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1-бөлім

ҚОРШАҒАН ОРТАНЫ ҚОРҒАУ ЖӘНЕ ҚОРШАҒАН ОРТАҒА АНТРОПОГЕНДІК ФАКТОРЛАРДЫҢ ӘСЕРІ

Section 1

ENVIRONMENTAL IMPACT OF ANTHROPOGENIC FACTORS AND ENVIRONMENTAL PROTECTIONY

Раздел 1

ВОЗДЕЙСТВИЕ НА ОКРУЖАЮЩУЮ СРЕДУ АНТРОПОГЕННЫХ ФАКТОРОВ И ЗАЩИТА ОКРУЖАЮЩЕЙ СРЕДЫ

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PRODUCTIVITY AND ACCUMULATION OF HEAVY METALS IN GRAIN OF VARIOUS GENOTYPES OF SPRING DURUM WHEAT UNDER CONDITIONS OF SOIL CONTAMINATION WITH CADMIUM AND ZINC

The developed industry has an adverse effect on the ecological state of the environment, accompanied by the accumulation of harmful substances in the soil, including heavy metals. Therefore, the creation of technogenically resistant varieties of agricultural crops is one of the components of environmentally friendly technologies. This study is aimed at studying various genotypes of spring durum wheat for their resistance to the accumulation of cadmium and zinc in grain, which is a commercial part of the product. The content of the studied heavy metals in the soil of the root zone of various genotypes of spring durum wheat was investigated. The accumulation of the studied elements in seeds was determined, which is the most important studied indicator. The indices of productivity and survival of spring durum wheat genotypes were investigated in the field of natural pollution of the environment with heavy metals. The most stable and sensitive to the action of cadmium and zinc genotypes were revealed. The structure of spring wheat productivity from the collection and the relationship of its elements were analyzed. The identified resistant genotypes are recommended for further study of their productivity and survival in weather conditions of the East Kazakhstan region in field experiments to identify forms promising for agricultural production.

Key words: cadmium, zinc, spring durum wheat.

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Топырақтың кадмиймен және мырышпен ластануы жағдайында жаздық қатты бидайдың әртүрлі генотиптері астығының өнімділігі мен ауыр металдардың жинақталуы

Дамыған өнеркәсіп қоршаған ортаның экологиялық жағдайына теріс әсер етеді, топырақта зиянды заттардың, соның ішінде ауыр металдардың жинақталуымен бірге жүреді. Сондықтан дақылдардың техногендік төзімді сұрыптарын жасау экологиялық таза технологиялардың құрамдас бөлігі болып табылады. Бұл зерттеу жұмысы жаздық қатты бидайдың әртүрлі генотиптерін олардың өнімнің тауарлық бөлігі болып табылатын астығында кадмий мен мырыштың жиналуына төзімділігі бойынша зерттеуге бағытталған. Жаздық қатты бидайдың әртүрлі генотиптерінің базальды аймағының топырағындағы ауыр металдардың құрамы зерттелді. Зерттелген ауыр металдардың бидай тұқымдарында жинақталуы анықталды, бұл ең маңызды зерттелген көрсеткіш болып табылады. Қоршаған ортаның ауыр металдармен табиғи ластануы жағдайында жаздық қатты бидай генотиптерінің өнімділігі мен өмір сүру көрсеткіштері зерттелді. Тәжірибе нәтижесінде кадмий мен мырыштың әсеріне ең төзімді және сезімтал генотиптер анықталды. Жинақтан жаздық бидайдың өнімділік құрылымына және оның элементтерінің өзара байланысына талдау жүргізілді. Анықталған төзімді генотиптер ауыл шаруашылығы өндірісі үшін перспективалы нысандарды анықтау үшін Шығыс Қазақстан өңірінің ауа-райы жағдайларында олардың өнімділігі мен өмір сүруін далалық тәжірибелерде одан әрі қарай зерттеу үшін ұсынылды.

Түйін сөздер: кадмий, мырыш, жаздық қатты бидай.

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Урожайность и накопление тяжелых металлов в зерне различных генотипов яровой твердой пшеницы в условиях загрязнения почвы кадмием и цинком

Развитая промышленность оказывает неблагоприятное воздействие на экологическое состояние окружающей среды, сопровождающееся накоплением в почве вредных веществ, в том числе тяжелых металлов. Поэтому создание техногенно-устойчивых сортов сельскохозяйственных культур является одной из составляющих экологически чистых технологий. Данное исследование направлено на изучение различных генотипов яровой твердой пшеницы по их устойчивости к накоплению кадмия и цинка в зерне, которая является товарной частью продукции. Было исследовано содержание изучаемых тяжелых металлов в почве прикорневой зоны различных генотипов яровой твердой пшеницы. Определены накопления изучаемых элементов в семенах, что является наиболее важным исследуемым показателем. Также были изучены показатели урожайности и выживаемости генотипов яровой твердой пшеницы в полевых условиях естественного загрязнения среды тяжелыми металлами. Выявлены наиболее устойчивые и чувствительные к действию кадмия и цинка генотипы. Проведен анализ структуры урожайности яровой пшеницы из коллекции и взаимосвязь ее элементов. Выявленные устойчивые генотипы рекомендованы для дальнейшего изучения их урожайности и выживаемости в погодных условиях Восточно-Казахстанского региона в полевых экспериментах для выявления перспективных для сельскохозяйственного производства форм.

Ключевые слова: кадмий, цинк, яровая твердая пшеница.

Introduction

The mining industry and metallurgy are well developed in Kazakhstan, however, the developed industry has an adverse impact on the ecological state of the environment, accompanied by the accumulation of harmful substances in the soil, including heavy metals. Soils of agrocenoses may also be contaminated. So, for example, it was noted that in regions where ferrous metallurgy is developed, soil pollution with lead is 3, and zinc is 2 times higher than on unpolluted soils, while the accumulation of heavy metals by agricultural plants is 1.5 – 2.0 times higher than theirs maximum permissible concentration (MPC) for soil. Metal compounds emitted into the air by industrial enterprises in the form of dust settle on the soil, plants at a distance of 10-40 km from pollution sources [1].

The study of lead content in the soil and plants of wheat and potatoes in the zone of influence of enterprises of the West Siberian industrial region showed that chernozems annually accumulate this element in amounts exceeding the MPC by 2.0-5.4 times, and plants – by 1.5-2.8 times. At the same time, in the area of maximum distribution of dust aerosols, an increasing increase in metal occurs both in the soil and in plants. Thus, in the third year of observations, the highest concentration of metal in the soil was 54 mg / kg, in plants – 2.8 mg / kg. compared with its concentration in the first year of observation – 20 mg / kg and 1 mg / kg 20 mg / kg, respectively [2].

There is also information that very high concentrations of Cd, Pb and Zn were found in plants and soils adjacent to smelters [3]. As a result of the activity of the zinc smelting plant, the soils turned out to be heavily contaminated with zinc, lead and cadmium, the gross amount of metals in the soil within a radius of 1.5 km from the enterprise exceeded the MPC: for zinc 4-10 times, for lead 2-4 times, for cadmium – in 4 times. In crop production, the maximum concentrations of zinc and cadmium were detected in almost all crops, which is an environmental hazard and worsens the quality of agricultural products [4].

Excessive amounts of heavy metals in the soil affect the productivity of agricultural plants and the quality of the products obtained. For example, an increase in the level of soil contamination with cadmium led to a decrease in yield by 21-34% compared to the control variant, and to a decrease in the removal of basic nutrients. A.O. Shumilin showed that at background values of the cadmium content in the soil, about 0.1 mg of cadmium per kilogram of dry weight was accumulated in the seeds of spring wheat; with an increase in the cadmium content by 10 mg / kg of soil, its content in the grain increased 23 times, and with the cadmium content in soil at the level of 50 mg / kg of soil – 55 times [5].

The presence of polluting trace elements can have a huge impact on the state of the biosphere. Violation of mineral metabolism and, as a result, an imbalance of chemical elements in food products, is the main cause and trigger mechanism for the occurrence and development of many diseases of humans and animals [6]. Scientists are of the opinion that the bulk of heavy metals enters the human body with plant food [7]. Zinc and copper are recognized as essential, that is, vital elements, but, as toxicants, they are classified as hazard classes I and II. Lead and cadmium are pollutants that can be toxic to the body [8].

Due to the fact that large areas are contaminated with heavy metals and methods of soil cleaning are ineffective, a promising direction for solving this problem is the search for varieties of agricultural crops with a reduced level of their accumulation in the commercial part of plants in order to grow in contaminated areas or selection in this direction, there is information that a different ability to accumulate cadmium was revealed in varieties of soft and durum wheat [9, 10]. Therefore, the purpose of our work was to study various genotypes of spring durum wheat for their resistance to the accumulation of cadmium and zinc in grain, which is a commercial part of the product.

Materials and methods

The object of research in this work is the genotypes of spring durum wheat from the collection of the East Kazakhstan Research Institute of Agriculture. The experiment studied varieties and genotypes of spring durum wheat: Nauryz, Lan, GVK (East Kazakhstan genotype)-10008, GVK-19005, GVK-5/14.

Growing plants in conditions of natural pollution. Plants were grown in nurseries of primary seed growing of the research site of the East Kazakhstan Research Institute of Agriculture, in conditions of natural pollution, in the suburban area of Ust-Kamenogorsk, East Kazakhstan region, north-east direction, 3 km from the city border. The area of the experimental plot is 5 m2 in triplicate. Sowing is mechanized, plotting, the seeding rate is 5-6 million germinating grains per hectare. The width of the aisles is 15 cm, the space between the rows is 50 cm.

The soil cover of the experimental site is represented by ordinary heavy loamy chernozem, widespread in the foothill-steppe zone. The soil of the experimental plot is neutral (pH 7.0). The humus content in the arable horizon averages 2.6%. The soil is moderately supplied with easily assimilable nitrogen (22.6-18.4 mg / kg soil), highly supplied with mobile potassium (390-400 mg / kg soil) and low supplied with mobile phosphorus (16.3-18.5 mg / kg soil).

The predecessor – black fallow after autumn plowing – 23-25 cm. When laying the experiments, soil preparation, sowing and plant care were carried out according to the accepted technology of barley cultivation in the foothill steppe zone of East Kazakhstan. Early spring harrowing, cultivation, pre-sowing cultivation. Plant care (rolling, weeding by hand).

Determination of the content of heavy metals in the soil of the root zone and in the grain. The concentration of heavy metals (zinc and cadmium) was determined using an atomic absorption spectrophotometer. The method of atomic absorption spectrophotometry (AAS) is based on the property of atoms of chemical elements formed when the solutions of the substances used are sprayed in a “cold” flame (acetylene-air, propane-air, etc.) to absorb light of a certain wavelength. The radiation intensity of low-pressure gas-discharge lamps after the passage of light through a combustible gas flame and its absorption by the atoms of the investigated element is recorded photoelectrically. Samples of grain and soil in the root zone taken in the field of natural soil contamination with heavy metals were ashed in a muffle furnace. The ash material was treated with nitric and hydrochloric acids and water was added. The atomic absorption of the test and control samples was measured using an atomic absorption spectrophotometer [11, 12, 13].

*Determination of plant survival***.** To determine the survival rate of plants, the number of spring durum wheat plants emerging and remaining before harvesting was calculated per unit area. By the difference between these indicators, one can judge the survival rate of plants during the spring-summer growing season.

Determination of vegetative indicators and productivity in conditions of natural environmental pollution.

Phenological observations, field and laboratory assessments, records were carried out according to generally accepted methods [14, 15].

Observations were carried out for the following developmental phases – seedlings, tillering, renewal of vegetation, tube emergence, heading, flowering, ripeness.

The productive bushiness was determined in plants. Plants were dug up in each variant and the actual number of stems per plant (total, including productive ones) was counted. The arithmetic mean obtained from dividing the total number and number of productive stems by the number of plants, respectively, characterizes the total or productive tillering, depending on the variety.

Plant survival was determined. Plants were counted in the full germination phase and before harvesting. The number of preserved plants (%) is calculated by the formula:

$$A = \frac{(Cx100)}{B}$$

where: A – the number of plants preserved for harvesting, %; B – the number of plants in the full germination phase, pcs. per m^2; C – the number of plants to be harvested, pcs. per 1 m^2.

The yield was determined by a direct gravimetric method. The grain moisture was determined by the gravimetric method. From each plot, grain samples are taken into aluminum cups with a tight lid, weighed and dried at a temperature of 100 ° – 105 ° C to a constant weight of about 4 – 6 hours, then the calculation is carried out using the formula:

$$X = B : H$$

where: X – grain moisture, % ; B – mass of evaporated water, g; H – raw weight, g.

The standard 14% humidity is recalculated according to the formula:

$$X = Y \text{ x } (100 – b) / 100 – c,$$

where: X – yield reduced to standard moisture content; Y is the yield obtained; b – moisture content of the crop (%); c – standard humidity for this object.

When analyzing the plants by the elements of the structure of the grain yield, 10 plants were selected from each plot of all repetitions of the experiment.

Research results and discussion

First of all, the content of the studied heavy metals in the soil of the root zone of various genotypes of spring durum wheat was investigated. With prolonged intake of heavy metals from emission sources into the atmosphere, a significant amount of them accumulates on the soil surface. The mining and processing of metal ores, coupled with industry, have led many countries to widespread metal contaminants in the soil. During mining, tailings (heavier and larger particles deposited on the bottom of the flotation machine during mining) are directly discharged into natural depressions, including wetlands, resulting in increased concentrations of heavy metals [16]. Most of the heavy metals are emitted into the atmosphere in the form of solid aerosols with particles of 0.1 – 0.5 microns. The bulk of emissions settles near the source of pollution, quickly enters the surface of soil and plants, is carried out and migrates with surface and ground runoff. As a result, technogenic geochemical regions of heavy metals are formed [17].

Soil contamination with cadmium is one of the most dangerous environmental phenomena [17]. In terms of its effect on the natural environment and humans, cadmium is of particular concern due to its potential harm, therefore, in various environmental programs it is classified as a priority pollutant to be controlled [18].

The results of the study of the cadmium content in the soil of the root zone showed that in relation to the MPC of cadmium in the soil, there is an excess of one and a half, two and a half times.

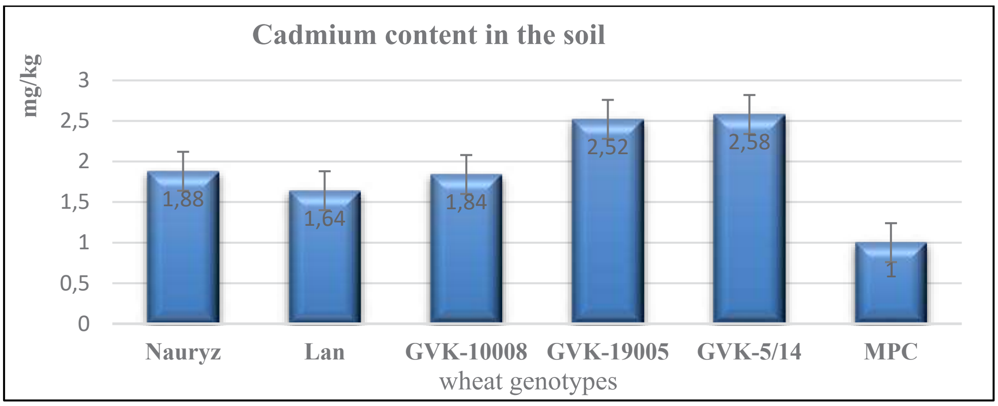

Figure 1 – The content of cadmium in the soil of the root zone of various wheat genotypes in relation to the MPC

The ratio of the cadmium content in the soil of the root zone to the Regional Clark was also determined. There is an opinion that the content of elements in the topsoil should be compared with the background [19, 20]. Some researchers understand the "background" as proposed by A.P. Vinogradov "clarks" – the average content of elements in the biosphere, others – the average regional content of chemicals in soils that have not experienced anthropogenic impact, that is, unpolluted areas [21]. In East Kazakhstan, all soils are experiencing, to one degree or another, a technogenic impact, taking into account this circumstance, in our studies we compare the content of heavy metals with "clarks." Studies have shown that in relation to Regional Clark, the excess of the metal content has higher values, than in relation to MPC (approximately 2.5 -3.5 times).

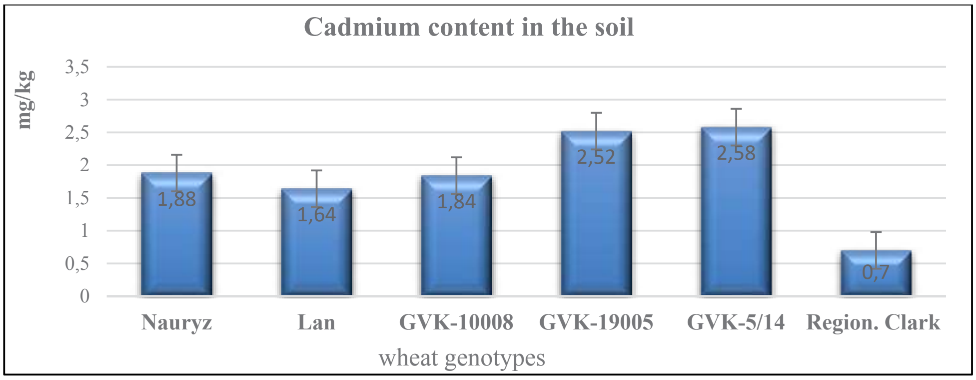

Figure 2 – The content of cadmium in the soil of the root zone of various wheat genotypes in relation to Regional Clark

The content of zinc in the soil of the root zone of various genotypes of spring wheat was also investigated (Figures 3, 4).

Intensive mining and smelting of lead-zinc ores and zinc leads to soil contamination, which poses a threat to human health and the environment. Many methods of reclamation of these areas are long and expensive and cannot restore soil productivity. The environmental risk of soil heavy metals to humans is associated with their bioavailability [22]. The presence of the mining and metallurgical industry in East Kazakhstan also causes polymetallic soil pollution.

The results of the study of the zinc content showed that in relation to MPC of zinc in the soil, there is an excess of 1.8 -1.9 times (Figure 3).

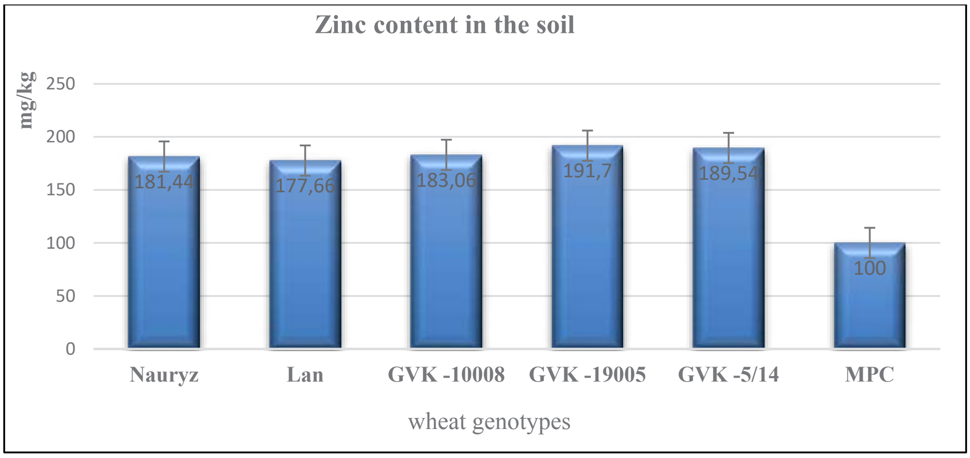

Figure 3 – The content of zinc in the soil of the root zone of various wheat genotypes in relation to the MPC

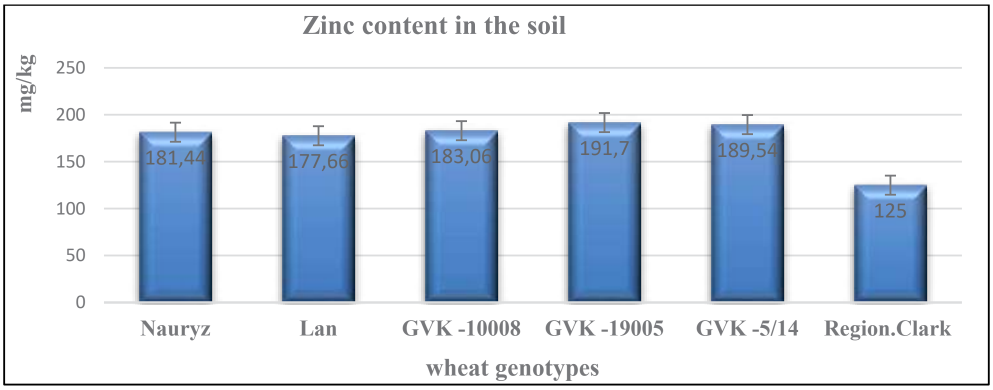

Figure 4 – The content of cadmium in the soil of the root zone of various wheat genotypes in relation to Regional Clark

The ratio of the zinc content in the soil of the root zone to the Regional Clark was also determined. Studies have shown that in relation to Regional Clark, the excess of zinc content has lower values than in relation to MPC (approximately 1.42 -1.53 times).

Thus, all studied genotypes are stressed by the increased content of cadmium and zinc in the soil. At the same time, the content of cadmium makes a greater contribution to stress, since compared to its natural content in the region, the excess is 2.5-3.5 times, while zinc is about 1.5 times.

Determination of the accumulation of the studied elements in seeds is the most important studied indicator, since wheat grain is used in the food industry.

Our studies have shown that zinc ions accumulate in seeds of all genotypes of spring durum wheat and their amount exceeds the MPC for grain by about two and a half times. Less, in comparison with other genotypes, accumulates zinc ions of the Lan genotype, most of all – the GVK-19005 genotype, the other genotypes of spring durum wheat show average values of the content of this element (Figure 5).

The study of the content of cadmium ions in seeds of spring durum wheat showed that this metal accumulates and its amount exceeds the MPC for grain for all studied genotypes, except for the GVK-10008 genotype. At the same time, there are significant differences between the genotypes of spring durum wheat in terms of cadmium content in seeds (Figure 6).

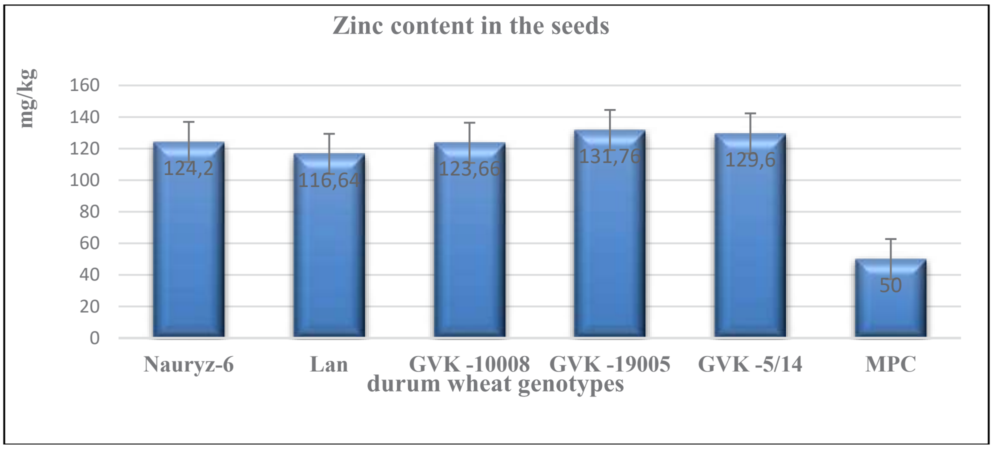

Figure 5 – The content of zinc in seeds of various genotypes of durum wheat in relation to the MPC

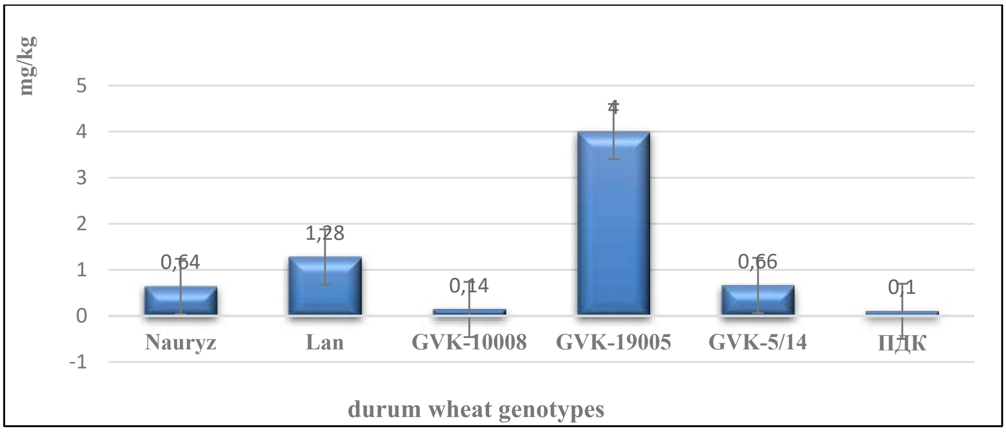

Figure 6 – The content of cadmium in seeds of various genotypes of durum wheat in relation to the MPC

According to the number of cadmium ions accumulated in seeds of plants of various genotypes of spring durum wheat, they can be arranged in the following order as they decrease: GVK-19005> Lan> GVK-5/14> Nauryz> GVK 10008. The smallest amount of cadmium in seeds contains genotype GVK-10008, the largest – genotype GVK-19005.

