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COMPARING THE BUFFERING ABILITY OF SEDIMENT SAMPLES ALONG THE UPPER PART OF TISZA RIVER

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ABSTRACT. Environmental pollution, urbanization and development of technologies have lead to the fact that in the last few decades' emission of heavy metals has been multiplied. Their pernicious effects can be experienced globally at a highly increased rate which reduces quality of life all over the globe. In our research buffering ability of sediments derived from the upper part of the river Tisza, Hungary, was examined. Sediment samples were collected a few meters away from the river on the riverbank, and from the river basin around one meter away from the riverside. The sediments were treated with copper. Copper is an essential heavy metal, in small quantity it is an important element of several proteins, but in high quantities it has a toxic effect on plants as well as on animals. Copper, bound especially to organic matter, can be adsorbed rapidly to sediments thus it takes its toxic effects fast. The aim of our research was to assess the copper buffering ability of sediments of different origins. The buffering ability of sediment samples derived from the riverbank were compared at each site to the ones derived from the river basin. The average length of seedlings grown in sediment suspensions of different copper concentrations was also compared to average length of seedlings grown in sediment suspensions with distilled water. The used seed germination test was the *Sinapis alba* ecotoxicological test, which shows the rate of the pollution emerges due to the treatment. Relationships between concentration of organic matter and metal content of sediments were also studied. Results were evaluated statistically.

Keywords: sediment copper, river Tisza, ecotoxicological testing, *Sinapis alba*

INTRODUCTION

It is well known that due to technology and urbanization environmental pollution tend to be a serious problem (Olade, 1987). Plants easily take up heavy metal ions which accumulate in them and become nutrient source for animals. In this way heavy metal ions can become risk factors for humanity, so they have to be monitored (Clemens, 2006). Copper is an essential heavy metal, it is a co-factor of many enzymes and important element of many proteins (Amiard et al., 1987). In low concentrations diseases evolve but in high concentration it can be toxic (Riedel, 2008). The copper, especially bounded to organic materials, adsorbs easily in sediments therefore it takes its harmful effect fast (Bird et al., 2005). Copper is on of the most important metals that humanity uses for thousands of years (Macklin et al., 2003). Due to mining it can be found in a high concentration in the environment (Osán et al., 2007). It is especially true near copper mines, which have an increased environmental risk (Mighall et al., 2002). During the last decades several environmental accidents happened on the catchment area of river Tisza, of which most of them are in relation with metal mines. The aim of our experiments was to assess the copper buffering ability of sediments derived from the upper part of river Tisza.

Description of studied sites

Samples are derived from the upper part of river Tisza, Hungary (Table 1). Sediment samples were collected a few meters away from the river on the riverbank, and from the river basin around one meter away from the riverside.

Table 1

Sampling sites and their codes

Sampling sites	C1	C2	C3	C4	C5	C6
	Tiszabecs	Kisar	Aranyosapáti	Lónya	Tuzsér	Dombrád

MATERIALS AND METHODS

Ecotoxicological seed germination tests study how the polluting heavy metals affect germination. In our experiments 10 mass percent of sediment suspensions were shaken for one hour using 50, 100, 250, 500 and 1000 ppm concentrations of copper ions. Shaking period illustrates the period of interaction of sediment and water phases. The experiments were carried out with *Sinapis alba* seed germination test.

RESULTS AND DISCUSSION

Germination tests in untreated sediments

Sediments samples derived from the upper part of the river Tisza were mildly toxic or took no toxic effects on the seeds. Comparing the sediments derived

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from the riverbasin and the riverside, samples from the riverbasin buffer the copper ions better except in sample C3, it can be said that the average length of seedlings were significantly larger in samples from the riverbasin than the ones from the riverside (Figure 1.). Probably due to shaking matters dissolved that blocked the growth of seedlings.

Germination tests in treated sediments

Under laboratory circumstances 50 ppm, 100 ppm, 250 ppm, 500 ppm and 1000 ppm copper ions were added. Treated sediment samples were compared to the same untreated ones. On figures the average length of seedlings grown in distilled water is also showed.

