ASSESSMENT OF THE STATUS OF AQUATIC ECOSYSTEMS FOR THE COMMUNITY OF MACROPHYTES

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Abstract: The article concerns biogeochemical studies on water bodies, which show the effectiveness of the use of macrophytes in the evaluation of human disturbance in the natural aquatic ecosystems. The purpose of the work is to assess the ecological status of the water bodies from three areas of Leningrad and St. Petersburg region. The data obtained were investigated by standardless spectral X-ray. There has been reported a significant increase in the concentration of the chemical elements in aquatic plants ranging from the coastal to the submerged zone. The areas under consideration are non-uniform in the degree of anthropogenic pressure. Of the three studied reservoirs, the North Island Elagina Pond undergoes human impact.

Keywords: bioindication, bodies of water, chemical elements, environmental monitoring, macrophytes, Standardless X-ray method

Introduction:

Water features, both natural and man-made, are an important component of the modern city environment. Taking into account the specifics of the organization, structure and functioning of aquatic ecosystems, and the nature of the human impact on water bodies in urban areas, this is appropriate to offer as an indicator of macrophytes and their community. As today significantly increases the level of anthropogenic impact on water bodies, the use of bio-indication can solve the problem of environmental monitoring. This shows the relevance of this work.

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To assess the ecological status of the water bodies the following tasks have been completed:

- description of coastal aquatic vegetation on the embedded profiles of the water;
- water sampling and macrophytes in the study sites;
- analysis of the structural characteristics of macrophyte communities (species richness, species diversity, projective cover, abundance) of the studied reservoirs;
- determination of the chemical elements in the studied macrophytes;
- evaluation of the ecological status of water bodies on the basis of the data.

Materials and methods:

The study investigated the vegetation water route survey conducted by the description of aquatic plant communities.

Work formed the basis for the samples collected in the waters of the Leningrad region and St. Petersburg in the period from July to August 2011.

My research work was conducted in three different areas:

- 5th North Islands Elagina Pond - St. Petersburg: 24.06.2011 - 10.07.2011;
- Lake Suuri - pos. Blacksmithing Priozersky district of Leningrad region: 12.07.2011 - 26.07.2011;
- Gulf Lahti Nizhnesvirsky Nature Reserve: 27.07.2011 – 26.08.2011.

The areas were chosen considering three different qualities:

- the city's social and cultural place to stay;
- quite remote from the city, which does not have such a strong anthropogenic pressure;
- body of water - which is a protected territory of the Leningrad region intended for research.

We examined seven stations (sample plots). 33 relevés were achieved.

The macrophytes and soil sample handling method was used for the quantitative chemical analysis of standardless spectral X-ray method.

Results and discussion:

The results of the taxonomic, geographical and ecological analyses of reservoirs' flora showed its heterogeneity which is due to the environmental natural features of the study area (Kryukov 1999).

Based on these data we can say that these different types of aquatic weeds selectively accumulate chemical elements.

In the vegetative organs of *Potamogeton natans* in the Gulf Lahti there has been recorded the highest total content of elements such as titanium, manganese, iron, nickel, copper, zinc, and bromine in *Sparganium emersum* in the Gulf Lahti.

The lowest total content of chemical elements in the leaves was registered in *Nuphar lutea*, the stems and leaves of *Phragmites australis*, *Carex acuta* in lake Suuri and the Gulf Lahti (Fig. 1 and Fig. 2, Annexes).

For *Nuphar lutea*, the first description of a macrophytes' (hydrophytes) with floating leaves, i.e. the low concentrations of copper, zinc, nickel and manganese, is due to the conditions of its habitat which are less favourable for the absorption of heavy metals (Bahtiarov 1985; Lychagina and Kasimov 1998).

However, compared with a cane (*Saccharum* sp.), the elevated concentrations of some chemicals in the bodies of *Nuphar lutea* are primarily concerned with their greater need for these micronutrients. So, for example iron and zinc are actively involved in oxidation- reduction reactions in leaves' chloroplasts and chlorophyll synthesis of large quantities of leaf development needs of these plants, unlike cane (Sadchikov 2005).

Low concentrations of Ni in the studied reservoirs, for preferring stagnant areas of water bodies, are to be associated with the poor mobility of these elements in the given conditions (Anischenko and Buhovets 2009).

