NUTRIENTS AND TROPHIC STATUS OF THE DANUBE DELTA LAKES

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Abstract. The dynamics and processes related to bio-available nutrients in the Danube Delta were studied by algae bioassays. The bio-available nutrients quantity from sediments and suspensions was estimated. The biolimiting nutrient for the primary production was determined for diffrenet areas of the delta. Toxicity generated by pollutants bound to sediments from the delta was assesed.

Key words: Nutrients, bio-availability, bio-limiting factor, algae biotest *Raphidocelis subcapitata*, sediments, supended solids, toxicity.

INTRODUCTION

For the evaluation of the particulate material quality, in this study, the algal assay test *Raphidocelis subcapitata* (previously *Selenastrum capricornutum*) was chosen. It is one of the tests developed to determine toxicity (Environment Canada, 1992) but also eutrophication capacity of a sample (Santiago; 1991, Miller et al., 1978). The significance of measuring the algal growth potential is that a differentiation can be made between nutrients that are in the sample (as determined by chemical analyses) and the nutrients that are actually available for algal growth (Cairns and Pratt, 1989). The addition of a given nutrient to a sample can give an indication of which nutrient is limiting for the algae growth, in a certain environment.

The test is intended primarily for use in the following situations:

Assessment of a receiving water to determine its nutrient status and sensitivity to changes in N and P loading.

It was also intended that the test be used to identify algal growth limiting constituents, to determine biologically the availability of algal growth limiting constituents and to determine whether the samples are inhibitory to the algae growth due to associated organic and inorganic compounds. This test is considered representative for the chronic effect of the sample (Miller et al., 1978).

The result is related to the quantity of sediment which was used during the extraction and interpreted as the potential ability of the sediment to induce high levels of algae growth i.e. eutrophication risk, or as a potential toxicity of the sediment sample.

In this study, for nutrient limitation, the US EPA-600/9-78-018 standard procedure was used, as an adaptation for microplates and with a reduced incubation time associated with a bigger initial number of algae. Whether this limitation is due to nitrogen or phosphorus was determined. This is accomplished by an experimental design centred around the growth response of *Raphidocelis subcapitata* to singular and combined additions of nitrogen and phosphorus. Due to the complex character of sediment in the Danube Delta, a trace element deficiency is mostly unlikely.

For data quality control (Analytical quality assurance, R.Briggs) each sample was measured in duplicate. One blank (deionised water) was measured for each 30 samples, in order to check contamination free working condition. Calibration of precision balance and micro-pipettors was checked by 50 successive measures of standards weight.

PREVIOUS RESULTS

In 1995, a field campaign was organised in the Danube Delta and on the lower course of the Danube. (Bostan et al., 1998) Bottom sediments and suspended solids were collected from the main distrbutaries.

Stimulation and inhibition effect on the series of TSS samples was determined using the algae bio-test Raphiocelis subcapitata. The CE50 graphic (Fig. 1) shows both effects measured on the series of samples. This test showed a stimulatory effect of the samples from upstream and downstream Tulcea, Sulina, Murighiol, Galati, and Braila.

That study tried to bring a new approach by using, for the first time in this area, ecotoxicological bio-tests. The toxic potential of suspended solids and bottom sediments was evaluated by the means of the chronicle toxicity algae test

