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БАЯНДАМАЛАРЫ

ДОКЛАДЫ

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THE ROLE OF HIGHER VASCULAR PLANTS IN BIOLOGICAL WASTEWATER TREATMENT

Abstract. The article presents the results of a botanical analysis of water systems in the south of Kazakhstan.

Hydromacrophytic vegetation of the reservoir reflects its hydrological and thermal regime and can characterize the features of its chemical composition, trophic status, age (as a stage of development). In some cases, phytocenosis and some types of macrophytes can be used as bioindicators, for example, in clean water, as well as to determine the degree and nature of anthropogenic impacts.

Metals, metal compounds and toxins cause disturbances in many metabolic processes in plants. As a result, the highly toxic nature of their ions selectively affects the species composition of the phytocenosis.

In Shymkent, almost a unique system of treatment facilities has been operating for about 20 years, during this time, resistant species adapted to the environment were selected, and a plant cenosis consisting of dominant species was formed. In this regard, a floristic study was carried out in the canals around the treatment plant, adapted to climatic conditions and pollutants. As a result of the study, the species composition and the number of plant communities decreased due to the toxic concentration of water.

It is clearly seen that Cerathophyllum demersum, Lemna minor, L. trisulca, Phragmites australis, Scirpus lacustris, Epilobium adnatum were identified as effective phytomeliorants, significantly reducing the content of the main pollutants in urban wastewater. In addition, algae have been found to be indicators of pollution. Highly effective organic fertilizers can be obtained from the used vascular plants and algae.

In general, these data showed that the optimal consortium of wastewater treatment plants at low temperatures should be formed from different ecological groups of plants: coastal, floating and inhabiting the aquatic environment. In addition, among these plants were found sedimentary hornbeam, campfire fish, southern reed, lake reed and a related cypress.

Key words: wastewater, water plants, phytomeliorants, water system, algae.

Introduction. Hydromacrophytic vegetation of the reservoir reflects its hydrological and thermal regime [1] and can characterize the features of its chemical composition, trophic status, age (as a stage of development). In some cases, phytocenosis and some types of macrophytes can be used as bioindicators, for example, in clear waters [2], as well as to determine the degree and nature of anthropogenic impacts [3].

Metals, metal compounds and toxins cause disturbances in many metabolic processes in plants. As a result, the highly toxic nature of their ions selectively affects the species composition of the phytocenosis [4].

Research by Senze et al. showed that among the group of metals such as cadmium, copper and nickel, cadmium is primarily accumulated in ecosystems. A number of plants are capable of accumulating heavy metals. According to Tangahu et al., Scirpusrossus is one of the promising lead hyperreactor cells capable of reducing the metal content in water by more than 99.7% in 28 days. A number of studies suggest the use of *Ceratophyllum demersum* [5] and *Typha angustata* [6] for the treatment of polluted waters. When comparing seven types of accumulation of heavy metals in aquatic plants *Ipomoea aquatic Forsk, Eichhornia crassipes*, (Mart.) *Solms, Typha angustata Bory & Chaub, Echinochloa colum* (L.) *Link, Hydrilla verticillata* (L.f.) Royle, *Nelumbo nucifera Gaerth. and Vallisneria spiralis L. Nelumbo nucifera*

had the highest accumulation capacity [7]. At the same time, it was found that metals are unevenly distributed over plant organs and depend on the plant species.

Thus, the impact of technogenic factors on plants causes certain morphological and genetic changes caused by the toxic properties of various types of pollutants [8-10]. In the plant communities of contaminated areas, there is a natural selection of tolerant species, which are defined as the dominant plants of disturbed ecosystems. Establishing a correlation relationship between influencing factors and morphometric changes, the dominant plant species serve as the basis for the bioindication method for assessing the ecological state of regions.

Objects and methods of research. Floristic studies of the hydromacrophytic communities were carried out on mountain rivers Zhabagly-Su, Kaskasu, Balda-Breck, Keltie-Mashat, Sayramsu and lowland rivers Badam and Koshkar-Ata in Southern Kazakhstan.

Sampling and hydrochemical analysis of water were carried out according to government standard (GOST) 18826-73, 4388-72, 18293-72, 18309-72, 4245-72, 3351-74, 4979-49, 4151-72 and 18293-73, as well as according to the generally accepted method of V.M. Katanskaya.

To determine the species composition of the plant communities references have been used and determination keys (Pavlov N.V., 1956-1966). Sampling of plants was carried out by route and reconnaissance method followed by post-processing of collected herbarium material. The frequency of occurrence of terrestrial plant species was determined on the Drude scale, and aquatic plants using its modified version according to V. Sukachev.

Statistical analysis of the results. Experiments were carried out five times in repetition, calculate the standard deviation at 0.95> P> 0.80. Statistical processing was performed using the statistical software package Microsoft Excel. By the number of measurements and in general diagnostic group determined the arithmetic mean.

