137-235, 1998.
[11] Kim, S-Y., Geary, P.M. The impact of biomass harvesting on phosphorus uptake by wetland plants. Water Science and Technology 44 (11-12): 61-67, 2001.
[12] Lewis, M.A. Use of freshwater plants for phytotoxicity testing: a review. Environ. Pollution 87: 319-336, 1995.
[13] Lewis, M.A., Wang, W. Water quality and aquatic plants. In: Plants for Environmental Studies. (W. Wang, J. W. Gorsuch and J. S. Hughes, eds.). Lewis Publishers, Boca Raton, F.L. pp. 141-175, 1997.
[14] Matagi, S.V., Swai, D., Mugabe, R. A review of heavy metal removal mechanisms in wetlands. Afr. J. Trop. Hydrobiol. Fish. 8: 23-35, 1998.
[15] Nelson, D. W., Sommers, L.E. Determination of total nitrogen in plant material. Agronomy Journal, 65:109-112, 1973.
[16] Pajević, S., Vučković, M., Matavulj, M., Radulović, S., Kevrešan, Ž. Heavy metals in the aquatic macrophytes of the Danube-Tisza-Danube Canal network (Vojvodina, Serbia). Internat. Assoc. Danube Res. (IAD), Limnological Reports 34 (Proceedings of the 34th Conference, Tulcea, Romania): 219-227, 2002a.
[17] Pajević, S., Vučković, M., Stanković, Ž., Krstić, B., Kevrešan, Ž., Radulović, S. The content of some macronutrients and heavy metals in aquatic macrophytes of three ecosystems connected to the Danube in Yugoslavia. Large Rivers Vol.13, (1-2); Archiv für Hydrobiologie Suppl. 141/1-2: 73-83, 2002b.
[18] Ravera, O. Monitoring of the aquatic environment by species accumulator of pollutants: a review. Scientific and legal aspects of biological monitoring in freshwater. O. Ravera (Ed.), J. Limnol. 60 (1): 63-78, 2001.
[19] Sondergaard, M., Jensen, J. P., Jeppesen, E. Retention and internal loading of phosphorus in shallow, eutrophic lakes. The Scientific World 1: 427-442, 2001.
[20] Stanković, Ž., Pajević, S, Vučković, M., Stojanović, S. Concentrations of trace metals in dominant aquatic plants of Lake Provala (Vojvodina, Yugoslavia). Biologia Plant. 43: 583 – 585, 2000.

WATER QUALITY OF THE ZRENYANIN-BANATSKA PALANKA STRECH OF THE MAJOR CANAL OF THE DANUBE-TISZA-DANUBE CANAL SYSTEM ACCORDING TO MICROBIOLOGICAL PARAMETERS

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

Department of Biology and Ecology,
Faculty of Sciences, University of Novi Sad
Trg D. Obradovicya 2, YU-21000 Novi Sad, Serbia.
E-mail: matavuly@im.ns.ac.yu

ABSTRACT

In the frame of complex investigations of the biodiversity of Voyvodinian Danube-Tisza-Danube (DTD) canal system, the investigations of the qualitative and quantitative composition of microorganisms, have also been undertaken. Sapromicrobiological, hydrobiological and biochemical (enzymological) parameters of the water quality of the main, magistral canal of the Danube-Tisza-Danube canal net at the Zrenyanin–Banatska Palanka strech have been investigated. The seasonal fluctuations of the number of bacterioplankton, amount of chlorophyll "a", and water phosphatase activity, have been studied at the 5 sampling sites: Botosh, Banatska Dubica, Yermenovci, Vlaykovac and Banatska Palanka.

The obtained results point to the satisfactory good water quality, as well as good selfpurification ability. Compared with the results obtained in period of time before 1984, when the Canal waters belonged mainly to III and on some sampling sites to IV class of water quality according to Kohl classification (7), in the 2000 year, canal waters belonged mainly to the II-III class. Results of biochemical analyses of rate of heterotrophic activity, confirmed the results obtained by sapromycrobiological and hydrobiological analyses of water quality.

According to the results obtained, we point to the necessity of undertaking of strict measures of protection of canal ecosystem. The anticipated intensification of industrial production and transportation in the main canal region could endanger the ecological balance and wise, sustainable use of canal ecosystem becomes permanent task of our society.

1. INTRODUCTION

The main net of the irrigation and transportation Danube-Tisza-Danube (DTD) canal system in the northern Serbian Voyvodina province 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 being under 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 in the Canal riparian zone 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 (Tisa, Theiss) and other smaller watercourses (Begey, Tamish, Brzava, Moravica, Karash, etc.) coming from the neighbouring Romania.

Considering the fact that a 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 (3, 11, 13), especially at the certain sections. 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 fourteen years ago a condition of canal waters of the Zrenyanin-Banatska Palanka section was very bad with a very low quality of water, the aim of our investigations was to determine a recent quality of water of the same object in order to compare the condition before and after all measures undertaken for the protection and conservation of natural surface watercourses of DTD system.

2. MATERIAL AND METHODS

During the course of four seasons (seasons order given at the figures: winter, spring, summer, autumn) of the 2000, water sampling was done at the sites: Botosh (Botoš), downstream of the lock of canal; Banatska Dubica, downstream of the river Brzava mouth; Yermenovci (Jermenovci), at the Yermenovci–Yanoshik bridge; Vlaykovac (Vlajkovac) - railway bridge, and Banatska Palanka, upstream of the point where the canal empties into the river Danube.

The samples for microbiological analyses were taken from the middle of the watercourse from the 1 m depth. Viable organotrophic (heterotrophic) bacteria count was determined on nutrient (Torlak, Belgrade) agar. The facultative oligotrophic bacteria count as well as the number of physiological groups of bacteria (proteolytic, lipolytic, saccharolytic) was determined as described in Petrovicy *et a.l*'s manual (13).

Water phosphatase activity was determined in original, untreated water sample on p-Nitrophenylphosphate as a substrate according to modified method of Flint and Hopton (5), as described earlier (2, 8, 9).

The water quality estimation was carried out according to Kohl's classification (6), based on the number of heterotrophic bacteria, and also according to the water phosphatase activity level (8).

Chlorophyll *a* concentration was determined according to standard method (9) and used for the water trophic level according to Felföldy (3).

3. RESULTS AND DISCUSSION

Results of microbiological analysis of water of Zrenyanin–Banatska Palanka strech of DTD canal system in the course of 2000 point to characteristic variations of

qualitative and quantitative composition of microbial population between different sampling sites, as well as depending on season at the same locality.

According to the quantitative composition of heterotrophic bacterioplankton shown (Fig. 1) in the course of 2000, canal water had relatively even quality belonging to slightly polluted waters - II class according to Kohl (7), with a few exceptions. One of them was Vlaykovac locality where water quality in the spring season belonged to the category of polluted - III class according to Kohl (7), and another was Banatska Palanka locality with water quality belonging to the slightly polluted (II-III class) category of waters.

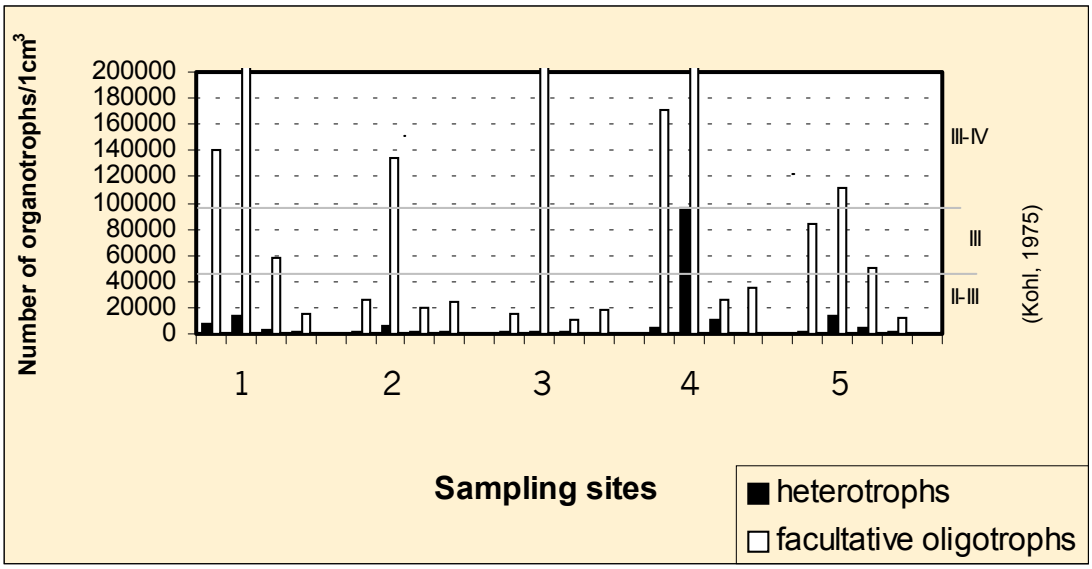


Figure 1. DTD Canal water quality estimation according to organotrophic bacteria number (Sampling sites: 1 – Botosh, 2 – Banatska Dubica, 3 – Yermenovci, 4 – Vlaykovac, 5 – Banatska Palanka)