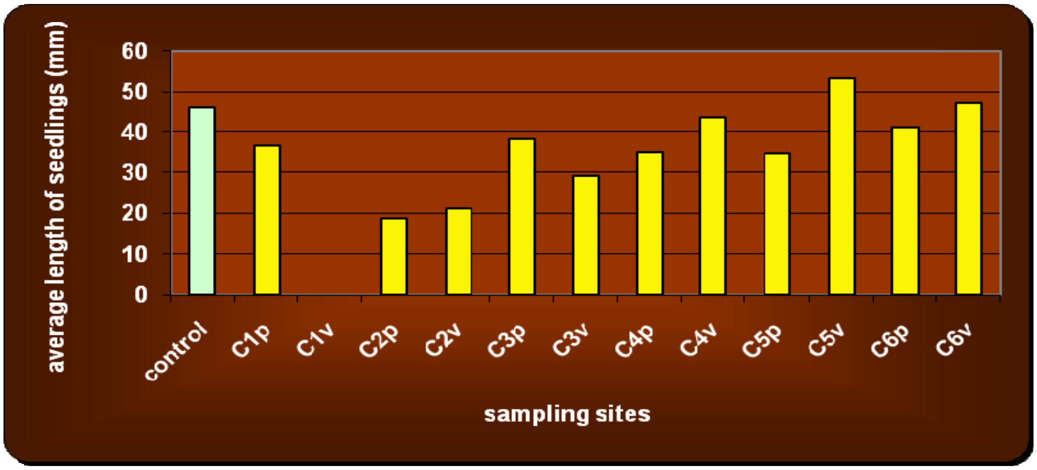

Fig. 1 Effects of sediment samples derived from the upper part of the Tisza on seedlings growth

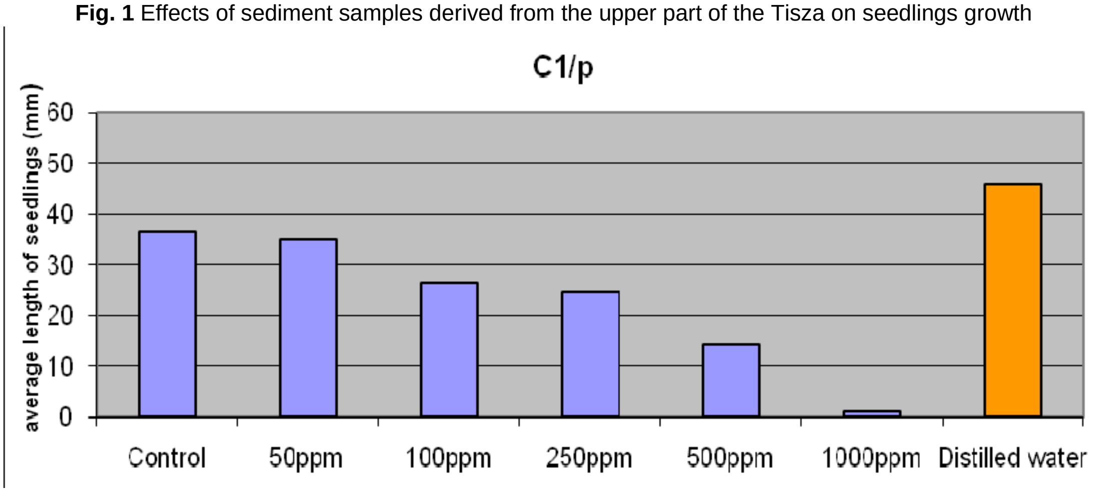

Fig. 2 Length of seedlings in treated sediments derived from the site C1 from the riverside

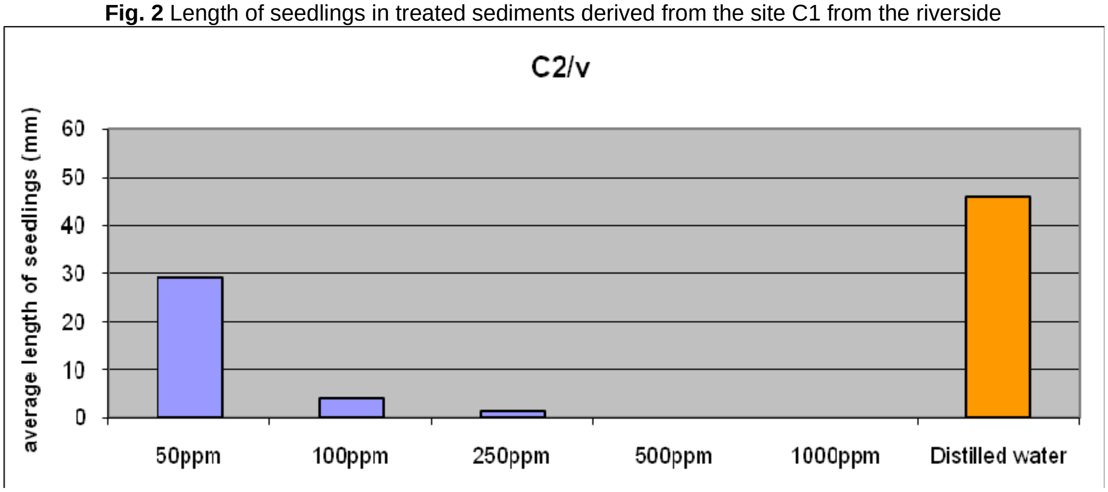

Fig. 3 Length of seedlings in treated sediments derived from the site C2 from the riverbasin