Several studies have shown that the accumulation of metals is closely related to the relationships between them. In particular, the ratio of Fe and Mn that may be a good indicator of anthropogenic pollution of water bodies (Fig. 3, Annexes). It was also featured on macrophytes (Anischenko and Buhovets 2009).

Violation of the relations between the corresponding pairs of elements, iron and manganese, is a feature of the trace element composition of the ecological and morphological groups of macrophytes in water bodies.

Thus, in the Gulf of Lahti we have found some deviation of the normal relationships of the elements Fe and Mn., observed in

Potamogeton natans (1.8), *Phragmites australis* (2.7) and *Sparganium emersum* (3.3). For the rest of macrophytes observed in Lahti Gulf, the normal ratio is inversion of *Nuphar lutea* and *Carex acuta* is absent.

Despite the inversion of the normal ratio of Fe and Mn in some studied macrophytes, the excess accumulation of one element over another is not too large, and exceeds, on average, twice. Therefore, we may say that the studied water bodies do not have a strong urban anthropogenic influence (Ufimtseva and Terekhina 2005).

The bioaccumulation factor (Kbn1), which is the ratio of the element concentration in the plant to Clark lithosphere, identifies common patterns of species-specific accumulation of chemical elements by plants.

Regarding Clarke in the lithosphere in all studied water bodies, the following elements are piling up: Mn, Ni, Cu, Zn, Sr. The Kbn1 conveys high values relative to manganese in the Suuri Lake different *Sparganium emersum* (25.1), in the Lahti Gulf *Potamogeton natans* (154), with respect to strontium *Potamogeton natans* (46.5) and *Sparganium emersum* (16.3) in the Suuri Lake (Fig. 4, Annexes).

These hydrophytes have higher concentrations of the chemical elements, showing selectivity in their accumulation (Ufimtseva and Terekhina 2005). This high accumulation of trace elements in the vegetative parts of pondweed is due to the fact that the chemical composition of floating leaves plants on the surface of the water, which is dependent on the concentration of trace elements in both soil and water (Lychagina and Kasimov 1998; Kurylenko 2004).

For copper and zinc Kbn1 had high rates in *Scirpus sylvaticus* in North Island Pond Elagina and *Sparganium emersum* in the Gulf of Lahti (Fig. 4, Annexes). In turn, macrophytes elements such as iron and titanium (Kbn1 < 1) were depleted, but titanium is a man-made element and the lack of accumulation in the studied reservoirs indicates relative well-being. However, the accumulation of man-made elements, as nickel, strontium, is present in the studied water bodies.

The values of Kbn2 reveals the ratio of the concentration of the element in the plant to the concentration of this element in the soil. By using the Kbn2, we can explain the content of chemical elements in various environmental macrophyte groups and give an idea of the regional patterns of accumulation of chemical elements (Ufimtseva and Terekhina 2005).

The trend of Kbn2 for manganese and rubidium for all macrophytes is almost always greater than 1 or equal to 1 regarding all investigated waters.

Copper and zinc are accumulated only in the macrophytes found in North Pond Elagina Islands (Fig. 5, Annexes). Titanium, iron, nickel have Kbn2 below unity for all macrophytes growing in the studied water bodies, which is due to different reasons.

For the iron (biohpility element), its entry into the plant is on the barrier type, so even a large concentration in the soil does not lead to an increased accumulation of this element in the body, as evidenced by low values of Kbn2 (Ufimtseva and Terekhina 2005). For zinc, an another biohpility element, the Kbn2 has high values compared with all values of the highlighted elements. We can also note the high concentrations of man-made strontium element average of biological uptake in plants of the Suuri lake. An objective assessment of the intensity of water pollution is given by ratios concentration (QC), representing the ratio of chemical elements in plants growing.

In the North Island Elagina Pond, the ratios concentration is given by content in plants' background areas, ranked by *Carex acuta* (Fig. 6, Annexes).

All minerals accumulate in this hygrophite, particularly rubidium and titanium, are two to three times higher than the background concentration. *Scirpus sylvaticus* accumulates only zinc, which is three times higher than the background concentration of habitats. Other elements have similar or even lower values.