The abundance of facultative oligotrophic microflora was in all cases greater than the number of heterotrophic bacteria, revealing the dominance of autochthonous microflora. The ratio between facultative oligotrophic and heterotrophic bacteria number ranged between 2.5 and 177.5. This fact was a good indication of an outstanding regenerative power of these watercourses, what was revealed by positive changes considering water quality, when compared with the water condition 1984 [6].

Considering the abundance of bacteria belonging to different physiological groups (Tab. 1), relatively low number during 2000 and at all investigated localities was recorded, consequently the investigated canal water was slightly and relatively evenly loaded by organic matter differing in chemical composition. Only slightly higher count of lipolytic bacteria was noted, pointing to the slight prevalence of pollutants of fatty nature. Follow number of naphta-degrading and phenol-degrading bacteria indicating increased pollution by this kind of pollutants, especially at the lowest section of canal, just before empting water into the river Danube. The relatively low number of mold particles point to the low amount of organic pollutants in investigated waters (Tab. 1).

At almost all localities the coliform bacteria count was considerably higher during the spring and summer than during autumn and winter seasons. In term of sanitary status, waters of the DTD canal in the course of 2000 were found to be slightly to moderately polluted according to the classification after Kavka (5).

According to the values of chlorophyll "a" content, the level of nutrients content (trophic level) of canal water et the Banatska Dubica and Yermenovci sampling sites, belonged to oligo-mezotrophic waters; at the Botosh locality water belonged to the mezotrophic category, and at the Banatska Palanka and the Vlaykovac sampling sites water belonged to mezo-eutrophic category (14).

In the same time, since they do not indicate the current state of water, but reflect a certain previous state considering level of organic pollution, saprobiological and microbiological analyses should be supplemented and completed by biochemical, enzymological analyses that indicate contemporary eco-physiological status of investigated water environment (9, 11).

Table 1. Seasonal distribution of physiological groups of microorganisms at different localities (CFU/cm^3)

Sampling sites	Season	*Physiological groups of microorganisms*						
		1	2	3	4	5	6	7
Botosh	Winter	30	3470	1800	1450	7500	2010	130
	Spring	2220	470	24300	7080	6320	970	36
	Summ.	600	2800	2200	7300	4500	20	40
	Autum.	300	80	640	900	340	10	170
	Mean	**788**	**1705**	**7235**	**4182**	**4665**	**753**	**94**
Banatska Dubica	Winter	1110	490	450	150	370	170	190
	Spring	300	580	12150	4450	3200	370	28
	Summ.	100	1200	800	1800	1150	600	40
	Autum.	230	70	330	830	200	30	210
	Mean	**435**	**585**	**3433**	**1808**	**1230**	**293**	**117**
Yermenovci	Winter	1330	430	1000	860	330	80	40
	Spring	530	430	5270	3600	3320	180	35
	Summ.	100	400	600	2700	1800	100	50
	Autum.	50	60	330	310	250	50	140
	Mean	**503**	**330**	**1800**	**1868**	**1425**	**103**	**66**
Vlaykovac	Winter	3450	8500	6370	1920	4370	1080	220
	Spring	6330	1520	60670	11450	13730	2480	80
	Summ.	1000	1600	3500	9800	11900	150	3
	Autum.	230	120	970	640	500	70	190
	Mean	**2753**	**2935**	**17878**	**5953**	**7625**	**945**	**123**
Banatska Palanka	Winter	610	390	1270	940	550	400	30
	Spring	2000	6000	24700	11480	3550	1610	42
	Summ.	1500	700	800	7500	5000	10	70
	Autum.	400	30	110	440	60	40	50
	Mean	**1128**	**1780**	**6720**	**5090**	**2290**	**515**	**48**

Legend: 1 - proteolytic bacteria; 2 - saccharolytic bacteria; 3 – lipolytic bacteria; 4 – naphta-oxidizing bacteria; 5 – phenol-degrading bacteria; 6 – total coliforms; 7 – molds

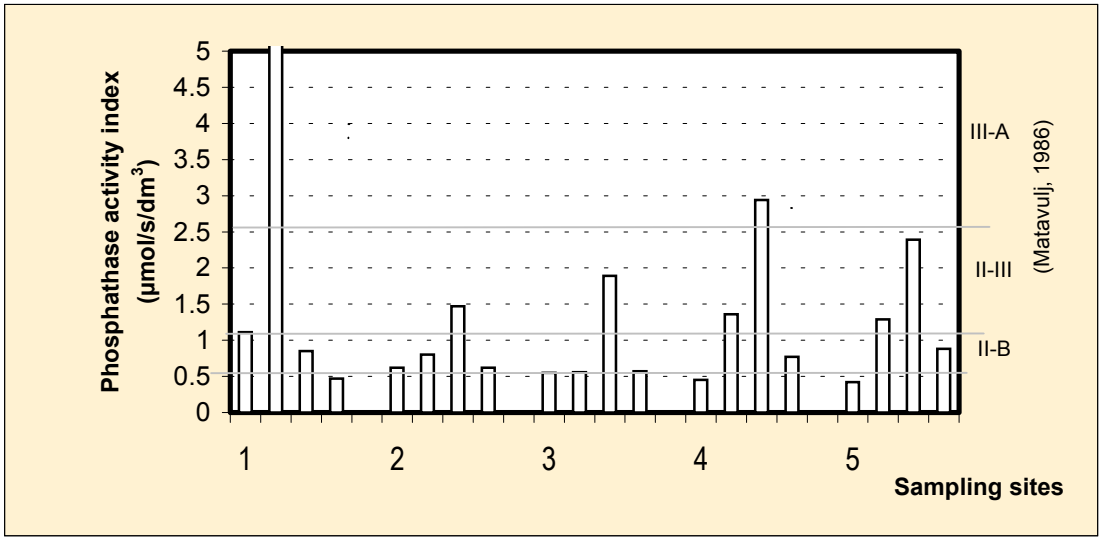


Figure 2. DTD Canal water quality estimation based on phosphatase activity index

The level of enzyme phosphatase activity of water testifies to slightly to moderately polluted waters during the period of investigations (Fig. 2). According to the phosphatase activity index (PAI) the canal waters belonged mainly to II-B class, e.g. to slightly polluted water category according to Matavuly (8), or to the II-III class or moderately polluted category. Only samples taken at Botosh in the spring and at the Vlaykovac during the summer season belonged to the III-A class, or to the category of polluted waters.