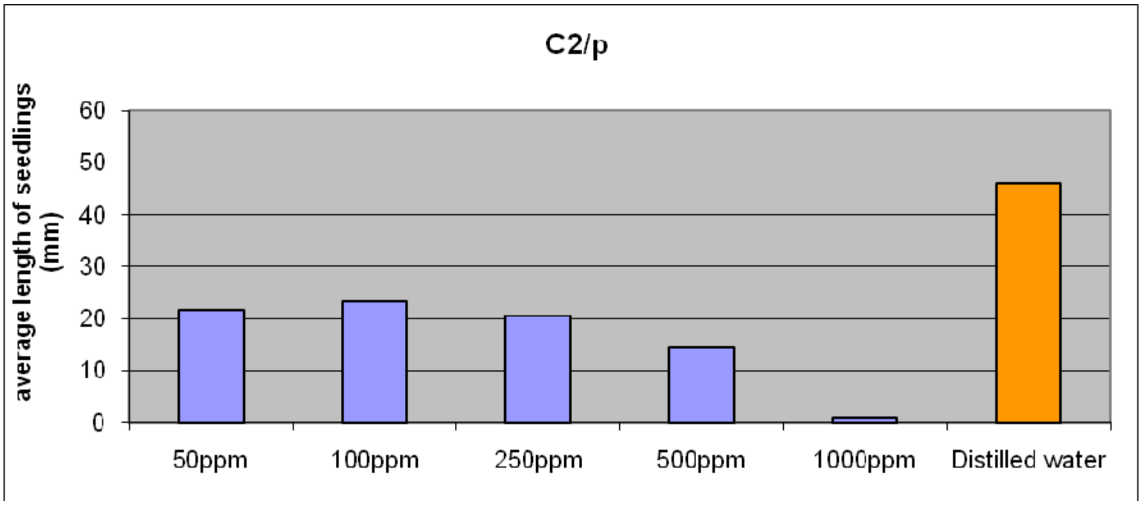

Fig. 4 Length of seedlings in treated sediments derived from the site C2 from the riverside

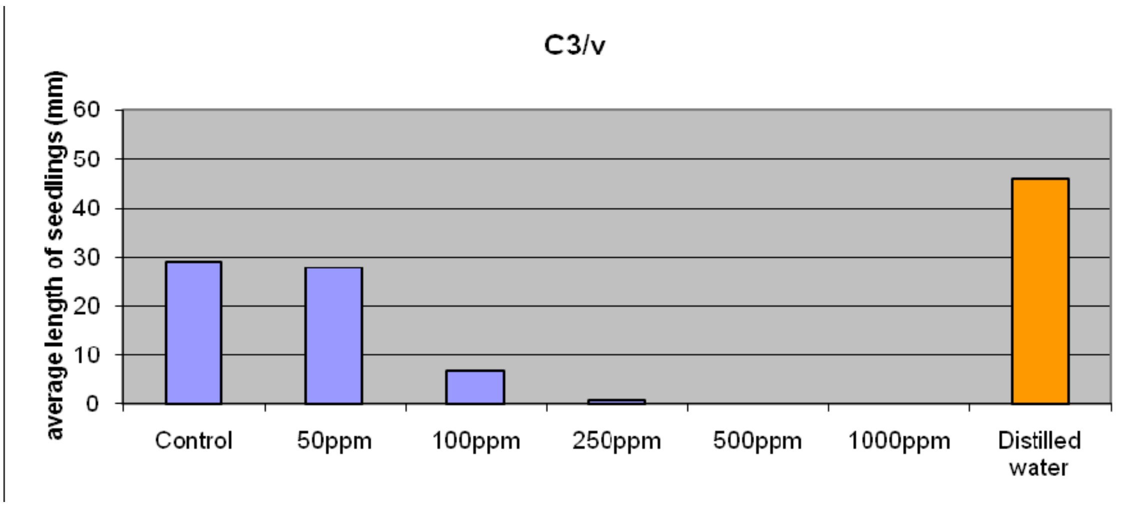

Fig. 5 Length of seedlings in treated sediments derived from the site C3 from the riverbasin