The same data were obtained in other studies, for example, cadmium in quantities significantly exceeding the MPC established for cereals (0.2 mg / kg dry weight) was found in grain of wheat, rice and barley when growing these species on soils containing metal [23, 24, 25]. When the soil was contaminated with 50 mg / kg of cadmium, the weight and grain size of grain decreased by 20%, and with an increase in the content of cadmium to 100 mg / kg of soil, the resulting grain was feeble [26, 27]. Most organisms do not have a defense mechanism specific for heavy metals, however, there are several systems for controlling the intake of toxic elements in plants [28]. The first barrier to the entry of heavy metals from the soil into the aboveground part is the cover tissue of the roots, which has a significant selective adsorption capacity [29]. When toxic elements penetrate into the cytoplasm of plant cells, chelate compounds are formed with almost 90% of the metals entering the cell [30]. An important role in the resistance to cadmium accumulation in plants is played by vacuolar compartment or the binding of toxicants by cell walls in leaves; phytochelatins, metal-binding peptides, are part of the system for detoxification of heavy metals [31, 32, 33]. Apparently, similar mechanisms are present in the GVK-10008 genotype. In plants, reproductive organs are especially well protected. However, this rule is not always true for cadmium; there is evidence of a greater accumulation of the element in the grain of winter wheat compared to the stems [34].

Tolerance to heavy metals in plants is genetically controlled and has a certain capacity. When the ability of the roots to retain toxic elements is exhausted, metals enter the leaves and fruits. The accumulation of lead, cadmium, zinc, copper above a certain threshold level causes serious disturbances in the metabolic process and leads to a noticeable decrease in yield and product quality. Heavy metals cause numerous changes in plants at different levels: molecular, subcellular, cellular, tissue and organismal [35]. The toxicity of these elements is manifested in a decrease in the activity of enzymes, mainly alkaline phosphatase, catalase, oxidase, ribonuclease, nitrate reductase [36, 37]. When interacting with phosphate-sulfate ions, lead and cadmium form precipitates, with metabolic products enter into a complexation reaction, reduce the intake of potassium and iron into the plant, causing chlorosis and wilting. The ability of lead and cadmium to replace some metals in metal-protein complexes of enzymes is noted, disrupting their most important functional roles [38, 39]. Cadmium is especially dangerous for plants, because, having chemical properties close to those of zinc, it can play its role in many biochemical processes, causing their disruption [40].

Entering plants and accumulating in large quantities in organs that are used for food, they pose a potential risk to human health [41]. Industrial gaseous emissions are one of the main reasons for the high cadmium content in food, and cadmium is also extremely easily transferred from soil to plants. Cadmium is excreted for a very long time from the body, displaces calcium from the bones, provoking the development of osteoporosis, bone deformation and curvature of the spine. Has a pronounced toxic effect on the sex glands, affects the nervous system. It accumulates in the liver and kidneys. The carcinogenic effect of cadmium compounds increases the risk of developing cancer [35].

In areas experiencing an intense technogenic impact on soil and plants, it is necessary to improve the specialization of agriculture, to conduct a careful selection of crops and varieties with increased resistance to polluting heavy metals [42, 1]. Soils containing toxic elements in concentrations (mg / kg): zinc – 200, lead – 20, chromium – 100, nickel – 50, vanadium – 50, cadmium – 3, cobalt – 50, copper – 100, molybdenum – 5 should be removed for industrial crops and cereal crops resistant to toxic effects [1]. The possibility of selecting crops and varieties with increased resistance to polluting heavy metals is confirmed by studies, so the study of soft wheat varieties according to the level of accumulation of heavy metals in grain revealed 5 varieties with a reduced level of accumulation of Cd in grain, 11 – Pb, 7 – Ni and 7 – Cr (VI). Among them, Karavajj and Legenda from Belarus, Korund and Altos from Germany were characterized by a reduced level of accumulation of both Cd, Pb, and Ni, variety Zavet (Belarus) – Pb, Ni, and Cr, and variety Shhara (Belarus) – all four studied heavy metals. Some varieties from Sweden, Belarus, and Russia accumulated a low amount of Cr (VI) [43].

Thus, zinc ions are contained in seeds of spring durum wheat in quantities exceeding the maximum permissible concentration of zinc for grain and there are no large differences between genotypes for this parameter. The cadmium content in seeds of spring durum wheat also exceeds the MPC for grain, with the exception of the GVK-10008 genotype. This genotype of spring durum wheat can be recommended for use in breeding and genetic research as a donor of cadmium resistance.

Metal-resistant varieties and genotypes should also be characterized by high resistance to unfavorable weather conditions of spring and summer vegetation, in particular to drought, as well as the ability to maintain a high yield in conditions of soil contamination with heavy metals. For this purpose, the indicators of productivity and survival of spring durum wheat genotypes were studied in field conditions of natural pollution of the environment with heavy metals.

To determine the survival rate of plants, the number of spring durum wheat plants emerging and remaining before harvesting was calculated per unit area. By the difference between these indicators, one can judge the survival rate of plants during the spring-summer growing season.

Studies have shown that the number of plants in the period before harvesting decreases in all genotypes of spring durum wheat, compared to their number in the period before tillering (Figure 7).

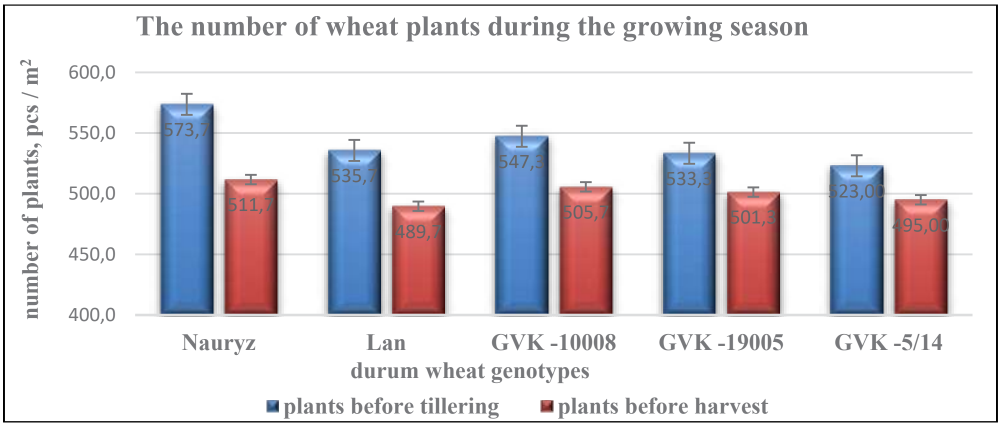

Figure 7 – Decrease in the number of plants in different genotypes of spring durum wheat during the growing season

Analysis of the data (Figure 8) allows us to conclude that the largest number of dead plants during the spring-summer growing season is observed in the Nauryz variety (10.8%), which indicates their low adaptive ability to the effects of external environmental factors. An average reduction in the number of plants was found in the GVK-10008 genotypes and the Lan variety (7.6

and 8.6%, respectively). The smallest losses in relation to the number of surviving plants during the spring-summer growing season belong to the genotypes of durum wheat GVK-5/14 and GVK-19005, the seedlings of which decreased only by 5.4 and 6.0%.

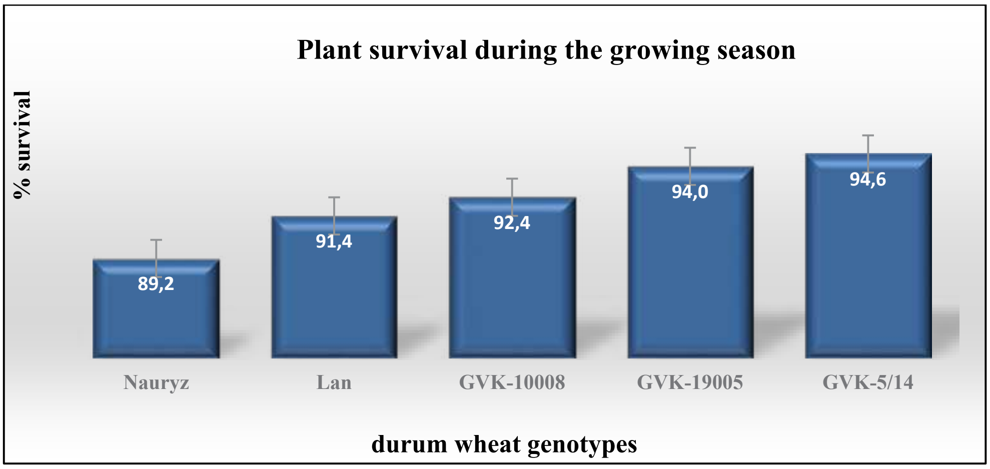

Figure 8 – Survival of plants of various genotypes of spring durum wheat during the growing season

The next stage of our research was to analyze the structure of the yield of spring wheat from the collection of the East Kazakhstan Research Institute of Agriculture and the relationship of its elements. Productivity is the most important and complex quantitative trait, the sum total of the result of plant development during the growing season. By the structure of the harvest, it is possible to identify the main factors in the formation of the harvest and to judge the nature of their influence. In the course of our study, important economically valuable traits associated with the yield of wheat genotypes were analyzed. Optimal parameters of the main elements of the yield structure correspond to a high level of yield. Elements of the spring wheat yield structure are formed in certain phenological phases.

It is known from the literature that when the soil was contaminated with 50 mg / kg of cadmium, the weight and grain size of grain decreased by 20%, and when the content of cadmium increased to 100 mg / kg of soil, the resulting grain was shriveled [44, 45]. Under the influence of cadmium, the number of seeds per ear decreased in winter barley, and in the presence of zinc, in spring barley [41]. Conducted by N.M. Kaznina's experiments showed that with an increase in the concentration of cadmium in the substrate in spring barley, the length and biomass of an ear, as well as the number of spikelets in an ear, decrease, which affects the potential and real seed productivity of plants [46]. It was revealed that under the influence of cadmium, the processes of formation and development of the reproductive sphere of plants are inhibited due to a decrease in the number of rudimentary flowers as a result of a decrease in the intensity of cell division, as well as the processes of realization of flowers into grain [47]. The study of the effect of cadmium on wheat yield showed that against the background of 10 mg / kg of cadmium in the soil, the processes of formation of generative organs are more disturbed, with a dose of cadmium of 50 mg / kg of soil – the intensity of the accumulation of vegetative mass. This leads to a decrease in the share of grain in the structure of the crop [5].

A very important indicator is productive tillering, it shows the ability of plants to form productive side shoots, which make a significant contribution to the overall yield of the variety (Figure 9).

According to our research, the GVK-5/14 genotypes have the highest productive tillering among the studied spring wheat genotypes (Figure 9). Among the studied genotypes, GVK-19005 and GVK-10008 have an average productive tillering, while Nauryz and Lan durum wheat varieties have a lower level.

One of the tasks of our study was to determine the mass of 1000 grains of the studied genotypes of spring durum wheat from the collection of the East Kazakhstan Research Institute of Agriculture, to determine their productivity. The mass of 1000 grains characterizes the amount of substances contained in the grain, this indicator is closely related to the size and completeness of the grain. The grain size, an important agronomic trait, is given great attention in breeding and genetic research. The degree of development of a trait of the mass of 1000 grains is largely determined by the genotype in combination with external conditions during the period of grain formation [48].

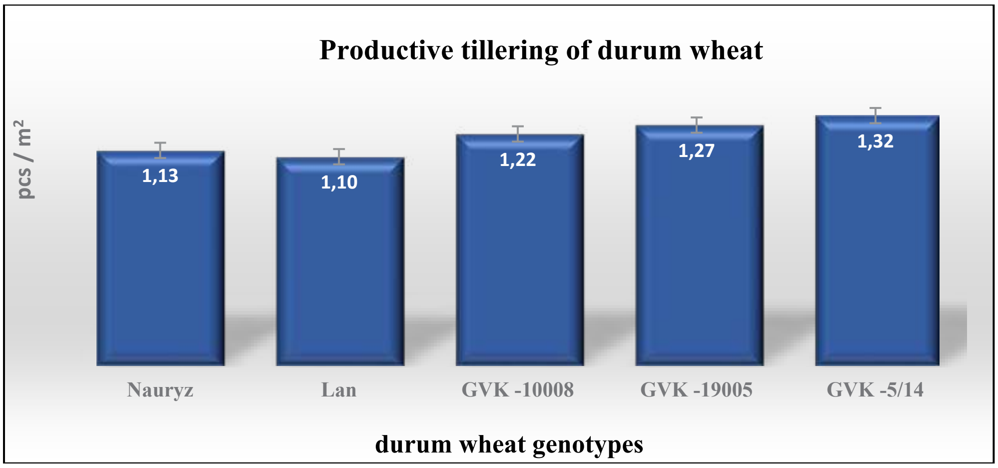

Figure 9 – Productive tillering of plants of various genotypes of spring durum wheat

According to our research, the genotypes of spring durum wheat GVK-5/14 and GVK-19005 (42.3 and 41.7 g, respectively) are characterized by the largest mass of 1000 grains. The genotypes GVK-10008 and the Lan durum wheat variety (40.2 g) are characterized by an average weight of 1000 grains. The durum wheat variety Nauryz is characterized by the smallest mass of 1000 grains.

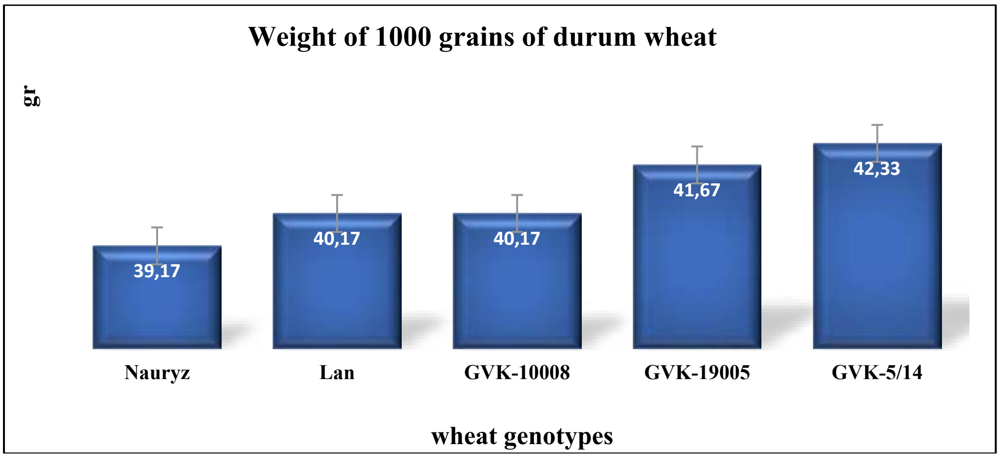

Figure 10 – Weight of 1000 grains of plants of various genotypes of spring durum wheat

Productivity, as well as morphometric indicators, is the most important indicator of the productivity and adaptive capabilities of the variety. In this regard, in the course of our research, it has been assigned one of the key places. In the course of our study, the yield was calculated (Figure 11), which is the largest in the genotype of spring durum wheat GVK-5/14. This is most likely due to the highest mass of lateral stems and 1000 grains, and the highest productivity and survival during the spring-summer vegetation period among the studied durum wheat genotypes.

In terms of yield, the genotype of spring durum wheat GVK-19005 ranks second after GVK-5/14.

The high yield of this genotype can be associated with good productive tillering and survival, as well as a rather high weight of the main spike, side shoots and 1000 grains. For all these indicators, the GVK-19005 genotype ranks second among the studied genotypes.

The third place in terms of productivity is occupied by the spring durum wheat variety Lan, which is characterized by the highest mass of the main spike and the number of grains per ear, but at the same time has an average weight of 1000 grains, low productive bushiness, the weight of grains of lateral shoots and survival during the spring-summer growing season.

The genotype GVK-10008 shows an average yield, it is characterized by an average survival rate during the growing season, an average productive tillering and an average number of grains per ear, but has a low grain weight of the main spike and side shoots (Figure 8, 10).

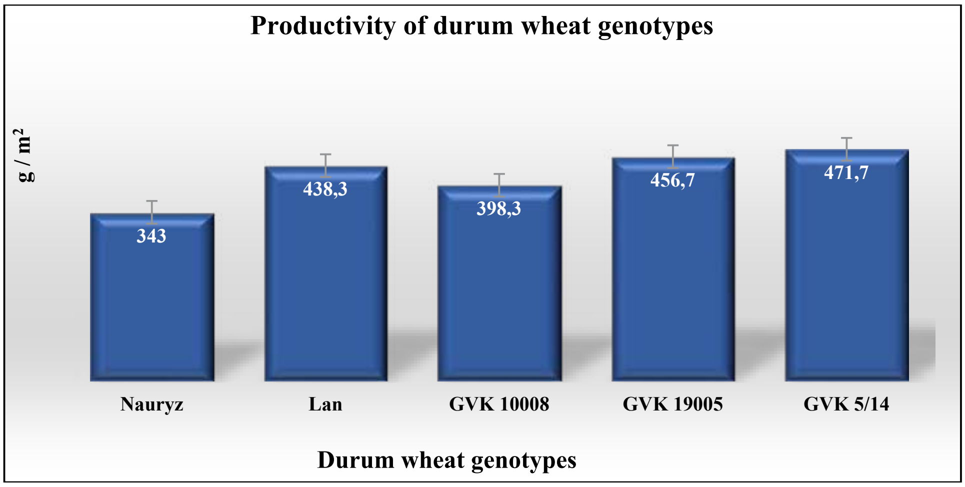

Figure 11 – Productivity of plants of various genotypes of spring durum wheat

The lowest yield was found by the spring durum wheat variety Nauryz, it has average grain mass of the main spike and side shoots, but a small mass of 1000 grains and the lowest survival rate during the spring-summer growing season.

Thus, it can be concluded that the main role in the formation of yield is played not only by the mass of the main spike and side shoots, but also by the sufficient survival of plants during the spring-summer growing season.

Conclusion

1. Under conditions of soil contamination with zinc and cadmium ions, their content in seeds of various genotypes of spring durum wheat exceeds the MPC for grain, except for the content of cadmium in seeds of the GVK-10008 genotype.

2. Genotype GVK-10008 of spring durum wheat can be recommended for use in selection and genetic research as a donor of cadmium resistance.

3. The main role in the formation of productivity under conditions of polymetallic soil contamination is played not only by the mass of the main spike and side shoots, but also by the sufficient survival of plants during the spring-summer growing season.

Conflict of interest

All authors have read and are familiar with the content of the article and have no conflicts of interest.

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PLANT GROWTH-PROMOTING BACTERIA ISOLATED FROM AGROCENOSES OF AGRICULTURAL PLANTS

The article presents data on the isolation of 7 forage and grain crops from agrocenoses (soy, barley, alfalfa, rapeseed, safflower, donut and esparcet) of bacteria and the study of their PGPB properties.

PGPB properties were evaluated in isolated bacteria by studying the ability to dissolve phosphates, nitrogen-fixing activity, antagonistic activity against the phytopathogen Fusarium graminearum, the ability to synthesize IUC. Determination of bacteria and actinobacteria before the genus was carried out by studying morphological, physiological and biochemical properties.

Main results. It was found that 659 different bacterial isolates were isolated from agrocenoses of various agricultural plants, while a significant part of the isolated isolates had a complex of properties (up to 30% of the strains show a pronounced ability to produce IUC), which may provide biocontrol and growth-stimulating effects. Among the isolated isolates, 191 are classified as gram-negative, 216 – non-spore-forming gram-positive, 136 – actinobacteria, 117 – as gram-positive spore-forming bacteria of the genus Bacillus. During the work, 7 promising strains were selected, representatives of the genera Agromyces, Bacillus, Streptomyces, which have a complex of properties: growth-stimulating, phosphate-dissolving, nitrogen-fixing and antagonistic activities for further development of highly effective microbiological preparations for crop production on their basis.

Key words: soil bacteria, agrocenosis, phosphate-solubilizing activity, nitrogen-fixing activity, antagonistic activity, synthesis of IUK.

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Ауылшаруашылық өсімдіктерінен бөлініп алған өсімдіктердің өсуін жетілдіретін бактериялар

Мақалада агроценоздардан 7 жемдік және дәнді дақылдардан (соя, арпа, жоңышқа, рапс, сафлор, түйе жоңышқа және эспарцет) бөлініп алған бактерияларды бөліп алу және олардағы PGPB қасиеттерін зерттеу туралы мәліметтер көрсетілген. Бөлініп алған бактериялардағы PGPB қасиеттерді фосфаттарды еріту, азотфиксипрлеуші белсенділігін, Fusarium graminearum фитопатогенді саңырауқұлағына қатысты антагонистік белсенділігі, ИСҚ түзуге қабілетін зерттеу бойынша бағаланды. Бактериялар мен актинобактериялардың туысқа дейінгі белгілерін анықтауды олардың морфологиялық, физиологиялық және биохимиялық қасиеттерін зерттеу арқылы анықталынды.

Негізгі нәтижелері. Әртүрлі ауылшаруашылық культураларының агроценоздарынан 659 бактерия изоляттары бөлініп алды және 354 қиын еритін фосфаттарды in vitro мобилизациялау қабілеті бар изоляттар іріктеп алынды. Олардың арасында 40% изолят азотфиксирлеуші белсенділікті және айқын көрінген антагонистік қасиет көрсетті. Бірқатар штаммдар биобақылау және өсуді жетілдіру әсері бар ИСҚ белсенді өндірді. Бөлініп алынған изоляттардың ішінде 191 грамтеріс, 216 – споралы грам-оң, 136 – актинобактериялар, 117 – грам – оң спора түзуші Bacillus туысының өкілдеріне жатқызылды. Алынған нәтижелер өсімдіктердің агроценозында PGPB сипаттамалары бар микроорганизмдерді іздеуде қолдануға жоғары мүмкіншіліктері бар екендігін дәлелдейді. PGPB қасиеттері бар изоляттардың едәуір көп мөлшері арпа мен үш жылдық жоңышқа агроценоздарынан бөлініп алды. Зерттеу жұмысын жүргізу барысында өсуді жетілдіруші, фосфат еріткіш, азотфиксирлеуші және антагонистік белсенділіктері бар Agromyces, Bacillus және Streptomyces туысына жататын 7 жетістігі мол штамдар іріктеп алынды және олардың негізінде өсімдік шаруашылығына арналған тиімділігі жоғары микробиологиялық препараттарды жасауда қолдануға болады.

Түйін сөздер: топырақ бактериялары, агроценоз, фосфат-солюбилизирлеуші белсенділік, азотфиксирлеуші белсенділік, антагонистік белсенділік, ИСҚ түзу.

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Стимулирующие рост растения бактерии, выделенные из агроценозов сельскохозяйственных растений

В статье представлены данные о выделении из агроценозов 7 кормовых и зерновых культур (сои, ячменя, люцерны, рапса, сафлора, донника и эспарцета) бактерий и изучение у них PGPB свойств. PGPB свойства оценивали у выделенных бактерий, изучая способность к растворению фосфатов, азотфиксирующую активность, антагонистическую активность в отношении фитопатогена Fusarium graminearum, способность к синтезу ИУК. Определение бактерий и актинобактерий до рода проводили, изучая морфологические, физиологические и биохимические свойства. Основные результаты. Установлено, что из агроценозов различных сельскохозяйственных растений выделено 659 различных бактериальных изолятов, при этом значительная часть выделенных изолятов обладала комплексом свойств (до 30 % штаммов проявляют выраженную способность выраженные ряд штаммов способные продуцировать ИУК), которые, возможно, обеспечивают биоконтрольные и ростстимулирующие эффекты. Среди выделенных изолятов, 191 отнесены к грамотрицательным, 216 – неспорообразующим грамположительным, 136 – актинобактериям, 117 – к грамположительным спорообразующим бактериям рода Bacillus. В ходе работы было отобрано 7 перспективных штаммов, представителей родов Agromyces, Bacillus, Streptomyces, обладающих комплексом свойств: ростстимулирующей, фосфатрастворяющей, азотфиксирующей и антагонистической активностями для дальнейшего создания на их основе высокоэффективных микробиологических препаратов для растениеводства.

Ключевые слова: почвенные бактерий, агроценоз, фосфатсолюбилизирующая активность, азотфиксирующая активность, антагонистическая активность, синтез ИУК.

Introduction

Developing sustainable and ecological methods to increase agricultural productivity without increasing the area of cultivated soil has become a critical issue for ensuring food safety. Among the various tools used to increase productivity in agriculture, the use of plant growth-promoting bacteria (PGPB) has great potential [1].

Plant growth-promoting bacteria (or PGPB) belong to a useful and heterogeneous group of microorganisms that can be found in soil, rhizosphere, root surfaces or plant tissues, they are able to enhance plant growth and protect them from disease as well as abiotic stress [2-5]. The mechanisms by which PGPB stimulates plant growth include nutrient availability, biological nitrogen fixation and phosphate solubilization, stress relief by modulating ACC deaminase expression and phytohormone and siderophore production, and others.