Comparing background concentrations of chemical elements in the test, the macrophytes indicates an increase in their concentration and for manganese, titanium, iron (only for *Scirpus sylvaticus* and *Phragmites australis*) is slightly lower due to regional characteristics of biogenic migration trace (Fig. 6, Annexes).

Conclusions:

As a result of analyzing the chemical composition of aquatic plants there has been shown a significant increase in the concentration of chemical elements from the coastal to the submerged aquatic plants.

These observations are consistent with the literature in the field confirming that during their lifetime the aquatic plants accumulate a greater concentration of the chemical elements (Lychagina and Kasimov 1998).

The macrophyte vegetation is one of the most promising bands to phytomonitoring (estimates of the natural environment on the botanical characteristics). Biochemical studies on water bodies, show the effectiveness of the use of macrophytes in the evaluation of human disturbance in these natural complexes.

Using the methods of bio-indication in assessing ecological status of the studied water bodies, the following conclusions may be drawn:

- analysis of hydro-chemical parameters of the studied reservoirs showed that the objects under consideration are a mixed degree of anthropogenic pressure;
- based on these data, it was found that different types of macrophytes selectively accumulate chemical elements. The highest concentration of the chemical elements are listed in the bodies of plants growing in the Lahti Gulf of the Nizhnesvirsky State Reserve;
- the study showed a trend of chemical elements concentrations of the aquatic plants from shallow coastal water parts to the deep zones;
- bioaccumulation factor (Kbn1) reveals common patterns of species - specific accumulation of chemical elements of macrophytes: in the studied water bodies are piling up elements such as Mn, Ni, Cu, Zn, Sr;
- concentration ratio suggests that some chemical elements as titanium, copper, zinc, strontium exceed background concentration habitats in North Island Elagina Pond;
- in assessing the ecological status of water bodies of the three reservoirs studied, in the North Island Elagina Pond the anthropogenic impacts were able to be identified by using the biogeochemical indicators;
- results of the study of macrophytes indicate that these bodies of water have become a promising target for future environmental monitoring.

Rezumat:

EVALUAREA STĂRII ECOSISTEMELOR ACVATICE PENTRU POPULAȚIILE DE MACROFITE

Articolul se referă la studiul biochimic al apei, care demonstrează eficacitatea folosirii macrofitelor în evaluarea acțiunilor antropice în ecosistemele acvatice naturale. Scopul cercetării este de a evalua starea ecologică a apei din trei zone din regiunea Leningrad și St. Petersburg. Rezultatele au fost obținute prin folosirea raxelor X. S-a raportat o creștere semnificativă a concentrației elementelor chimice din plantele acvatice, din zona de coastă până la cea submersă. Zonele studiate nu sunt supuse în aceeași măsură presiunii antropice. Din cele trei

bazine acvatice studiate, North Island Elagina Pond este afectată cel mai mult de impactul uman.

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Annexes:

