1 Introduction and objectives

1.1 Actuality and interest of topic

One of the most important tasks of modern society is monitoring temporaly and spatialy the level of environmental loads and environmental conservation due to industrial activities and development. The same demand raised a variety of methods and in recent decades great emphasis was put on biomonitoring and bioindicating the environment and its changes. Monitoring the level of pollution or yearly alterations are possible using measuirng devices or biological indicator (bioindicator) species. The latter means that a bioindicator organisms are capable of responding to the combined effects of environmental factors and permit cheap and simply designable investigations without any major arrangemets. A qalitative image can be achieved by applying bioindication methods about the investigated area, while biomonitoring investigations provide quantitative results of polluting agents. The main line of biomonitoring and bioindication research is the long temporal and spatial investigations. Application of these methods have been introduced for decades in developed countries. By means of biomonitoring bioindicaton methods, the spatial trends and local sources are identiticable. In order to make an appropriate comparison it is essential to know the current level of background contamination reach biological organisms from cleanest areas.

It is critical to achieve the deepest possible identification of the physiological answers of bioindication organism for the polluttants. Besides the cobined application of the passive long spatial and temporal-scale bioimonitoring systems with the short term studies, these supply extra information about the quantitaive distribution of pollutants, moreover about the physiological effects of these materials on living organisms.

While the investigations of air depositing polluttants have a detailed literature background, the monitoring of water pollutions is rarerly explored especially on a river like Danube in Hungary. The short spatial and temporal water studies had been mainly careid out by passive, short temporal-scale techniques in streams previously.

1.2 Aims of the research

Aims of this study are the follows:

1 Estabilishment of the applicability of a moss-transplantation technique in a Danube-size river, developed in low-flow streams and water-courses.

2 Is there any detectable effects of the waste water of an idustrial plant that is considered environmentally polluting on river Danube? Is there any detectable changes in the status of the ernvironment around the investigted plant?

3 Estabilishment of adaptability of the physiological parameters of the terrestrial ecophysiological bioindication method on *Fontinalis antipyretica* L. ex Hedw water monitoring moss.

4 Description the air depositing pollution of tropical East-Africa using herbarium materials. Determination the „absolute" air deposition background concentrations of ten highly important polluting elemets (Al, Zn, Cd, Co, Cr, Ni, Pb, Cu, V, Fe) by

analyzing moss materials gathered from territories of unindustrialized tropical national parks.

5 Comparitions our results to European and Hungarian data.

2 Materials and methods

Our small temporal and sptial research area was near Százhalombatta, a city 27 km far from the South of Budapest, the capital of Hungary. The investigated heavy industrial plant is situated next to river Danube on the West of Százhalombatta. Two important industrial plants, the highest capacity oil-refinery (MOL PLC., Duna Plant) of Hungary and a former oil-burning (from January 2002 gas burning) power plant are located there. The waste-water quality of oil-refinery and its effects on river Danube had been investigated using transplantation ecophysiological moss technique. Investigation periods were 07.06.2007 - 02.08.2007; 02.08.2007 - 15. 10. 2007; 21.04.2008 – 17.06.2008; and water moss *Fontinalis antipyretica* L. ex Hedw was applied as bioindicator. The moss chambers were sited in the sewer (1 plot) and in river Danube (7 plots), floated on the surface of water. The pond of the botanical garden of SZIU and a fresh water stream in Mátra-mountain were used as control sites. Elemental content of mosses (Al, Cd, Cr, Cu, Co, Fe, Ni, Pb, V and Zn) and fluorescent-inductive curve (Fv/Fm, RFd) were determined before and after transplantation.

Moss material taken from the Herbarium of Eszterházy Károly College was analysed according to large temporal and spatial scale biomonitoring method from the period of 1986-1994 [Plant materia were collected in East-Africa (Tanzania 1986-1991; Kenya 1992, Réunion 1994; 1996), total of 82 plots were collected]. The Al, Cd, Cr, Cu, Co, Fe, Ni, Pb, V and Zn content of terrestrial mosses were analysed.

All data from large and small scale biomonitoring and bioindication investigations were analysed using multivariant statistical methods (eg. PCA, cluster analysis).

MS-Excel 2003 (Microsoft) software were used for basic statistics. The multivariant analysis were calculated by MINITAB 12.21 for Windows. Figures and tables were designed by Origin 6.0, charts by ArcView GIS 3.3 software.

3 Results

In the investigated waste-water from the drain of oil-refinery, magnitudely lower elemental pollution were detectable compared to river Danube, moreover most of the cases of the investigated elments the results were similar to control areas. The results of reduced vitality inferred from the reduction of physiological parameters may be the effects of other, non-predictable and here not investigated agents. Post-identification of these stressors is not possible. Contingent negative effects of the waste-water from the oil refinery (in case of parameters that were investigated) on river Danube were not detectable because of its better (purified) quality compared to Danube

The origin of some elements (Pb, Ni, Cd, Cu) that were accumulated in Danube were not fully possible, most of them most likely were originated from sludge, as residual effects of past pollutions. Some minor periodic pollutants were estabilished (agriculural and communal activities) as well.

Results of monitoring the tropical areas (Kenya, Tanzania and Réunion) by large spatial and temporal technique resulted similar or lower values detected compared to our results to background-pollutions in some of the European studies. The „absolute background-pollution” could be determined using results from investigated periods and absolute unindustrialised areas. The difference among sub-areas from Africa were not higher than the difference between investigated periods. However we can conlclude, that most of the elemental (Al, Fe, V, Ni, Cu, Cd) content of mosses from herbarium material (Kenya) originated from local sources such as the windblown dust and rocks. The geological feature of these areas confirm these results. Results are similar in case of Cr and Cd from the analysis of dry moss material of Réunion.