The relations between plants and microorganisms has been well studied for a long time, but their use in agriculture for partial or complete replacement of chemical fertilizers is still insufficiently studied [6]. The use of microorganisms as plant inoculants is one of the most important sustainable practices in agriculture. The positive effect of inoculation depends on a number of factors: on the activity of microorganisms; on the quantity and quality of synthesized substances by microorganisms; indigenous soil microflora; the inoculation method. It has been established that the best introduction is carried out by microorganisms originally isolated from plant agrocoenosis. Nevertheless, despite the large number of studies devoted to the use of PGPB as useful inoculants for agricultural plants, most researchers note that the use of PGPB is poorly understood. Some researchers note the lack of effect of inoculum application, they associate this with insufficient study of the structure, composition and function of microorganisms of plant agroceonosis, therefore, it is necessary to study their ecology, physiology and biochemistry to assess the role of PGPB and the suitability of their use [7, 8].

The aim of this study is to isolate bacteria from plant agrocoenosis that may have potential as environmentally friendly biofertilizers. The main directions of research: selection of strains with the ability to dissolve insoluble phosphates, to have nitrogen-fixation and antagonistic activities, and to produce IAA among isolated bacteria.

Materials and methods

The objects of research are microorganisms of different taxonomic groups isolated from plant agrocenoses.

Standard culture media and methods described in the manual [9] were used for the isolation of bacteria and actinobacteria from plant agrocenoses.

Methods for determining PGPB properties

Phosphate dissolving ability of microorganisms was studied by the formation of zones of dissolution of calcium phosphates around the colonies [10]. The ability to phosphate mobilization was assessed by calculating the IS solubilization index using the formula (IS = clearing zone diameter / colony diameter) and by the efficiency of ES solubilization according to the formula (ES = clearing zone diameter / colony diameter × 100).

Nitrogen fixation ability to of isolates was carried out by growing in a nitrogen-free medium [9].

The study of antagonistic activity was carried out by the method of double cultures [11]. Plates with phytopathogenic *Fusarium graminearum* without inoculation of the test isolates were used as a control. Determining the distance from the point of phytopathogen inoculation to the edge of the isolate colony.

To study the isolated strains properties that promote plant growth, we determined the calorimetric method using the Salkowski reagent in a liquid PDA medium with the addition of 2 mM L-tryptophan [12, 13].

Determination of bacteria and actinobacteria to genus was carried out according to the traditional scheme based on morphological, physiological, and biochemical properties [14].

Results and their discussion

The taxonomic composition of agrocenosis bacteria depends on the type of soil, temperature, humidity, light, and other factors. At the same time, in addition to these main factors that determine both the functional and spatial distribution of bacteria, the generic and species composition of bacterial communities depends on the degree of floristic saturation of biocenoses, their spatial position, the amplitude of vertical and horizontal distribution, the nature of individual species of life forms, and the biochemical structure of dominant species. Each type of soil and plant association is characterized by a specific composition of the bacterial community [15, 16, 17].

In general, bacterial diversity in agrocenoses is represented mainly by species belonging to *Proteobacteria, Firmicutes* and *Actinobacteria* phylae, where the most common genera known to include *Bacillus, Pseudomonas, Enterobacter, Arthrobacter, Rhizobium, Agrobacterium, Burkholderia, Azospirillum, Mycobacterium, Flavobacterium, Cellulomonas* and *Micrococcus.* Various researchers note that soil microbial communities of argocenoses are dynamic, capable of significant changes in time due to seasonality, they are influenced by local environmental conditions and form recognizable types of structure of microbial communities [18-21].

In the studies carried out, a number of similar features and general patterns in the distribution of the bacterial community in soil samples from the studied agrocoenosis were revealed. At the same time, the confinement of soils to a certain type of vegetation and the content of organic matter caused certain differences in the bacterial community. So, while studying the microbial community of soils under: barley, clover, green beans, soybeans, millet, the researchers noted that the soils under barley had the highest content of actinomycetes and fluorescent pseudomonads. The highest microbial activity was characteristic of the soils under barley and corn. The fungi / bacteria ratio was highest in soils under barley and lowest in soils under soybeans and potatoes. These data demonstrate that different cultures have different effects on microbial communities [22].

Soil suspensions of various dilutions were plated on solid media in order to isolate microorganisms, plates on which more than 30 colonies grew, were used for isolation. Morphologically different colonies were chosen and used for further research. 659 isolates were isolated from plant agrocoenosis. The number of colony morphotypes was insignificant and amounted to no more than 15. Table 1 shows the quantitative ratio of isolates depending on the plant species and taxonomic belonging of the isolated isolates. Among the isolated isolates, 191 were classified as gram-negative, 216 – non-spore-forming gram-positive, 136 – actinobacteria, 117 – as gram-positive spore-forming bacteria of the genus *Bacillus.* The largest number of isolates was isolated from barley agroceonosis – 81 out of 659, and the smallest number of isolates was selected from rapeseed agrocoenosis. The obtained data shows that more gram-positive non-spore-forming bacteria were selected from plant agrocoenosis than actinomycetes and spore-forming bacteria. The groups of isolated microorganisms can be arranged in the following order: gram-positive non-spore-forming bacteria> gram-negative bacteria> actinobacteria> spore-forming bacteria.

Table 1 – Component composition of the bacterial community from plant agrocenoses

Plants	Number of isolates				
	Total	Gram- bacteria	Gram + bacteria	actino-bacteria	spore-forming bacteria
Barley	81	23	28	16	14
Lucern of the first year	76	23	21	18	13
Lucern of the second year	78	22	29	15	12
Lucern of the third year	74	18	29	15	12
Sainfoin	74	19	28	14	13
Soya bean	72	24	21	16	13
Safflower	71	22	20	15	14
Clover	68	21	20	14	13
Colza	65	19	20	13	13
Total	659	191	216	136	117

The use of microbial inoculants with phosphate-solubilizing activity in soils is considered as an environmentally friendly alternative to the use of chemical phosphorus fertilizers.

One of the reasons limiting the productivity of agricultural plants in Kazakhstan is the deficiency of two main nutrients in soils – nitrogen and phosphorus. Plants can use small amounts of phosphates from chemical sources, because 75-90% of the added phosphorus is precipitated through metal-cationic complexes and quickly becomes fixed in soils [23]. It is believed that inoculation of phosphate-solubilizing microorganisms into the soil is an effective way of converting insoluble phosphorus compounds into a form accessible to plants, leading to better plant growth and yield. Representatives of various genera, such as, for example, *Bacillus, Pseudomonas, Rhizobium, Aspergillus, Penicillium* are the most effective phosphorus solubilizers to increase its bioavailability in soil. Phosphate-solubilizing microorganisms not only promote plant growth by providing an easily assimilable form of phosphorus, they are able to synthesize plant growth hormones such as IAA, support plant growth through the production of siderophores and increase the efficiency of nitrogen fixation, and can also act as a biocontrol against plant pathogens [24-26]. And therefore, at the first stage of the study, we selected isolates with phosphate-solubilizing activity.

Screening of microorganisms for phosphate-solubilizing activity in 659 isolates made it possible to select 354 isolates with the ability to mobilize hardly soluble phosphates *in vitro* (Table 2).

Table 2 – Component composition of the bacterial community with phosphate-solubilizing activity from plant agrocoenosis

Plants	Number of isolates				
	Total	Gram- bacteria	Gram + bacteria	Actino-bacteria	Spore-forming bacteria
Barley	50	13	15	10	12
Lucern of the first year	41	10	14	8	9
Lucern of the second year	37	9	13	7	8
Lucern of the third year	47	11	16	11	8
Sainfoin	37	11	11	6	9
Soya bean	34	8	11	7	8
Safflower	36	9	10	8	9
Clover	36	11	9	7	9
Colza	36	9	10	8	9
Total	354	91	109	72	82

The largest number of isolates with phosphate-solubilizing activity was isolated from the agrocoenosis of third year lucern and bdrley. The smallest number of isolates with the ability to mobilize phosphorus can be noted for soya beans. Among the selected isolates, the largest number belongs to selected gram-positive non-spore-forming bacteria.

In further studies, nitrogen-fixation activity was studied in 354 selected isolates. It was shown that 130 isolates had this activity, and the largest number of isolates was noted for third year lucern (Figure 1). Among the isolates, the largest number with nitrogen-fixation activity was selected in spore-forming bacteria and gram-negative bacteria.

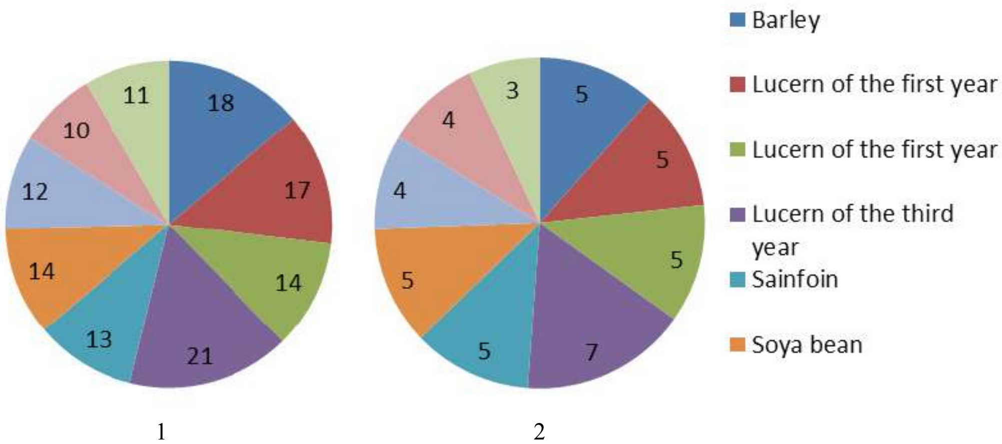

Figure 1 – The quantitative ratio of isolates with nitrogen-fixing (1) and antagonistic (2) activities depending on the plant species

The antagonistic properties of microorganisms with phosphate-solubilizing and nitrogen-fixing activities are presumably associated with competitive conditions in nutrient-poor ecological niches [27, 28]. Therefore, in our opinion, such microorganisms should be a potential target for the search of a new active antagonist strain.

Screening for antagonistic activity was performed by the block method. 45 were selected of the 130 studied, which gave clearly visible zones of no growth of the test culture. The highest activity was observed in 12 isolates, with the maximum zones of suppression of the growth of phytopathogens (from 16.2 to 25.2 mm). 3 isolates are spore-forming bacteria, 2 are gram-positive non-spore-forming bacteria, and 7 are actinobacteria.

Indole-3-acetic acid (IAA) is one of the widespread phytohormones in nature, the most active in the group of auxins. Auxins affect the division and differentiation of plant cells and tissues, stimulate the germination of seeds and tubers, promote xylem and root formation, are responsible for tropism, flowering and fruiting of plants, affect photosynthesis, pigment formation, biosynthesis of various metabolites, and plant resistance to stress factors [29, 30].

The detection and quantitative assessment of phytohormones of the auxin group was carried out by the colorimetric method using the Salkovsky reagent. Thus, out of 23 studied bacteria, 7 isolates showed a positive reaction to IAA production. IAA was most intensively produced by 4 isolates from 11.2 ± 1.4 µg / ml, but one isolate, in which the total production level reached 28.7 ± 2.1 µg / ml, is a particularly active producer of auxins. Ability to produce IAA among 17 strains of actinobacteria, 10 active isolates were identified, producing IAA in an amount from 11.0 µg / ml to 115 µg / ml (Table 3). The most active isolates were isolated from agrocoenosis of third year lucern and barley.

Screening of isolates with a complex of valuable properties made it possible to select a number of promising bacterial strains isolated from plant agrocoenosis. Initial identification revealed a wide variety of isolated microorganisms. The dominant groups of bacteria with PGPB properties among the studied microorganisms were representatives of the genera *Bacillus* and *Streptomyces* (Table 4).

Table 3 – Detection of phytohormone IAA in bacteria

Plant	Isolate number	IAA amount, μg / ml
	Bacteria	
Soya bean	П-15-6/1 П Д/4	6,0 ± 0,2
Lucern of the third year	МПА III-5	15,1±1,4
Lucern of the third year	МС-16-4-10	10,1±1,1
Barley	П-7-2-10	28,7±2,1
Barley	П-8-1	13,1±1,4
Lucern of the third year	LP-29-4	11,2±1,4
Lucern of the third year	П-9-2	19,1±1,5
	Actinobacteria	
Barley	12АК	11,0 ± 2,1
Lucern of the third year	12АМ	14,1 ± 1,1
Lucern of the third year	13АК	15,1 ± 1,5
Soya bean	ККЛЛ 10 – 2	15,0 ± 1,3
Lucern of the second year	ККЛЛ 10 – 3	15,3 ± 1,2
Lucern of the second year	ККЛЛ 10	10,2 ± 1,1
Soya bean	ККСЛ 10	13,1 ± 2,1
Barley	ВАК 15 – 10/2	15,1 ± 1,5
Lucern of the third year	12АК	38,2 ± 2,1
Lucern of the third year	ВАК – 9 – 10	115,1±3,1

Table 4 – Physiological properties of the most active isolates.

Isolate number	Genus	NFA	Efficiency of phosphorus solubilization,%	Zone of *F.graminearum* growth suppression, in mm	IAA amount, μg / ml
МС-16-4-10[2]	*Agromyces*	+	250,3	30,1±1,2	15,1±1,4
П-9-2	*Bacillus*	+	240,3	8,5±0,9	19,1±1,5
П-7-2-10	*Bacillus*	+	280,5	11,2±1,1	28,7±2,1
МПА III-5	*Bacillus*	+	240,1	20,2±1,1	15,1 ± 1,5
ККЛЛ 10 – 3	*Actinomadura*	+	200,0	37,0±2,2	15,3 ± 1,2
12АК	*Streptomyces*	+	172,3	41,0±8,5	38,2 ± 2,1
ВАК – 9 – 10	*Streptomyces*	+	140,0	28,1±1,3	115,1±3,1
Note: NFA – nitrogen-fixation activity; + there is an activity.					

The largest number of active bacteria was isolated from the agrocoenosis of two plants, barley and the third year lucern. The obtained results in this research indicate a high potential for the search for microorganisms with PGPB characteristics of plant agrocoenosis. The selection of promising microorganisms is a complex process, in this study, the screening was carried out taking into account the productivity of plants and therefore paid attention to such properties as growth-stimulating, phosphate-dissolving, nitrogen-fixation and antagonistic activities.

Conclusion

It was found that 659 different bacterial isolates were isolated from agrocoenosis of various agricultural plants, while a significant part of the isolated isolates had a set of properties (more than 40% of bacteria exhibit pronounced properties and a number of strains are capable of actively producing IAA), which, possibly, provide biocontrol and growth-stimulating effects. During the research, 7 promising strains were selected, representatives of the genera *Agromyces*, *Bacillus Streptomyces*, possessing a set of properties: growth-stimulating, phosphate-dissolving, nitrogen-fixationn and antagonistic activities for further creation on their basis of highly effective microbiological preparations for plant growing.

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Conflict of interest

The authors have no conflicts of interest.

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2-бөлім

ҚОРШАҒАН ОРТА ЛАСТАУШЫЛАРЫНЫҢ БИОТАҒА ЖӘНЕ ТҰРҒЫНДАР ДЕНСАУЛЫҒЫНА ӘСЕРІН БАҒАЛАУ

Section 2

ASSESSMENT OF ENVIRONMENTAL POLLUTION ON BIOTA AND HEALTH

Раздел 2

ОЦЕНКА ДЕЙСТВИЯ ЗАГРЯЗНИТЕЛЕЙ ОКРУЖАЮЩЕЙ СРЕДЫ НА БИОТУ И ЗДОРОВЬЕ НАСЕЛЕНИЯ

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ECOLOGICAL ASSESSMENT OF LAKE AKBAS BY HYDROPHYSICAL, HYDROCHEMICAL AND ALGOLOGICAL INDICATORS

This paper evaluates the results of hydrophysical and hydrochemical indicators of Lake Akbas of the Kokshetau State National Natural Park, which belongs to the category of specially protected natural areas. Changes in the lake area over a period of about 50 years are shown. In terms of water color and turbidity, there has been a decrease over the past 3 years. The area of the Akbas lake basin has decreased by 15.3% over the past 50 years. During the study period, the content of dry waste in the lake water exceeded the MAC by 1.1–1.5 times annually. Lake Akbas is moderately polluted in 2018-2019 in terms of the level and quality of class III pollution. However, it was found that some hydrochemical parameters exceed the MAC. Along with the hydrophysical and hydrochemical indicators of Lake Akbas, we identified the species composition of microalgae in the lake, seasonal changes and conducted a systematic analysis. As a result of the study, the algae flora of Lake Akbas consisted of 61 species, 20 of which are indicator-saprobic microalgae. To study the sensitivity of algae to environmental factors and various chemical reactions, we carried out biotesting of water samples from Lake Akbas. Biotesting showed that the Chlorella sp-3K strain is moderately sensitive to toxic concentrations in Lake Akbas. Researches have shown that bioassays for microalgae in lake water are quick and easy and complement the results of chemical studies. According to the results of hydrophysical, hydrochemical studies and biotesting of algocenoses, it was determined that the water of Lake Akbas belongs to 3 classes of pollution.

Key words: Hydrophysical and hydrochemical indicators, algoflora, biotesting.

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Ақбас көліне гидрофизикалық, гидрохимиялық және альгологиялық көрсеткіштер бойынша экологиялық баға беру

Бұл жұмыста ерекше қорғалатын, табиғи аумақ санатына жататын «Көкшетау» мемлекеттік ұлттық табиғи паркіне қарасты Ақбас көлінің гидрофизикалық және гидрохимиялық көрсеткіштерінің нәтижелеріне баға берілді. Көл айдыны ауданының 50 жылға жуық кезеңдегі өзгерістері көрсетіледі. Судың түсі мен лайлығының көрсеткіштері бойынша соңғы 3 жыл бойы төмендегені байқалады. Ақбас көлі су айдынының ауданы 50 жылға жуық мерзімде 15,3%-ға азайған. Көл суындағы құрғақ қалдықтар зерттеу кезеңінде ШРК-дан әр жыл сайын 1,1-1,5 есеге артып отырған. Ақбас көлі ластану деңгейі және сапасы бойынша 2018-2019 жылдары орташа ластанған, ІІІ класс дәрежесін көрсетеді. Алайда кейбір гидрохимиялық көрсеткіштердің шекті рұқсат етілген концентрациядан артып кеткендігі анықталған. Ақбас көлінің гидрофизикалық және гидрохимиялық көрсеткіштерімен қатар бізбен көлдегі микробалдырларының түрлік құрамдары, мезгілдік өзгерісі анықталынып, систематикалық талдау жасалынды. Зерттеу нәтижесінде Ақбас көлінің альгофлорасы 61 түрді құрап, олардың 20 түрі индикатор-сапробты микробалдырларға жататындығы анықталды. Экологиялық факторлардың және әр түрлі химиялық реакциялардың балдырларға сезімталдығын зерттеу үшін Ақбас көлі су үлгілеріне биотестілеу жүргіздік. Биотестілеу жүргізген зерттеу нәтижесінде Chlorella sp-3K штамы Ақбас көліндегі улы заттар концентрациясына орташа сезімтал екені анықталды. Зерттеулерден байқағанымыздай көл суына микробалдырлар көмегімен биотест жүргізу жылдам, әрі тез және химиялық зерттеулер нәтижесін толықтыратындығы анықталды. Гидрофизикалық, гидрохимиялық зерттеулер және альгоценоз құрамы мен биотестілеудің кешенді нәтижелері негізінде Ақбас көлінің суы ластану дәрежесі бойынша 3 класқа жататыны анықталды.

Түйін сөздер: гидрофизикалық және гидрохимиялық көрсеткіш, альгофлора, биотестілеу.

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Экологическая оценка озера Акбас по гидрофизическим, гидрохимическим и алгологическим показателям

В этой работе дана оценка результатов гидрофизических и гидрохимических показателей озера Акбас, относящегося к категории особо охраняемых природных территорий Государственного Национального природного парка «Кокшетау». Указываются изменения площади акватории озера в период около 50 лет. По показателям цвета и мутности воды наблюдается снижение за последние 3 года. Так, площадь водоема озера Акбас за 50 лет уменьшилась на 15,3%. Сухие отходы в озерной воде в период исследований увеличивались ПДК в 1,1-1,5 раза каждый год. Озеро Акбас по уровню и качеству загрязнения демонстрирует степень III класса, т.е. умеренно загрязненное состояние, в 2018-2019 годах. Однако установлено, что некоторые гидрохимические показатели превышают предельно допустимую концентрацию. Наряду с гидрофизическими и гидрохимическими показателями озера Акбас нами был выявлен видовой состав, периодические изменения микроводорослей в озере, проведен систематический анализ. В результате исследования установлено, что альгофлора озера Акбас составляет 61 вид, из них 20 видов относятся к индикаторно-сапробным микроводорослям. Для изучения чувствительности экологических факторов и различных химических реакций к водорослям мы провели биотестирование водных образцов озера Акбас. В результате исследования, проведенного биотестированием, было установлено, что штамм Chlorella sp-3K умеренно чувствителен к концентрации ядовитых веществ в озере Акбас. Из исследований выяснилось, что биотестирование озерной воды с помощью микроводорослей дополняет результаты химических исследований. На основании комплексных результатов гидрофизических, гидрохимических исследований и биотестирования в составе альгоценоза было установлено, что вода озера Акбас по степени загрязнения относится к 3 классам.

Ключевые слова: гидрофизические и гидрохимические показатели, альгофлора, биотестирование.

Introduction

The concept of the Republic of Kazakhstan for the transition to a “green economy” provides for the sustainable use of water resources, pollution reduction, conservation and effective management of ecosystems[1]. In addition to large-scale protection of the integrity and authenticity of typical ecosystems and ecological processes, national parks protect, preserve and restore the region’s biodiversity, important species and their habitats, and natural and cultural heritage sites of global or national importance.

Thus, by focusing on one aspect of the ecosystem, it focuses on preventing the loss and damage of other resources and the environment [2].

In connection with global changes in the natural shortage of water, the problem of rational use, protection and restoration of lake resources is of particular importance. Therefore, the relevance of such studies today is beyond doubt. The actual use of the lakes is very limited. Lakes are not only an important part of the hydrological system of the North Kazakhstan region, but also a source of fresh water and recreation areas, habitats for waterfowl and fish [3].

The lakes of this region were the object of study of hydrometric indicators associated with the development of virgin and fallow lands. In the mid-1960s. scientists have found a sharp decrease in humus thickness and productivity throughout the territory of Northern Kazakhstan. These processes were characterized by an intensification of deflationary processes, including the hydromass and biomass of geosystems. During these years it mentioned in the works of G. D. Ovchinnikov (1960), A. G. Popolzin (1967), G. G. Muravlev (1973), P. P. Filonets, T. R. Omarov (1974), N. P. Beletskaya (1971, 1976), M. E.Gorodetskaya (1972) and others [4,5,6].

Lake Akbas is a freshwater lake belonging to the Ishim basin. In accordance with the Decree of the Government of the Republic of Kazakhstan dated October 18, 2012,№1323 “On some issues of the Kokshetau State National Natural Park of the Committee for Forestry and Hunting of the Ministry of Agriculture of the Republic of Kazakhstan” has the status of specially protected natural areas [7]. A satellite image of the lake is shown in Figure 1.

Figure 1 – A satellite image of Lake Akbas taken by Mapcarta.

SNNP «Kokshetau» was created by the Decree of the Government of the Republic of Kazakhstan April 10, 1996 with the aim of preserving and restoring amazing mountain-forest and lake ecosystems, natural and archaeological monuments, the national culture of Northern Kazakhstan, which have ecological, scientific, educational and recreational significance for the inhabitants of our and other countries.The territory of the park is 182,076 hectares and covers the territory of the Aiyrtau district of the North Kazakhstan region and the Zerendi district of the Akmola region [8].

Due to the geographic location of the lakes located in the national park, some lakes are rapidly being decommissioned due to the fact that they are fed by sources of precipitation, melted snow and springs. The urgency of the problem of preserving the lakes of SNNP «Kokshetau» is distinguished by the value of this natural complex [9,10].

The purpose of the research. Assessment of water quality in the lake by long-term hydrophysical, hydrochemical indicators and the study of algae of the Akbas lake of the Aiyrtau branch of the Kokshetau state national natural park.

Materials and research methods

The ecological state of Lake Akbas has been published, and the average value of the data from many years of laboratory research has been estimated based on fishing standards. Water sampling was carried out in accordance with the interstate standard ST RK GOST R 51592-2003. Hydrophysical indicators: by smell organoleptic methods according to GOST 3351-74; Color according to GOST 31868-2012 – method of visual determination of color (method a); GOST 3351-74 t. Turbidity of 5 was determined by photometric method [11,12].

Hydrochemical parameters were determined according to GOST 26449: pH of the medium – by electrometric method; carbon dioxide, potassium, sodium, nitrates – by potentiometric titration; dissolved oxygen, dry residue mineralization, oxidation of permanganate, hydrocarbons, carbonates, chlorides – by titrometric method; sulfates,calcium,magnesium,total–complexometric hardness; chromium (III) – by photocolorimetric method, hydrocarbons, bicarbonates, carbonates, chlorides – by titration method.