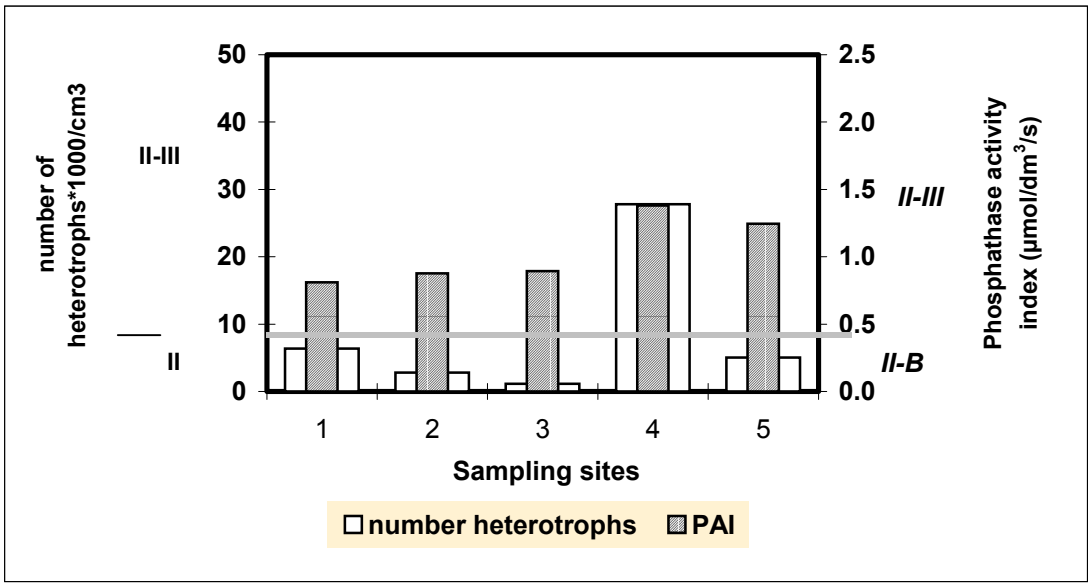


Figure 3. DTD Canal water quality estimation based on mean values of number of heterotrophs and phosphatase activity index (Sampling sites: 1 – Botosh, 2 – Banatska Dubica, 3 – Yermenovci, 4 – Vlaykovac, 5 – Banatska Palanka)

It should be also emphasized the high level of positive correlation between the enzyme activity of water and other microbiological indicators of water organic load. Mean values of heterotrophic bacteria count and phosphatase activity index for the whole 2000 point to the slightly to moderately polluted canal water of the majority of samplings (Fig. 3).

4. CONCLUSIONS

Comparing the quality of water of the canal DTD in 1984 with the condition sixteen years later, significant improvement of water quality due to measures of protection and conservation undertaken and also due to reduced water transportation and industrial production has been recorded at the Zrenyanin – Banatska Palanka strech of Main canal of DTD canal net.

Since chemical analyses do not explain the ecological status of water organisms, and since saprobiological and microbiological parameters indicate certain previous condition of water organic pollution, the biochemical, enzymological parameters, indicating contemporary water condition should be employed as parameters of water condition appraisal.

5. REFERENCES

1. APHA - AWWA – WEF (1995): Standard methods for the examination of water end wastewater. 19th edition. Washington.
2. Flint, K.P. and Hopton, J.W. (1977) Substrate specificity and ion inhibition of bacterial and particle associated alkaline phosphatase of waters and sewage sludges. Eur. J. Appl. Microbiol., 4: 195-204.
3. Felföldy, L. (1980): A biológiai vizminösités. 3. Javitott és bövittet kiadás. Vizugyi Hidrobiologia, 9. Budapest.
4. Gayin, S., Matavuly, M., Petrovicy, O., Radnovicy, D. (1998): Water quality of the Vrbas-Zrenyanin section of the Major canal of the Danube-Theiss-Danube canal system according to microbiological parameters. Proc. 3rd International Symposium Interdisciplinary Regional Research, Novi Sad, 24-25 sept. 1998, pp: 807-811.
5. Kavka, G.G. (1994) : Erfassung und Bewertung der bakteriologischen Beschaffenheit der Donau im Jahre 1993. Vergleich der Grenzprofile Deutschland - Österreich und Österreich - Slowakei. 30 Arbeitstagung der IAD der SIL, Wissenschaftliche Kurzreferate: 296.1-296.7.
6. Kohl, W. (1975): Über die Bedeutung Bakteriologischer Untersuchungen für die Beurteilung von Fleissgewässern, Dargestellt am Beispiel der Österreich Donau. Arch. Hydrobiol., 44: 392-461.
7. Matavuly, M., Gayin, S., Gantar, M., Petrovicy, O., Erbezhnik, M., Bokorov, M., Stoyilkovicy, S. (1984): Phosphatase activity as an additional parameter of water condition estimate in some lakes of Voyvodina province. (In Serbian, English Abstract) Mikrobiologija (Beograd): 21: 53-61.
8. Matavuly, M. (1986): The unspecific phosphomonoester-hydrolases of microorganisms and their role in phosphorus cycle in aquatic environments. Ph.D. Thesis, Faculty of Natural Sciences, University of Zagreb (in Serbian, English summary).
9. Matavuly, M., Bokorov, M., Gayin, S., Gantar, M., Stoyilkovicy, S., Flint, K.P. (1990): Phosphatase activity of water as a monitoring parameter. Wat. Sci. Tech., 22, 5: 63-68.
10. Matavuly, M., Gajyn, S., Petrovicy, O., Svirchev, Z., Radnovicy, D., Bokorov, M., Tamash, I. (1996): Water Quality of the Danube-Theiss-Danube channel at the Bezdan - Vrbas section according to microbiological and enzymological parameters. IAD Limnological reports*, 3:* 29-34.

11. Matavuly, M., Gayin, S., Petrovicy, O., Radnovicy, D., Tamash, I., Zeremski, Y., Bokorov, M. (1998): Water phosphatase activity as a reliable indicator of organic biodegradable nontoxic load of the aquatic ecosystyems of Banat region. Proc. 3rd International Symposium Interdisciplinary Regional Research, Novi Sad, 24-25 sept. 1998, pp: 785-792.
12. Matavuly, M., Chukicy, Z., Gayin, S., Petrovicy, O., Radnovicy, D. (1999): Ecological investigations of the Danube-Tisza-Danube canal net of Voyvodina with the aim of wise use and sustainable development of water resources. Proc. Int. Conf. on EU Water Management Framework Directive and Danubian Countries, Bratislava, 21-23 june 1999, p.287-288.
13. Petrovicy, O., Gajyn, S., Matavuly, M., Radnovicy, D., Svirchev, Z. (1998): Microbiological investigations of the surface freshwater quality, Manual. Institute of Biology, University of Novi Sad, Novi Sad (In Serbian).

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, Tab. 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.

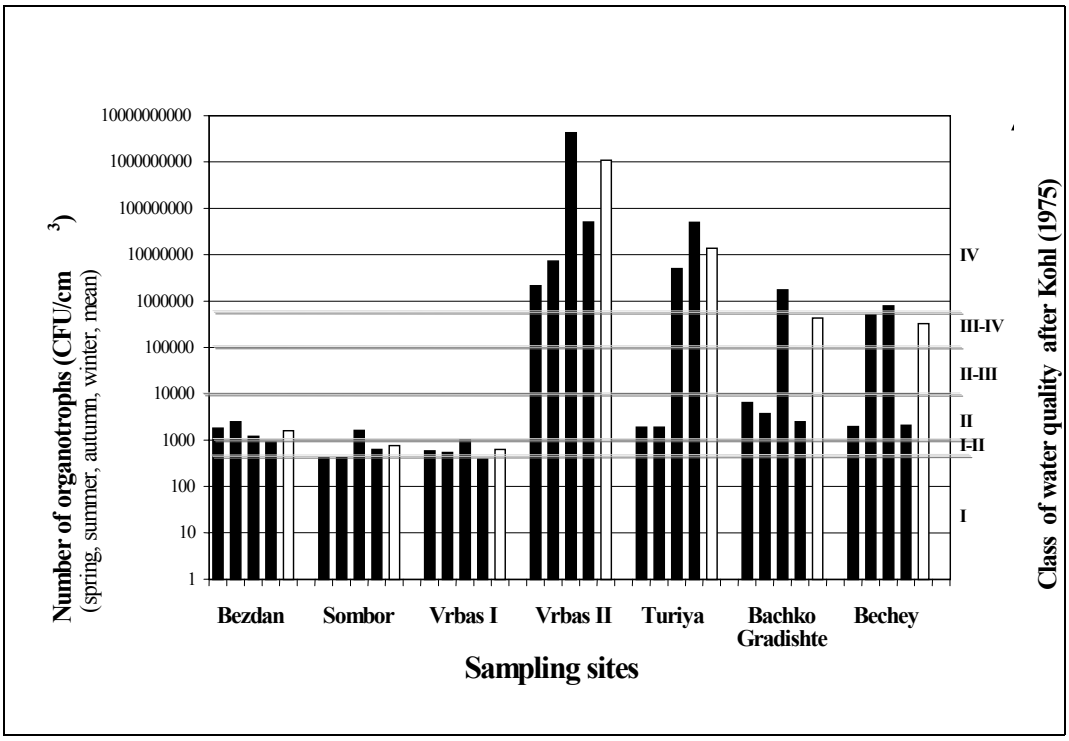


Fig. 1 Number of heterotrophic bacteria and water quality after Kohl (1975)

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).