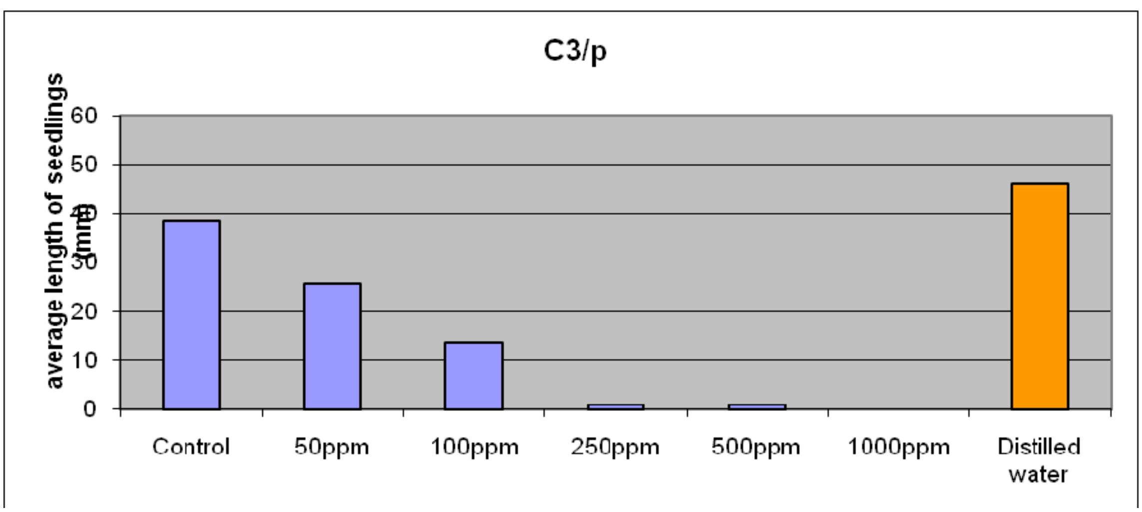

Fig. 6 Length of seedlings in treated sediments derived from the site C3 from the riverside

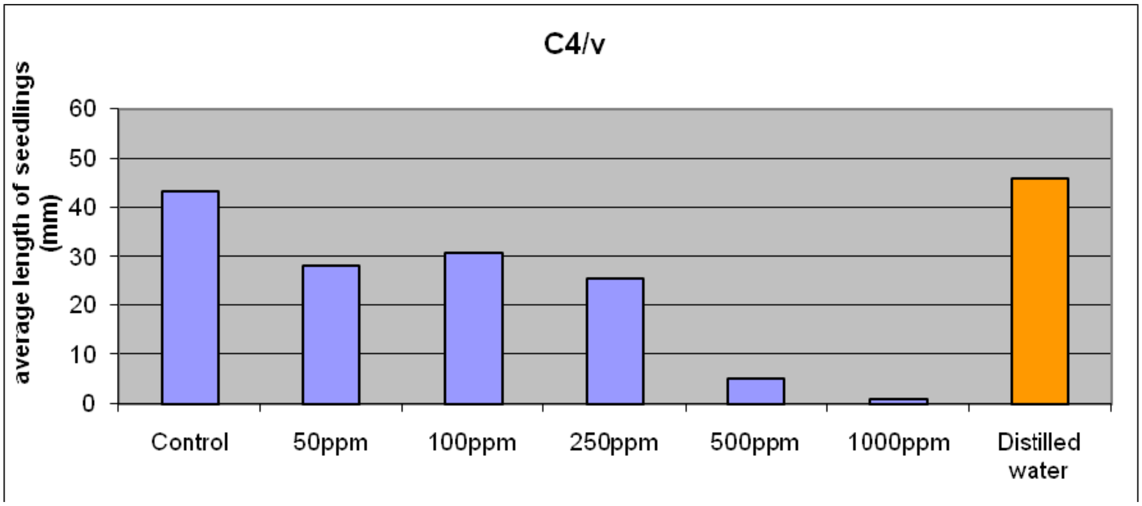

Fig. 7 Length of seedlings in treated sediments derived from the site C4 from the riverbasin