Nitrites on M 01 – 46 – 2013 by fluorimetric method; ordinary iron, zinc, lead, cadmium, copper, cobalt, manganese, molybdenum, nickel, chromium, silver, strontium, beryllium – by the method of atomic absorption spectrometry on the MGA-915 spectrometer [13,14, 15].

Sirenko's guidelines for determining the species composition of algae and "Keys to freshwater algae of the USSR", v. 1-14, 1951; "Keys to the blue-green algae of Central Asia", volumes 1-3, 1987; "Key to the protococcal algae of Central Asia", Volume 1-2, 1988; "A short guide to chlorococcal algae of the Ukrainian SSR". Kiev, 1990; identifiers were used

[16-23]. The number of cells was determined using a Goryaev chamber. To assess the state of aquatic ecosystems with phytoplankton, the methods of Pantle, Bukka and modified Sladechka were used [24].

Research results and discussion

Lake Akbas is located to the north-west of the Syrymbet village of the Aiyrtau region, at an altitude of 220.4 m above sea level, with the geographical coordinates of the lake from 53^0 31 degrees to 67^0 56 degrees east longitude. The lake is 6.0 km long, 3.1 km wide. The length of the coastline is 19.0 km. The lake shore is open, the bottom is muddy. The catchment area is 110 km2, flat, 20% plowed [25].

In some parts of the coast there are reeds and thickets. The area of the lake in 1959 was 13 km^2, and in 2004 it decreased by about 2 km^2, or 11.08 km^2. This situation is associated with the narrowing of the catchment area. The lake is replenished by atmospheric precipitation and groundwater. The role of precipitation and evaporation in the water balance is increasing. In spring, the water level rises in May and reaches a maximum, then decreases in June and is minimum in winter. As soon as the temperature drops to 0^0, ice flakes begin to form in the lake. The lake freezes over in October-November.

The hydrophysical parameters of Lake Akbas are shown in Table 1 below. Considering that the organoleptic and commercial characteristics of lake water, along with changes in its physical properties (transparency, color, smell, taste) and chemical composition, reduce its quality (Lobanovo, 2002; Popov, 2003;) (hereinafter – MAC). It can be seen that the color and turbidity of the water has decreased over the past 3 years.

Table 1 – Hydrophysical indicators of Lake Akbas

Indicators	Measurement measures	Indicators by years					MAC
		2015	2016	2017	2018	2019	
Smell of water	scores	no	no	no	no	no	not more than 2
Water color	temperature	0	0	110,2	98,6	97,1	not normalized
Turbidity of water	mg / dm^3	29,54	0	7,72	7,5	7,2	not normalized

According to the general hardness of Lake Akbas: in 2015 – solid, in 2016, 2018, 2019 – medium hard, in 2017 – very hard (Table 2). In terms of hydrogen or pH of natural waters, the water in the lake did not exceed the MAC in the years of control. In 2015, 2018, 2019, this indicator was 8.1-8.3 – slightly alkaline, in 2016 – neutral, in 2017 – 8.92 – alkaline water. Over the years of research, the amount of dry waste in the lake water has increased 1.1-1.5 times from the annual MAC. The peak was1.5 times higher in 2017, but was 1.3–1.4 times higher than the maximum permissible concentration, although over the past two years it has slightly decreased.

According to the level of dissolved oxygen in the water of Lake Akbas, the level and quality of water pollution in 2018-2019 showed an average level of pollution of the III class. The appearance of iron compounds in surface waters is associated with mechanical destruction and melting of rocks in water under the influence of wind. Part of the iron enters through groundwater, industrial and agricultural wastewater, but the amount of iron in the lake water over the past two years was 0.5-0.6 times less than the MAC.

Compounds of HCO_3^-, CO_3^{2-}, Cl^-, SO_4^{2-}, Ca^{2+}, Mg^{2+}, Na^+, K^+ ions in natural water determine the mineralization of water. Calcium ions in water are in the form of Ca $(HCO_3)_2$ and $CaSO_4$. As the salinity of the water increases, their content decreases due to the slow solubility of calcium salts in water. It turned out that the amount of calcium in the water of Lake Akbas from 2015 to 2019 was 5.29 – 21.9 times less than the MAC.

Magnesium in chemical composition is close to calcium, but has low biological activity. The predominance in natural waters is rare, but the rapid solubility in the form of $MgSO_4$ increases its amount in water, which is clearly seen in Table 2 above. In the dynamics of long-term monitoring, it was found that magnesium exceeds the MPC in 2015 (2.4 times), 2016 (2.01 times), 2017 (4.38 times), 2018 (4.1 times)), 2019 (3.8 times).

Sodium ions are the predominant cations. However, over the years of research in the lake, the amount of sodium was 3.1-3.8 times less than the MAC.

Table 2 – Hydrochemical composition of water in Lake Akbas

Indicators	Measures	Indicators by years					MAC	Notes
		2015	2016	2017	2018	2019		
Solidness	mg-eq/l	9,7	7,27	15,14	4,6	4,2	not normalized	
pH	pH.Unit rev	8,24	7,2	8,92	8,3	8,1	6,0-9,0	not more
Dry waste	mg/l	1100	1200	1550	1439	1377	1000	more
Oxygen dissolved in water	mgO_2/l	0	0	0	7,3	7,6	not less than 4	
Common iron	mg/l	0	0	0	0,18	0,15	0,1	not more
Calcium	mg/l	34	11,4	10,8	8,9	8,2	180	
Magnesium	mg/l	96	80,4	175,2	164	152	40	more
Sodium	mg/l	38	31	32,5	33,6	31	120	not more
Potassium	mg/l	138	184,8	183	176,3	163	50	more
Nitrite	mg/l	0,27	0,06	0,42	0,87	0,85	3	not more
Nitrates	mg/l	0	0,05	0,3	1,9	12,3	45	not more
Carbonates	mg/l	0	1,1	2,04	8 <	8<	not normalized	
Hydro-	mg/l	73,2	67,1	51,24	48,3	42,6	not normalized	
carbonates	mg/l	165,2	40,32	162,68	154	102	350	not more
Chlorides	mg/l	560,78	728,1	890,07	846	514	500	more

Potassium ions are found in small amounts in natural waters due to their slow movement and high biological requirements for living organisms. Potassium ions for Lake Akbas are higher than sodium, and the minimum threshold in 2015 was 2.8 times higher than the maximum permissible concentration, and the maximum threshold in 2016 was 3.7 times higher.

Nitrogen is found in surface waters in the form of inorganic (ammonium nitrogen, nitrite, nitrate) and organic (amino acids and proteins in the tissues of organisms, their decomposition products). It was shown that the amount of nitrite in these years was 3.4 – 50 times less than the MAC. Although the concentration of nitrates in the studied lake did not exceed the MAC, in the period from 2015 to 2019 there was a steady increase from 0.05 to 12.3 mg / l.

Chlorine ions are found in natural waters in the form of sodium chloride, magnesium chloride, calcium chloride and, in rare cases, potassium chloride. Mineralization is increased by increasing chlorine ions. The concentration of chlorides for Lake Akbas is low compared to the MAC, the lowest level of this indicator in 2016 was 8.7 times, the maximum level in 2015 was 2.1 times less.

Most of the sulphate gets through the death of living organisms into water, domestic and agricultural wastewater [14]. As a result of hydrochemical studies carried out from 2015 to 2019, the amount of sulfate exceeded the MAC. In particular, in 2015 and 2019 it added a little and amounted to 560.78 – 514 mg / l, in 2016 – 1.4; in 2017 – 1.8; In 2016, it increased 1.7 times.

According to the indicators of the ionic composition of Lake Akbas, in 2015 there was weak fresh water with sulfate-chloride sodium, in 2016 – magnesium-sulfate, in the form of weak fresh water with sulfate-magnesium sodium from 2017 to 2019 (Table 3).

As a result of our research, the content of cadmium among heavy metals was 50 times higher than the MPC in 2016 (Figure 2). This indicator was equal to the MAC in 2017, and in 2018-2019, on the contrary, it was less than 0.0001 mg / l. Contamination of Lake Akbas with other heavy metals did not exceed the permissible level (Table 4, Figure 2).

The area of the Akbas lake basin has decreased by 15.3% over the past 50 years. During the study period, the content of dry waste in the lake water exceeded the MAC by 1.1–1.5 times annually. Lake Akbas is moderately polluted in 2018-2019 in terms of the level and quality of class III pollution. The amount of sulfate was 514 – 890.07 mg / l, which exceeded the permissible concentration. The highest levels of cadmium were found to be 50 times the maximum concentration in 2016 and below the maximum concentration in the last three years.

Table 3 – Indicators of the ionic composition of Lake Akbas

Years	Mea-sures	Mass concentration of cations			Mass concentration of anions			The sum of ions, mg / l	Formula of salt composition of water	Name of water
		Na^{1+}+K^{1+}	Ca^{2+}	Mg^{2+}	Cl^{1-}	SO_4^{2-}	HCO_3^{1-}			
2015	mg / dm^3	176	34	96	165,2	560,78	73,2	1105,18	1,11 $SO_4$67 Cl 27 [HCO_3 6] 8,24 Mg46 Na44 [Ca10]	chloride water - sulphate sodium-magne-sium, slightly fresh
	mg / dm^3	7,66	1,7	7,9	4,66	11,68	1,2			
	% eq / dm^3	44,38	45,79	9,83	6,84	26,58	66,58			
2016	mg / dm^3	215,8	11,4	80,4	40,32	728,1	67,1	1143,12	1,14 $SO_4$87 [Cl 7 HCO_3 6] 7,2 Na57 Mg40[Ca3]	water magnesium sulfate - sodium, slightly fresh
	mg / dm^3	9,39	0,57	6,61	1,14	15,16	1,1			
	% eq / dm	56,65	3,43	39,92	6,54	87,14	6,32			
2017	mg / dm^3	215,5	10,8	175,2	162,8	890,07	51,24	1505,49	1,51 $SO_4$77 [Cl 19 HCO_3 4] 8,92 Mg59 Na39 [Ca2]	sulphate water sodium magnesium slightly fresh
	mg / dm^3	9,37	0,54	14,41	4,59	18,53	0,84			
	% eq / dm^3	38,53	2,22	59,25	19,15	77,34	3,5			
2018	mg / dm^3	209,9	8,9	164	154	846	48,3	1431,1	1,43 $SO_4$77 [Cl 19 HCO_3 3] 8,3 Mg58 Na40 [Ca2]	sulphate water sodium magnesium slightly fresh
	mg-eq/ dm^3	9,13	0,44	13,49	4,34	17,61	0,79			
	% eq / dm^3	39,58	1,93	58,49	19,1	77,43	3,48			
2019	mg / dm^3	194	8,2	152	102	514	42,6	1012,8	1,51 $SO_4$75 [Cl 20 HCO_3 5] 8,1 Mg59 Na40 [Ca1]	sulphate water sodium magnesium slightly fresh
	mg-eq/ dm^3	8,44	0,41	12,51	2,88	10,7	0,7			
	% eq / dm^3	39,52	1,92	58,56	20,15	74,96	4,89			
Notes: : [] –less than 25%										

Table 4 – Actual concentration of heavy metal pollution in Lake Akbas, mg / l

Name of contami-nants	Actual concentration by years					MAC	Notes
	2015	2016	2017	2018	2019		
Zinc	0,0007	0,011	0,053	0,16	0,11	5	not more
Lead	0,025	0,0025	0,0025	0,005	0,008	0,03	not more
Cadmium	0,001	0,05	0,001	<0,0001	<0,0001	0,001	more
for example	0,0004	0,0014	0,0164	0,08	0,09	1	not more
Cobalt	0,024	0,001	0,01	0,0006	0,0005	0,1	not more
Manganese	0,0006	0,0006	0,0006	0,007	0,008	0,1	not more
Molybdenum	0,003	0,003	0,003	<0,001	<0,001	0,25	not more
Nickel	0,0008	-	-	0,007	0,005	0,1	not more

Continuation of table 4

Name of contaminants	Actual concentration by years					MAC	Notes
	2015	2016	2017	2018	2019		
Chromium (III)	0,012	0,014	0,012	<0,001	<0,001	0,5	not more
Silver	0,35	0,07	0,0035	<0,005	<0,005	0,05	not more
Strontium	0,347	-	-	<0,001	<0,001	7	not more
Beryllium	0,002	-	-	<0,0001	<0,0001	0,0002	not more

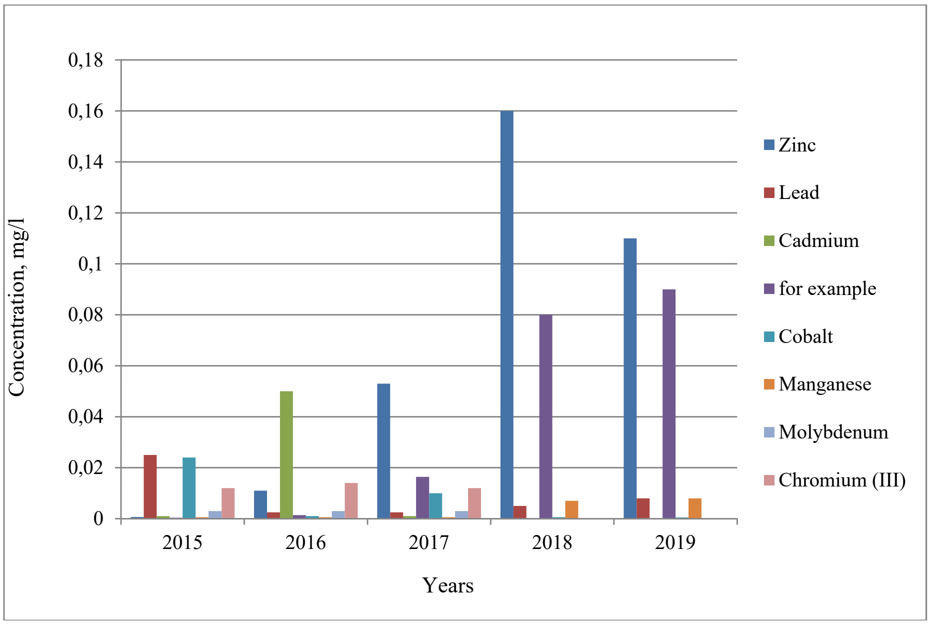

Figure 2 – Actual concentration of heavy metal pollution in Lake Akbas, mg / l

In addition to hydrophysical and hydrochemical studies, we carried out studies of algae for a comprehensive assessment of the ecological state of Lake Akbas.

As a result of the study of algae in water samples taken from Lake Akbas, 61 species of microalgae were identified. 47.5% of the identified species were green algae (*Chlorophyta*), 26% were diatoms (*Bacillariophyta*), 23% were blue algae (*Cyanophyta*), and 4% were euglena algae (*Euglenophyta*) (Fig. 3).

The identified species are divided into 4 sections, 9 classes, 12 rows, 16 genera, 27 relatives.

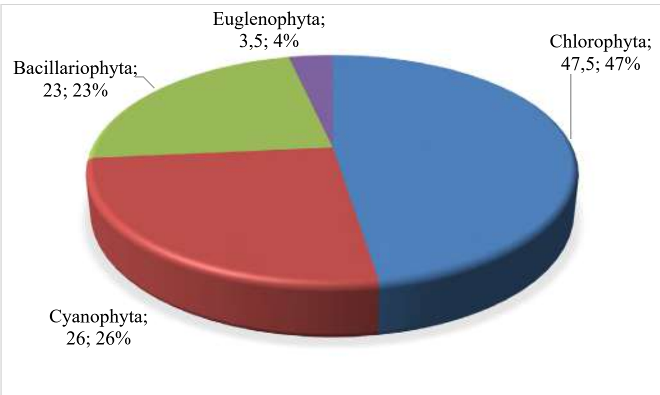

Figure 3 – Detection of microalgae in Lake Akbasratio of species

Among the microalgae found in Lake Akbas were the green algae *Chlorella vulgaris, Chlorella sp, Ankistrodesmus longissimus, Scenedesmus acuminatus, Scenedesmus quadricauda, Chlamydomonas reinhardtii*. From diatoms*Navicula dicephala, Navicula radiosa, Navicula specula, Synedra ulna, Nitzschia palea* were more than others.There are also *Ulothrix tenerrima Kutz., U. Variabilis Kutz*, from blue-green algae – *Phormidium tenue., Anabaena variabilis, Spirulina major, Oscillatoria tenuis, Oscillatoria chalybea* and many others.

The sensitivity of algae to various pollutants depends on their absorption of substances from the environment throughout the body. In addition, some types of algae are indicators of the presence of certain pollutants in the water.

Water pollution of Lake Akbas is primarily associated with the entry of various pollutants into the reservoir. Most pollutants are caused by precipitation. The share of household waste pollution is also high.

When assessing the ecological state of water bodies, not only physicochemical methods are widely used, but also the role of indicator-saprobic microalgae.

After determining the species composition of microalgae living in Lake Akbas, we settled on the indicator-saprobic species of microalgae. It is impossible to determine the spectrum of all pollutants using indicator species. But it allows you to quickly determine the fact of environmental pollution.

As a result of algological studies, it has been established that 20 species of microalgae found in the reservoir of Lake Akbas are indicator-saprobic species (Table 5).

If we distribute microalgae by saprobity, out of 20 species of indicator saprobes identified in Lake Akbas, 1-xeno-alpha-mesosaprobic, 1-oligosaprobic, 8-beta-mesosaprobic, 3-alpha-mesosaprobic, 1-beta-alpha-mesosaprobic, 3 – beta-oligosaprobic, 1-oligo-beta-mesosaprobic, 2-poly-alpha-mesosaprobic microalgae (Fig. 4).

In the reservoir, microalgae of the beta-mesosaprobic zone accounted for 40% of all algae.

The fact that the saprobity index according to the Pantle-Bucchi method is 1.95 proves that Lake Akbas belongs to the β-mesosaprobic zone.

After carrying out chemical and algal studies of Lake Akbas, we conducted biotesting of water samples from Lake Akbas to study the sensitivity of algae to environmental factors and various chemical reactions.

Table 5 – Indicators-saprobic species of microalgae found in Lake Akbas (2015-2019)

№	Saprobic species indicator	Saprobic S
1	*Merismopedia glauca (Ehr) Nag*	β
2	*Merismopedia major (Ehr) Nag*	β – o
3	*Merismopedia tennissima lemm.*	β – α
4	*Microcystis aerouginosa.*	β
5	*Anabaena affinis*	β
6	*Oscillatoria tenuis Ag.*	α
7	*Oscillatoria chalybea (Mert.)Com*	α
8	*Oscillatoria Limnetica lemm.*	o – β
9	*Oscillatoria brevis (Kuetz.) Com*	α
10	*Scenedesmus acuminatus*	β
11	*Scenedesmus quadricauda var.*	β
12	*Pediastrum boryanum Meyen*	β
13	*Chlorella vulgaris*	ρ-α
14	*Ulothrix zonata*	o
15	*Cladophora glomerata*	β
16	*Euglena viridis*	p-α
17	*Euglena hemichromata Skuja*	β
18	*Nitzschia palea*	α
19	*Fragilaria capucina*	β-o
20	*Synedra ulna*	χ – α

First of all, nutrient media were prepared for control and experiments for biotesting Lake Akbas. Then a test organism, the Chlorella sp-3K strain, was introduced into it. The dynamics of cell growth was studied for 8 days, and a comparative analysis of the data was carried out. Mineral salts necessary for cell nutrition were added to the preparation of pure control water and culture medium of lake water in an amount corresponding to standard culture medium 04.

For the study, 2 different variants of lake water were taken. In Option 1, lake water was diluted by half, and in Option 2, the first sample of lake water was taken without changes. The number of introduced chlorella cells was the same in all variants 5x106 ± 0.6 ml (table 2).

Nutrient media for control and experiment and the *Chlorella sp-3K* strain were used for biotesting Lake Akbas.

When observing the dynamics of cell growth for 8 days, it was found that the number of cells of the *Chlorella sp-3K* strain in pure control water increased by 22.8 × 106 ± 0.65 in 4 days. The number of cells of the *Chlorella sp-3K* strain in the lake water diluted by half increased to 19.1x106 ± 0.45 per ml in the first 4 days, and no increase was observed in the following days. In 2 variants of the first sample of lake water taken without changes, the number of cells increased to 17.5x106 ± 0.5 per 1 ml in the first 4 days, and no increase was observed on the following days (Table 6).

In figure 5 shows the dynamics of cell growth during biotesting of the water of Lake Akbas using the *Chlorella sp-3K* strain.

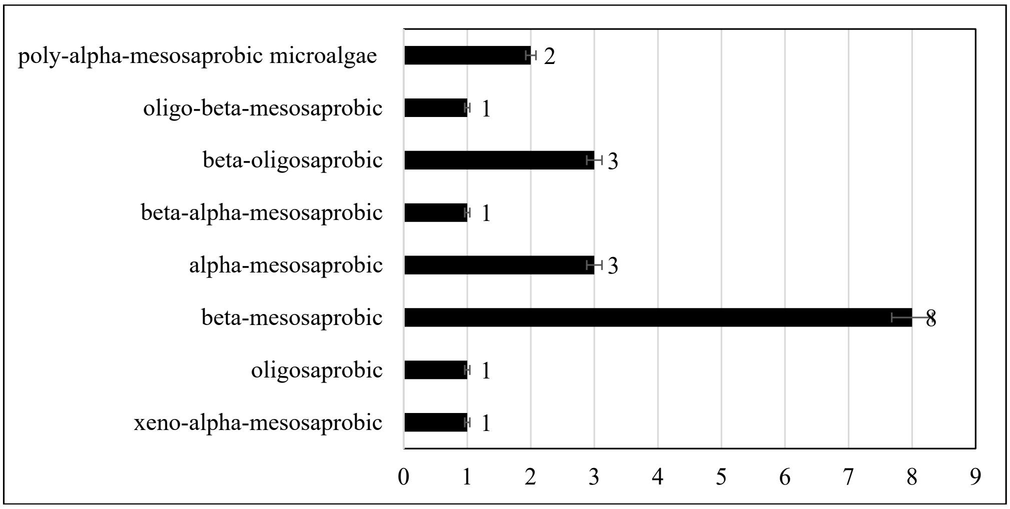

Figure 4 – Indicator of the saprobity of the algal flora of Lake Akbas quantitative ratio of species

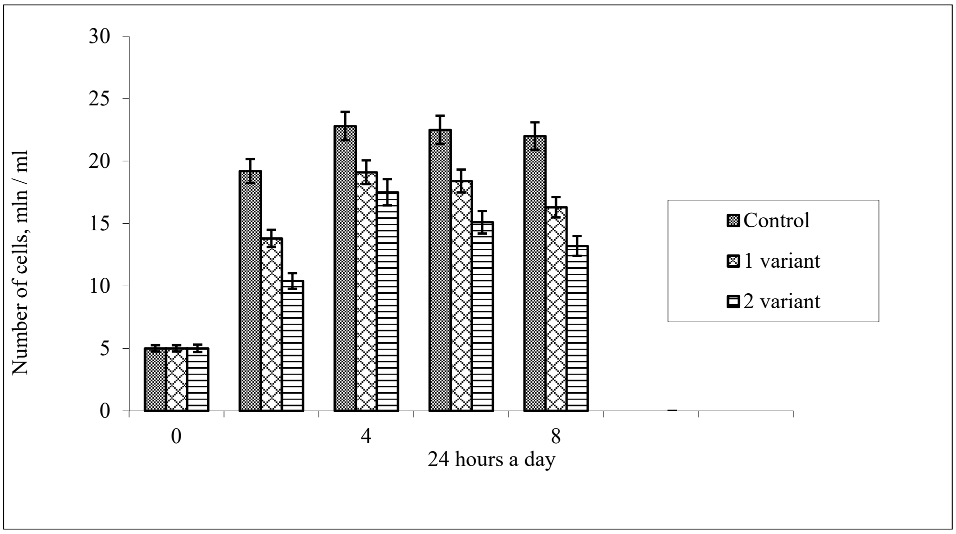

Figure 5 – Growth dynamics of the *Chlorella sp-3K* strain in a water sample from Lake Akbas and control

Table 6 – Growth of *Chlorella sp*-3K cells during biotesting in the water of Lake Akbas

Tests	Number of cells in 1 ml per day				
	0	2	4	6	8
Control	5x10^6±0,25	19,2 x10^6±0,6	22,8 x10^6±0,65	22,5 x10^6±0,55	22 x10^6±0,54
1-variant	5 x10^6±0,3	13,8 x10^6±0,36	19,1 x10^6±0,45	18,4 x10^6±0,5	16,3 x10^6±0,48
2-variant	5 x10^6±0,3	10,4 x10^6±0,35	17,5 x10^6±0,5	15,1 x10^6±0,49	13,2 x10^6±0,46

There was a decrease in the number of chlorella cells in the test water compared to the control. This is due to the fact that Lake Akbas contains more fluoride, iron and copper, which inhibit the growth of the *Chlorella sp-3K* strain.

Biotesting showed that the *Chlorella sp-3K* strain is moderately sensitive to toxic concentrations in Lake Akbas.