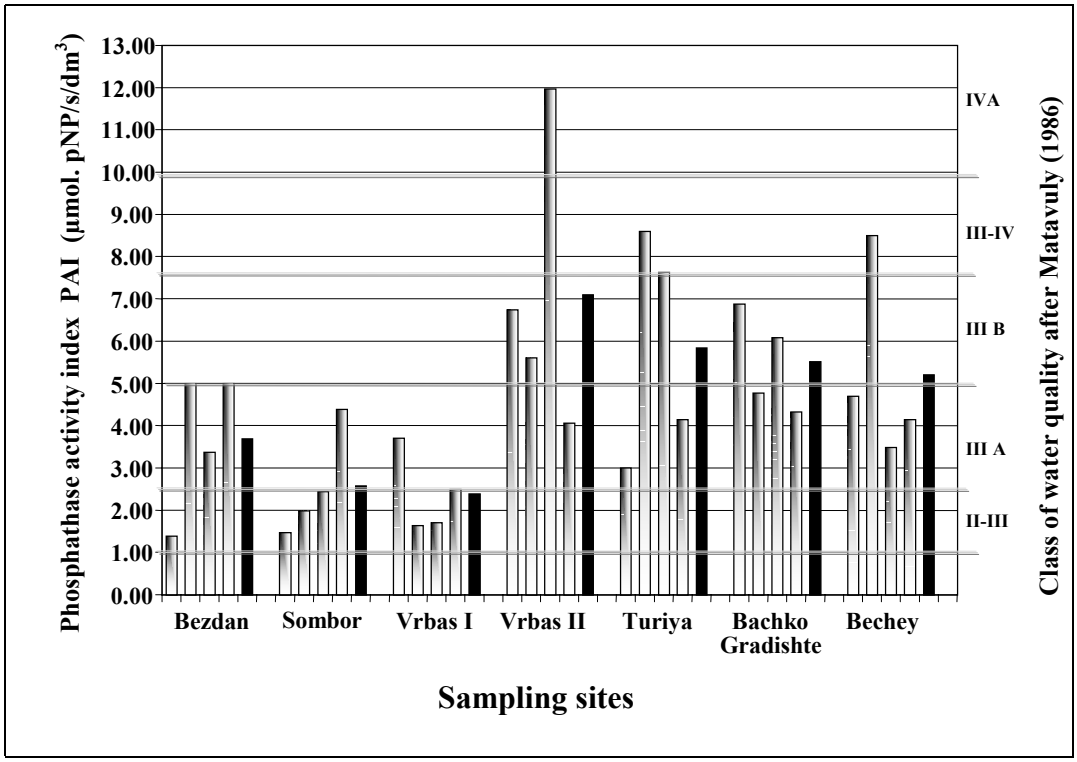


Fig. 2 Water enzyme phosphatase activity and water quality after Matavuly, 1986)

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).

Tab. 1 Water quality of Great Canal according to some microbiological and hydrobiological parameters

Sampling site	Season	Heterotrophs (H) CFU/cm^3	Class (Kohl, 1975)	Facultative oligotrophs (FO) CFU/cm^3	FO/H Ratio	Water selfpurif. potential	PAI (μmol/ s/dm^3)	Class (Matavuly 1986) (PAI)	Chlorophyll "a" (mg/m^3)	Level of trophism (Chlorophyll)
Bezdan	spring	1,800	II	34,100	18.9	good	1.38	II-III	3.74	oligo-meso-trophic
	summer	2,450	II	38,530	15.7	good	8.59	III-IV	60.08	eu-trophic
	autumn	1,200	II	7,200	6.0	satisfactory	3.37	III-A	16.25	meso-trophic
	winter	910	I-II	9,750	10.7	good	5.01	III-A	20.60	meso-eu-trophic
Sombor	spring	410	I	1,890	4.6	satisfactory	1.47	II-III	5.67	oligo-meso-trophic
	summer	420	I	9,550	22.7	good	1.99	II-III	9.35	oligo-meso-trophic
	autumn	1,600	II	4,870	3.0	satisfactory	2.44	II-III	11.74	meso-trophic
	winter	630	I-II	7,110	11.3	good	4.38	III-A	16.77	meso-trophic
Vrbas I	spring	580	I-II	69,250	119.4	very good	3.70	III-A	24.14	meso-eu-trophic
	summer	540	I-II	8,810	16.3	good	1.64	II-III	6.41	oligo-meso-trophic
	autumn	1,000	I-II	3,800	3.8	satisfactory	1.70	II-III	1.98	oligo-trophic
	winter	390	I	23,610	60.5	very good	2.49	II-III	4.45	oligo-meso-trophic
Vrbas II	spring	215x10^5	IV	23x10^5	1.0	poor	6.74	III-B	48.06	meso-eu-trophic
	summer	73x10^5	IV	309x10^5	4.2	satisfactory	5.60	III-B	5.34	oligo-meso-trophic
	autumn	42,700x10^5	IV	7,200x10^5	0.2	poor	11.97	IV-A	5.04	oligo-meso-trophic
	winter	505x10^5	IV	485x10^5	1.0	poor	4.06	III-A	3.45	oligo-meso-trophic
Turi-ya	spring	1,870	II	147,010	78.6	very good	3.00	III-A	22.43	meso-eu-trophic
	summer	1,870	II	29,790	15.9	good	8.59	III-IV	108.71	eu-poli-trophic
	autumn	5,022,500	IV	243,0000	0.5	poor	7.63	III-IV	19.58	meso-trophic
	winter	>50x10^5	IV	>50x10^5	1.0	poor	4.14	III-A	146	eu-poli-trophic
B.Gradishte	spring	6,500	II	16,500	2.5	satisfactory	6.88	III-B	27.59	meso-eu-trophic
	summer	3,670	II	8,490	2.3	satisfactory	4.77	III-A	10.68	meso-trophic
	autumn	1,731,700	IV	290x10^5	16.8	good	6.08	III-B	24.48	meso-eu-trophic
	winter	2,460	II	9,000	3.7	satisfactory	4.32	III-A	88.64	eu-trophic
Bechey	spring	1,950	II	166,330	85.3	very good	4.69	III-A	22.12	meso-eu-trophic
	summer	502,780	III-IV	226,670	0.5	poor	8.50	III-IV	140.17	eu-poli-trophic
	autumn	791,700	IV	5,848,300	7.4	satisfactory	3.48	III-A	4.45	oligo-meso-trophic
	winter	2,090	II	8,100	3.9	satisfactory	4.14	III-A	91.97	eu-trophic

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.

5. REFERENCES

1. APHA-AWWA-WEF (1995): Standard methods for the examination of water end wastewater. 19th edition. Washington.
2. Dalmaciya, B., Tamash, Z., Karlovicy, E., Ivanchev-Tumbas, I., Davidovicy, R., Kilibarda, P., Bugarski, R., Berkovicy, M. (1996): The importance of the data bank concerning water pollution for the planning of recipient water protection. Proc. Yug. Conf on “Water Protection ‘96”, (in Serbian), pp. 406-411.