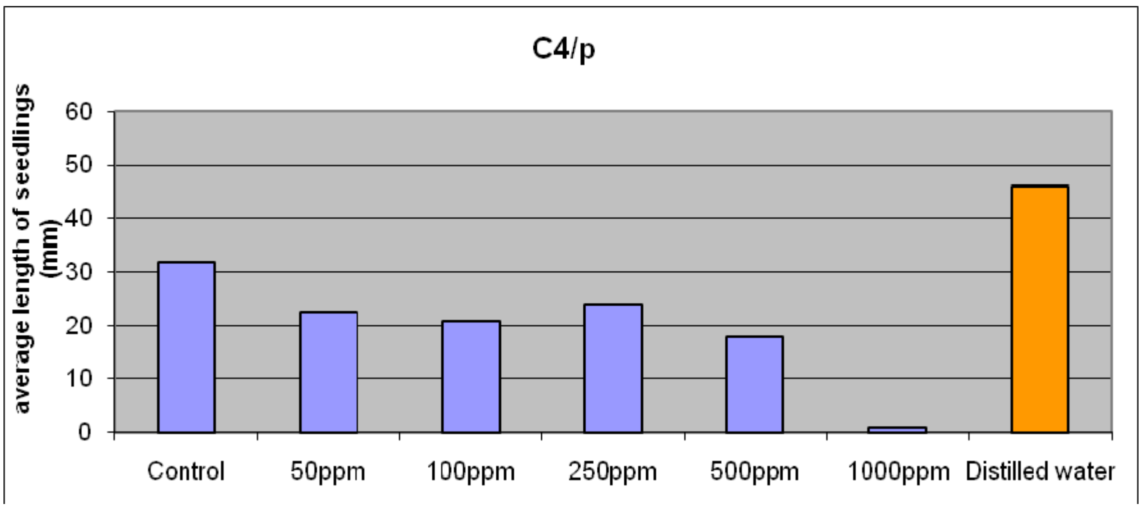

Fig. 8 Length of seedlings in treated sediments derived from the site C4 from the riverside

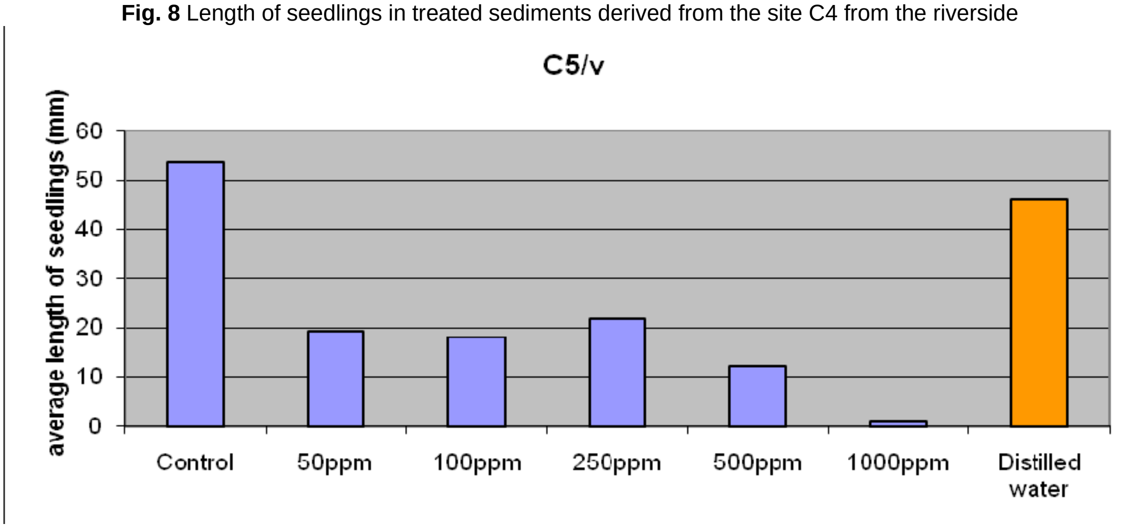

Fig. 9 Length of seedlings in treated sediments derived from the site C5 from the riverbasin

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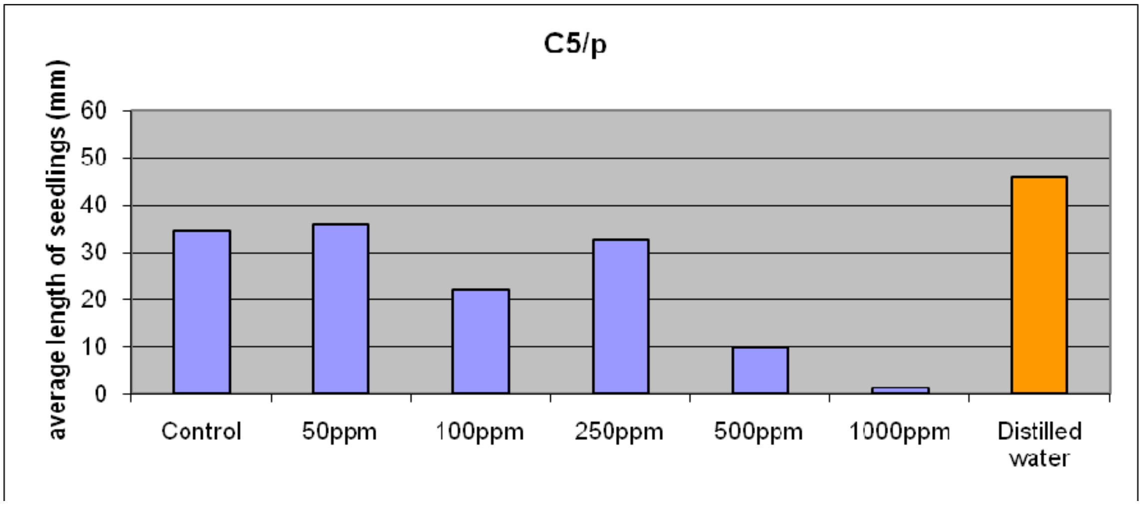