Studies have shown that bioassays for microalgae in lake water are quick and easy and complete the results of chemical studies. Thus, the biotesting results supplemented the previous data and correctly responded to the toxicity of the *Chlorella sp-3K* strain in water bodies.

In the period of the work it was proved that the results of hydrochemical, algal and biotesting studies carried out on Lake Akbas completed each other. According to these indicators of a comprehensive assessment of the lake water, the water of Lake Akbas belongs to the 3rd class of pollution and is moderately polluted.

Conclusion

Lake Akbas has been studied and analyzed using hydrophysical, hydrochemical and algological studies. The ecological state of Lake Akbas has been published, and the average value of the data of long-term laboratory studies has been estimated based on the lists of fishing standards. As a result of research in 2015-2019, according to the hydrophysical, hydrochemical studies and the results of complex testing of algocenoses and biotesting, it was determined that the water of Lake Akbas belongs to 3 classes of pollution.

The amount of sulfate was 514 – 890.07 mg / l, which exceeded the permissible concentration. It was found that the maximum level of cadmium is 50 times higher than the MAC in 2016, but below the MAC for the last three years.

In studies of algae, microalgae in the beta-mesosaprobic zone accounted for 40% of all algae in the reservoir, and the saprobity index 1.95 according to the Pantle-Bucchi method proved that Lake Akbas belongs to the β-mesosaprobic zone. Biotesting showed that the Chlorella sp-3K strain is moderately sensitive to the concentration of toxic substances in Lake Akbas.

Conflict of interest

All authors are familiar with the text of the article and declare that they have no conflict of interests.

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3-бөлім

БИОЛОГИЯЛЫҚ АЛУАНТҮРЛІЛІКТІ САҚТАУДЫҢ ӨЗЕКТІ МӘСЕЛЕЛЕРІ

Section 3

ACTUAL PROBLEMS OF BIODIVERSITY CONSERVATION

Раздел 3

АКТУАЛЬНЫЕ ПРОБЛЕМЫ СОХРАНЕНИЯ БИОЛОГИЧЕСКОГО РАЗНООБРАЗИЯ

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SPATIAL STRUCTURE OF VEGETATION COVER OF SHARYN SNNP

The article presents the results of a study of the spatial structure of vegetation SNNP (State National Nature Park) «Sharyn» on the basis of the inventory and assessment of vegetation in SNNP «Sharyn» in Almaty region. The spatial distribution of the SNNP «Sharyn» vegetation cover was based on the landscape structure of the territory and ecological and physiognomic types of vegetation. The assessment of Botanical diversity of vegetation included an assessment of floral and phytocenotic diversity of vegetation. The floral diversity of the SNNP «Sharyn» vegetation cover consists of 915 species of vascular plants from 406 genera and 84 families, which indicates a significant species richness of the flora.

According to the Botanical and geographical division, the vegetation of the territory under consideration belongs to the Sahara-Gobi region, the Iran-Turan subdistrict, the Dzungarian province and belongs to the intermountain-basin deserts.

The taxonomic analysis of the flora of the SNNP «Sharyn» showed that the 10 leading families include 578 species, or 63.12% of the total number of species. The spatial heterogeneity of the vegetation cover of the SNNP «Sharyn» includes the vegetation of low-mountains, low-hills, foothill plains, arid-denudation plateaus, deluvial-proluvial plains, ancient alluvial plains, canyons and dry channels, valleys of the Temirlik and Sharyn rivers, anthropogenically disturbed agricultural lands.

The result of the assessment of the spatial distribution of vegetation cover was the creation of a vegetation map at a scale of 1: 300000. The created map contains 39 allotments.

Key words: Sharyn, floristic and phytocenotic diversity, inventory monitoring.

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Шарын МҰТП өсімдік жамылғысының кеңістіктік құрылымы

Мақалада Алматы облысындағы «Шарын» МҰТП (Мемлекеттік ұлттық табиғи парк) аумағының өсімдік жамылғысының жай-күйін бағалау және инвентаризация негізінде «Шарын» МҰТП өсімдік жамылғысының кеңістіктік құрылымын зерттеу нәтижелері келтірілген. «Шарын» МҰТП өсімдік жамылғысының кеңістіктік таралуы аумақтың ландшафтық құрылымына және өсімдіктердің экологиялық және физиомиялық түрлеріне негізделген. «Шарын» МҰТП өсімдіктердің ботаникалық әртүрлілігін бағалауға өсімдіктердің флоралық және фитоценотикалық әртүрлілігін бағалау кірді. «Шарын» МҰТП өсімдік жамылғысының флористикалық әртүрлілігі 406 туысқа және 84 тұқымдасқа жататын тамырлы өсімдіктердің 915 түрін құрайды, бұл флораның едәуір түрге бай екендігін көрсетеді.

Ботаникалық-географиялық бөлініске сәйкес, қарастырылып отырған аумақтың өсімдік жамылғысы Сахаро-Гоби аймағына, Ирано-Туран субаймағына, Жоңғар провинциясына және тау аралық-шұңқыр шөлдерге жатады.

«Шарын» МҰТП флорасына таксономиялық талдау көрсеткендей, ең жақсы 10 тұқымдастыққа 578 түр кіреді немесе олардың жалпы санының 63,12% құрайды. «Шарын» МҰТП өсімдік жамылғысының кеңістік гетерогенділігі төмен тауларды, тау бөктеріндегі жазықтарды, құрғақ-денудациялық үстірттерді, делювиалды-пролувиалды жазықтарды, ежелгі аллювиалды жазықтарды, каньондар мен құрғақ каналдарды, Темірлік және Шарын өзендерінің аңғарларын, антропогендік ауылшаруашылық жерлерді қамтиды.

Өсімдік жамылғысының кеңістіктік таралуын бағалаудың нәтижесі 1:300000 масштабтағы өсімдіктер картасын жасау болды. Жасалған карта 39 бөліктен тұрады.

Түйін сөздер: Шарын, флористикалық және фитоценотикалық әртүрлілік, инвентаризация¸ мониторинг.

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Пространственная структура растительного покрова Шарынского ГНПП

В статье приведены результаты исследования пространственной структуры растительного покрова ГНПП (Государственный национальный природный парк) «Шарын» на основе инвентаризации и оценки состояния растительного покрова территории ГНПП «Шарын» в Алматинской области. Пространственное распределение растительного покрова ГНПП «Шарын» основывалось на ландшафтной структуре территории и эколого-физиономических типах растительности. Оценка ботанического разнообразия растительности ГНПП «Шарын» включало оценку флористического и фитоценотического разнообразия растительности. Флористическое разнообразие растительного покрова ГНПП «Шарын» составляют 915 видов сосудистых растений из 406 родов и 84 семейств, что указывает на значительное видовое богатство флоры.

По ботанико-географическому делению растительность рассматриваемой территории относится к Сахаро-Гобийской области, Ирано-Туранской подобласти, Джунгарской провинции и относится к межгорно-котловинным пустыням.

Таксономический анализ флоры ГНПП «Шарын» показал, что 10 ведущих семейств включают 578 видов, или 63,12% от общего количества видов. Пространственная неоднородность растительного покрова ГНПП «Шарын» включает растительность низкогорий, мелкосопочников, предгорных равнин, аридно-денудационных плато, делювиально-пролювиальных равнин, древнеаллювиальных равнин, каньонов и сухих русел, долин рек Темирлик и Шарын, антропогенно нарушенных сельскохозяйственных земель.

Итогом оценки пространственного распределения растительного покрова было создание карты растительности масштаба 1:300000. Созданная карта содержит 39 выделов.

Ключевые слова: Шарын, флористическое и фитоценотическое разнообразие, инвентаризация¸ мониторинг.

Introduction

State National Natural Park «Sharyn» is located within the Ili intermountain basin. The central part of the basin is characterized by extremely arid rubble deserts of the Dzungarian type, which are Gobi analogs [1]. There is a deep-cut (50-120 m) canyon-shaped valley of the Sharyn River, a large left-bank tributary of the Ile River, whose sources are in the Kungey-Alatau mountains. The relict broad-leaved ash (Fraxinus sogdiana) forest has survived under the specific conditions of the canyon microclimate. Passing through the entire Eurasian chain of ranges of ash species, the ash species Fraxinus sogdiana naturally grows in Central Asia [2]. Among a wide range of terrestrial habitats, forests and woodlands are the richest, both biologically and genetically, due to their inherent structural and compositional complexity and diversity. While species composition is an important characteristic of biodiversity, forest structure may be even more relevant to biodiversity assessment, because a diversified structure is likely to have more niches, which in turn accommodate more species and facilitate more efficient use of available resources. Structure plays an important role as an indicator of diversity for management purposes, where maps of structural diversity of forests are very useful in planning conservation strategies. Airborne laser scanning data is a reliable and source of information for describing the three-dimensional structure of a forest [3]**.** Ecological networks can provide insight into how biodiversity loss and changes in species interactions affect the provision of ecosystem services [4]. There are 4 key areas for the conservation of forest biodiversity: the ability of species to survive in post-disturbed forest landscapes, the impact of plantation on biodiversity, the effectiveness of modified silvicultural systems on forest structure, vegetation composition and biota, and the relationship between deforestation and fire hazards [5]. High quality data on the occurrence of plant species are considered one of the most important data sources for ecological research and conservation purposes. However, ecologically valuable fine-grained mosaics of dissimilar shrubs and herbaceous formations create a complex environment for creating distribution maps of such species. Remote sensing can be useful for such purposes, but it faces a number of problems, especially with the need to obtain ultra-high spatial resolution data and distinguish between plant species or genera [6].

The high botanical diversity of the territory is due to the position of the territory between the Kazakh and Dzungarian deserts, the influence of the Northern Tien Shan mountains and the presence of large river valleys (Ile, Sharyn).

According to the botanical-geographical zoning [1], the vegetation of the Ili depression belongs to the Sahara-Gobi desert botanical-geographical region, the Irano-Turan subregion, the Dzungar province within the middle deserts. The spatial structure of the habitat of plant communities based on soil functions includes the identification of the leading factors of biodiversity and the determination of the spatial heterogeneity of soil function. Therefore, the composition of plant communities (accuracy 95%) and a reference group of soils (accuracy 88%) were modeled depending on soil moisture conditions and used as a tool for spatial forecasting [7]. Land-use change requires measuring patterns of biodiversity change at different spatial scales to inform landscape management. Assessing changes in vegetation at different scales is challenging [8]. Research [9] describes a spatially structured, individual rangeland model that embodies this perspective and simulates the dynamics of forage and livestock production in semi-arid rangelands, using both continuous and alternating grazing. The ability to predict spatial variation in biodiversity is a long-standing but elusive goal of landscape ecology. It depends on a detailed understanding of the relationships between landscape and site structure and taxonomic richness, as well as accurate spatial modeling [10].

Bioclimatic substantiation of the spatial structure of vegetation based on the altitudinal division of vegetation using the global climate model. Statistical analysis showed differences between altitudinal belts, subbelts, and types of larch in terms of average annual temperature and average annual precipitation. The possibility of using climate as a factor of differentiation of vegetation cover at the regional level has been proven [11]. Spatial distribution patterns were determined using the Morisita overlap index for the species with the highest importance [12].

For the classification of ecosystems, the block structure of the system of water-terrestrial ecotones was used. Ecosystem mapping was based on an integrated approach that takes into account the patterns of plant distribution depending on the environment. For each block, a list of ecosystems was determined based on an assessment of species and phytocenotic diversity and environmental condition [13].

For each block, a list of ecosystems was determined based on an assessment of species and phytocenotic diversity and environmental conditions. Floristic features including floristic composition, life forms and aquatic plant ecotypes, floristic geographic elements were also evaluated [14].

Analysis of the current state of vegetation is an integral part of a comprehensive research program on landscape planning, which reveals the dynamics of vegetation, territorial differentiation, biological diversity, the degree of disturbance of the communities of the territory and the possibility of their preservation [15]. An indirect method for assessing biodiversity from Earth observations is the hypothesis of spectral variability. Spectral variability shows that the higher the spatial variability of the spectral response of an optical image with remote sensing, the greater the number of accessible ecological niches and, therefore, the higher the biodiversity in the considered area [16].

Measurements of the spatial structure and Botanical diversity of vegetation SNNP «Sharyn» is performed on the basis of the field work of the authors on the territory 2016, 2017, 2019, 2020, drawing on the materials of the herbarium of Institute of botany and Phytointroduction of MES RK, Center for Remote sensing and GIS "Terra" (2008) [17] and the work of the scientific Department of SNNP «Sharyn». Still, the relative importance of environmental and spatial factors in shaping the structure of local plant diversity remains unclear.

The aim of this research was to identify the spatial structure of vegetation SNNP «Sharyn» on the basis of the inventory and assessment of vegetation in SNNP «Sharyn». Inventory, monitoring and analysis of the Botanical diversity of a specific territory is the scientific basis for nature protection.

Objects of research: vegetation cover of the territory of SNNP "Sharyn", its composition, structure, spatial distribution, anthropogenic disturbance

Methods of research: vegetation cover was studied using traditional geobotanical research methods «Field geobotany...,1959-1976» [18]

«Program and methodology of biocenological research.., 1974 "[19] and special techniques for assessing the state and mapping vegetation, developed as in other regions " Methods of field landscape research.., 1998» [20], so in the laboratory of geobotany of the Institute of botany and Phytointroduction of MES RK «Transformation of vegetation cover of Kazakhstan..,1997» [21].

The species composition of vegetation cover was detected by traditional methods – route survey, as well as collection and determination of herbarium material. Herbarium collection and study of anthropogenic transformation of flora was carried out on the basis of « Field geobotany., 1959-1976» [18] and «Floristic research programs...,1987» [22]. Factors of anthropogenic disturbance for assessing the current state of vegetation are identified on the basis of methods developed in the laboratory of geobotany ISCIF RK [21,23]. "Flora of Kazakhstan, 1956-1966" was used to determine plant species" [24], " Illustrated plant identifier, 1969-1972 "[25] and "flora of Kazakhstan..., 1999" [26]. Latin names of plants are given according to the « list of vascular plants of Kazakhstan..., 1999» [27]. Plants that could not be recognized in the feld were collected and specimens were classifed in the laboratory. All plants were identifed to the level of species. After the point intercept lines were finished, a thorough visual search was made along the central point intercept line including the photographic plot and additional plant species were listed. Starting in 2016-2020 this was done following the point and fexible area methodology. Te number of individuals and approximate dimensions (length × width) of new species within 1m at each side of the central transect were recorded. Plants that were farther away were recorded as number, dimensions and modal distance from the central transect. A total of 578 vascular plants have been [28].

The Botanical diversity of the vegetation cover of the SNNP «Sharyn» includes floristic and phytocenotic diversity Floristic diversity in the compilation of the NSJ was indicated in 1500 species [17]. Phytocenotic diversity is represented by six types of vegetation (steppe, desert, shrub, riparian woodland, meadow and marsh), numerous, often unique in composition, plant communities.

Inventory of the floristic composition of refined species composition of the flora of the SNNP «Sharyn» when creating the NSJ account of the much larger area and therefore given the current situation, many species were removed from the list, added some newly discovered species.

Field mapping was performed using the route method using a GPS device to determine coordinates. At the same time, the selected points in the descriptions, which reflect the diversity of landscapes and PTC in the study area, described in detail the components of the landscape (topography, soil, vegetation, etc.) and their condition.

Floristic diversity of vegetation cover of the SNNP «Sharyn»

Taxonomic analysis

According to literature data, the flora of the park numbers about 1000 species of plants, of which 51 are rare and endemic.

Current research for 2016-2020 shows that the floral diversity of the vegetation cover of the SNNP «Sharyn» consists of 915 species of vascular plants from 406 genera and 84 families, which indicates a significant species richness of the flora.

Taxonomic analysis of the flora of the SNNP «Sharyn» showed that the first 10 families include 578 species, or 63.12% of the total number of species (Table 1).

Table 1 – The number of species in the 10 leading families of the flora of the SNNP «Sharyn»

№	FAMILIES	Number of species	%
1	Asteraceae Dumort – Asteraceae	128	13.98
2	Poaceae Barnhart – Poaceae	83	9.07
3	Fabaceae Lindl. – Pea family	74	8.08
4	Chenopodiaceae Vent – Goosefoot family	72	7.86
5	Brassicaceae Barnett – Crucials	65	7.10
6	Rosaceae Juss – Rose family	45	4.91
7	Lamiaceae Lindl. – Mint family	34	3.71
8	Boraginaceae Juss. – Heliotropes	29	3.17
9	Ranunculaceae Juss. – Crowfoot family	25	2.73
10	Cyperaceae Juss. – Cyperaceae	23	2.51
11	Number of species in the top 10 families	578	63.12
12	Total species in the flora of the SNNP «Sharyn»:	**915**	**100%**

The sequence of the most multi-species families is as follows: Asteraceae (128), Poaceae (83), Fabaceae (74), Chenopodiaceae (72), Brassicaceae

(65), Rosaceae (45) Lamiacea (34), Boraginaceae (29) Ranunculaceae (25), Cyperaceae (23).

The number of the largest families, including from 55 to 5 genera is 15 (table 2). They contain 306 genera from 408 genera of the entire flora of SNNP «Sharyn», or 75% of all genera.

The largest genera, including 10 to 26 species, are: the next 10 genera: Astragalus (26 species), Artemisia (18), Allium (17), Carex, Potentilla по (14 species), Euphorbia (12), Salix, Veronica (11 species), Salsola, Stipa (10 species).

Further from 9 to 5 species contain the following 32 genera: Oxytropis, Tulipa (9 species); Taraxacum, Rosa (8 species); Lappula, Iris, Zygophyllum (7 species); 8 genus (Ferula, Centaurea, Silene and etc.) contains 6 species; 17 genus (Atriplex, Erysimum, Scorzonera and etc.) – 5 species.

There are 26 families of monotypic families containing one genus, one species in the flora of SNNP «Sharyn».

Table 2 – The number of genera in large families of the flora of SNNP «Sharyn»

№	Families	Number of genera
1	Asteraceae Dumort – Asteraceae	55
2	Poaceae Barnhart – Poaceae	48
3	Brassicaceae Barnett – Crucials	41
4	Chenopodiaceae Vent – Goosefoot family	32
5	Fabaceae Lindl. – Pea family	20
6	Apiaceae Lindl. – Parsley family	16
7	Lamiaceae Lindl. – Mint family (Labiatae)	16
8	Rosaceae Juss – Rose family	16
9	Boraginaceae Juss. – Heliotropes family Boraginaceae	14
10	Caryophyllaceae Juss. – Pink family	11
11	Ranunculaceae Juss. – Crowfoot family	11
12	Polygonaceae Juss – Buckwheat family	10
13	Crassulaceae DC. – Orpine family	6
14	Scrophulariaceae Juss. – Figwort family	6
15	Cyperaceae Juss. – Cyperaceae	5
16	Total genera in 15 families	307
17	Total species in the flora of the SNNP «Sharyn»	406

Rare species

The uniqueness and originality of the flora of a particular territory is determined by the presence of rare and endemic plants. There are 39 species listed in the Red book of the Republic of Kazakhstan on the territory of the SNNP «Sharyn» (Table 3). Among them: *Aquilegia vitalii* Gamajun., *Arthrophytum iliense* Iljin, *Berberis iliensis* M.Pop., *Chesneya dshungarica* Golosk., *Crocus alatavicus* Regel et Semen, *Ferula iliensis* Krasn.ex Korov., *Ferula sjugatensis*.Bjat, *Fraxinus sogdiana* Bunge, *ikonnikovia Kaufmanniana* (Regel) Lincz, *Lonicera iliensis* Pojark., *Plagiobasis centauroides* Schrenk, *Populus pruinose* Schrenk, Tulipa alberti Regel, etc. At the limit of the range grow *Iljinia regelii* Bunge, *Simpegma regelii* Bunge and others.

Table 3 – Species of the SNNP «Sharyn» listed in the Red Book of the Republic of Kazakhstan

1	*Aquilegia vitalii* Gamajun.
2	*Armeniaca vulgaris* Lam.
3	*Arthrophytum iliense* Iljin
4	*Astragalus tscharynensis* M.Pop.
5	*Berberis iliensis* M.Pop.
6	*Celtis caucasica* Willd.
7	*Centaurea turkestanica* Franch.
8	*Chesneya dshungarica* Golosk.
9	*Crataegus korolkowii* LHenry
10	*Crocus alatavicus* Regel et Semen
11	*Ferula iliensis* Krasn.ex Korov.
12	*Ferula sjugatensis* Bjat.
13	*Fraxinus sogdiana* Bunge
14	*Fritillaria pallidiflora* Schrenk
15	*Haplophyllum dshungaricum* Rubtz.
16	*Heliotropium parvulum* M.Pop.
17	*Hepatica falconeri* (Thoms) Steward
18	*Ikonnikovia kaufmanniana* (Regel) Lincz
19	*Iris alberti* Regel
20	*Juno kuschakewiczii* (B.Fedtsch) Poljak.
21	*Lepechiniella michaelis* Golosk.
22	*Limonium michelsonii* Lincz.
23	*Lonicera iliensis* Pojark.
24	*Malus sieversii* (Ledeb.) M.Roem.
25	*Oxytropis almatensis* Bajt.
26	*Oxytropis niedzweckiana* M.Pop.
27	*Paeonia hybrida* Pall.
28	*Plagiobasis centauroides* Schrenk
29	*Populus pruinosa* Schrenk
30	*Rheum wittrockii* Lundstr.
31	*Rhodiola rosea* L.
32	*Serratula dshungarica* Iljin
33	*Stipa kungeica* Golosk.
34	*Stroganovia sagittata* Kar. et Kir.
35	*Tulipa alberti* Regel
36	*Tulipa brachystemon* Regel
37	*Tulipa kolpakovskiana* Regel
38	*Tulipa patens* Agardh & Schult.
39	*Tulipa uniflora (L.)* Bess.ex Baker.

On the territories of SNNP «Sharyn» grow 39 species listed in the Red book of the Republic of Kazakhstan.

Phytocenotic diversity of vegetation cover of the SNNP «Sharyn»

According to the Botanical and geographical division, the vegetation of the territory under consideration belongs to the Sakhar-Gobi region, the Iran-Turan subdistrict, the Dzungarian province and belongs to the intermountain-basin deserts.

The following types of vegetation are found on the territory of the Sharyn state Park: steppe, desert, shrub, meadow, swamp, and tugai. The diversity of landscapes and belonging to the ili basin, which is the «enclave of the Dzungarian deserts», determines the unique combination and diversity of vegetation cover. The spatial heterogeneity of the vegetation cover of the Sharyn national Park includes vegetation of low mountains, small hills, foothill plains, arid-denudation plateaus, deluvial-proluvial plains, ancient alluvial plains, canyons and dry channels, valleys of the Temirlik and Sharyn rivers, and anthropogenic disturbed agricultural lands.

The range of zoning on the plains is characterized by a change of desolate steppes on light chestnut soils (1400-1500 m), settled deserts on brown soils (1200-1400 m) and real deserts on gray-brown soils (700-1200), extremely arid deserts (600-700 m) are represented fragmentally in the lower part. The altitudinal zone structure of vegetation distribution in low mountains and mountains includes: mountain settled deserts, mountain desolate steppes, dry steppes. The Central, lowest part of the basin is occupied by fragments of extreme arid deserts. It is characterized by a combination of stony gammads, devoid of vegetation, with iljinia (*Iljinia regelii*) communities on the sayam. Real deserts on gray-brown soils occupy the largest territory in terms of length and amplitude of heights (700-1200 m). Desolate steppes on light chestnut soils and settled deserts (semi-deserts) on brown soils are common in the high part of the territory adjacent to the mountains. The surveyed territory is dominated by the ecological and physiognomic type of perennially saline deserts: tasbiyurgunovye deserts (Nanophyton erinaceum) with subtypes: pure tasbyurguns, feather grass-tasbyyurguns (Nanophyton erinaceum, Stipa caucasica, S. orientalis), saxaulchik-tasbyyurgun (Nanophyton erinaceum, Arthrophytum iliense), biyurgun-tasbyyurgun communities (Nanophyton erinaceum, Anabasis salsa). Salsola (Salsola arbusculiformis) common only in high hills and low mountains. In real deserts on gray-brown soils, tasbyurgun-salsola are common (Salsola arbusculiformis, Nanophyton erinaceum), wormwood-salsola communities (Salsola arbusculiformis, Artemisia sublessingiana). The belt of steppe deserts on mountain brown soils is characterized by the predominance of species rare in composition and floristically rich hawkers: cereal-boalychia (Salsola arbusculiformis, Stipa macroglossa, S. orientalis, Agropyron cristatum), cereal-tasbyurgun-salsola (Salsola arbusculiformis, Nanophyton erinaceum, Convolvulus tragacanthoides, Stipa orientalis, Cleistogenes songorica), shrub-feather-grass-salsola (Salsola arbusculiformis, Atraphaxis replicata, Caragana kirghisorum, Stipa orientalis, Cleistogenes songorica), злаково-multiherb-karagana-salsola (Salsola arbusculiformis, Caragana kirghisorum, Ikonnikovia kaufmanniana, Allium galanthum, Stipa macroglossa, S. orientalis, Agropyron cristatum).