3.1 Theses

1 The technique that was originally developed under different conditions in runoff streams and water-courses was successfully modified and applied to river Danube. The water quality of river Danube was described and compared to other international studies.

2 Polluting effects of waste-water from oil refinery to river Danube were not detectable in case of those parameters that were investigated using the transplantation ecophysiological bioindication moss technique. The decrease of measured physiological parameters indicate some negtive effects of waste water, but effects of these unidentified agents were not detectable in River Danube.

3 The transplantation ecophysiological moss bioindication technique previously developed for terrestrial ecosystems were sucessfully adapted to a previously uninvestigated period, river and moss (*Fontinalis antipyretica*).

Moreover, some disturbing factors, like effects of parent material (Cd), and human activities (Pb) which had not been predictale, but could modify results (eg. selection of control sites) were identificated.

In case of active bioindication technique the measurement of accumulation or leaching at least as much important as the comparison of data from investigated areas to a controls site.

With measuring the accumulation/leaching the Accumulation Ratio (AR), the applicability of a test organism can be investigated from a new perspective; from the point of view of the real accumulation or leaching.

We could present further proofs, that the employement of multivariant analysis is absolutely necessary in bioindication and biomonitoring studies. Using these kind of analysis, we were able to prove, that the variation among the monitoring plant material at the beginning of the measurements has no significant effect on the elemental accumulation capability of *Fontinalis antipyretica* water moss during water bioindication, if the transplantation period is long enogh and paralels are applied.

4 The rarely investigated tropical areas had been described by large scale biomonitoring technique using herbarium

materials from Kenya, Tanzania and Réunion. In case of the elements Al, Cd, Co, Cr, Cu, Fe, Ni, Pb, V, Zn the absolute background pollution values were determined using materials gathered in national reserves of Kenya, Tanzania and Réunion. The results, from these unindustrialised tropical areas may be useful as reference values in future studies. These reference values reflect very well to the backgroung concentration according to actual industrialised level of world.

5 Our results were compared to other, European and Hungarian studies. The pollution by air deposition were lower in tropical areas according to our investigation method.

4. Proposals and conclusions

Studies show that the water transplantation bioindication moss technique can be applied on a Danube size river. Thus, I suggest at least in every 3-5 years, the investigation of the water quality in river Danube or other rivers loaded by any industrial activities combined with Lemna-test, phytoplankton-tests, and measurement of other parameters, eg.: biological oxygen demand, chemical oxygen demand, pH, polyciclic aromated hydrocarbons, or measurements of any polluting agents originated from industrial processes.

Beside the fluorescence parameters were used in this study, in case of *Fontinalis antipyretica* L. ex Hedw water moss it would be reasonable to consider the application of other, for this plant not yet fully standardized parameters, eg. CO_2 gas-exchange (in case of terrestrial moss *Syntrichia ruralis ssp. ruralis* it routinely used). I consider desirable to add other, under laboratory conditions well described, physiological parameters to the applications of ecophysiological bioindication technique.

When sufficiently homogeneous, initial bioindicator / biomonitor plant population is used, it is not necessary to separate the measurement of each sub-samples at the beginning of the transplant. For adequate long period of transplantation the applied indicator organism is a good indicator of the status or change of the studied environment.

I consider to be necessary adding information from hydrological aspects to water bioindication method. This information should describe how the effect of a given amount of pollutant can be detected in terms of time, space and to what extent it mixes with the surrounding water spatially and temporally.

It is useful to ivestigate further, eg. tropical areas loaded by background pollution to determinate the basic level of pollution in case of other, here not investigated elements.

It would be useful to focus on the using of moss *Hypnum cupressiforme* again as a good accumulator and more cosmopolitan compared to others (*Pleurozium schreberi, Hylocomium splendens*) used in European studies. This species is native in many tropical areas. This requires a further intercalibration with species still have not been used in the biomonitoring surveys.

5. List of publications

Publications related to topics

Suchara I., FlorekM., Godzik B., Maňkovská B., Rabnecz G., Tuba Z. & Kapusta P. (2007): Mapping of main sources of pollutants and their transport in the Visegrad spacePart I: Eight toxic metals.- *Průhonice*, VÚKOZ, 127 pp.

Suchara I., Florek M., Godzik B., Maňkovská B., Rabnecz G., Tuba Z. & Kapusta P. (2007): Mapping of main sources of pollutants andtheir transport in the Visegrad space. Part II: Fifty free elements.-*Průhonice,* VÚKOZ, 214 pp. which are results of the solving of the11007-2006-IVF project.

Gyula Rabnecz, Bea Papp, György Végvary (2007): Comparison of heavy metal deposition by large scale biomonitoring in Europe and tropical Africa (Cadmium

accumulation and the physiology of the moss *T. Ruralis* under heavy metal treatment) *Cereal Research Communications*, Volume 35, 961-965.

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Poster presentations:

Gyula Rabnecz, Tamás Pócs, Bea Papp, Zoltán Tuba (2006): Comparison of heavy metal deposition by large scale biomonitoring in Europe and tropical africa. *TEFC kongresszus 2006. 05. 26-27*. Budapest, Hungary

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Oral presentations:

Rabnecz Gyula, Tuba Zoltán. Légköri nehézfémszennyezés nagy tér és időléptékű öszehasonlító vizsgálata moha bioindikáció technikával magyarországon és trópusokon.

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