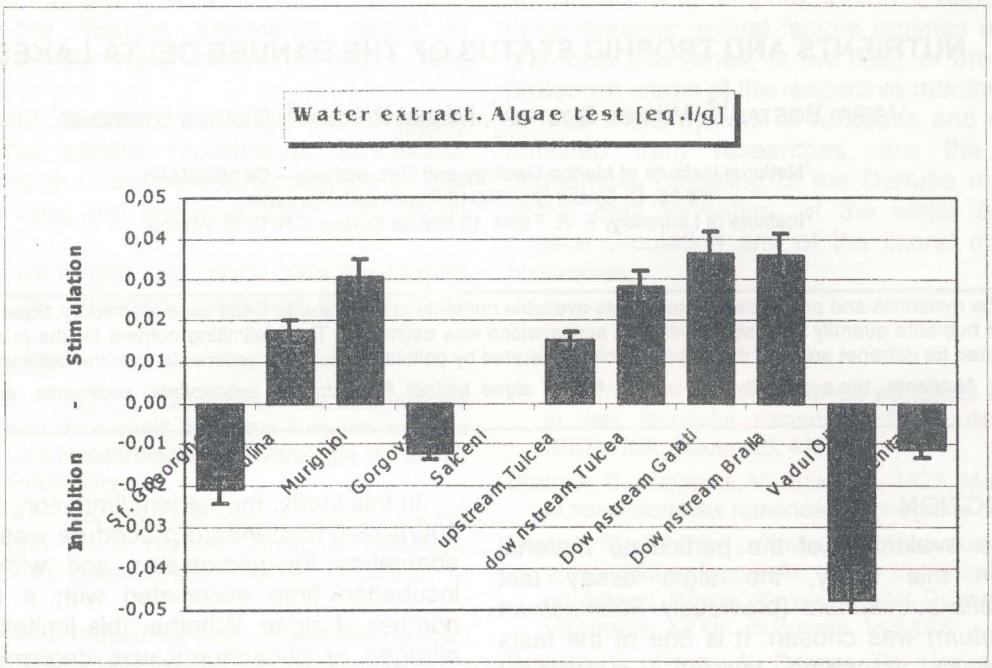

Fig. 1 Results of *Raphidocelis subcapitata* algae test on suspension solids from the Danube River.

Raphidocelis subcapitata and the bacterial acute test Microtox®.

The limited number of samples, the analyses realised only on solid material (TSS and BS), place this study in the category of pilot studies. It allowed the design of a more complex sampling campaign, with a much larger coverage in the deltaic system.

Several chemical analyses have also been performed.

FIELD WORK

Samples presented in this study have been taken during two field campagnes. The first field campaign began the 18th of July and finished the 22nd of August 1997.

62 samples of which 16 centrifuges (Horowitz et al. 1989) have been taken. During this campaign several areas have been sampled: The Matita - Merhei depression; The Lungu - Mesteru depression – which is in the northern part of Tulcea and might be influenced by the industry of the city; The Uzlina depression; The Rosu – Rosulet depression; The area between Dranov and Dunavat branches (which was completely transformed in agriculture polders and fisheries and now, part of it is ecologically restored), the Razim lake which takes different inflow of water from the Danube delta by diffuse flow and also by several channels.

Between the 14th and the 22nd of September a second expedition is organized. During this second expedition the sampling for the biotests analyses could be completed by the depression in the South of the Sulina branch (Gorgova – Isac – Uzlina) and centrifuge sampling of Sontea channel and of Matita depression (Eracle channel).

RESULTS

The map of the distribution of the bioavailable nutrients based on the algae growth (Figs. 2, 3) in the sample is shown in three gray shades.

The light gray points out an environment poor in bio-available nutrients. The mid gray shade indicates an environment with nutrients concentration close to the ones in artificial culture medium. This is presented as assuring a nutrient rich environment, giving optimal conditions for the algae growth, (in culture artificial medium, concentration for nutrients are: PO_4-P of 0.186 mg/l and NO_3-N of 4.2 mg/l, Shyroyama et al. 1975). The dark gray shows areas where the concentration of bio-available nutrients are in very high concentration, providing conditions for a highly eutrophic environment.

Nevertheless, for lakes we must remember that samples are of bottom sediment (Luoma,1989). The previously described process of remobilization of P in reductory conditions (Stanley, 1994), P now present in solution, in the interstitial water is likely to take place. A resuspension of this sediments from the shallow water of the studied lakes can make this nutrients available for the phytoplankton.

Danube river comes with high loadings of nutrients. The influence of Tulcea can not be seen