Arid-denudation plateaus are characterized by gray-brown gypsum-bearing soils and saxaulchik *(Arthrophytum iliense, A. longibracteatum)* deserts. On the territory of the SNNP «Sharyn» there is a series of rare perennial saxaul communities: *Suaeda dendroides, Iljinia regelii, Reaumuria songarica, Sympegma regelii.*

Among the wormwood deserts, we should mention the Semirechye wormwood *(Artemisia heptopotamica)* on foothill brown soils. Particularly widespread are the cereal-semirechensky wormwood *(Artemisia heptapotamica, Stipa sareptana, Festuca valesiaca, Agropyron cristatum, Kochia prostrata)* communities. Sublessingiana-wormwood *(Artemisia sublessingiana)* communities are found on gravelly-fine earth, usually on the northern slopes of the hummocks. Wormwoods *(Artemisia santolina)* are a common type of communities on saline sands. The saxaul-santal wormwood *(Artemisia santolina, Haloxylon aphyllum)* and the rheumurian-santalus wormwood *(Artemisia santolina. Reomuria songarica)* communities are widespread. White earth wormwood *(Artemisia terrae-albae)* rarely wind and are associated mainly with soils of light texture.

The composition of the communities on the sands is peculiar. Thus, for mixed saxaul *(Haloxylon aphyllum, H. persicum)* communities of sands with a close occurrence of groundwater, the participation of meadow plants and tugai species is characteristic (*Halimodendron halodendron, Phragmites australis).* Sand-acacia-saxaul *(Haloxylon persicum Ammodendron bifolium)* deserts are found in small areas along the tops of sandy ridges, as well as psammophytic shrubs *(Calligonum junceum)* – a rare type of communities, also confined to the waving tops of sandy ridges. Saline vegetation is concentrated within the Ili Valley on terraces above the floodplain or in areas of secondary salinization associated with irrigation. Vegetation is represented by: carabarak *(Halostachys caspica),* sarsazan *(Halocnemum strobilaceum),* suaeda *(Suaeda physophora)* communities.

Among the rare desert formations, we should mention the Suaeda dendroides, *Arthrophytum balchaschense*, *A. iliense, Iljinia Regelii,* and *Reaumuria songarica.*

At the same time, there are communities of desert formations typical of the North Turan region: *Anabasis salsa, Haloxylon aphyl- lum, Salsola orientalis, Artemisia terrae-albae, Halocnemum strobilaceum, Halostachys caspica, Suaeda physophora.*

In the mountains weather can be found: balycheva community with a predominance of East-Gobi species *Salsola laricifolia.* They include *Nanophyton erinaceum, Stipa orientalis, Iljinia regelii, Atraphaxis compcta.* The Aeolian sediments are characterized by an extremely Western location of the Gobi species *Ephedra przewalskii.* At lower hypsometric levels common Iliense community. The following series of communities are typical for the Sharyn river valley in the territory under consideration: shrub-salix-wilhelmsiana (Salix songarica, S. wilhelmsiana, Elaeagnus oxycarpa, Tamarix ramosissima), *Populus diversifolia* (Populus diversifolia), Asiatic poplar- Elaeagnaceae (Elaeagnus oxycarpa, Populus diversifolia) Fraxinus (Fraxinus sogdiana), motley grass-grasses (Leymus multicaulis, Elytrigia repens, Glycyrrhiza uralensis), Asiatic poplar (Populus diversifolia, P. pruinosa), Aeluropus littoralis-frutescent (species Tamarix, Halostachys belangeriana, Aeluropus littoralis) with Poacinum pictum and Achnatherum splendens – desert woodland with Haloxylon aphyllum [29].

Spatial structure of the vegetation cover of the SNNP «Sharyn»

When drawing up the vegetation map of the SNNP «Sharyn», we assumed that it should reveal the regularities of the structure of vegetation cover associated with the differentiation of environmental conditions. Variegated vegetation cover, due to the heterogeneity of the physical and geographical environment and various degrees of anthropogenic transformation of vegetation, is particularly pronounced at the SNNP «Sharyn».

The developed map reflects modern vegetation. The map shows both the poster and the entire spectrum of non-poster communities. Both typological and horological mapped vegetation units were used to reflect the heterogeneous spatial structure of vegetation cover on the «SNNP «Sharyn» vegetation Map M 1:300000».

Map legend consists of a subtitle system. The subheadings reflect the high-level connection with the high tiers of relief. In the legend to the map of vegetation of the SNNP «Sharyn», the following are highlighted: low mountains, small hills, foothill plains, intermountain basin (including arid-denudation plateaus, deluvial-proluvial plains, ancient alluvial, canyons and dry channels), modern alluvial plains (Sharyn river valley).

Along with the homogeneous homogeneous units of vegetation – fotocamere (groups, communities, or associations) as mapped units for heterogeneous cover of the widely used types pirozenko (complexes, series, aggregate, and combinations of series, environmental series, etc.), allowing to emphasize the characteristic of SNNP «Sharyn» spatial heterogeneity of vegetation.

The map legend contains 39 selections. The drawing on the map is highlighted in color and texture. Solid color shows the vegetation of the mountains, the low hills, and Piedmont plains etc. The texture shows the spatial differentiation of specific selections. The floral diversity of vegetation of the SNNP «Sharyn» has been clarified. At the moment, it consists of 915 species of vascular plants from 406 genera and 84 families. There are 39 species of red book species on the territory of the Sharyn state farm.

Phytocenotic diversity includes seven types of vegetation (swamp, water, meadow, forest, shrub, steppe, desert). The spatial structure of the created vegetation cover map includes the following divisions: low mountains, small hills, foothill plains, intermountain basin (including arid-denudation plateaus, deluvial-proluvial plains, ancient alluvial, canyons and dry channels), modern alluvial plains (Sharyn river valley).

Vegetation map SNNP «Sharyn»

The following maps were used for the analysis of cartographic materials on Botanical diversity: vegetation Map of Kazakhstan and Central Asia (within the desert region) M 1:2500000, forage land Map of the Kazakh SSR M 1: 2000000, vegetation Map for the national Atlas of the Republic of Kazakhstan M 1:7000000, landscape map and Ecosystem Map created during the compilation Center for Remote sensing and GIS Terra.

When creating the vegetation map of the SNNP «Sharyn» M 1:300 000, the methodology and methods developed for the cartographic assessment of vegetation in various regions were taken into account. When drawing up the vegetation map of the SNNP «Sharyn», it was assumed that it should reveal the regularities of the structure of vegetation cover associated with the differentiation of environmental conditions. Variegated vegetation cover, due to the heterogeneity of the physical and geographical environment and various degrees of anthropogenic transformation of vegetation, is particularly pronounced at the SNNP «Sharyn».

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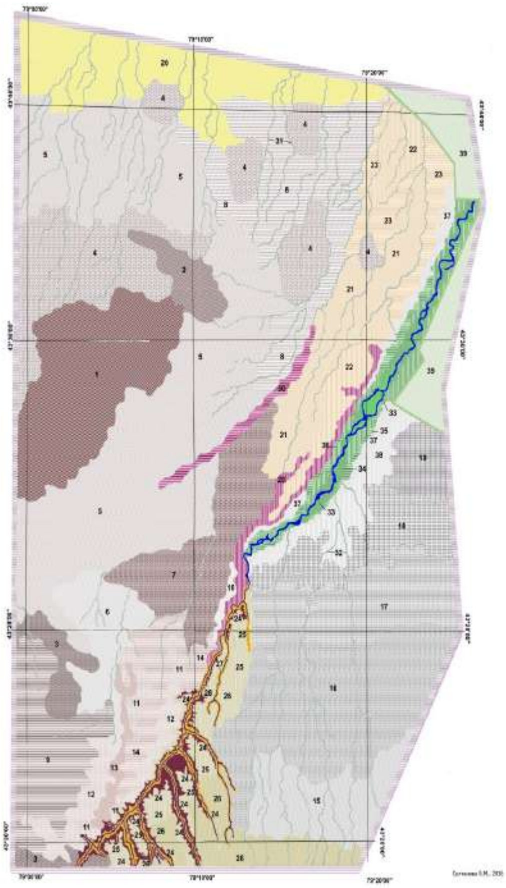

Figure 1 – SNNP «Sharyn» vegetation Map

Cover story to
SNNP «Sharyn» vegetation Map 2016 year

№ apportion-ment	Color and texture	Content
VEGETATION OF LOW MOUNTAINS		
		(**Helictotrichon desertorum, Stipa zalesskii, Festuca valesiaca, Agropyron cristatum, Dracocephalum integrifolium Cotoneaster melanocarpus, Lonicera hispida**) steppes on mountain low-power chestnut soils in combination with shrubby thickets (**Rosa plathyacantha, Spiraea lasiocarpa, Rosa alberti, Lonicera albertii**) on mountain meadow-chestnut soils on the logs of rocky-hilly and low mountains
		(**Festuca valesiaca Artemisia heptapotamica, Artemisia sublessingiana**) steppes on mountain light chestnut soils, combined with **(Stipa orientalis, Artemisia rutifolia, Allium galanthum, A.senescens)** the coenosis on mountain light chestnut underdeveloped and primitive soils and rocks of the hilly ridge of low mountains

Table continuation

№ apportion-ment	Color and texture	Content
		(Salsola arbusculiformis, Stipa orientalis, S. macroglossa, Caragana kirghisorum) communities on mountain brown stony-gravelly soils on the upper parts in combination with grasses-saline **(Helianthemum soongarica, Stipa orientalis), (Convolvulus tragacanthoides, Stipa caucasica)** cenoses on mountain brown primitive soils and rock outcrops on the slopes of rocky strongly dissected low mountains
THE VEGETATION OF THE HUMMOCKS		
		(Caragana kirghisorum, Ephedra intermedia, Ephedra distachya) on grey-brown soils of undeveloped and stony soils of peaks and upper parts of slopes in combination with (***Salsola arbusculiformis, Nanophyton erinaceum, Anabasis truncata, Artemisia sublessingiana, A. heptapotamica***) on (Convolvulus tragacanthoides, Convolvulus gortshakovii, Helianthemum soongoricum) communities on grey-brown shallow soils of rocky slopes and hilly
		(Anabasis truncata) on rocky peaks, ***(Salsola arbusculiformis)*** on gray-brown undeveloped and underdeveloped soils, ***(Salsola arbusculiformis, Artemisia sublessingiana)*** on grey-brown shallow soils fine-knoll hilly
		(Artemisia sublessingiana) on ***(Nanophyton erinaceum, Artemisia heptapotamica)*** the gray-brown featuring poorly developed soils of the low uplands
VEGETATION OF FOOTHILL PLAINS		
		(Artemisia heptapotamica, Stipa orientalis) on brown low-power soils in combination with **(Nanophyton erinaceum, Stipa caucasica)** on brown unformed and primitive soils on the foothill plain
		(Nanophyton erinaceum) on gray-brown low-power gravelly-pebble soils in combination with (Artemisia terrae-albae, Stipa orientalis) communities on meadow-brown soils of dry streams of the foothill plain
		(***Nanophyton erinaceum***) the gray-brown loam and schebnisto-dresvyanskii soils in combination with **(*Salsola arbusculiformis*)** and karahanovym the say on the sloping Piedmont plain
VEGETATION OF THE INTERMOUNTAIN BASIN		
VEGETATION OF ARID-DENUDATION PLATEAUS		
		(**Arthrophytum ihense)** on gray-brown gypsum-bearing low-power loamy soils of the arid-denudation plateau
		(Arthrophytum iliense, Nanophyton erinaceum) community to grey-brown weakly gypsum soils and **(Arthrophytum iliense)** deserts on gray-brown gypsum-bearing. soils in combination with perennially saline **(Salsola orientals, Salsola arbusculiformis, Arthrophytum iliense)** communities on the sayam arid-denudation plateau
		(Arthrophytum ihense) on gray-brown washed-out gypsum-bearing loamy pebbly-gravelly soils ***(Haloxylon aphyllum, Salsola orientalis)*** and ***(Haloxylon aphyllum, Ephedra lomatolepis)*** on meadow-brown soils of arid-denudation plateaus
		(***Nanophyton erinaceum, Arthrophytum iliense)*** on gray-brown low-power (***Arthrophytum iliense***) gypsum-bearing loamy gravelly-woody soils of arid-denudation plateaus
		(*Suaeda dendroides, S. microphylla*, ***Salsola orientalis,*** *Reaumuria soongorica)* **communities on gray-brown saline gypsum-bearing soils of arid-denudation plateaus**
VEGETATION OF DELUVIAL-PROLUVIAL PLAINS		
		(Nanophyton ennaceum) and ***(Artemisia heptapotamica) communities on gray-brown shallow and normal soils in combination with*** (*Artemisia terrae-albae, Krascheninnikovia ceratoides*) on meadow-brown soils of temporary watercourses on a gently sloping deluvial-proluvial plain

Table continuation

№ apportion-ment	Color and texture	Content
		(Suaeda dendroides, ***S. microphylla,*** Reaumuria ***soongorica, Salsola orientalis)*** communities on gray-brown saline gypsum-bearing soils in combination with **(*Haloxylon aphyllum*)** on meadow-brown soils along the slopes of a gently sloping proluvial plain
		(Suaeda ***dendroides, Suaeda microphylla, Arthrophytum iliense) communities on gray-brown gypsum-bearing eroded soils of gently sloping deluvial-proluvial plain***
		(Nanophyton erinaceum) communities on gray-brown normal and shallow soils in combination with ***(Arthrophytum iliense, A. longibracteatum)*** on gray-brown slightly gypsum-bearing rubble-pebble loamy soils of gently sloping deluvial-proluvial plain
		(*Nanophyton erinaceum, Arthrophytum iliense*) on gray-brown gypsum-bearing loamy rubble-pebble soils in combination with (*Nanophyton erinaceum, Anabasis salsa*) on the salt licks of the gently sloping deluvial-proluvial plain
VEGETATION OF ANCIENT ALLUVIAL PLAINS		
		Complex of (*Haloxylon aphyllum*) and ***(Artemisia terrae-albae, Salsola orientalis)*** on takyr-like soils with an eolian mantle in combination with takyrs without vegetation on the ancient alluvial accumulative plain
VEGETATION OF EXTREME ARID PLAINS		
		Single plants **Iljinia regelii, Arthrophytum longibracteatum, A. iliense on extremely arid loamy-pebble-gravelly deposits of a rocky gammada of gently sloping weakly dissected plains**
		(Nanophyton erinaceum) and ***(*Arthrophytum longibracteatum, A. iliense)** on extremely arid gravelly-gravelly soils of gentle undulating plains in combination with shrub (Caragana **balchashensis, Athraphaxis replicata, Ephedra** intermedia, **Acanthophyllum pungens,** Salsola arbuscula, **Convolvulus gortshakoviicommunities on meadow-brown soils along the say**
		(Arthrophytum longibracteatum, A.iliense) and **(Salsola orientalis)** communities on extremely arid pebble-gravelly soils of undulating-ridged dissected plains
THE VEGETATION OF THE CANYONS AND DRY RIVERBEDS		
THE VEGETATION OF THE CANYONS		
		(Salsola arbusculiformis), (Salsola arbusculiformis, Nanophyton erinaceum), (Nanophyton erinaceum) and(Anabasis truncata, A.eriopoda) communities on gray-brown primitive gravelly-stony soils of canyon slopes combined with **(Caragana balchaschensis, Athraphaxis replicata)** on meadow-brown poorly developed soils of stony logs
		(Arthrophytum iliense), (Nanophyton erinaceum), (Suaeda dendroides) communities on gray-brown unformed soils of slopes to the canyon
		(Salsola arbusculiformis, Nanophyton erinaceum), (Salsola arbusculiformis, Ephedra intermedia) communities on grey-brown gravelly-stony soils combined with shrubs and semi-shrubs **(Ephedra intermedia, Caragana balchaschensis, Nanophyton erinaceum)** over rocks and shrubs **(Caragana balchaschensis, Athraphaxis spinosa, A decepiens)** along the logs in the rocky hillock
		Sparse factions involving (Ephedra intermedia, E. equisetina, Athraphaxis decipiens, Caragana kirghisorum, Convolvulus tragacanthoides, Salsola arbusculiformis, Artemisia rutifolia, A. juncea, A. sublessingiana, Brachanthemum titovii, Nanophyton erinaceum***) on the rocky sides of the canyon***
		(Populus diversifolia, P.nigra, Salix kirillovii, Rosa iliense, Trachomitum lancifolium, Clematis orientalis) on primitive alluvial meadow-tugai soils along the channel and shrub thickets (Rosa plathyacantha, R. silverhjelmii, Berberis iliensis Lonicera iliensis, **Clematis songarica**) on primitive alluvial-meadow soils of the first floodplain terrace in combination with single shrubs (Atraphaxis virgata, Caragana kirghisorum, Ephedra intermedia, Salsola arbuscula) rocky steep slopes

Table continuation

№ apportion-ment	Color and texture	Content
VEGETATION OF DRY RIVERBEDS		
		Complex communities: *(*Haloxylon aphyllum, Salsola arbuscula, Salsola orientalis) and *(*Artemisia terrae-albae, Ephedra intermedia) ***on alluvial-proluvial deposits of bottoms in combination with settlements of shrubs*** (Ephedra intermedia, Athraphaxis decipiens, Caragana kirghisorum, Convolvulus tragacanthoides) on the steep slopes of dry channels of temporary watercourses
		Complex communities: **(Arthrophytum iliense), (Salsola orientalis** Artemisia terrae-albae) with **Haloxylon aphyllum** on the outcrop of the ancient alluvial-lacustrine deposits (Artemisia terrae-albae, Convolvulus gortshakovii) gray-brown unformed soils by say
VEGETATION OF RIVER VALLEYS		
VEGETATION OF STREAMS AND TEMPORARY WATERCOURSES		
		A number of communities: **(Tamarix ramosissima, Alhagi pseudalhagi, Phragmites** australis) → **(Tamarix ramosissima, Karelinia caspica)** → (Haloxylon aphyllum, **Saisola orientalis)** on meadow-brown soils of dry channels of temporary watercourses
		A number of communities: (**Artemisia terrae-albae, Acanthophyilum pungens, Ferula iliensis**) → (**Caragana balchashensis, Athraphaxis replicata**) (**Salsola arbuscula, Ephedra intermedia, Calligonum junceum, Convolvulus gortshakovii**) on the sandy loam-sandy soils with desvanece-gravelly inclusions of streams and dry river beds of temporary streams
VEGETATION OF THE SHARYN FLOODPLAIN		
		A number of communities: sparse groupings (Chenopodium botrys, **Chondrilla ambigua, Crypsis schoenoides, Mentha arvensids, Xanthium strumarium)** on shingle shallows on primitive alluvial-meadow soils → grass-grass meadows **(Phragmites australis, Calamagrostis epigeios, Glycyrrhiza uralensis, Trachomitum lanacifolium)** on alluvial-lute soils → grasslands of different grasses (**Vexibia alopecuroides, Leymus multicaulis**) with groups of trees (Salix songarica, Elaeagnus oxycarpa) on meadow-tugai soils of a low floodplain
		A number of communities: **(Fraxinus sogdiana)** with sparse groupings of **Asparagus officinallis и Ribes saxatile** → **(Elaeagnus oxycarpa, Salix angustifolia, S.alba, Hippophae rhamnoides)** → **(Fraxinus sogdiana, Populus nigra, P.alba)** with a shrub layer of **(Rosa iliensis, Lonicera iliensis, Berberis iliensis)** → **(Elaeagnus oxycarpa, Salix alba, S.kirillovii, Hippophae rhamnoides, Clematis orientalis)** on alluvial tugai soils of low floodplains and river banks
		A number of communities: (*Elaeagnus oxycarpa, Salix alba, S. songorica, Tamarix ramosissima, Hippophaë rhamnoides*) **with single (**Fraxinus sogdiana) → (*Fraxinus sogdiana*) → (*Populus diversifolia, P. pruinosa, Fraxinus sogdiana*) **with a shrub layer of (***Berberis iliensis, Tamarix ramosissima*) → *Haloxylon aphyllum* on alluvial-meadow soil is presented of the high floodplain
		A number of communities: (Elaeagnus oxycarpa, Salix michelsonii, S.songarica, Tamarix ramosissima, Clematis orientalis) – (Glyzyrrchyza glabra, Leymus multicaulis, Calamagrostis epigeios) → (Populus diversifolia, P.pruinosa, Berberis iliensis, Tamarix ramosissima, Reamuria songorica) → (**Tamarix ramosissima, Halimodendron halodendron, Nitraria sibirica, Ceratoides papposa**) → ***(*Kalidium schrenkianum, Tamarix hispida, Achnatherum splendens, Limonium gmelinii**) on alluvial-meadow dried soils with signs of salinity and meadow salt marshes of high floodplain
VEGETATION OF THE ABOVE-FLOODPLAIN TERRACES OF SHARYN		
		A number of communities: **(Populus pruinosa, P.diversifolia)** with the participation of **(Fraxinus sogdiana)** with **(Kalidium foliatum. К schrenkianum, Halostachys belangriana, Nitraria sibirica, Limonium gmelinii)** on the salt marshes of meadow → shrub ***(Tamarix hispida, T.ramosissima, Atraphaxis spinosa, A.pyrifolia, Krascheninnikovia ceratoides) on meadow-brown soils of above-floodplain terraces***

Table continuation

№ apportion-ment	Color and texture	Content
		(Kalidium schrenkianum, Tamarix hispida, Tamarix ramosissima, Achnatherum splendens) community in combination with planting of tree species **(Elaeagnus oxycarpa)** and **(Ulmus pumila)** on salt marshes of meadow and secondary floodplain terraces
ANTHROPOGENIC TRANSFORMED VEGETATION		
		Agricultural land

Conclusion

Taxonomic analysis of the floral diversity of the plant cover of the SNNP «Sharyn» showed that 915 plant species and 406 genera were identified in the flora. the species of the *Asteraceae Dumort family – Aster, which is 13.98%, and Poaceae Barnhart species – Cereals 9.07% and 8.08% -Fabaceae Lindl. – Legumes-dominate.* There are 39 species listed in the Red Book of the Republic of Kazakhstan.

The phytocenotic diversity of the plant cover of the SNNP «Sharyn» was determined. The following types of vegetation are found on the territory: steppe, desert, shrub, meadow, swamp, and tugai.

An assessment of the spatial structure of the vegetation cover of the SNNP «Sharyn» was made, and a vegetation map of the SNNP «Sharyn» was created, in which 39 natural contours were marked. The map contains 13 vegetation sections: vegetation of low mountains, small hills, foothill plains, intermountain basins, deluvial-proluvial plains, ancient alluvial plains, extreme arid plains, canyons and dry channels, river valleys, floodplains of Sharyn, above-floodplain terraces of Sharyn, as well as anthropogenic transformed vegetation.

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GEOBOTANICAL DESCRIPTION AND ECOLOGY OF THE POPULATION OF THE ENDEMIC SPECIES *GALATELLA SAXATILIS* NOVOPOKR. IN SYUGATY MOUNTAIN GORGE

This article presents the geobotanical characteristics and ecological conditions of populations of the endemic species Galatella saxatilis found in the mountain gorge of Syugata.

The natural conditions of the territory areconsidered: topography, soil cover, water resources, climate, where the object of research is found, and geobotanical characteristics of plant community types are compiled. The results are filled in the table and displayed in the figures. The percentage of yield of types in communities is calculated.

The morphological features of the Galatella saxatilis species are described and the life States and quality level of generative stems are determined. During repeated observations of the species Galatella saxatilis, only 7 individuals were found in the first population. The second population contained 10 individuals. The following types are distinguished by life States: generative age(g1), mature(g2), old(g3) and postgenerative sub-senile(ss), senile(s).

24 plant species found in the population have been identified and a systematic list has been compiled.

The main tasks of the research work were completed in full and successfully completed.

Key words: topography, water resources, soil cover, climate, plant communities, forage yield, community types.

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Сөгеті тау шатқалындағы эндем түр *Galatella saxatilis* Novopokr. популяциясының экологиясы мен геоботаникалық сипаттамасы

Бұл мақалада Сөгеті тау шатқалында кездесетін эндем түр Galatella saxatilis популяцияларының геоботаникалық сипаттамасы мен экологиялық жағдайлары келтірілген.

Зерттеу объектісі кездесетін аумақтың табиғи жағдайлары: жер бедері, топырақ жамылғысы, су ресурстары, климаты қарастырылып, өсімдіктер қауымдастығы мен ондағы типтердің геоботаникалық сипаттамасы жасалды. Алынған нәтижелер кестелерге толтырылып, суреттерде көрсетілген. Қауымдастық типтерінің өнімділік пайызы есептелінген.

Galatella saxatilis түрінің морфологиялық ерекшеліктері сипатталып, тіршілік күйлері мен генеративті сабақтарының сапалық деңгейі анықталған. Galatella saxatilis түрін бірнеше рет қайталап бақылау барысында бірінші популяцияда 7 дарақ қана кездесті. Ал, екінші популяцияда 10 дарақ кездесті. Тіршілік күйлері бойынша: генеративті жас(g1), піскен(g2), қартайған(g3) және постгенеративті субсенильді(ss), сенильді(s) типтер ажыратылды.

Популяцияда кездесетін 24 өсімдік түрі анықталып, систематикалық тізімі жасалды.