Fig. 10 Length of seedlings in treated sediments derived from the site C5 from the riverside

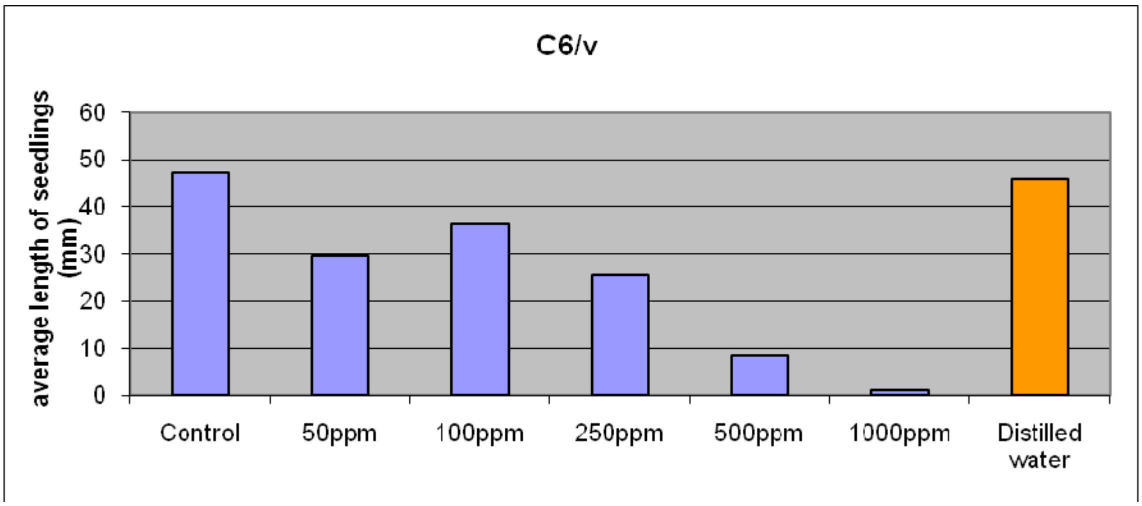

Fig. 11 Length of seedlings in treated sediments derived from the site C6 from the riverbasin

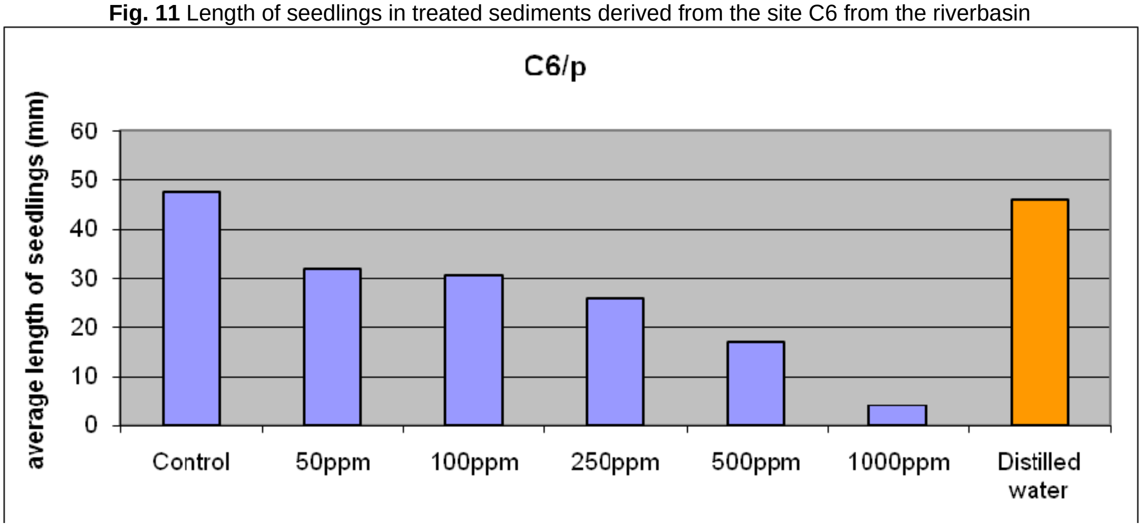

Fig. 12 Length of seedlings in treated sediments derived from the site C6 from the riverside