Research results and discussion. The study did not take into account the artificial phytocenosis, which is located along the water channels, but not related to the aquatic environment. This is due to the fact that plant species, often belonging to the annual or biennial ruderal and segetal groups, do not significantly affect the aquatic ecology.

Due to research the ratio of ecological groups in the species composition of the studied phytocenosis, it was found that in the composition of phytocenoses 1-3 there are no representatives of hydrophytic groups. This showed that the aquatic environment was unfavorable for them. It is associated with very high concentrations of organic and mineral pollutants. Cosmopolitan species such as the southern reed (*Phragmites australis* (Cav.) Trin.) and the amphibian (*Polygonum amphibium* L.) predominate. The third phytocenosis includes 4 species of *Diatomophyta,* 2 species of *Cyanophyta* and 3 species of *Chlorophyta*. Further, due to the purification of the aquatic environment, in 4-5 phytocenoses lake reeds (*Scirpus lacustris* L.), several species of sagebrush (*Potamogeton natans L., P. filiformis* Pers.), Veronica (*Veronica anagallis-aquatica* L., V. beccabunda L.) appears. Phytocenosis includes sedimentary hornbeam (*Ceratophyllum demersum* L). The occurrence of water mint (*Mentha aquatica* L) among these plants has been estimated to be rare on the Drude scale. Among the representatives of algoflora there are 7-9 species of *Diatomophyta, Chlorophyta*. Thus, the results of this study clearly show that the chemical composition of the aquatic environment has a strong influence on the species composition of plant communities. In addition, the reduction of excess toxic concentrations of organic and mineral substances in the aquatic environment creates favorable conditions for the survival of true hydrophytic plants. As a result, in the 3-4 phytocenosis begins to form a high-level community of true hydrophytic plants and algae. A decrease in the toxic concentration of pollutants activates the life of plants, and this is due to the concentration of optimal amounts of minerals by strengthening the nutrient base.

It is worth noting the important role of the algae association in the purification of the aquatic environment. This is because algae have a much higher contact with the aquatic environment than higher aquatic plants. Analyzing the results of the study, it can be seen that algae predominate in certain periods, and the composition of the phytocenosis after their periods of rapid development consists of plants that live in moderately purified water. This conclusion was confirmed by chemical analysis of the aquatic environment.

The second characteristic of the plant community was the design of the water surface. These values of phytocenoses 1 and 2 did not exceed 5-10 ± 2.2%, it reached 25-30 ± 1.7% in 3 phytocenoses, 85-100 ± 7.4%

in 4 -6 phytocenoses. In order to study the phytomeliorative properties of local aquatic plants identified in these studies, 8 glue bottles with a capacity of 50 liters were tested in production model experiments. Each box was filled with 2 kg of biomass of individual plant species and 40 liters of wastewater from the primary radial settler. The cans were placed in the open air near the sandbox. The duration of the experiment was 10 days. The results of the study showed that the aquatic environment was purified by a number of ingredients. All plants continued their normal vegetation processes and increased their biomass by 2-2.5 times under the experiment. However, the deterioration of the aeration regime contributes to the biological pollution of the aquatic environment due to contamination by aquatic organisms. This is due to the fact that the decrease in the concentration of dissolved oxygen in the aquatic environment contributes to the rapid development of anaerobic microorganisms. As a result, the optimal parameters of the aquatic plant's habitat are violated, which adversely affects their life processes, impairing the growth, development and reproduction of plants. And sometimes it even stops.

The dynamics of absorption of ammonium and nitrite ions of these plant species was studied in laboratory experiments. For this purpose, glass aquariums with a capacity of 20 liters with a model solution of 15 mg / l ammonium and 1 g / l mineral salts were used. The experiment was performed for 7 days at a temperature of 0 + 50C in a Samsung refrigerator, where additional lighting was turned on. The study showed that Cerathophyllum demersum, Lemna minor, L. trisulca, Phragmites australis, Scirpus lacustris, Epilobium adnatum are exposed to 0 + 50C for a long time. In this case, the level of purification of the aqueous solution from the nitrogen group is in the range of 10.6-43.6 ± 3.3%, and the value of mineral salts is in the range of 5-16 ± 1.2%. Additional light significantly extended the viability of the plant.

It can also be noted that algae are an indicator of water pollution. Waste algae and higher vascular plants can be used in the future to obtain biofertilizers.

Conclusion. Overall, these data showed that the optimal consortium of plants for wastewater treatment at low temperatures should be formed from different ecological groups of plants: coastal, floating and living in the aquatic environment. In addition, such plants were found sedimentary hornbeam, small fish fire, southern reed, lake reed and related cypress.

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АҒЫНДЫ СУЛАРДЫ БИОЛОГИЯЛЫҚ ТАЗАРТУДАҒЫ ЖОҒАРҒЫ ТАМЫРЛЫ ӨСІМДІКТЕРДІҢ МАҢЫЗЫ

Аннотация. Мақалада Қазақстанның оңтүстігіндегі су жүйелерін ботаникалық талдау нәтижелері көрсетілген.