Зерттеу жұмысының негізгі міндеттері толығымен орындалып, жұмыс сәтті жүргізілді.

Түйін сөздер: жер бедері, су ресурстары, топырақ жамылғысы, климат, өсімдіктер қауымдастығы, өнімділік, түсім пайызы, қауымдастық типтері.

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Геоботаническое описание и экология эндемического вида популяции *Galatella saxatilis* Novopokr. в Сюгатинском горном ущелье

В данной статье приведена геоботаническая характеристика и экологические условия популяций эндемичного вида Galatella saxatilis, встречающегося в горном ущелье Сюгаты.

Рассмотрены природные условия территории: рельеф, почвенный покров, водные ресурсы, климат, на которой встречается объект исследования, и составлена геоботаническая характеристика типов растительного сообщества. Полученные результаты занесены в таблицу и отображены на рисунках данной статьи. Рассчитан процент урожайности типов в сообществах.

Описаны морфологические особенности вида Galatella saxatilis и определены жизненные состояния и уровень качества генеративных стеблей. В ходе неоднократных наблюдений за видом Galatella saxatilis в первой популяции встречались только 7 особей. Во второй популяции встречались 10 особей. По жизненным состояниям различают следующие типы: генеративный возрастной (g1), зрелый (g2), старый (g3) и постгенеративный субсенильный (ss), сенильный (s).

Определены 24 вида растений, встречающихся в популяции, и составлен систематический список.

Основные задачи исследовательской работы выполнены в полном объеме и успешно выполнены.

Ключевые слова: рельеф, водные ресурсы, почвенный покров, климат, сообщества растений, кормовой урожайность, типы сообщества.

Explanation of some concepts

Forage unit – measuring unit of fodder value calculated on 1 kg of dry grass.

Topography (relief) –structure, general appearance and natural characteristics of the Earth's surface in a particular area.

Plants cover –a community of plants growing on Earth.

Productivity– an indicator that characterizes the average yield of agricultural products (usually the harvest collected from 1 hectare of land is calculated in quintals).

Introduction

Re-study and correction of geobotanical survey materials requires conducting an average of once every ten years to identify quantitative and qualitative changes in vegetation cover and as the main methods of assessing the state of plants, as well as in the monitoring mode. In accordance with the requirements of the time, environmental issues, including the preservation of biodiversity and bioresources, have become one of the most important topics that must be addressed to all mankind [1-2].

The issue of plant protection and preservation of the plant gene pool, especially the preservation of endemic and rare relict species, has now become one of the most pressing issues. In order to preserve the species of plants that are currently threatened with extinction in nature, it is necessary to take into account all types of plants that need protection in order to effectively use plant resources [3-4].

Since endems and rare plants are important components of the flora, there is an increasing need for various geobotanical studies of them [5]. Most of them are listed in the Red Book and are protected by the special law of the Republic of Kazakhstan.

The main tasks set for the course of work in this direction are::

1) Focus on the natural conditions of the sögeti mountain gorge (terrain, climate, water resources, soil cover);

2) Identify and draw up a systematic list of the main plant groups and species in the distributed area of the research object;

3) Development of a morphological description of the studied species using basic geobotanical methods.

Research materials and methods

The object of the study was the main features of the endemic species ***Galatella Saxatilis*** **Novopokr**, found in the Sogeti mountain gorge in the south-eastern part of Sogeti rural district of Enbekshikazakh District of Almaty region.

Galatella saxatilis is a rare, limited endemic species. Perennial, 20-30 cm tall, the base of the stem is hard. The leaf ribbon is lanceolate, the ends are minimized. Baskets are collected in a loose shield, or single, with mother flowers at the edges, tapered, ash-shaped rudiments. The flowers are Terry, tubular pale yellow in color. The seeds are short-haired, with serrated spines. Blooms in July-September. It is propagated by seeds. It is found on rocks, rocky slopes. It is distributed in the Syugeti gorge in the eastern part of the Trans-Ili Alatau. The main dangerous conditions are: low population size, constant grazing of livestock.

The species is listed in the Red Book of Kazakhstan. Control over the state of the natural population, study of the biological characteristics of the species in cultural conditions [6-7].

The main geobotanical methods were used in the control of the object of study, the description of the species composition and morphological features.

Methods for determining productivity

Two methods of calculating productivity are used to determine the productivity of natural pastures. They are: the method of sowing (root field) and the method of model plant or shrub (vertical root system – root).The first method is used for herbaceous and deciduous shrubs, the second – for shrubs and deciduous shrubs. [8].

Reaping method. At the site of the description, a rectangular 1x1 m cutting area is used. If the projective coating of the community is uniform, the mowing area should be laid 4 times, and if the vegetation is sparse, the area should be laid 8 times. In shrubby pastures,a 1x2.5 m cutting area is laid out in the open ground between bushes [9].

When determining productivity, the total weight (including non-pollinated plant species) and the dry weight of feed per hectare are taken (if there is only one livestock, the pollinated plant).At the same time, during the study of the plant, the moisture weight is also measured, which is necessary to determine the drying coefficient of the plant. Therefore, once every decade, the moisture weight of the plant is measured. All information is filled in on the form and converted to hundredweight [10].

Model plant method. The accuracy of the method depends primarily on the accuracy of determining the average size of the plant, the selection and quantity of the model plant. This method is used to determine the yield of shrubs, semi-shrubs and large herbaceous plants. In the Model Method, a 10x10 m transept is constructed. Bushes inside the transept are united in 2-3 groups in height and diameter.From each group, 5-10 plants are taken from small ones, and 1-2 from large ones, according to which the wet and dry weight is measured. Then the average weight of one plant is calculated and the yield per hectare is calculated.The number of pieces of bushes is taken at each description, and the yield is measured once in a decade [11].

Research results and their analysis

Ecological conditions of *Galatella saxatilis* populations

The main relief of the studied territory is a rocky, rocky Mountain system with a high belt, with an absolute height of 600 to 3000 meters. The rocky Mountains here are classified as low mountains. The rocky Mountains of Syugata are a mountain range consisting of strongly cut, rocky slopes consisting of open rocky rocks and high cliffs forming a gorge [12].

The main water system of the sögety mountain gorge includes the waters of the Syugata, Almaly, and Sarbastau rivers. This is where the streams of Karabulak and Akshitek Springs begin. These springs and springs flow mainly from the bowels of the mountains and are filled with rain and snow waters depending on the season.

Since the gorges of Syugata are a High-Altitude Area, the climatic conditions are Continental, characterized by cold winters and cold summers.The number of days that exceed $+10^0$ is 150. According to long-term indicators, the average annual air temperature is $–0{,}2^0$C. The average precipitation is 407 mm.

The spring season in the mountains begins from 2-3 December of April. The average temperature at this time $+1{,}3^0$C, and in may $+6{,}2^0$C, in June $+9{,}5^0$C.

The first cold snap is observed in September. And the main snow cover falls at the end of October. Snow height varies between 25-90 CM. Snow cover and cold retention are observed for up to 160 days.

In the mountainous region, there is also a weak wind. Its speed is 2-4 m/s. In winter, wind gusts are detected for 1-3 days. In addition, there are also fogs 8-10 days a month [13-14].

On the high, rocky slopes of the Syugata mountains, undeveloped light brown soil of the mountain is found. These soils form a weak humus horizon of 20-30 cm. In addition, they often contain dirty substances and stones [15-16].

***Galatella saxatilis* geobotanical characteristics and morphological features of the population**

Population. Terrain elements play an important role in the distribution of vegetation cover. In all parts of the district, it covers a large area, forming a complex of grass-grain pastures, sagebrush and ephemera. Zhetysuzhusan and karazhusan pastures are also common. On the banks of river valleys and streams, kokpekty pastures are distributed, forming a complex with sagebrush, sorrel, grain-various grasses, grain-licorice-sagebrush pastures. As a result of the study, a geobotanical description of the first population found in Galatella saxatilis was carried out.The first population was identified at the top of a mountain gorge, 2.5 km southwest of the village of Kokpek, and the vegetation of the community was described. The first determined population determined the species composition of the community and gave it a geobotanical description.The plant community, distributed in low-lying mountainous terrain, on muddy gravel-Stony dark brown soil of the Mountain, Forms two types of complexes. A special geobotanical form was filled out and the following description was given.

The first type is bushy – Semirechye sagebrush-cereal Galatella saxatilis. Low mountainous terrain with an absolute height of 972 m. Soil moisture occurs atmospheric.The projective coverage of the soil with plant cover is 65%.The dominant here is the bushes. The percentage in the association is 25%.Among the shrubs are *Spiraea hypericifolia, Rosa spinosissima and Cerasus tianschanika.* The height of the bushes varies from 65 cm to 135 cm.The subdominant is *Artemisia heptapotamica* – 20%. Its height is 30-58 cm. Grain crops occupy the third place, making up 15% of the community.These include: *Stipa sareptana, Koeleria gracilis and Festuca sulcata. The height is observed, respectively – from 10 to 55 cm. The Galatella saxatilis is distributed evenly everywhere, with a share of 5% in the community type [17-19].*

Figure 1 – Control of the species composition of the association by the method of harvesting

There are also individual plants that are part of the community. The are: Helianthemum soongoricum, Scutellaria transeliensis, Seseli strictum, Lonicera microphylla, Acanthophyllum pungens, Bromus inermis, Peganum harmala, Carex pachystylis, Ephedra intermedia, Meniocus linifolius, Poa bulbosa.

At the designated place, the plants of the area 1м^2 were completely cut by the method of harvesting, each plant was wrapped in individual papers and dried in a special shady covered place. At the designated place, the plants were completely cut off by the method of harvesting, each plant was wrapped in individual papers and dried in a special shady covered place. Dried plants for 7-10 days were weighed on an electronic scale to determine their dry weight. Accordingly, the yield of the general type of production was calculated [20].

Total summer yield of dry mass type 9.5-12.0 d/ha. Seasonal yield of fodder(d/ha$\frac{dry\ weight}{fodder\ unit}$): in the spring $\frac{7,6}{4,3}$-$\frac{8,5}{4,9}$, in summer $\frac{8,4}{5,1}$-$\frac{9,8}{5,7}$, in autumn $\frac{6,1}{3,3}$-$\frac{7,8}{4,2}$, winter $\frac{4,7}{2,1}$-$\frac{6,0}{2,5}$.

Figure 2 – Growth of the ***Galatella saxatilis*** on the rocky slopes of the Syugata gorge

The second type – **Cereal-zhetysu wormwood-galatella type**. Low mountainous terrain with an absolute height of 972 m. Soil moisture occurs atmospheric. The projective coverage of the soil with plant cover is 70%.The dominant here is cereals. *The percentage in the association is 40%.They are: Stipa caucasica, Stipa capillata, Poa bulbosa and Festuca sulcata.* Heights range from 10 to 60 cm, respectively.Subdominant *Zhetysu wormwood* – 20%. Its height is 30-55 cm. *Galatella saxatilis* is in third place with a 10% share of the community. Height 12-28 cm. Қауымдастық құрамына кіретін жекелеп кездесетін өсімдіктер де бар. They are: *Acanthophyllum pungens, Carex pachystylis, Scutellaria transiliensis, Seseli strictum, Lonicera microphylla, Ephedra intermedia, Meniocus linifolius, Poa bulbosa, Spiraea hypericifolia, Cerasus tianschanika.*

Total summer yield of dry mass type6,5-9,5 d/ha. Жемдік массаның мезгіл бойынша түсімі (d/ha$\frac{dry\ weight}{fodder\ unit}$): in the spring $\frac{6,6}{3,7}$ - $\frac{7,0}{4,8}$, in summer $\frac{7,5}{4,4}$ - $\frac{9,5}{5,7}$, in autumn $\frac{5.8}{2.8}$ - $\frac{7,4}{3,7}$, winter $\frac{4,6}{1,8}$ - $\frac{5,8}{2,0}$.

In the course of several repeated measurements of the method of harvesting the *Galatella saxatilis* plant found in the main mountain gorge at the site 1m^2 (1x1), the density and generative active organs of the *Galatella saxatilis* were classified, and the morphological features of the plant showed the following results:

There were 2 trees in the first square. Tree$_1$ – belongs to the genus mature (g2) type with mature generative organs. Number of generative stems – 3. The corresponding indicators of seeds in a basket inflorescence: 1 – 13 seeds, 2 – 12 seeds, 3 – 15 seeds. The height of the plant is 15-22 cm. Tree$_2$ – state of life generative aging (g3). Number of generative stems – 1. The corresponding indicators of seeds in a basket inflorescence: 1 – 11 seeds. The height of the plant is 17-25 cm.

There were no *Galatella saxatilis* in the second square.

There was only one tree in the third square. It belongs to the generative mature (g2) type. Number of generative stems – 2. Seedlings in the basket inflorescences, respectively: 1 – 7 seeds, 2 – 10 seeds. The height of the plant is 17-25 cm.

There was a tree in the fourth square. According to the state of life were divided into postgenerative subsenyl (ss). There are no generative stems, the flowers are fallen. The height of the plant is 15-23 cm.

On the fifth, sixth, and seventh squares, there were no *Galatella saxatilis.*

Only one tree met in the eighth square. The state of life is generative mature (g2). The number of generative stems is 2. the corresponding indicators of seed germination in the basket inflorescence are: 1 – 9 seeds, 2 – 13 seeds. The height of the plant is 15-27 cm.

There were no trees in the ninth square.

Two trees met in the tenth square. Tree$_1$- generative maturity (g2). Number of generative stems – 3. Seeds in the basket inflorescence, respectively: 1 – 10 seeds, 2 – 9 seeds, 3 – 12 seeds. The height of the plant is 13-24 cm. Tree$_2$- state of life generative aging (g3). Number of generative stems – 1. The corresponding indicators of seeds in a basket inflorescence: 1 – 12 seeds. The height of the plant is 15-25 cm.

The study was conducted in the last stages of the life cycle of the plant ***Galatella saxatilis***, which became the basis for its description only on the basis of generative maturity and postgenerative life. Depending on the method of harvesting, the numerical density of the object of study on the land plot 1m^2 was determined, and the projective soil coverage was determined. The number of generative stems of each tree was calculated, and the indicators of seed production and reproduction were determined.

Population. The second population of the species was identified 1.5 km south-west of the Suygata mountain gorge, 1.5 km south of the first population, and community vegetation was described. The species composition of the community was determined and a geobotanical description was given.Only one type was distinguished in the defined community area. The plant community with the absolute height of 1025 m, located in the low mountainous terrain, on the clayey gravel-brown soils of the mountain, forms the following type: steppe-shrub-grain-shrub type. A special geobotanical form was filled out and described as follows.

Shrub grain-galatella type. Soil moisture occurs atmospheric. The projective coverage of the soil with plant cover is 65%. The surface layers of the soil are large-lobed, and the visibility of the rocks is clearly marked. The dominant here is the bushes. The percentage in the association is 35%.Among the bushes are *Spiraea hypericifolia, Cerasus tianschanika, Rosa spinosissima.* The height of the bushes reaches from 60 cm to 115 cm.

Subdominant-cereals. They account for 25% of the community. They are: *Stipa sareptana, Stipa caucasica and Festuca sulcata.* The height will be from 10 to 55 cm, respectively. The *Galatella saxatilis* is distributed evenly everywhere, with a share of 5% in the community type.

Figure 3 – During the observation of the second population of the *Galatella saxatilis*

List of individual plants that are part of the association: *Artemisia heptapotamica, Artemisia terrae-albae, Lonicera microphylla, Caragana pleiophylla, Eremopyrum orientale, Lasiagrostis splendens, Acanthophyllum pungens, Carex pachystylis, Ephedra intermedia, Scutellaria transeliensis, Meniocus linifolius, Seseli strictum, Poa bulbosa, Spiraea hypericifolia*.

According to the association, the plants of the sampled land were dried and the percentage and yield indicators were calculated.

Total summer yield of dry mass type 8.4-11.2 c/ha. Seasonal receipt of feed mass(d/ha$\frac{dry\ weight}{fodder\ unit}$):

in the spring $\frac{7,4}{4,1}$-$\frac{8,1}{4,8}$, in the summer $\frac{9,8}{5,3}$-$\frac{10,2}{5,9}$, in the autumn $\frac{5.9}{3.8}$-$\frac{7,2}{4,1}$, in the winter $\frac{4,5}{1,9}$-$\frac{5,5}{2,7}$.

In the course of several repeated measurements of the method of reaping the *Galatella saxatilis* at an area of 1m^2 (1x1), the density and generative active organs of the species were classified, and the morphological features of the plant showed the following results:

The tree in the first square belongs to the generative age (g1) type with mature generative organs. Number of generative stems – 3. Seeds in the basket inflorescence, respectively: 1 – 11 seeds, 2 – 14 seeds, 3 – 12 seeds. The height of the plant is 12-20 cm.

In the second square there was only one ***Galatella saxatilis***. According to the state of life, it belongs to the generative aging type (g3). It is a plant before flowering, without flowers. Height – 13-22 cm.Two trees met in the third square. Tree$_1$- generative maturity (g2). Number of flower stalks

– 2. Seeds in the basket inflorescences, respectively: 1 – 15 seeds, 2 – 13 seeds. Plant height – 15-23 cm. $Tree_2$- generative maturity (g2).Number of generative stems – 2. Seed inflorescences in the basket, respectively: 1 – 10 seeds, 2 – 16 seeds. The height of the plant is 18-22 cm. In the fourth and fifth squares there were no trees of the ***Galatella saxatilis***.

Two trees in the sixth square. $Tree_1$- generative maturity (g2). Number of flower stalks – 1. The corresponding indicators of seeds in a basket inflorescence: 1 – 14 seeds. The height of the plant is 14-20 cm. $Tree_2$ _ postgenic senile (s). There are no generative stems. The height of the plant is 13-20 cm.

In the seventh square there was only one ***Galatella saxatilis***. It is a postgenerative senile (s) by state of survival. A species without flowers, about to wither. Plant height is 15-22 cm.

There were no trees in the eighth and ninth squares.

There were three trees in the tenth square. $Tree_1$- generative aging (g3). Number of generative stems – 1. Number of seeds in a basket inflorescence – 9 seeds. The height of the plant is 15-22 cm. $Tree_2$ _ state of life generative aging (g3).

There is no generative stem. The seeds in the basket have completely fallen off. Plant height – 17-23 cm. $Tree_3$- postgenerative subsenyl (ss). There is no generative stems. The height of the plant is 20-25 cm.

Productivity and chemical composition of forage plants in the plant community

Pastures and pasture forage are important for animals. Green grass is a type of highly nutritious fodder. Grasses of good pastures, especially cereals and legumes, contain up to 10 kg of protein and 100 feed units per 100 kg. In addition, the digestibility of forage grass is 15-20% lower than that of green grass. Pasture grass, for example, contains 10 times more vitamin A than fodder grass [21-22].

Pasture grasses must contain minerals (calcium and phosphorus salts) that have a lasting effect on the growth and development of animals. Pasture composition has a multifaceted effect on animals. It creates favorable conditions for the proper development and growth of food and increases its resistance to various diseases [23-24].

According to such data, the chemical composition of plants directly suitable for fodder production in the study area was determined, the relative level of absolute productivity of natural organic matter and total feed mass was determined [25-26].

Systematic list of plant species in the plant community

The list of plants found in the study by double populations of ***Galatella saxatilis*** was compiled and filled in the table below [27].

Table 1 – Productivity and chemical composition of forage plants found in the Suygata mountain gorge

№	Plant species	Season of the year	Occurs in the absolute dry matter of forage, %					100 kg abs. occurs in dry fodder, kg	
			protein	fat	cage	BBZ	ash	Absorbable protein	feed unit
1	2	3	4	5	6	7	8	9	10
1	Festuca sulcata (Hack.)	winter	3,77	0,93	39,97	46,42	8,91	2,08	42,6
		spring	13,67	2,97	27,82	45,99	9,55	9,06	72,8
		summer	7,97	2,69	33,99	47,65	7,70	5,10	61,0
		autumn	6,19	2,99	36,22	46,76	7,84	3,81	51,3
2	Stipa caucasica Schmalh.	spring	11,90	3,17	29,13	49,39	6,40	8,64	75,2
		summer	7,01	3,31	33,28	19,14	7,26	4,69	67,4
		autumn	3,92	3,70	36,48	50,47	5,43	3,18	59,2
3	Koeleria gracilis Pers.	winter	2,84	1,30	38,68	53,38	3,80	1,40	43,0
		spring	21,52	3,30	26,22	40,17	8,79	15,70	83,0
		summer	7,63	2,80	31,85	52,53	5,19	4,96	60,6

Continuation of table 1

№	Plant species	Season of the year	Occurs in the absolute dry matter of forage, %					100 kg abs. occurs in dry fodder, kg	
			protein	fat	cage	BBZ	ash	Absorb-able protein	feed unit
1	2	3	4	5	6	7	8	9	10
		autumn	4,72	2,48	36,20	51,66	4,94	2,14	45,5
4	Poa bulbosa L.	winter	4,26	1,16	39,04	48,19	7,35	2,25	76,3
		spring	12,22	2,44	28,97	49,72	6,65	8,52	104,8
		summer	6,25	1,87	33,24	53,31	5,33	3,83	87,2
		autumn	3,72	1,50	40,06	49,89	4,83	1,98	78,6
5	Bromus inermis Leyss.	winter	6,04	1,10	38,23	45,81	8,92	3,26	56,7
		spring	11,65	2,58	30,87	47,68	7,22	7,24	65,9
		summer	6,72	1,98	32,68	51,50	6,60	3,98	66,1
		autumn	5,00	1,58	36,10	51,63	5,69	2,71	65,4
6	Stipa sareptana (Beck)	winter	3,18	2,75	45,77	40,52	7,78	1,68	35,9
		spring	13,01	2,92	30,52	44,42	9,13	9,50	75,9
		summer	8,25	2,41	32,18	51,18	5,98	5,55	68,4
		autumn	5,40	2,30	35,01	51,27	6,02	3,23	56,2
7	Carexpachystylis J.Gay.	winter	3,27	0,45	36,13	53,45	6,70	1,75	47,1
		spring	11,69	2,59	29,30	47,07	9,35	7,95	69,1
		summer	8,29	2,52	32,29	49,34	7,56	5,25	66,0
		autumn	5,24	2,34	36,89	48,05	7,48	2,81	45,1
8	Eremopyrum orientale Jaub.	spring	7,68	2,52	17,81	41,09	29,08	7,29	70,0
		summer	10,19	3,08	19,01	43,43	26,80	5,68	70,4
9	Artemisia terrae-albae Krasch.	spring	13,46	3,42	25,31	49,29	8,52	10,08	80,1
		summer	10,16	5,03	25,76	52,00	7,05	6,71	73,4
		autumn	8,81	6,23	27,24	50,48	7,27	5,21	74,7
10	Artemisia heptapotamica Poljak.	spring	15,67	5,12	21,33	47,80	10,08	11,49	85,6
		summer	10,47	6,18	24,63	50,51	8,21	8,12	83,8
		autumn	8,76	6,84	27,01	50,39	7,00	6,22	72,0
11	Galatella saxatilis Novopokr	winter	6,57	3,96	28,42	55,88	5,17	2,81	46,0
		spring	17,73	4,77	21,12	45,97	10,41	13,24	81,6
		summer	11,10	6,12	22,84	52,68	7,26	7,87	76,8
		autumn	8,43	5,73	26,78	52,89	6,17	4,35	55,7
12	Spiraea hypericifolia L.	winter	3,53	1,41	30,93	45,76	8,94	1,41	21,0
		spring	17,50	2,06	33,74	40,80	10,40	8,52	53,5
		summer	11,55	2,11	34,36	41,16	10,82	5,52	46,3
		autumn	6,46	1,92	38,25	40,08	13,29	2,74	29,9

Table 2 – List of plants in the population of ***Galatella saxatilis*** in the gorges

№	Latin scientific name of plants	Kazakh name	Russian name	Life form
1	*Acanthophyllum pungens (Bge.) Boiss.*	*Тікенді бозтікен*	Колючелистник колючий	Perennial
2	*Artemisia heptapotamica Poljak.*	*Жетісу жусан*	Полынь семиреченская	Perennial
3	*Artemisia terrae-albae Krasch.*	*Боз жусан*	Полынь белоземельная	Semi-shrub
4	*Bromus inermis Leyss.*	*Қызылот арпабас*	Костер безостый	Perennial
5	*Caragana pleiophylla (*	*Көпжапырақты қараған*	Караганамноголистая	Bush
6	*Carex pachystylis J.Gay.*	*Толық қиякөлең*	Осока толстостолбиковая	Perennial
7	*CerasustianschanikaPojark.*	*Тәншән шиесі*	Вишня тяньшанская	Bush
8	*Ephedra intermedia Schrenk.*	*Қызыл тамыр қылша*	Хвойник средний*(эфедра)*	Bush
9	*Eremopyrum orientale (L.) Jaub. Et Spach.*	*Шығыс мортығы*	Мортук восточный	Annual
10	*Festuca sulcata Hack.*	*Кәдімгі бетеге*	Овсяница бороздчатая (типчак)	Perennial
11	*Galatella saxatilis Novopokr.*	*Жартас далазығыры*	Солонечникскальный	Perennial
12	*Helianthemum soongoricum*	*Жоңғар сәулетгүлі*	Солнцецвет джунгарский	Perennial
13	*Koeleria gracilis Pers.*	*Қоңырбас шисабақ*	Тонконог тонкий	Perennial
14	*Lasiagrostis splendens (Trin.) Kunth.*	*Ақ ший*	Чий блестящий	Perennial
15	*Lonicera microphylla*	*Ұсақжапырақ ушқаты*	Жимолость мелколистная	Bush
16	*Meniocus linifolius (Steph.) D.C.*	*Зығыр жалпақжеміс*	Плоскоплодникльнолистный	Annual
17	*Peganum harmala L.*	*Кәдімгі адыраспан*	Гармала обыкновенная (адраспан)	Perennial
18	*Poa bulbosa L.*	*Жуашықты қоңырбас*	Мятлик луковичный	Perennial
19	*Rosa spinosissima L.*	*Аран раушан*	Шиповник колючейший	Bush
20	*Seseli strictum*	*Ербиген тыраншөп*	Жабрица торчащая	Perennial
21	*Scutellaria transeliensis*	*Іле томағашөбі*	Скутеллярия (шлемник) илийская	Perennial
22	*Spiraea hypericifolia L.*	*Шайқурай тобылғы*	Таволга зверобоелистная	Bush
23	*Stipa caucasicaSchmalh.*	*Аққылтан*	Ковыль кавказский	Perennial
24	*Stipa sareptana Beck.*	*Тырсық қау*	Ковыль сарептский	Perennial

Conclusion

Thus, on the basis of the conducted geobotanical research, two populations of the endemic species Galatella saxatilis were identified and their communities were studied, which are found in the Syugata mountain gorge of Syugata rural district of Enbekshikazakh District of Almaty region. The topography, climate, soil and water system of the mountain gorge were described and the main physical features were shown. The Rocky Mountains of Syugata are a mountain range consisting of strongly cut, rocky slopes, open Rocky rocks and high cliffs that form a gorge.

