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MULTISPECTRAL TELEVISION MONITORING OF CONTAMINATION OF WATER OBJECTS BY USING MACROPHYTE-BASED BIOINDICATION

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ABSTRACT

Bioindication quality of the aquatic environment can be carried out using of macrophytes, including duckweed (Lemna minor). The study recorded the following morphological deviation from the norm duckweed plants under the influence of pollutant: chlorosis, yellowing, wilting leaves, specific reaction. For the diagnosis of cell damage using vital staining method.

To automate the calculation of parameters used bioindicators method multispectral television monitoring, which is to obtain a series of images using a CCD-camera at the characteristic wavelengths of pigments. For each pixel in the image is computed distance in the multi spectral space that allows to divide the image into three areas: free of duckweed water surface (A), the surface occupied by duckweed without damage (B), as well as the surface occupied by duckweed damaged as a result of exposure to toxic compounds in water (C).

To evaluate the water quality in the river Snivoda following steps were performed: a sample in a petri dish containing 150-200 plants were divided by species. After sampling, it was estimated the number of plants of each species, the total number of shields, the number of shields with damages. To damage include black and white spots (necrosis), yellowing (chlorosis). After staining by safranin, we obtained a number of digital images using a CCD camera at characteristic wavelengths.

According to the results it can be concluded that the water quality correspondence estimation "3" by 5-point scale in accordance to the characteristics of duckweed. Also determined toxicity index was equal to 17% according to the percent of plants stained.

Keywords: multispectral, monitoring, macrophytes, bioindication, water.

INTRODUCTION

Water quality – a characteristic which determines the suitability of water for a specific method of its use in human life and economic activity. Water quality assessment is the primary goal of any measures in the field of water management, environmental management and implementation of environmental action in bodies of water [1].

Biological methods for assessment of water quality have a large number of advantages over chemical and physical as well as the grouping of living organisms show all changes to the aquatic environment, while responding to a variety of complex natural and anthropogenic factors, including pollutants. Assessment of the degree of water pollution on the composition of its population to quickly determine its sanitary condition, trophic status, the degree of contamination. Bioindication – method of evaluating water quality and ecological status of the water body composition indicator species or groups of structural indicators. In other words, bioindication – a way to assess the anthropogenic load on the reaction to it of living organisms and their communities.

The use of certain types of macrophytes, as well as groups like the ecological status of water bodies indicators looks very attractive because they are convenient for the object of observation. Even a brief investigation of the vegetation of the reservoir allows you to make a rapid assessment of its environmental condition. Bioindication by using macrophytes has certain limitations. First of all, it is only possible when the sum certain set of external conditions are favorable for the development of aquatic plants, namely in the pond: a moderate flow rate, the availability of sheltered and shallow water waves suitable sediments, water clarity and others. Good results for bioindication macrophytes can be obtained in the case study of the vegetation of lakes or ponds with good shallow area, or small and medium size rivers characterized by slow flow and shallow depths.

Bioindication for macrophytes is limited in time and is only possible in the vegetation period [2]. Selecting a group of organisms for which bioindication will be held, it should be remembered that water macrophytes characterized by a certain permanency by the reaction to short-term changes in environmental conditions. The most rapidly in aquatic ecosystems respond to changes in the environment of phytoplankton groups, which are subject to a short life cycle. The grouping of macrophytes consist mainly of perennial plants, it is stable, more adaptable to changes in the environment, so they are less responsive to short-term transformation of the state of the water body.

MATERIALS AND METHODS

Analysis of the viability of the species and their resistance to stress factors can be carried out at different levels: cellular, organismal, population. This morphological responses of organisms on technological factors are included in the practice of assessment of environmental quality. In studies of are recorded morphological deviations from the norm macrophytes under the influence of the pollutant:

1. chlorosis;
2. yellowing;
3. withering of leaves;
4. specific reactions.

The biological parameters are change of leaf color [3]:

1. yellowing;
2. browning;
3. the loss of color intensity.

For the diagnosis of cell damage are using vital staining method. It is based on staining with safranin stain of dead cells. Living cells severely limit penetration into organic substances, and placed in a dye solution almost not colored. The dye penetrates dead cells freely, so they can be immediately detected and taken into account. Safronin used as a dye, as it has the ability to paint well cell walls.

Phytotoxicity – the ability of toxic substances present in soil, water, air, etc. have poisonous (toxic) effects on the plant. The number of filled cells as a percentage of the total leaf area index of phytotoxicity was adopted.
To automate the calculation of parameters used bioindicators method multispectral television monitoring, which is to obtain a series of images using a CCD-camera at the characteristic wavelengths of pigments [4]. For each pixel in the image is computed distance in the multi spectral space that allows to divide the image into three areas: free of duckweed water surface (A), the surface occupied by duckweed without damage (B), as well as the surface occupied by duckweed damaged as a result of exposure to toxic compounds in water (C). Further calculation C / B ratio allows us to estimate toxicity index and water quality (fig.1).