3. Gayin, S., Matavuly, M., Petrovicy, O., Radnovicy, D. (1998): Water Quality of the Vrbas-Zrenyanin Section of the Mayor Canal of the Danube-Theiss-Danube Canal System According to Microbiological Parameters. Proc. 3rd Int. Symp. Interdisciplinary Regional Research (Hungary, Romania, Yugoslavia). pp. 233.
4. Gayin, S., Matavuly, M., Petrovicy, O., Kilibarda, P., Radnovicy, D., Simeunovicy, Y. (2002): Water and Sediment Quality of the Most Polluted Vrbas-Srbobran Section of the DTD Canal Net. According to Sapromicrobiological Parameters. Internat. IAD Limnological Reports, 34: 547-555.
5. Kohl, W. (1975): Über die Bedeutung Bakteriologischer Untersuchungen für die Beurteilung von Fleissgewässern, Dargestellt am Beispiel der Österreich Donau. Arch. Hydrobiol., 44: 392-461.
6. Matavuly, M., Gayin, S., Gantar, M., Petrovicy, O., Erbezhnik, M., Bokorov, M., Stoyilkovicy, S. (1984): Phosphatase activity as an additional parameter of water condition estimate in some lakes of Voyvodina province. Mikrobiologija (Beograd): 21: 53-61.
7. Matavuly, M. (1986): The unspecific phosphomonoester-hydrolases of microorganisms and their role in phosphorus cycle in aquatic environments. Ph.D. Thesis, Faculty of Natural Sciences, University of Zagreb (in Serbian, English summary).
8. Matavuly, M., Bokorov, M., Gayin, S., Gantar, M., Stoyilkovicy, S., Flint, K.P. (1990): Phosphatase activity of water as a monitoring parameter. Wat. Sci. Tech., 22, 5: 63-68.
9. Matavuly, M., Gayin, S., Petrovicy, O., Svirchev, Z., Radnovicy, D., Bokorov, M., Tamash, I. (1996): Water Quality of the Danube-Theiss-Danube canal at the Bezdan - Vrbas section according to microbiological and enzymological parameters. IAD Limnological Reports: 29-34.
10. Matavuly, M., Gayin, S., Petrovicy, O., Svirchev, Z., Radnovicy, D., Bokorov, M., Tamash, I. (1996): Water Quality of the Danube-Tisa-Danube channel at the Bezdan - Vrbas section according to microbiological and enzymological parameters. IAD Limnological Reports, 31: 29-34.
11. Matavuly, M., Gayin, S., Radnovicy, D., Petrovicy, O., Vuchkovicy, M., Payevicy, S., Ivanc, A., Milyanovicy, B., Teodorovicy, I., Bokorov, M., Svirchev, Z., Radulovicy, S., Borkovicy, Z., Simeunovicy, Y., Matavulj, M. (2002): Results of the hydrobiological and microbiological study of the Bachka Region canal net as a basis of wise use and sustainable development of resources. IAD Limnological Reports, 34: 565-573.
12. Petrovicy, O., Gayin, S., Matavuly, M., Radnovicy, D., Svirchev, Z. (1998a): Microbiological investigations of the surface freshwater quality, Manual. Institute of Biology, University of Novi Sad, Novi Sad (In Serbian).
13. Petrovicy, O., Matavuly, M., Radnovicy, D., Gayin, S. (2002): The organic load of the DTD canal water as a recipient of edible oil factory wastewater according to some microbiological parameters. IAD Limnological Reports, 34: 435-442.

RESEARCHES CONCERNING THE MINE WASTE DUMPS' AFFORESTATION IN THE FOREST AREA FROM BANAT

Dr.eng. FRĂȚILĂ Eugeniu – Corneliu, principal scientific researcher

Forest Research and Management Institute, Section Timisoara,
Researsh Team Caransebes

ABSTRACT

The geological and hydro technical works, in the forest areas, generally produce the mine waste dumps. The paper presents the researches concerning afforestation process on a such mine waste dump situated in Forest District Caransebes, from Caras-Severin County. The aim of the research has been the study of the remaining level of black pine (Pinus nigra) planted on different site of the dump.

The preliminary conclusions, considering the remaining percentages one year after plantation, was presented for the dump's plateau , when the small sized saplings(5 mm,22 cm) of black pine (Pinus nigra) are recommended and on the dump's cutting slopes, when a mixed composition for afforestation, with black pine and with a shrub (Tamarix ramossisima) , is necessary.

Keywords : *Mine waste dump, afforestation, black pine, Tamarix ramossisima*

1. INTRODUCTION

The degradation lands' process and how can these lands be reinserted in the productive cycle, is nowadays a general and acute problem. Especially the small residual materials, which have been accumulated in the mine waste dumps, represent an unwelcome situation because, in a way, these dumps cover the agricultural and forester productive lands and, in the other way, they are very instable and can spread out the dust and the other small particles over the neighboring lands. More dangerous in this category are the industrial ashes or mineral flotation dumps, with fine particles that can be easy spread by the wind, over a large area, covering the towns, villages, orchards, meadows etc. These industrial dumps are also very unstable and can easily move down, into the rivers valley or into the lakes when are taken away by the water, forming the sediments or dams on water streams.

These mine waste dumps are often formed in the proximity of human settlements and industrial objectives. Then, they will generate a permanent source of dust in houses, industrial halls, offices, mainly in stormy days, not to mention the bed aspect of the landscape. The danger is greater when the waste dumps are formed by the toxic materials (sulfur and it compounds, chlorides etc.) who can spread around the dump by the action of wind and erosion. Therefore, the waste dumps are the

main cause of water pollution and the destruction of the fauna, along the river way, in the areas where they reside .

For all these reasons, the problem of waste dumps consolidation and afforestation represents a social necessity.

The waste dumps, like shown above, are also situated on the big unused lands who can have a productive utility. Covering them by useful vegetation is a good solution not only for dumps consolidation and for landscapes improvement, but also for good use of empty lands.

The afforestation of the forest lands temporary covered by the mine waste dumps, not to mention the ecological and social reasons, represents an imperious necessity because these areas must turn back, by low, to their initial destination. There are many situations like this in all south-western counties of Romania. The most frequently and difficult cases are in Caras-Severin and Hunedoara Counties where, in the last decades, many of geological and hydro technical works have been executed.

A very different from one another, a general solution applicable to all of them does not exist. In most of the cases, research activities and experimentations, extended over a couple of years, are recommended in order to come up with the best technical solutions.

2. PLACE AND METHODS OF THE RESEARCHES

The researches, during almost two years, were carried out on a mine waste dump produced by the hydro technical works . These works was necessary for accumulate some secondary water sources from the basin area of Slatina river.

In the forest management project, this waste dump was described like an unproductive land that, in administrative meaning, forms the subplot N68, with 1.2 ha. (Amenajamentul UP IV Turnu Ruieni, OS Caransebes, 1996).

They can mention the following natural conditions , characteristic for this area:

- geological substratum, whit sericito -chloritoses schists ;
- hydrological net with permanent water (Slatina River):
- moderate continental climate, with Mediterranean's influences, the annual average temperature being 7°C and 800-1200 mm pluviometer annual regime .

The waste dump has a trunk of pyramida form, with two side longer than the other. It superior section, meaning the plateau, is a rectangle with 60/150m dimensions, border by the 40 - 45° proclivity slops that going down on the plateau to the river valley. The dump material is principally formed by the big stoniness fragment, over 2 cm in diameter.

Considering the dimensions, the compositions and the provenance of this waste dump, we can classify it into a follow category (Traci, 1985): the mine waste dump composed by acid and basic fragments of stone (heavy stones, boulders, gravels etc.) , deposed in hillocks and billows, 20-30m in height , with 40-45°stabile slops, located in the beech vegetation sub zone, that may included in *Hmcl* type of station .

ACH Caransebes is finished the transport and deposit of the waste material, on spring time of 2000 and has delivery the mine waste dump from the ancient owner, OSE Caransebes . At deliverance, the user has been obligated to spread a fertile soil stratum over the dump, mainly on the plateau, for a future successful afforestation

The research has started on March, 2001, and consist in :

- observation regarding the spontaneous install of vegetation on the waste dump ;
- to take the sample material over the dump, for the laboratory analyses ;
- to install some formula experiments of afforestation, using the forest an the other species, with adequate ecological characteristics.

The experiments use a single forest specie, black pine(Pi.n) - *Pinus nigra* and a shrub , red tamaris (Ct) – *Tamarix ramossisima* . These two species are indicated on the bad soil conditions because its ecological characteristics assure the permanence and a normal development on these sites (Donita, 1977).

Two samplings plots of black pine are been installed, both on the plateau and on the slopes. The plots count 300 saplings black pine each . Every of these plots contain the six groups of 50 sapling, representing six categories of stem collar diameter size, as follow : I – 3mm ; II - 4mm ; III - 5mm ; IV – 6mm ; V – 7mm ; VI - 8 mm .