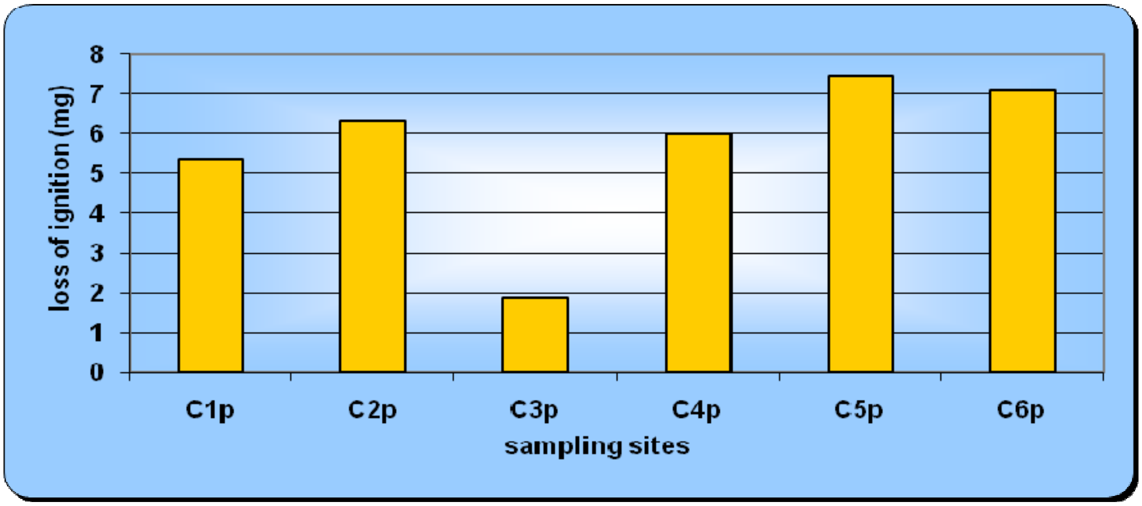

Fig. 13 Loss of ignition of sediments derived from the riverside

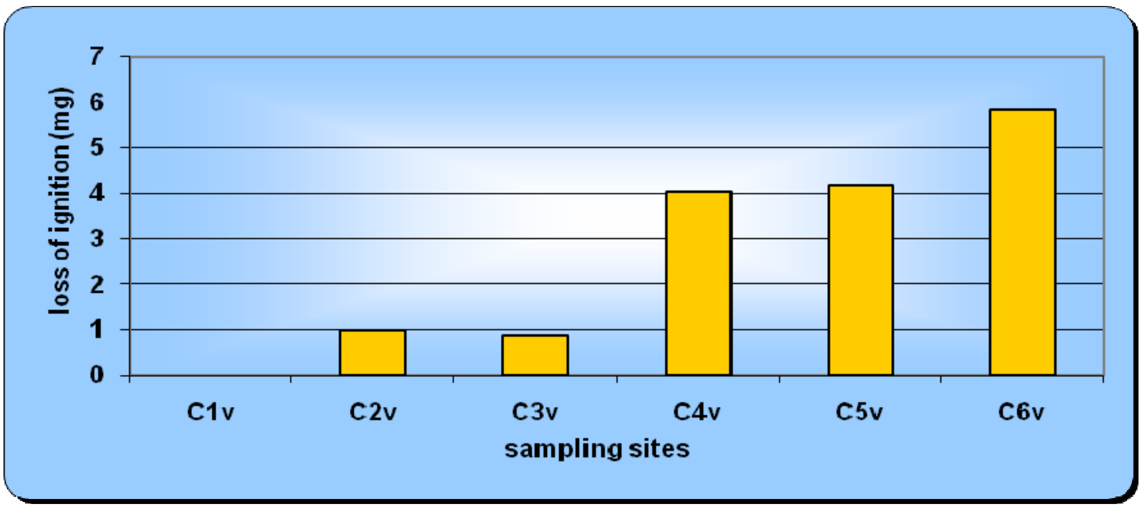

Fig. 14 Loss of ignition of sediments derived from the riverbasin

As the amount of copper ion increased the length of seedlings were decreased (Figure 2-12). When the organic matter was at present in a higher concentration significant difference could not be observed at 50 ppm. According to our experiments it can be said that sediments have a significant buffering ability. While seedlings in copper solution, which did not contain sediments, were not able to germinate, seedlings length in sediment-copper suspension always reached the 20 mm length. Sediments have significant buffering ability.