Figure no. 1 The average of trace elements in *Carex acuta*

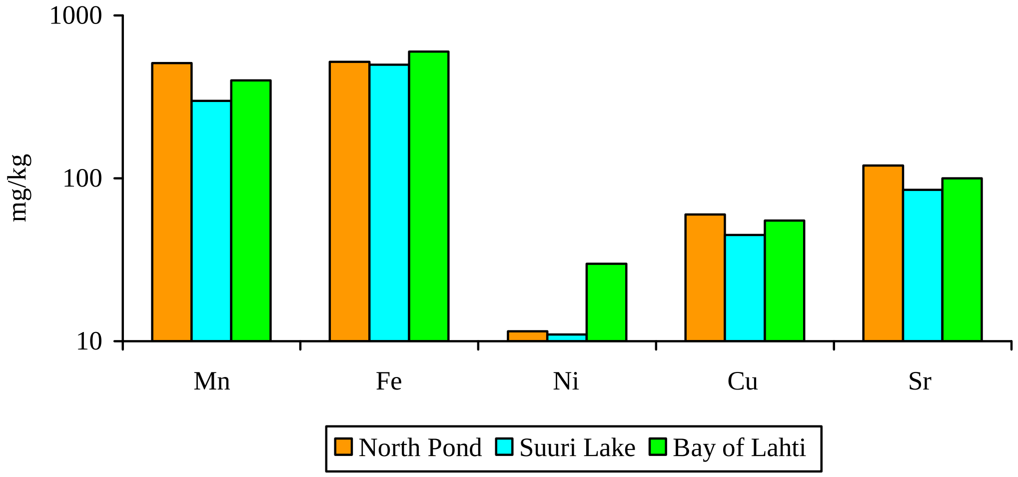

Figure no. 2 The average of trace elements in *Phragmites australis*

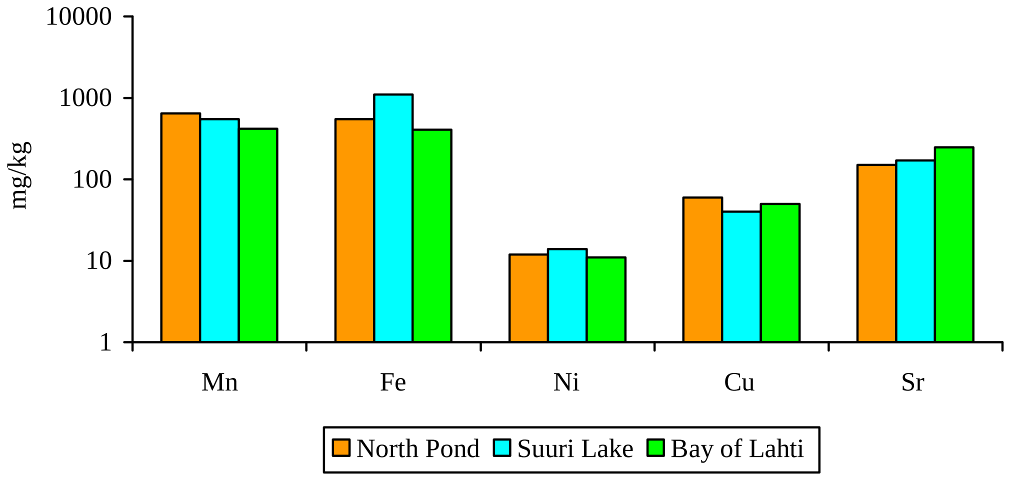

Figure no. 3 The ratio of Fe and Mn in macrophytes of studied reservoirs

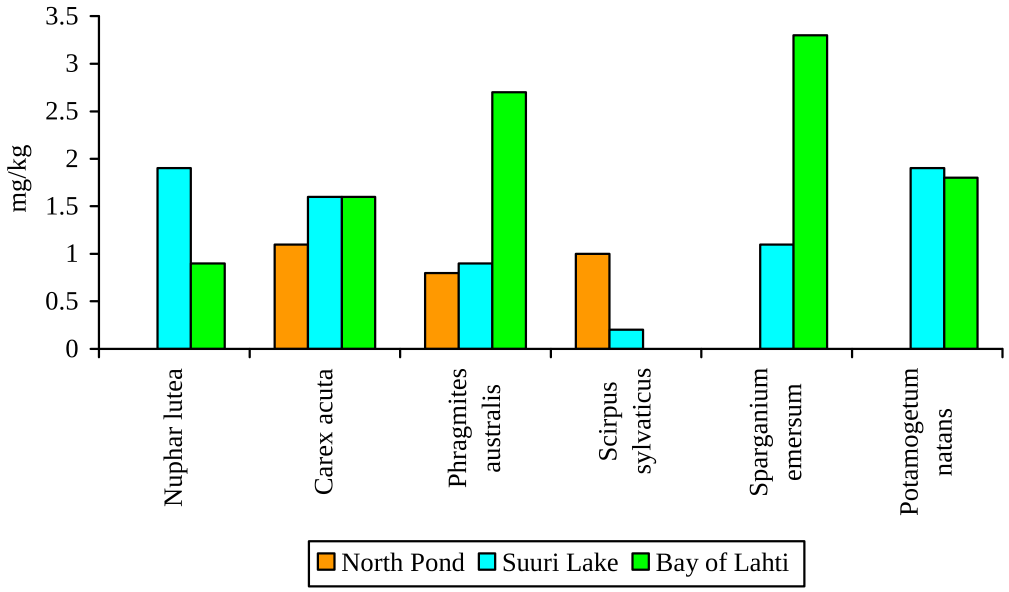