The plantation has done on March 10-15 , 2002 , using the individual sapling pits, in a plantation scheme with 5000 saplings/ha. The initial dimensions of the samplings have recorded and, after a years (on spring ,2003), the percentage of the remaining saplings has evaluated by the groups of size that have mentioned up there .

3. RESULTS AND DISSCUTIONS

The results of the soil laboratory analyses , by tree deep levels, are shown into the table 1 :

Table 1

The physical and chemical characteristics of the superficial strata over the mine waste dump

Soil profile	Deep level (cm)	Humidity %	Ph	Humus %	Carbonates %	Total nitrogen %
Ao	0 -10	0.813	8.170	1.442	0,973	0.074
	11-20	1.373	8.540	0.817	10.058	0.042
	21-30	0.950	8.790	0.096	8.347	0.005

Analyzing the table's data to the surface strata from the deep, they can observe that the humus and nitrogen content present a progressive diminish but, in the same time, the level of the other analyzed elements (humidity, pH, carbonates) is growing .The soil reaction (pH) is alkaline (8.170-8.790) .

Before plantation , they could observe that the spontaneous forest vegetations , like *Populus tremula* and *Salix caprea* species , are already installed on the surface. The thinning out of these species was heterogeneous on the small sites over the dump, forming the groups, bouquets and clusters. The spreading on the plateau (30% of surface , in a groups and clusters) and on the slopes (5 %, just isolated plants or a small bouquets of them) was very different. The similar situation were also observed on the mine waste dumps from Forest District Rusca Montana (Frățilă, 1994).

The black pine saplings evolutions, separately on the plateau and on the slopes, .were analyzed .

Table 2

Black pine (*Pinus nigra*) saplings evolutions , on the plateau

Saplings characteristics (2002)				2003 inventory	
Collar diameter (mm)		Height average (cm)	Number	Number	Remaining percentage
3		16.30	50	42	84.0%
4		19.56	50	40	80.0%
5		22.43	50	44	88.0%
6		25.36	50	32	64.0%
7		28.42	50	45	90.0%
8		32.34	50	38	76.0%
Statistics	Total		300	241	
	Average	24.07		40.17	80.3%
	St.dev.	5.87		4.75	9.5%
	S%	24.4%		11.8%	11.8%

The data from the table 2 show that the remaining percent of saplings was over 80%, on the plateau. The highest remaining percent was observed at medium dimensions saplings , with collar diameter (Dc) - 7mm and height (H) over 28 cm. The over average results (88%) were also recorded at the small dimensions saplings. (Dc – 5mm and H - 22 cm) .

Table 3

Black pine (*Pinus nigra*) plantation data , on the slopes

Plantings characteristics (2002)				2003 inventory	
Collar diameter (mm)		Height average (cm)	Number	Number	Remaining percentage
3		16.34	50	14	28.0%
4		18.78	50	24	48.0%
5		22.42	50	28	56.0%
6		24.87	50	24	48.0%
7		28.21	50	16	32.0%
8		33.21	50	14	28.0%
Statistics	Total		300	120	
	Average	23.97		20.00	40.0%
	St.dev.	6.19		6.07	12.1%
	S%	25.8%		30.3%	30.3%

Using the up table's data, for the plantation were effectuated on the slopes, remaining percent average was calculated a very small (40 %). The best result was

recorded at the small dimensions of the samplings (Dc-5mm and H – 22 cm), with a 56 % remaining percent average .

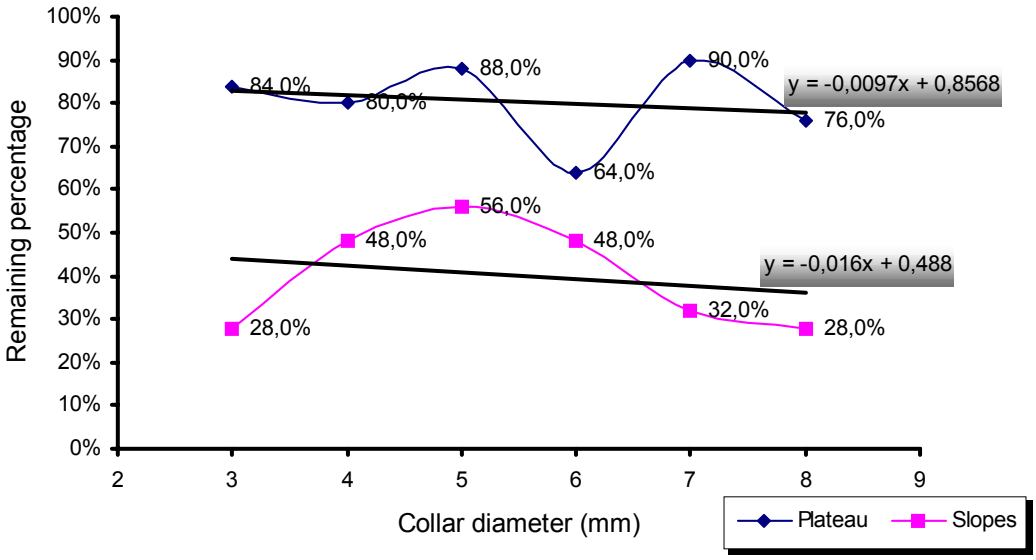


Figure 1 . Variation of remaining percentage with collar diameter , for the black pine , one year after plantation

There was, on the graphics, a comparative analyze of the remaining percentage variation, by collar saplings' diameter. They can observe that, on the plateau site, the variations of the remaining percentage are, generally, smaller (s% - 11.8 %) . The curve has a complex evolutions, reaching two peaks at the small and medium size category of the saplings (Dc – 5 mm and 7 mm). On the slope sites, the variations of the remaining percentage are generally higher (s% -30.3 %), The curve reach just a single peak, at Dc – 5 mm saplings size.

In both of these situations, seeing the tendency lines, they can appreciate that, over some certain dimensional size (Dc – 5 mm and H – 22 cm) of the saplings, the remaining percentage has a lower tendency. In conclusion, using the bigger dimensional saplings than these, is not indicated .

After the comparative data was presented up there, the black pine saplings more indicated are a small sized ones (Dc – 5 mm and H – 22 cm), both on the plateau and on the slopes.

The saplings with bigger size are also had a good remaining percentage, but only on the plateau sites . Therefore, for a complete afforestation on the plateau sites, over the mine waste dumps is sufficient to use a single forest specie with different dimensions samplings size. The situation is different on the slopes because the remaining percentage after plantation, for a main forest specie like black pine, is not enough . This specie can not assure, by itself , the covering and the stabilization of a mine waste dump's slopes. For that, the experimental plantations plots with a two species planted composition, was realized. A shrub, *Tamaris ramossisima,* were experimentally used , in 40 % mixture with black pine.

4 . CONCLUSIONS

As a result of these researches , the following preliminary conclusions can be formulated :

- the mine waste dumps, after the geological and hydro technical works , are generally formed by materials with very alkaline pH and high content of carbonates;
- for over 1cm particles sizes, the natural stabilization of the slopes is at 40 – 45 ° proclivity;
- the spontaneous forest vegetations installed on the mine waste dump was *Populus tremula* and *Salix caprea* ;
- the small sized saplings of black pine (Dc – 5 mm, H – 22 cm) have done the best results on the plateau site, with the highest remaining percentage (over 88 %) one year after plantation;
- the remaining percentage of black pine, on the slope sites (lower than 40%) is insufficient for cover and stabilize the mine waste dump. In this case, the mixed planted composition, with 40% a shrub (*Tamaris ramossisima*) and 60% black pine is recommended.

BIBLIOGRAPHY

1. Doniță, N., Purcelean, Şt., Ceianu, I., Beldie, A. – Ecologie forestieră. Ed. Ceres. Bucureşti, 1977.
2. Frățilă, E.,C. - Studiu tehnico-economic privind reintroducerea în circuitul forestier a terenurilor degradate prin activitatea S.C. FORMIN S.A. Caransebeş, din ocolul silvic Rusca Montană. Manuscris. ICAS Caransebeş. 1994
3. Traci. C. , - Împădurirea terenurilor degradate. Ed. Ceres . Bucureşti. 1985–
4. * * * - Amenajamentul UP IV Turnu Ruieni, OS Caransebeş.ICAS Bucureşti 1996 .