Су қоймасының гидромакрофиялық өсімдіктері оның гидрологиялық және жылу режимін көрсетеді және оның химиялық құрамының, трофикалық мәртебесінің, жасының ерекшеліктерін (даму сатысы ретінде) сипаттай алады. Кейбір жағдайларда фитоценозды және макрофиттердің кейбір түрлерін биоиндикатор ретінде қолдануға болады, мысалы, таза суда, сонымен қатар антропогендік әсердің дәрежесі мен сипатын анықтауға болады.

Металдар, металл қосылыстары мен токсиндер өсімдіктердегі көптеген метаболикалық процестердің бұзылуын тудырады. Нәтижесінде, олардың иондарының өте улы табиғаты фитоценоздың түрлік құрамына селективті түрде әсер етеді.

Шымкентте 20 жылға жуық бірегей тазарту құрылғылары жүйесі жұмыс істейді, осы уақыт аралығында қоршаған ортаға бейімделген төзімді түрлер таңдалып, басым түрлерден тұратын өсімдіктер ценозы қалыптасты. Осыған байланысты тазарту қондырғысының айналасындағы каналдарда климаттық жағдайларға және ластаушы заттарға бейімделген флористикалық зерттеу жүргізілді. Зерттеу нәтижесінде судың улы концентрациясына байланысты түрлер құрамы мен өсімдік қауымдастықтарының саны азайды.

Cerathophyllum demersum, Lemna minor, L. trisulca, Phragmites australis, Scirpus lacustris, Epilobium adnatum тиімді фитомелиорант ретінде анықталып, қалалық ағын сулардағы негізгі ластаушы заттардың

құрамын едәуір төмендеткені анық байқалады. Сонымен қатар, балдырлар ластану индикаторлары болып табылды. Жоғары тиімді органикалық тыңайтқыштарды қолданылған тамырлы өсімдіктер мен балдырлардан алуға болады.

Қорытындылай келсек, бұл мәліметтер ағынды суларды тазарту қондырғыларының төмен температурадағы оңтайлы консорциумы өсімдіктердің әр түрлі экологиялық топтарынан: жағалаудағы, өзгермелі және сулы ортада тіршілік ететін топтардан құрылуы керек екенін көрсетті. Сонымен қатар, осы өсімдіктерден шөгінді мүйіз, от жағатын балықтар, оңтүстік қамыс, көл құрағы және онымен байланысты кипарис табылды.

Түйін сөздер: ағынды сулар, су өсімдіктері, фитомелиораттар, су жүйесі, балдырлар

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РОЛЬ ВЫСШИХ СОСУДИСТЫХ РАСТЕНИЙ В БИОЛОГИЧЕСКОЙ ОЧИСТКЕ СТОЧНЫХ ВОД

Аннотация. В статье приведены результаты ботанического анализа водных систем юга Казахстана.

Гидромакрофитная растительность водоема отражает его гидрологический и термический режим и может характеризовать особенности его химического состава, трофического статуса, возраста (как стадии развития). В некоторых случаях фитоценоз и некоторые виды макрофитов могут использоваться как биоиндикаторы, например, в чистой воде, а также для определения степени и характера антропогенных воздействий.

Металлы, соединения металлов и токсины вызывают нарушения многих обменных процессов у растений. В результате высокотоксичная природа их ионов избирательно влияет на видовой состав фитоценоза.

В Шымкенте уже около 20 лет действует практически уникальная система очистных сооружений, за это время были отобраны устойчивые виды, адаптированные к окружающей среде, и сформирован растительный ценоз, состоящий из доминирующих видов. В связи с этим в каналах вокруг очистных сооружений было проведено флористическое исследование, адаптированное к климатическим условиям и загрязнителям. В результате исследования видовой состав и количество растительных сообществ снизились из-за токсической концентрации воды.

Отчетливо видно, что *Cerathophyllum demersum, Lemna minor, L. trisulca, Phragmites australis, Scirpus lacustris, Epilobium adnatum* были определены как эффективные фитомелиоранты, значительно снижающие содержание основных загрязнителей в городских сточных водах. Кроме того, было обнаружено, что водоросли являются индикаторами загрязнения. Из использованных сосудистых растений и водорослей можно получить высокоэффективные органические удобрения.

В целом эти данные показали, что оптимальный консорциум установок для очистки сточных вод при низких температурах должен формироваться из разных экологических групп растений: прибрежных, плавучих и обитающих в водной среде. Кроме того, среди таких растений были найдены осадочный граб, костровая рыбка, тростник южный, озерный тростник и родственный кипарис.

Ключевые слова: сточные воды, водные растения, фитомелиоранты, водная система, водоросли.

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