Figure no. 4 The geochemical spectrum KBN1 for macrophytes in the Gulf of Lahti

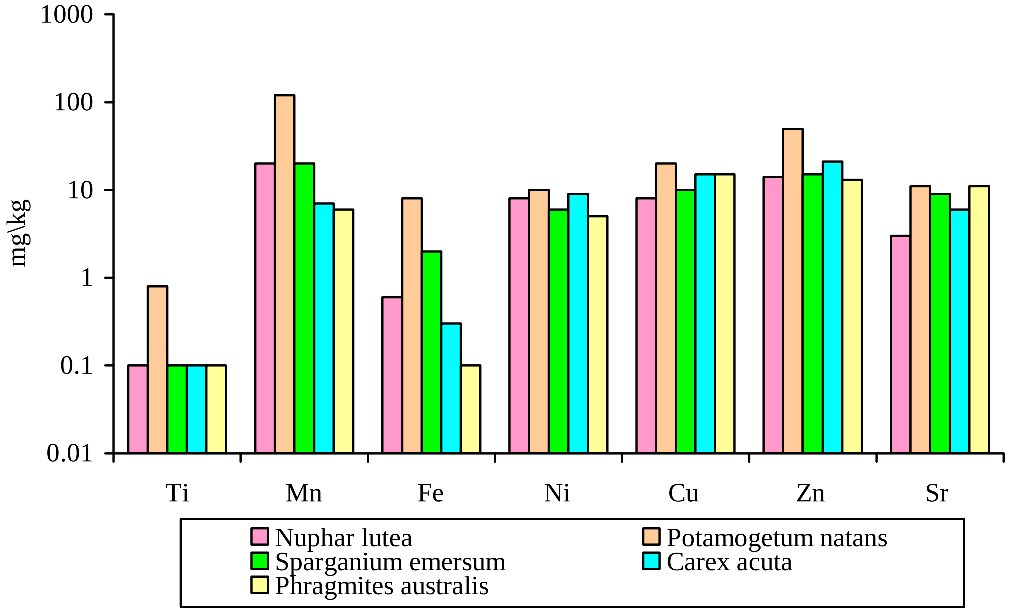

Figure no. 5 The geochemical spectrum KBN2 for macrophytes in the Gulf of Lahti

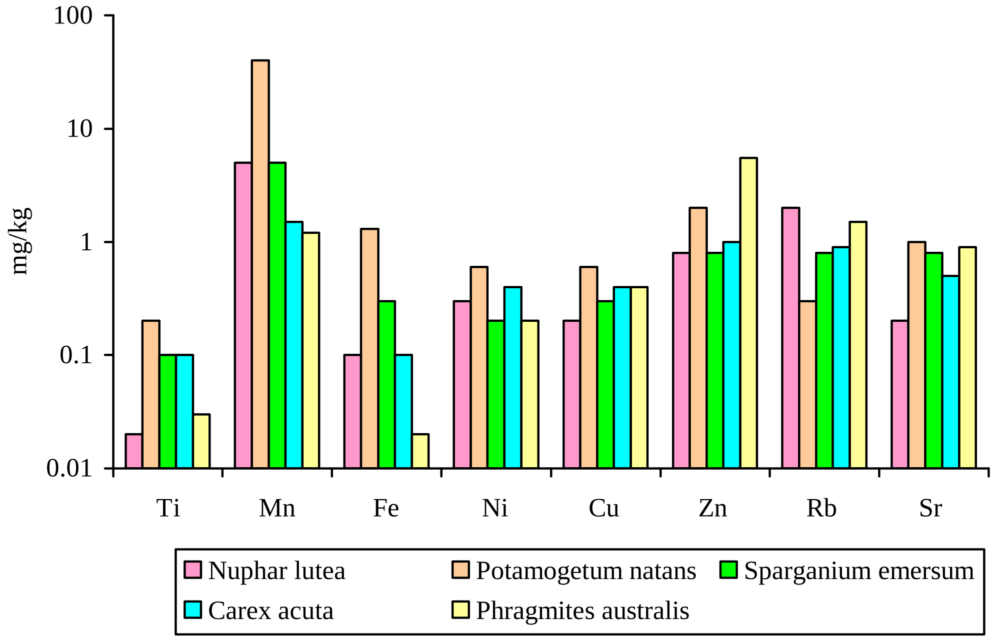

Figure no. 6 The ratio concentration of macrophytes in North Pond