ACCOUNTING POSSIBILITIES OF FEROUS WASTE FROM HUNEDOARA ZONE

[1]HEPUT Teodor, [1]ARDELEAN Erika, [1]KISS Imre, [1]RATIU Sorin

[1] University "Politehnica" – Timisoara, Faculty of Engineering - Hunedoara

ABSTRACT

In the area of Hunedoara important quantities of ferrous waste resulted from fabrication processes of siderurgical products (cast iron, steel, blank of steel) are deposited in dumps and dams. This waste must be reintroduced into the economical circulation because they represent a raw material source and for reduction of pollution grade of environment at air-water-soil level.

In this paper are presented the results of researches concerning utility of powder ferrous waste used at production of unsintered bodies for blast furnace charge and of necessary materials for slag frothing at EBT furnaces.

Keywords: *air-water-soil, ferrous waste, dumps and dams, raw materials, environment, reduction of pollution grade, Hunedoara area*

1. INTRODUCTION

From a quantitative point of view steel is ranked on the first among metallic materials produced in Romania even if there has been a major reorganization of the siderurgical industry, one of it's consequence being the reduction of steel production with approx. 50%. In fact in any country with a developed industry from the mentioned point of view steel is on the first place in the entire world.

Beside the great utility properties steel is distinguished through the possibility of recycling. The recycling operations are greatly facilitated by the its magnetic properties. In the industrially developed countries (in which the ferrous materials recirculate much faster in time) the steel produced out of old iron constitutes 40 – 50% of the total quantity of steel – there are differences from one country to another, as well as, in the same country, from one company to the other.

To produce one tone of steel it is necessary to have a medium of two tones – raw materials, as well as auxiliary materials, including reducting materials. Considering the processing of large quantities of such raw materials, auxiliaries and reducting materials, there is also a considerable quantity of wastes. For example, at the TKS company's factory in Duisburg, in year 2000, the quantity of re-usable wastes was 1.1 million tones, or compared to the steel production, 110 kg per tone. This quantity refers to wastes for external delivery. Internally, much larger quantities are in discussion, and they are re-used as valuable raw materials in the appropriate equipments.

Taking into account the study above, we put into practice a series of testing which had as purpose the producing of briquettes out of pulverous, ferrous and basic materials. The materials that were used and their characteristics are presented in table 1.

Table 1. *The Chemical Composition of the Steel Dust and of the Ferrous Concentrate in the Thermal Power Station Dust [%].*

	The Chemical Composition, [%]									
Ferrous Wastes	Fe_2O_3	FeO	%Fe total	SiO_2	Al_2O_3	CaO	MgO	MnO	P_2O_5	Other oxydes
Steel Plant Dust	90,03	1,57	64,71	1,25	0,25	0,45	0,15	4,57	0,3	1,70
Thermal Power Station Dust Concentrate	51,96	13,39	46,71	11,89	8,85	7,31	3,85	1,25	0,07	1,93

Table 2. *The Grain Composition of the Steel Plant Dust and the Thermal Power Station Dust Concentrate, [%]*

Ferrous Wastes	below 0,5μm	0,5-1,0μm	1,0-1,5μm	above 1,5 μm
Steel Plant Dust	11,23%	67,48%	12,52%	8,77%
Thermal Power Station Dust Concentrate	12,02%	68,68%	13,42%	6,58%

Table 3. *The Chemical Composition of the Wastes Resulting from Preparing the Ores Through Roasting, [%]*

Materials	The Chemical Composition, %							
	SiO_2	FeO	Fe_2O_3	Fe	Al_2O_3	CaO	MgO	MnO
Waste Pond Clarifying	34,39	7,01	7,84	9,12	2,87	16,39	6,68	1.35
Concentrate	19,86	9,92	18,64	21,03	3,16	20,22	7,56	2,29
Sterile after concentration	37,60	6,30	5,58	6,45	2,87	15,16	6,58	1,41

Table 4. *The Chemical Composition of the Agglomerating and Furnace Dust, [%]*

Material	The Chemical Composition, %										
	SiO_2	FeO	Fe_2O_3	Fe	P	S	C	Al_2O_3	CaO	MgO	MnO
Ferrous Waste Agglomerating Furnaces	8,41	7,12	26,45	25,86	0,11	1,11	17,7	7,11	8,43	2,02	0,71

Table 5. *The Chemical Composition of the Iron Scale, [%]*

Material	The Chemical Composition, %										
	SiO_2	FeO	Fe_2O_3	Fe	P	S	C	Al_2O_3	CaO	MgO	MnO
Ferrous Waste Agglomerating Furnaces	8,41	7,12	26,45	25,86	0,11	1,11	17,7	7,11	8,43	2,02	0,71

These materials were processed using the recipes presented in table 6. and a mixture of lime, cement and furnace slag as binding agent.

Table 6. *The Recipe's Composition, [%]*

Materials	No. of Recipe's			
	1	2	3	4
Steel Plant Dust	30	40	40	40
Furnace Dust	15	15	10	15
Spathic Concentrate	10	5	5	5
Ferrous Concentrate on the Thermal Power Station Dust	5	5	0	0
Iron Scale	20	10	18	27
Chip	2	2	7	0
Fine Coke	2	2	3	3
Lime Dust	5	5	7	2
Dolomite Dust	2	1	2	0
Cement	6	7	7	6
Furnace Slag	2	2	1	2
Total	100	100	100	100

The fine coke addition has the role of ensuring the reduction of ferrous oxides, in fact completing this process together with the carbon from the furnace dust.

The lime, cement, furnace slag addition has the role of binding the components and hardening the briquettes. To ensure a higher resistance of the briquettes, an addition of the chip is necessary.

The hardening of the briquettes takes place in the air, after a period of ten days an adequate hardening is to be noticed, therefore a fall from a height of two meters causes no destruction.

Due to objective causes, the production and testing of the briquettes was possible only in laboratory conditions.

The research was performed at the Tamann furnace in the "Steel Laboratory" of the Faculty of Engineering in Hunedoara, in a process containing four meltings (one for each recipe). The charge of the melting pot has the following composition, presented in *table 6*.

Table 7. *Components of The Experimented Charges*

No. Criteria	*Components of Charges*	*Weight, g*
1	******* *Ferrous Waste Powder*	*300*
2	*Briquette*	*100*
3	*Fluorite*	*20*
4	*Lime*	*30*
5	*Fine Coke*	*10*
6	*Total*	*460*

******* *laboratory samples from "Siderurgica" Company – Hunedoara*

During the melting, a foaming of the slag was noticed, and this was intense than in the case of using briquettes produced with the first recipe. This fact is explainable with the use, in this case, of a larger concentration of spathic concentrate, which contains calcium carbonate and undissociated magnesium. The dissociation releases CO_2, which causes the foaming of the slag.

In all the cases, the reduction of ferrous oxides was very good, the resulting slag having a light colour, which is typical for slags with low contents of ferrous oxides.

5. CONCLUSIONS

From the data presented in the studies written on this subject, as well as from the testing, we reached the following conclusions:

- the pulverous ferrous wastes and those with basic characteristics be re-introduced into the economical circulation from siderurgy;
- the pulverous ferrous wastes can be processed either through pelletising or through briquetting;
- the composition of the recipes will be established according to the pulverous waste at disposal and to the destination of the processed materials for steeling;
- in obtaining pellets for steeling, the granulation of wastes (steel plant dust, furnaces dust, concentrates) raises no problems – than can be used as they are without undergoing a classifying process;
- with the local conditions, we consider an intensification of the recovery process for the wastes to be necessary, on one side because of their status as an iron source, a raw material in deficiency, and on the other side out of technological reasons;
- the wastes deposited in ponds and dumps can be recovered also.