To evaluate the water quality in the river Snivoda (sample selection is carried out on the river in the area of the village Zhigalovka) following steps were performed: a sample in a petri dish containing 150-200 plants were divided by type. After sampling, it was estimated the number of plants of each species, the total number of shields (parent and child), the number of shields with damages. To damage include black and white spots (necrosis), and yellowing (chlorosis). The next step was to prepare the slide preparation leaves little duckweed (Lemna minor). According to the results it can be concluded that the water quality correspondence estimation "3" by 5-point scale in accordance to the characteristics of duckweed. Also determined toxicity index was equal to 17% according to the percent of plants stained.

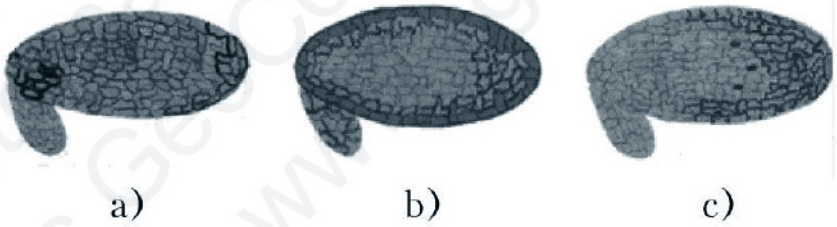

Figure 1. Application of the method of vital staining to study the degree of phytotoxicity environment by the example of duckweed (Lemna minor): a) "a mesh" staining associated with the penetration of the dye apoplastichnym way; b) "a mesh" staining, combined with damage at the edges of the sheet, as well as partial damage to young leaf; c) the combination of "mesh" with the local coloring dye penetration

RESULTS AND DISCUSSIONS

Duckweed were first used for testing water contamination by pesticides. As a correct assessment using indicators: growth rate, length and number of roots, leaf area, the reaction of photosynthesis and other physiological and morphological characteristics. Currently, by using species of the family Lemnaceae bioassays conducted on the toxicity of heavy metals, petroleum products, radionuclides and other pollutants [2].

During the 3-day experiment was determined Lemna minor response to various types of contaminants. For the experiment were prepared 0.5M solution NaI, NaCl, Na_2SO_4, NH_4NO_3, NaH_2PO_4, $NaNO_2$. Biological testing results after the first 24 hours, 48 hours and 72 hours of the experiment are presented in Table 1.

Table 1
Biological testing results by using duckweed (Lemna minor)

Solution	24 hours	48 hours	72 hours
NaI	Duckweed has changed color, darkened	Some individuals are reduced in size, darkening all the plants has increased	Some individuals are reduced in size, darkening all the plants has increased
NaCl	No change	No change	Duckweed is somewhat reduced in size
Na_2SO_4	Some individuals are reduced in size, darkening all the plants has increased	Some individuals are reduced in size, darkening all the plants has increased	Some individuals are reduced in size, darkening all the plants has increased
NH_4NO_3	No change	All the leaves are separated and become a little lighter	All the leaves are separated and become a little lighter
NaH_2PO_4	Duckweed greatly reduced in size and became lighter	Duckweed greatly reduced in size and became lighter	Plants completely lost their green color
$NaNO_2$	No change	No change	Some plants disengaged

CONCLUSION

Macrophytes are the sensitive indicators of the hydrological and thermal regimes of reservoirs, characterizing their trophic status, especially the chemistry and other properties. Certain types of macrophytes appear effective bioindicators of changes in the environment.

According to the results it can be concluded that the water quality correspondence estimation "3" by 5-point scale in accordance to the characteristics of duckweed. Also determined toxicity index was equal to 17% according to the percent of plants stained.

Based on these results, we can conclude that the most profound effect on duckweed (Lemna minor) include the following materials: NaI (some individuals are reduced in size, darkening all the plants has increased), NH_4NO_3 (All the leaves are separated and become a little lighter), NaH_2PO_4 (duckweed greatly reduced in size and became

lighter) and Na_2SO_4 (some individuals are reduced in size, darkening all the plants has increased). The smallest impact on the duckweed had the following substances: NaCl, $NaNO_2$. Also suggests that duckweed (Lemna minor) can comfortably compared with low contamination exist chlorides and nitrites, but strongly react to the presence of water iodides, nitrates, sulfates, orthophosphates. Also, it can be concluded that the duckweed (Lemna minor) bioindicators sufficiently sensitive, since changes were noticeable after 24 hours of the experiment.

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