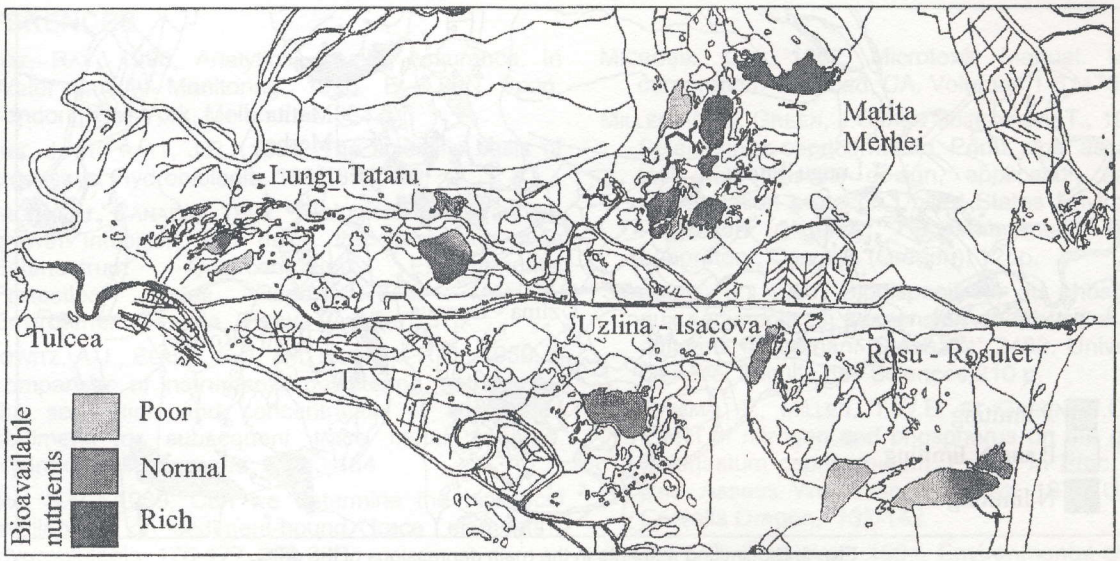

Fig. 2 Quantity of bioavailable nutrients in the main depressions of the delta.

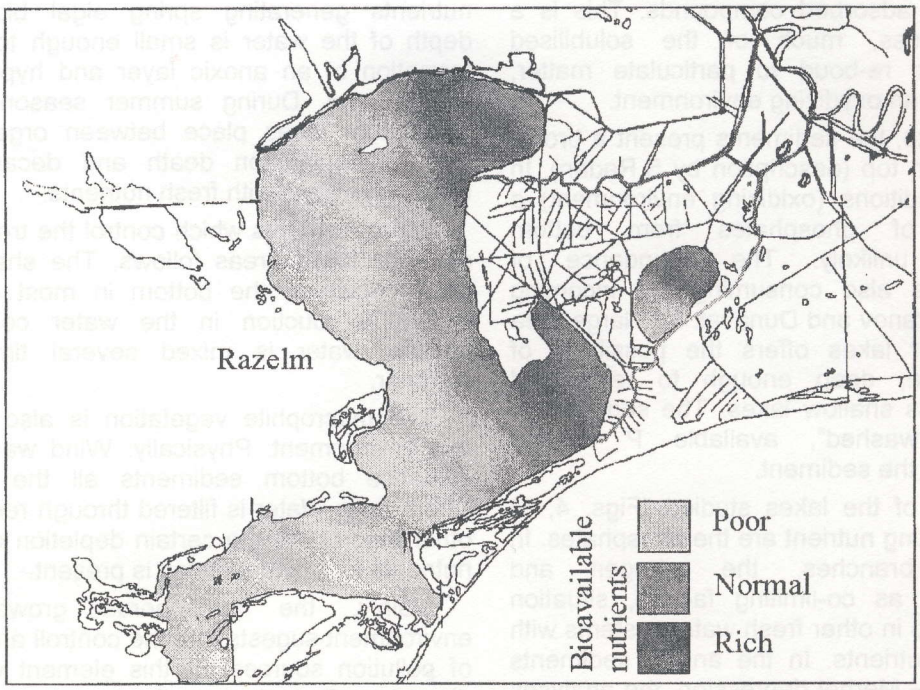

Fig. 3 Quantity of bioavailable nutrients in the Lake Razim area.

at the scale of this approach. This is due to the big amount of nutrients already present in the Danube from the upstream sources. This big concentration the main channels. Analyses of suspensions from secondary channels point out the influx of this nutrients in the delta system. In lake sediments, farther we are from the main channels (the distance of the water flow from its feed in from Danube) smaller the bio-available nutrient concentration. The large primary production of the Danube Delta consumes this nutrients.