Comparing the sediments derived from the riverbasin and the riverside it can be said that the ones from the riverbasin have a better buffering ability. It can be explained by their organic matter content. From C1 site it was not possible to get samples.

The organic matter content and buffering ability

Positive correlations were found between metal concentration and organic matter content of sediments (1984, Gerriste; 1981, Förstner). The higher the initial metal concentration is, the more the amount of the adsorbed heavy metal is in the organic matter because of the directing power of the higher concentration-gradient. (1997, Jain). The organic matter content of the sediment can also be used to establish the rate of pollution of different sediments. The more the amount of the sediment is, the more the amount of the adsorbed metal is, which means that the more is the organic matter content of the sediment is, the better the buffer capacity of the given sediment is.

This statement was underpinned by our experiments as well (Figure 13-14.). Samples containing more organic matter had better buffering ability. In samples with low organic matter content seedlings were not able to germinate even in the suspension containing 250 ppm copper ion. In samples with high organic matter content the length of seedlings reached even 10 mm.

CONCLUSIONS

The copper produced a more or less retarded germination. Due to our results it can be established that comparing the sediments derived from the river basin and the riverside, the average length of seedlings were significantly larger in samples from the river basin than the ones from the riverside. It can be explained by their organic matter content. Experiments in untreated sediments suggested the same. As the amount of copper ion increased the length of seedlings were decreased, although sediments with higher organic matter content buffered the copper ions better. Between the metal content and the organic matter of the sediments positive correlation was found. The higher the initial metal concentration is, the more the amount of the adsorbed heavy metal is in the organic matter. The organic matter concentration of sediments can be used as a potential toxic index of the sediment as well.

REFERENCES

Amiard J.C., Amiard-Triquet C., Berthet B., Metayer C. (1987): Comparative study of the patterns of bioaccumulation of essential (Cu, Zn) and non-essential (Cd, Pb) trace metals in various estuarine and coastal organisms. Journal of Experimental Marine Biology and Ecology, 106 (1): 73-89.

Bird G., Brewer P.A., Macklin M.G., Serban M., Baltenau D., Driga B. (2005): Heavy metal contamination in the Arieş river catchment, western Romania: Implications for development of the Roşia Montană gold deposit. Journal of Geochemical Exploration, 86 (1): 26-48.

Clemens S., 2006, Toxic metal accumulation, responses to exposure and mechanisms of tolerance in plants. Biochemie, 88: 1707-1719.

Forstner U., Wittmann G.T.W., 1981, Metal pollution in the aquatic environment. Springer-Verlag, Berlin: 463-486

Gerriste R.G., van Driel W., 1984, The relationship between adsorption of trace metals, organic matter and pH in temperate soils. J. Environ. Qual., 13: 197-204.

Jain C. K., Ram D., 1997, Adsorption of lead and zinc on bed sediments on River Kali. Water Res., 31: 154-162.

Macklin M.G., Brewer P.A., Baltenau D., Coulthard T.J., Driga B., Howard A.J., Zaharia S., 2003, The long term fate and environmental significance of contaminant metals released by the January and March 2000 mining tailings dam failures in Maramure County, upper Tisa Basin, Romania. Applied Geochemistry, 18 (2): 241-257.

Mighall T.M., Abrahams P.W., Grattan J.P., Hayes D., Timberlake S., Forsyth S., 2002, Geochemical evidence for atmospheric pollution derived from prehistoric copper mining at Copa Hill, Cwmystwyth, mid-Wales, UK. The Science of The Total Environment, 292 (1-2): 69-80.

Olade M.A., 1987, Heavy metal pollution and the need for monitoring: Illustrated for developing countries of Africa – in: Hutchinson, T. C., Meema, K. M.: 1987. Lead, Mercury, Cadmium and Arsenic in the Environment. Scope, 20: 335-342

Osán J., Török S.Z., Alföldy B., Alsecz A., Falkenberg G., Baik S.J., van Grieken R., 2007, Comparison of sediment pollution in the rivers of the Hungarian Upper Tisza Region using non-destructive analytical techniques. Spectrochimica Acta Part B: Atomic Spectroscopy, 62 (2): 123-136.

Riedel G.F., 2008, Copper. Encyclopedia of Ecology, 778-783.