6. BIBLIOGRAFY/REFERENCES

1. **HEPUŢ, T., SOCALICI, A., KISS, I.** – *"Experiments on the production and testing lubricating powders obtained out of industrial wastes on steel continuous casting"*, Vth International Symposium of Interdisciplinary Regional Research – ISIRR 2001, at Szeged Regional of the HUNGARIAN ACADEMY OF SCIENCES, SZEGED, HUNGARY, 4-6 October 2001, Technical Sciences (Energetics), pg. 193-194;

2. **HEPUŢ, T., MAKSAY, ŞT., ARDELEAN, M., KISS, I.** – *"Researches on the quality of lubricating powder used in steel continuous casting"*, Vth International Symposium of Interdisciplinary Regional Research – ISIRR 2001, at Szeged Regional of the HUNGARIAN ACADEMY OF SCIENCES, SZEGED, HUNGARY, 4-6 October 2001, Technical Sciences (Energetics), pg. 187-188

3. **HEPUŢ T., KISS I., RAŢIU S.** – *"Possibilities of turning into account the ferrous powdery wastes in siderurgy"*, Vth International Symposium of Interdisciplinary Regional Research – ISIRR 2001, at Szeged Regional of the HUNGARIAN ACADEMY OF SCIENCES, SZEGED, HUNGARY, 4-6 October 2001, Technical Sciences (Energetics), late abstracts

4. **ARDELEAN E., HEPUŢ T., MAKSAY ŞT., SOCALICI A., KISS I, RAŢIU S.** – *"Researches on the quality of lubricating powders used in steel continuous casting"*, in: "SCIENTIFIC BULLETIN" of the University "POLITEHNICA" TIMIŞOARA – series MECHANICS, 2001 Tomul 46, Fascicola 2, pg. 103…108

5. **HEPUŢ T., ARDELEAN E., SOCALICI A., KISS I, RAŢIU S., ARDELEAN M.** – *"Lubricating powders obtained out of industrial wastes on steel continuous casting"*, in: "SCIENTIFIC BULLETIN" of the University "POLITEHNICA" TIMIŞOARA – series MECHANICS, 2001 Tomul 46, Fascicola 2, pg. 109…112

6. **HEPUŢ T., KISS I., RAŢIU S., ARDELEAN M.** – *"Industrial experiments regarding the ferrous powdery wastes in siderurgy",* in: "SCIENTIFIC BULLETIN" of the University "POLITEHNICA" TIMIŞOARA – series MECHANICS, 2001, Tomul 46, Fascicola 2, pg. 113…116

7. **HEPUŢ, T., KISS, I., ARDELEAN, E., POPA, E., ARDELEAN, M.** – *"Research and experiments regarding the quality of continuous cast steel"*, at Scientific Conference Research and Development of

Mechanical Elements and Systems Jahorina – IRMES, SARAJEVO, BOSNIA & HERCEGOVINA, 2002

8. **HEPUŢ, T., IOAN, R., KISS, I., RATIU, S., PUTAN, V.** – *"Research and experiments regarding the environment's ecology, through the accounting of ferrous powdery wastes, stored in the ponds"*, at VIth International Symposium of Interdisciplinary Regional Research – ISIRR 2002, NOVI SAD, YUGOSLAVIA, 2002

9. **HEPUŢ, T., KISS, I., ARDELEAN, E., ARDELEAN, M., GĂVĂNESCU, A., MIHUŢ, G.** – *"Study regarding the environmental protection in the areas of the dolomite and lime plants"*, at VIth International Symposium of Interdisciplinary Regional Research – ISIRR 2002, NOVI SAD, YUGOSLAVIA, 2002;

10. **HEPUT, T., KISS, I., GAVANESCU, A., ARDELEAN, E., SOCALICI, A.**– *"Cercetări şi experimentări privind reintroducerea in fluxul siderurgic a unor deşeuri feroase pulverulente"*, at: The National Conference of Metallurgy and Materials Science, BUCHAREST, ROMANIA, 2002.

11. **HEPUŢ, T., ARDELEAN, E., SOCALICI, A., KISS, I.** – *"Researches And Experiments Regarding The Processing Through Pelletising Of The Pulverous Ferrous Wastes",* at The Metallurgy National Conference with International Participation – BraMat, BRASOV, ROMANIA, 2003;

ENDOHELMINTS OF *RANA*-COMPLEX AS INDICATORS OF PRESERVATION OF NATURAL PARK-BEGEČKA JAMA POND AND SPECIAL NATURAL RESERVATION KOVILJSKI RIT MARSH

Ester POPOVIĆ, Desanka KOSTIĆ,
Olivera BJELIĆ-ČABRILO

ABSTRACT

The aquatic ecosystems are an ecological gradient by judging a great number of their characteristics. In most biocoenoses, a human impact, degradation of plant and animal world, and degradation of their habitats load the aquatic ecosystems, resulting in a number of harmful changes of the structure and dynamics of their populations. A shift of biodiversity and changes of population density of the aquatic biocoenoses are reliable parameters of either a preservation degree or degradation of an ecosystem.

The essential task of our survey included a long lasting monitoring and density evaluation of zoocenoses constituted of tailless amphibians and their endoparasites from the Natural Park-Begečka jama pond and a Special Natural Reservation Koviljski rit marsh.

ACANTHOCEPHALUS RANAE (PALAEACANTHOCEPHALA: ECHINORHYNCHIDA) IN *RANA*-COMPLEX FROM PETROVARADINSKI RIT MARSH (SCG)

Olivera BJELIĆ-ČABRILO, Ester POPOVIĆ,
Desanka KOSTIĆ

ABSTRACT

Petrovaradinski Rit Marsh is protected area. Because of that, there was carried out parasitological analyses of 270 specimens of Anura belonging to three species: *Rana lessonae*, *R*. kl. *esculenta* and *R. ridibunda*. Analyses included frog lungs, stomach, intestines, rectum and bladder.

Only one species of phylum Acanthocephala was recorded-*Acanthocephalus ranae.* The results show extremely low degree of infestation-4.81%.

The highest degree and number of specimen of *A. ranae* was recorded for host *Rana ridibunda*. *Rana lessonae* is new host for certain species of parasite in our country.

THE ENVIRONMENTAL AND ECOLOGICAL QUALITY OF THE RIVER MAROS

Dr. Miklós MOHL

Municipality of SZEGED
Environmental officer

ABSTRACT

On the basis of the Duna – Körös – Maros – Tisza (DKMT) Regional Cooperation, initiated some 5 years ago, several cooperation actions have been started between Hungary and Romania. From this year on, the Municipality of Szeged is also taking part in the cooperation work.

As a first step, for an interdisciplinary research, the city is very much interested in improving the environmental and ecological quality of the River Maros. At the same time, it is assumed that this interest prevails all along the Maros valley.

The Municipality of Szeged together with the regional water and environmental authorities, The Institue of Environmental Research at the University of Szeged and the NGO CSEMETE with their relevant partners in Romania are interested to make an update of the environmental and ecological state of the River Maros. The update is to be followed by regular studies and actions in order to improve the environmental quality of the Maros ecosystem. In our presentation we are going to look at and show some recent data and evaluation studies on the state of the river and the nature along its banks.

It is hoped that on presenting the data and tendencies, new ideas and partners to further research and project appraisals can be gained.

ILL EFFECTS OF INORGANIC METAL POLLUTANTS

VEZÉR, T., PAPP, A.

Department of Public Health,
University of SZEGED, HUNGARY

ABSTRACT

The ecosystem is being charged with high amounts of health-deteriorating substances - including heavy metals - presenting a major problem in environmental and occupational medicine. Repeated exposure of humans by Hg and Mn compounds and the resulting pathological changes have been well described in the literature.

In the present experiments, male Wistar rats were treated for 10 weeks by gavage with low-doses $HgCl_2$ (0.5 and 2.0 mg/kg) and $MnCl_2 \cdot 4H_2O$ (14.84 and 59.36 mg/kg). It was tested how these doses of the two metals affected various elements of spatial learning and short- and long-term memory, spontaneous exploratory locomotion, and sensorimotor performance with psychomotor gating. Metal-specific functional neurotoxic effects in the CNS in general and in centers with special role in learning (hippocampus) were also looked for.

Both metals caused a dose-dependent significant decrease in the memory performance and in the local locomotor activity. In the sensorimotor (startle) reaction, the number of responses dose-dependently and significantly (high dose vs. control) decreased. In the Hg^{2+}-treated animals, spontaneous cortical activity was shifted to higher frequencies. The effect on the evoked cortical activity was below significance.

The Hg and Mn doses applied altered in the higher nervous functions of the treated adult rats. In cases of human exposure, similar effects can be expected.