Another process controlling the bio-available nutrients is related to reductory condition at the interface water sediment in small lakes from Matita Merhei depression and, partially, from the Lungu – Mesteru depression. This allows nutrients to be released in the interstitial waters. Part of this remobilsed nutrients becomes bioavailable for bottom macrophytes and can also be measured by the algae test. During summer season, resuspension of bottom sediments due to waves on this relatively small lakes happens less often than in the lagoonar complex. Due to bacterial decay at the bottom level, this allows the developpement of a reductory environment of bio-available nutrients related to suspended solids can

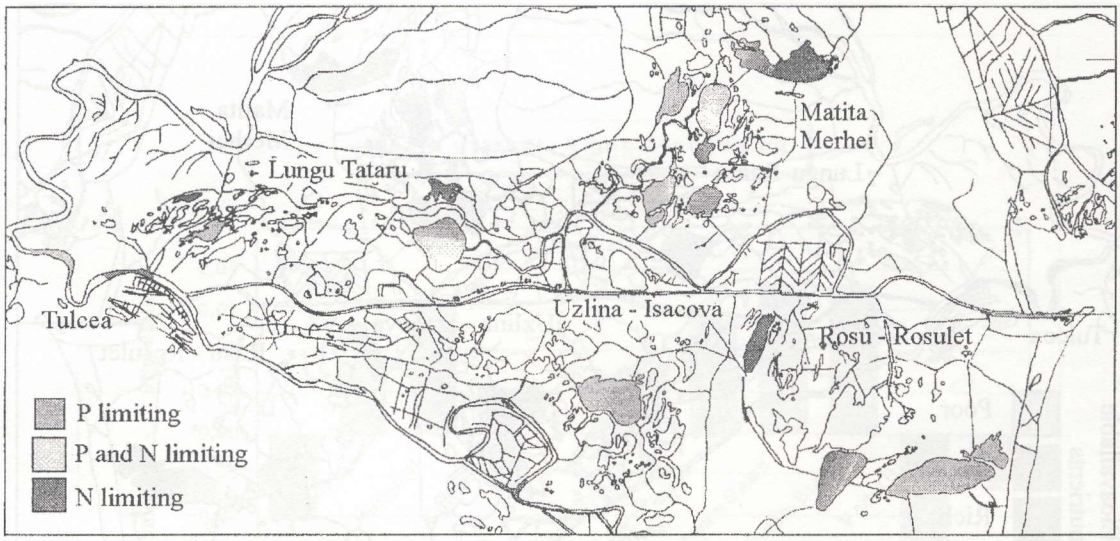

Fig. 4. Bio-limiting nutrients in the main depressions of the delta.

be noticed at all the sampling points on provoking resuspention of adsorbed compounds. This is a reversible process, much of the solubilised components are re-boud to particulate matter, once they reach an oxydizing environment.

In Razim Lake, the sediments present a brown oxidized layer on top (description by S.Radan). In such redox conditions (oxidizing environment) a remobilization of phosphates from bottom sediments is unlikely. The abundance of phytoplankton is also consuming the incoming nutrients from Dranov and Dunavat. The large area of this lagoonar lakes offers the possibility of waves formation, deep enough to resuspend sediments of this shallow lakes. The sediment is thus oftenly "washed", available P loading remaining low in the sediment.

In the most of the lakes studied (Figs. 4, 5) here, the biolimiting nutrient are the phosphates. In the Danube branches, the nitrogen and phosphorus act as co-limiting factors, situation encountered also in other fresh water systems with high loads of nutrients. In the anoxic sediments from the Matita – Merhei depression, the analyses pointed out a nitrogen limited environment.

CONCLUSIONS

According to the data obtained by the use of biotests, a potential toxicity associated to the solid material could not be determined. The big amount of pollutants is disseminated. We have a diffuse pollution. Long term chronically effect, the impact on the Black Sea may be subject of study.

The Danube river brings high quantities both of nitrogen and phosphorus based nutrients in the deltaic system.

The dynamics of nutrients in relation with eutrophication proces is controlled by several factors. The spring floods bring an overflow of nutrients generating spring algal blooms. The depth of the water is small enough to avoid the formation of an anoxic layer and hypereutrophic environment. During summer season a certain equilibrium takes place between organic matter from phytoplankton death and decay and the incoming waters with fresh nutrients.

Other elements which control the trophic status of these lakes areas follows. The shallow water photic down to the bottom in most cases with oxygen production in the water column. The shallow water is mixed several times during summer.

The macrophite vegetation is also controlling this environment. Physically: Wind waves do not influence bottom sediments all the time. and Chemically: Water is filtered through reed bed and other macrophites, a certain depletion of available nutrients for phytoplankton is present.

Mainly, the phosphorus growth limiting environment sugests that the controll and limitation of pollution sources for this element will have a direct benefic impact on the trophic stratus of the Danube Delta lakes.

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