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THE ROLE OF AQUATIC MACROPHYTE *NYMPHOIDES PELTATA* IN INDICATION OF HEAVY METAL ENVIRONMENTAL POLLUTION

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ABSTRACT

One of the most appropriate indicator of status and quality of aquatic ecosystems is monitoring of basic chemical parameters of water as well as a continuous monitoring of species number and their chemical composition which offer a relevant estimation of the chemical load degree of both water and its littoral zone. All the above makes an essential perquisite for a wide commercial application of phytoremediation to (bio) indication and (bio) purification.
Heavy metal concentration of plant tissue and substratum (mud), relying upon the distance from the bridge, should point to the pollution degree of the Danube caused by exhaust gases rich in Pb, Ni, Zn, and Cd. The obtained results should also point to the role of macrophytes in pollutant remediation, heavy metals and nutrients particularly.
Concentration of all the analyzed heavy metals in leaf varied as the distance from the bridge increased. In all the investigated plant organs a lower accumulation of the investigated heavy metals under the bridge was recorded. On the contrary, a significant content of heavy metals was found in mud under the bridge.

1. INTRODUCTION

One of the most appropriate indicator of status and quality of aquatic ecosystems is monitoring of basic chemical parameters of water as well as a continuous monitoring of species number and their chemical composition which offer a relevant estimation of the chemical load degree of both water and its littoral zone [1]. All the above makes an essential perquisite for a wide commercial application of phytoremediation to (bio) indication and (bio) purification [2].

The aim of our investigation was to highlight the status of ecological conditions relying upon chemical contamination of the Danube water and its littoral zone by employing heavy metal content of tissue of a dominant aquatic macrophyte *Nymphoides peltata* occurring at several sites being at various distance from the Beska bridge (highway) in the Danube littoral zone. Heavy metal concentration of plant tissue and substratum (mud), relying upon the distance from the bridge, should point to the pollution degree of the Danube caused by exhaust gases rich in Pb, Ni, Zn, and Cd. The obtained results should also point to the role of macrophytes in pollutant remediation, heavy metals and nutrients particularly.

2. MATERIAL AND METHODS

Sampling sites – the Danube in the vicinity of the Beshka bridge

The village Beshka is situated at 1232km of the Danube flow through Serbia and Voyvodina. A highway (E-75) goes across the river in the vicinity of this small settlement. The bridge represents a very important point of the highway. This region is daily loaded with exhaust gases while particles of soot, organic substances, carbohydrates, and heavy metals are deposited in water and littoral zone of the Danube. Worth to be mentioned is rinsing of different deposited chemical substances from the highway into the Danube when it rains.

An aquatic macrophyte dominant in the littoral zone of the Danube, Nymphoides peltata (Gmelin) Kuntze, was used as a test species. Sampling was done using a random block system in 2003 autumn at sites characterized by its highest density and covering.

Plant and mud samples were taken at various distance from the bridge to determine contamination, degree and spatial distribution of pollutants, i.e. heavy metals.

0 m – under the bridge
10 m – upstream from the bridge
10 m – downstream from the bridge
20 m – upstream from the bridge
20 m – downstream from the bridge
30 m – upstream from the bridge
30 m – downstream from the bridge
50 m – upstream from the bridge
100 m – upstream from the bridge
100 m – downstream from the bridge
500 m – upstream from the bridge
500 m – downstream from the bridge

Plant material was classified and leaves with stalks, rhizomes, and roots were separated. Quick-dry plant samples (at ambient temperature without rinsing) were dried at 105 °C. Chemical analyses were done according to the standard procedure for water and aquatic plants (APHA, 1995). Concentration of heavy metals, Fe, Mn, Ni, Pb, and Cd was determined by using atomic absorption spectrophotometry directly from stock solution. Concentrations were expressed in $\mu g \cdot g^{-1}$ dry plant matter.

3. RESULTS AND DISCUSSION

Purification efficacy and the degree of uptake and accumulation of heavy metals, Ni,Cd, Pb, Fe, and Mn, were evident, relying upon sampling site. When heavy metals are discussed, the investigated aquatic showed the highest Fe then Mn accumulation while the accumulation of Ni, Pb, and Cd was significantly lower. Concentration gradient of last three mentioned relied upon plant organ.

Concentration of all the analyzed heavy metals in leaf varied as the distance from the bridge increased. The lowest Fe was recorded under the bridge, then 30m and 100m upstream. No significant differences were found between the remaining measured concentrations. Mn concentration was site-dependant while found variations were weak. No significant effect upon Mn content was observed either upstream or downstream the bridge while the lowest Mn was found in samples 500m far from bridge. Ni content distribution relative to a distance from the bridge resembled that recorded for Fe. Pb content was not lower as the distance from the bridge decreased while its highest concentration was recorded at the greatest distance from the bridge (upstream). Variations of Pb concentrations were not site dependant while only partly they relied upon the sampling site. No significant effect of the distance from the bridge was obtained with Cd content, although a weak decrease was observed 30m from the bridge.

Fe concentration in rhizome tissue was the lowest under the bridge and at the greatest distance from the bridge. Upstream concentrations were greater than downstream ones in the samples taken at the same distance from the bridge. No correlation between rhizome Mn concentration and that of mud was recorded. The presence of Pb and Cd was recorded in all the rhizome samples.

Fe accumulation in root was extremely high, the highest concentration was recorded 10m upstream. No correlation between site dependant distribution of Fe and Mn contents was recorded, although the lowest concentration of both elements was observed under the bridge and 500m downstream. At these sites and 20m upstream also the highest Pb concentrations were recorded. Pb content increased as the distance from the bridge increased, up to 30m inclusive. A decrease was noticed after 50m.

The highest pollution of a mud layer with plant roots and rhizomes caused by the presence of heavy metals was found 20m downstream.

The lowest contamination of root, rhizome, and leaf tissues with heavy metals was recorded 500m downstream.

Root Fe accumulation was few times higher than in the aboveground part. Variations of the accumulation were site dependant. Unlike Fe, Mn concentration was higher in leaves at all the sampling sites. The lowest Mn was obtained with rhizome. Also, rhizome accumulated the lowest Pb. Leaf Pb possibly originated also from that adsorbed at the leaf surface. No clear correlation was defined between mud and root, namely rhizome Pb concentrations.

In all the investigated plant organs a lower accumulation of the investigated heavy metals under the bridge was recorded. On the contrary, a significant content of heavy metals was found in mud under the bridge.

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