The main water system of the Syugata mountain gorge includes the waters of the Sögety, Almaly, and Sarbastau rivers.

Since the gorges of Syugata are a High-Altitude Area, the climatic conditions are Continental, characterized by cold winters and cold summers. The number of days that exceed $+10^0$ is 150. According to Perennial indicators, the average annual air temperature is -0.2^0C. The average precipitation is 407 mm.

The average temperature at this time is $+1.3^0$C, in May $+6{,}2^0$C, and in June $+9{,}5^0$C.

The first cold snap is observed in September. The main snow cover will fall in late October. The snow depth is 25-90 cm. Snow cover and cold storage are observed for up to 160 days.

On the high, rocky slopes of the Syugata mountains there is an underdeveloped light brown soil. These soils form a weak humus horizontal, 20–30 cm. In addition, they often contain dirt and stones.

The plant community was classified into types and special geobotanical forms were filled out. According to the first population, two types were distinguished: Shrub-mature wormwood-cereal steppe-cereal type and Cereal-mature wormwood-steppe type.Productivity of the types was determined and the total summer harvest was calculated.

Density and generative active members of the species were classified and the morphological features of the plant were determined during several repeated measurements of the rocky steppe vegetation found in the mountain gorge on 1м^2 (1x1).

The study was conducted in the last stages of the life cycle of the ***plant Galatella saxatilis***, which became the basis for its description only on the basis of generative maturity and postgenerative life. Depending on the method of harvesting, the numerical density of the object of study on the land plot 1m^2 was determined, and the projective soil coverage was determined. The number of generative stems of each tree was calculated, and the indicators of seed production and reproduction were determined.

During the full development of the vegetation of the Syugata mountain gorge, a systematic list of plants found in the population of rock-grass vegetation was made. The amount and chemical composition of crops were calculated and tabulated by species.

The conducted geobotanical work is an important study in determining the population characteristics of the rocky steppe and its place in the flora as an endemic species.As a species listed in the Red Book, one of the main tasks of the work was to preserve the species composition, population density and quality. Morphological characteristics of the species have become a prerequisite for further study of the species.

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ШАРЫН МҰТП ӨСІМДІКҚОРЕКТІ АҒАШ ЖАРТЫЛАЙ ҚАТТЫҚАНАТТЫЛАРЫНЫҢ (HETEROPTERA) БИОЛОГИЯСЫ МЕН ЭКОЛОГИЯСЫ

Мақалада Шарын Мемлекеттік ұлттық табиғи паркі территориясында 2018-2019 жылдары жүргізілген далалық ғылыми зерттеулер нәтижелері беріліп отыр. Жүргізілген зерттеулер нәтижесінде жартылай қаттықанаттылардың 7 тұқымдасына жататын 26 түр анықталды: Miridae (11 түр, 43%), Aradidae (2 түр, 8%), Lygaeidae (1 түр, 4%), Coreidae (2 түр, 8%), Tingidae (3 түр, 11%), Acanthosomatidae (4 түр, 15%), Pentatomidae (3 түр, 11%). Бұлардың арасында түр құрамы жағынан басым тұқымдастар: Miridae (11 түр, 43%), Acanthosomatidae (4 түр, 15%), ал қалған 5 тұқымдастан 1-3 түрден ғана белгілі болды. Олар қоректік байланысы жағынан фитофагтар, олардың ішінде 13 түр – полифитофаг, 4 түр – кең олигофитофаг, 7 түр – тар олигофитофаг, 2 түр – мицетофаг болып табылады. Шарын МҰТП жартылай қаттықанаттылары жылына беретін ұрпақ санына қарай 4 топқа бөлінеді: моновольтинді (16 түр), бивольтинді (7 түр), поливольтинді (1 түр), ациклді (2 түр). Зерттеу аймағындағы дендробионтты түрлердің барлығы мезофилдер. Дендробионтты жартылай қаттықанаттыларының ішінде ересек дарасы күйінде – 15 түр (58%), ересек дарасы мен дернәсілдері күйінде – 2 түр (7%), жұмыртқалары күйінде – 9 түр (35%) қыстайды.

Түйін сөздер: ағаш өсімдікқоректі жартылай қаттықанаттылар, Шарын мемлекеттік ұлттық табиғи паркі, Оңтүстік-Шығыс Қазақстан.

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Biology and ecology of the dendrobiont half-winged (Heteroptera) Charyn state national natural park (South-East Kazakhstan)

The article presents the results of field studies in 2018-2019 in the Charyn GNPP. As a result of the studies, 26 species of half-winged from 7 families were identified: Miridae (11 species, 43%), Aradidae (2 species, 8%), Lygaeidae (1 species, 4%), Coreidae (2 species, 8%), Tingidae (3 species, 11%), Acanthosomatidae (4 species, 15%), Pentatomidae (3 species, 11%). Among them, the following families are distinguished by species diversity: Miridae (11 species), Acanthosomatidae (4 species), and in the remaining 5 families, only 1-3 species are known. According to trophic specialization, phytophages (24 species) and mycetophages (2 species) are distinguished. By the number of generations per year, they are divided into 4 groups: monovoltaic (16 species), bivoltine (7 species), polyvoltine (1 species), acyclic (2 species). All identified woody herbivorous species are mesophiles. Among arboreal semi-winged animals of the Charyn GNPP, 15 species (58%) winter in the adult stage, 2 species (7%) in the adult and larva stages, and 9 species in the egg stage (35%).

Key words: dendrobiontic half-winged heteroptera, Charyn State National Natural Park, South-East Kazakhstan.

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Биология и экология древесных растительноядных полужесткокрылых (Heteroptera) Чарынского ГНПП (Юго-Восточный Казахстан)

В статье приводятся результаты полевых исследований 2018-2019 гг. на территории Чарынского Государственного Национального природного парка. В результате проведенных исследований выявлено 26 видов растительноядных древесных полужесткокрылых из 7 семейств: Miridae (11 видов, 43%), Aradidae (2 вида, 8%), Lygaeidae (1 вид, 4%), Coreidae (2 вида, 8%), Tingidae (3 вида, 11%), Acanthosomatidae (4 вида, 15%), Pentatomidae (3 вида, 11%). Среди них по видовому разнообразию выделяются следующие семейства: Miridae (11 видов, 43%), Acanthosomatidae (4 вида, 15%), а в остальных 5 семействах известны всего по 1-3 вида. По трофической специализации выделяются фитофаги (24 вида) и мицетофаги (2 вида). По числу поколений в год разделяются на 4 группы: моновольтинные (16 видов), бивольтинные (7 видов), поливольтинные (1 вид), ацикличные (2 вида). Все выявленные древесные растительноядные виды – мезофилы. Среди древесных растительноядных полужесткокрылых Чарынского ГНПП в стадии имаго зимуют 15 видов (58%), в стадии имаго и личинки – 2 вида (7%), а в стадии яйца – 9 видов (35%).

Ключевые слова: дендробионтные растительноядные полужесткокрылые, Чарынский Государственный Национальный природный парк, Юго-Восточный Казахстан.

Кіріспе

Жартылай қаттықанаттылар немесе қандалалар – әртүрлі биотоптарды қоныстайтын және биогеоценоздарда маңызды рөл атқаратын насекомдардың ішіндегі өзіндік ерекше отряды. Жартылай қаттықанаттылар арасында жыртқыш немесе аралас қоректі түрлер бар, бірақ өсімдікқоректі түрлері басым. Олар кей кезде көп болып көбейіп, орман және ауыл шаруашылығына зиян келтіреді.

Жартылай қаттықанаттылар отряды жайлы соңғы онжылдықтағы шетелдік әдебиеттерге шолу жасасақ, жартылай қаттықанаттылардың Палеарктикалық каталогтары [1-3], оның систематикасы мен эволюциясының соңғы 25 жылдағы жетістіктері [4], жекелеген тұқымдастар: нағыз қалқаншалылар [5-6], жыртқыш қандалалар [7], қызыл қандалалар (Pyrrhocoridae) жайлы мәліметтер [8] және жай көзшесіз қандалалар (Miridae) түрлерінің ішіндегі зиянкестер мен жыртқыштардың ерекшеліктері [9], сонымен қатар нағыз жартылай қаттықанаттылар [10] және олардың экологиясы [11-13] жайлы мәліметтер осы басылымдарда көрсетілген.

Авторлар Шарын МҰТП территориясының су жартылай қаттықанаттылары мен су қаттықанаттыларын зерттеп, мақалалар жариялаған [14-15], ал ағаш өсімдікқоректі жартылай қаттықанаттылар зерттелмеген.

Зерттеу мақсаты – Шарын МҰТП территориясының ағаш өсімдікқоректі жартылай қаттықанаттыларының түр құрамын, биологиясы, экологиясын және таралуын зерттеу.

Зерттеу әдістері

Насекомдар ағаштар мен бұталарды арнайы энтомологиялық ауа сүзгісіне немесе ақ матаға қағу арқылы жиналды, ал ұсақ насекомдарды ұстауға эксгаустер аспабы пайдаланылды. Түнгі жарыққа ұшып келетін насекомдар арнайы жарық көздерінен, автокөлік жарықтарынан ұсталды. Сонымен қатар насекомдарды ағаш, бұта түбінде тұрып, көзбен қарап, суретке түсіріп, бақылау жұмыстары жүргізілді [16-18]. Насекомдардың түр құрамы зертханалық жағдайда микроскоппен және анықтағыштармен анықталды.

Зерттеу нәтижелері мен талқылау

Төменде зерттеу нәтижесінде табылған түрлердің аннотациялық тізімі беріліп отыр.

Жай көзшесіздер тұқымдасы – Miridae

Lygidea illota (Stal, 1858). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 1♀; 11.07.2018. 2♂, 2♀; 29.06.2019, 1♀, 3♂; Теміրлік өзені аңғары, 12.06.2018. 2♂, 3♀; 11.07.2018. 3♂, 2♀; 29.06.2019, 2♂, 1♀; ерен тоғайы, 18.06.2018. 2♂, 2♀; 28-29.06.2019, 3♀, 2♂; 11-12.07.2019, 3♂, 3♀;08-10.08.2019, 2♀, 2♂. Өзен аңғарлары бойындағы талдарда; мезофил; көпқоректі; жылына бір рет ұрпақ береді [19]; ересек дарасы қыстайды.

Lygocoris contaminatus (Fallen, 1807). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 4♀; 28-29.06.2019, 2♀, 1♂; Темірлік өзені аңғары, 12.07.2018. 2♂, 3♀; 29.06.2019, 1♂, 2♀; ерен тоғайы, 28-29.06.2019, 4♀, 3♂; 11-12.07.2019, 2♂, 1♀. Өзен аңғарлары бойындағы талдарда, қандыағашта, қайыңдарда кездеседі. Дендробионт; мезофил; көпқоректі; жылына екі рет ұрпақ береді; жұмыртқасы қыстайды [20].

Lygocoris rugicollis (Fallen, 1807). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 4♀; 28-29.06.2019, 2♀, 1♂; Темірлік өзені аңғары, 12.07.2018. 2♂, 3♀; 29.06.2019, 1♂, 2♀; ерен тоғайы, 28-29.06.2019, 4♀, 3♂; 11-12.07.2019, 2♂, 1♀. Хорто-тамно-дендробионт, мезофил; көпқоректі (ағаштар, бұталар мен шөптесін өсімдіктерде); жылына екі рет ұрпақ береді; жұмыртқасы қыстайды [19].

Auchenocrepis reuteri Jakovlev, 1876. Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 1♀; 29.06.2019, 3♀, 2♂; Темірлік өзені аңғары, 12.06.2018. 2♂, 3♀; 29.06.2019, 2♂, 1♀; 11-12.07.2019, 3♂, 4♀. Дендробионт; мезофил (өзен аңғарлары тоғайында); тар олигофитофаг (*Tamarix, Myricaria*); жылына бір рет ұрпақ береді; жұмыртқасы қыстайды [19].

Agnocoris rubicundus (Fallen, 1807). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 3♀; 12.06.2018. 2♂, 1♀; 28-29.06.2019, 2♀, 2♂; Темірлік өзені аңғары, 12.06.2018. 2♂, 2♀; 29.06.2019, 3♂, 2♀; ерен тоғайы, 28-29.06.2019, 1♀, 2♂; 11-12.07.2019, 3♂, 2♀. Дендробионт (жапырақты, жемісті ағаштар мен бұталарда, көбіне талда); мезофил; көпқоректі (тал *Salix*, үйеңкі *Acer* және т.б. дәндерімен қоректенеді); жылына бір рет ұрпақ береді; ересек дарасы қыстайды [20].

Salicarus concinnus V.G.Putshkov, 1977. Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 3♀; 28-29.06.2019, 2♀, 3♂; Темірлік өзені аңғары, 12.06.2018. 2♂, 1♀; 29.06.2019, 3♂, 3♀; 11-12.07.2019, 3♂, 4♀. Дендробионт (өзен аңғарлары тоғайында); мезофил; кең олигофитофаг (талда); жылына бір рет ұрпақ береді; жұмыртқасы қыстайды [19].

Salicarus roseri (Herrich-Schaeffer, 1838). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 1♂, 3♀; 28-29.06.2019, 2♀, 1♂; Темірлік өзені аңғары, 12.06.2018. 2♂, 2♀; 29.06.2019, 3♂, 2♀; 11-12.07.2019, 3♂, 3♀. Денробионт (тал *Salix*); мезофил (өзен аңғарлары тоғайында); кең олигофитофаг; жылына бір рет ұрпақ береді; жұмыртқасы қыстайды.

Tuponia distincta Drapolyuk, 1980. Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 3♀; 28-29.06.2019, 4♀, 3♂; Темірлік өзені аңғары, 12.06.2018. 4♂, 3♀; 29.06.2019, 2♂, 3♀; 11-12.07.2019, 5♂, 4♀;08-10.08.2019, 3♀, 2♂. Тамнобионт; мезофил (өзен аңғарлары тоғайында); тар олигофитофаг (жыңғылда *Tamarix, Myricaria*); жылына екі рет ұрпақ береді; жұмыртқасы қыстайды [21].

Tuponia prasina (Fieber, 1864). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 3♀; 28-29.06.2019, 3♀, 3♂; Темірлік өзені аңғары, 12.06.2018. 2♂, 2♀; 29.06.2019, 2♂, 1♀; 11-12.07.2019, 3♂, 4♀. Тамнобионт; мезофил (өзен аңғарлары тоғайында); тар олигофитофаг (жыңғылда *Tamarix, Myricaria*); жылына екі рет ұрпақ береді; жұмыртқасы қыстайды [21].

Tuponia spinifera Drapolyuk, 1982. Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 3♀; 28-29.06.2019, 2♀, 3♂; Темірлік өзені аңғары, 12.06.2018. 2♂, 1♀; 29.06.2019, 2♂, 2♀; 11-12.07.2019, 3♂, 4♀. Тамнобионт; мезофил (өзен аңғарлары тоғайында); тар олигофитофаг (жыңғылда *Tamarix, Myricaria*); жылына екі рет ұрпақ береді; жұмыртқасы қыстайды [21].

Tuponia elegans (Jakovlev, 1867). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 3♀; 28-29.06.2019, 4♀, 3♂; Темірлік өзені аңғары, 11.06.2018. 4♂, 3♀; 29.06.2019, 2♂, 3♀; 11-12.07.2019, 5♂, 6♀; 08-10.08.2019, 1♀, 2♂. Тамнобионт; мезофил (өзен аңғарлары тоғайында); тар олигофитофаг (жыңғылда *Tamarix, Myricaria*); жылына екі рет ұрпақ береді; жұмыртқасы қыстайды [21].

Tuponia roseipennis Reuter, 1878. Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 3♂, 3♀; 28-29.06.2019, 4♀, 4♂; Темірлік өзені аңғары, 12.06.2018. 2♂, 2♀; 29.06.2019, 2♂, 2♀; 11-12.07.2019, 5♂, 5♀; 08-10.08.2019, 3♀, 2♂. Тамнобионт; мезофил (өзен аңғарлары тоғайында); тар олигофитофаг (жыңғылда *Tamarix, Myricaria*); жылына екі рет ұрпақ береді; жұмыртқасы қыстайды [21].

Қабық асты қандалалары тұқымдасы – Aradidae

Aradus betulae (Linnaeus, 1758). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 4♀; 28-29.06.2019, 1♀, 1♂; Теміртлік өзені аңғары, 11.06.2018. 2♂, 3♀; 29.06.2019, 1♂, 2♀; ерен тоғайы, 28-29.06.2019, 2♀, 1♂; 11-12.07.2019, 2♂, 2♀; 08-10.08.2019, 1♀, 2♂. Дендробионт (Polyporacea тобының трутовик-саңырауқұлақтарынан әлсіреген жапырақты ағаштарда) [22]; мицетофаг, саңырауқұлақ шырынымен қоректенеді; мезофил; ациклді; ересек дарасы мен дернәсілдері қыстайды.

Aradus setiger Kiritshenko, 1913. Алматы облысы,Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 3♀; 28-29.06.2019, 2♀, 1♂; Теміртлік өзені аңғары, 12.06.2018. 2♂, 2♀; 28-29.06.2019, 2♀, 3♂; 11-12.07.2019, 3♂, 2♀. Дендробионт (тал, көктеректегі трутовик-саңырауқұлақтарда, терек пен ақ қараған қабығы астында) [22]; мезофил, мицетофаг, саңырауқұлақ шырынымен қоректенеді; ациклді; ересек дарасы мен дернәсілдері қыстайды.

Жер қандалалары тұқымдасы – Lygaeidae

Arocatus melanocephalus (Fabricius, 1798). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, Темирлик, 11-12.06.2018. 5♂, 7♀; 28-29.06.2019, 5♀, 6♂; 11-12.07.2019, 7♂, 6♀; 08-10.08.2019, 4♀, 3♂. Дендробионт (түрлі ағаштың жапырағы мен қабығы астында кездеседі); мезофил; көпқоректі; жылына бір рет ұрпақ береді, ересек дарасы қыстайды [23].

Kleidocerys resedae (Panzer, 1797). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, Темирлик, 11-12.06.2018. 4♂, 3♀; 28-29.06.2019, 3♀, 3♂; 11-12.07.2019, 3♂, 4♀; 08-10.08.2019, 4♀, 2♂. Тамно-дендробионт (жапырақты ағаштар мен бұталарда); мезофил; көпқоректі (*Betula, Fraxinus, Alnus, Ledum, Spiraea, Corylus*); жылына бір рет ұрпақ береді; ересек дарасы мен дернәсілдері қыстайды. Көбіне қайыңдарда, сонымен қатар басқа ағаштар мен бұталарда шілде-тамызда кездеседі. Гүлсағақпен жаппай көп болып қоректенгенде, тұқым өнімін дерлік жоққа шығарады [23].

Кенереуліктер тұқымдасы – Coreidae

Gonocerus patellatus Kiritshenko, 1916. Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, Темирлик, 11-12.06.2018. 2♂, 1♀; 28-29.06.2019, 3♀, 2♂; 11-12.07.2019, 3♂, 4♀; 08-10.08.2019, 1♀, 2♂. Дендробионт (ағаштарда: *Rosa* және т.б.); мезофил; көпқоректі; жылына бір рет ұрпақ береді; ересек дарасы қыстайды [24].

Gonocerus acuteangulatus Goeze, 1778. Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, Темирлик, 11-12.06.2018. 3♂, 3♀; 28-29.06.2019, 3♀, 3♂; 11-12.07.2019, 3♂, 2♀; 08-10.08.2019, 1♀, 1♂. Тамно-дендробионт (түрлі ағаштар мен бұталарда: *Quercus, Alnus, Juniperus, Rosa* және т.б.); мезофил; көпқоректі (жапырақты ағаштар мен бұталарда) [24]; жылына бір рет ұрпақ береді; ересек дарасы қыстайды.

Шілтерлілер тұқымдасы – Tingidae

Stephanitis pyri (Fabricius, 1775). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 3♂, 4♀; 28-29.06.2019, 2♀, 3♂; Теміртлік өзені аңғары, 12.06.2018. 2♂, 2♀; 29.06.2019, 3♂, 2♀; ерен тоғайы, 28-29.06.2019, 2♀, 4♂; 11-12.07.2019, 3♂, 4♀; 08-10.08.2019, 1♀, 2♂. Тамно-дендробионт (*Pyrus, Malus, Ulmus, Tilia, Sorbus, Rosa* және басқа да ағаштар мен бұталарда); мезофил; көпқоректі; жылына 3-4 рет ұрпақ береді; ересек дарасы қыстайды [25].

*Monosteira discoidalis (*Jakovlev, 1883). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 3♀; 28-29.06.2019, 2♀, 3♂; Теміртлік өзені аңғары, 12.06.2018. 2♂, 2♀; 29.06.2019, 3♂, 2♀; ерен тоғайы, 28-29.06.2019, 3♀, 4♂; 11-12.07.2019, 3♂, 1♀. Дендробионт (теректе, талда және басқа да жапырақты ағаштарда жапырақтарымен қоректеніп, едәуір зиян келтіреді, қандалалар жапырақтың төменгі бетінде үлкен топ болып жиналады); мезофил; кең олигофитофаг; жылына екі рет ұрпақ береді; ересек дарасы қыстайды [25].

Monosteira unicostata (Mulsant & Rey, 1852). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 3♀; 28-29.06.2019, 4♀, 3♂; Теміртлік өзені аңғары, 12.06.2018. 2♂, 1♀; 29.06.2019, 3♂, 2♀; ерен тоғайы, 28-29.06.2019, 2♀, 3♂; 11-12.07.2019, 3♂, 2♀. Дендробионт (тораңғы, тал, терек, қарағаш); мезофил; кең олигофитофаг (жапырақтармен қоректеніп, сары дақтар пайда болады, нәтижесінде жапырақтар уақтысынан бұрын түсіп қалады, өсімдіктің қалыпты өсуіне әсер етеді); жылына екі рет ұрпақ береді; ересек дарасы қыстайды [25].

Ағаш қалқаншалы қандалалары – Acanthosomatidae

Acanthosoma haemorrhoidale haemorrhoidale (Linnaeus, 1758). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 3♀; 28-29.06.2019, 2♀, 3♂; Темірлік өзені аңғары, 12.06.2018. 2♂, 1♀; 29.06.2019, 2♂, 2♀; ерен тоғайы, 28-29.06.2019, 3♀, 2♂; 11-12.07.2019, 3♂, 3♀; 08-10.08.2019, 3♀, 2♂. Дендро-тамнобионт (жапырақты ағаштарда: *Betula, Guercus, Crataegus, Corylus, Tilia, Carpinus, Prunus, Sorbus* және т.б.); мезофил; көпқоректі; жылына бір рет ұрпақ береді; ересек дарасы қыстайды [26].

Elasmotethus brevis Lindberg, 1934. Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, Темирлик, 11-12.06.2018. 3♂, 3♀; 28-29.06.2019, 2♀, 3♂; 11-12.07.2019, 2♂, 4♀; 08-10.08.2019, 1♀, 2♂. Дендробионт (талдарда); мезофил (өзен аңғарлары бойындағы тоғайларда); көпқоректі; жылына бір рет ұрпақ береді; ересек дарасы қыстайды [26].

Elasmotethus interstinctus (Linnaeus, 1758). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, Темирлик, 11-12.06.2018. 2♂, 3♀; 28-29.06.2019, 3♀, 3♂; 11-12.07.2019, 3♂, 2♀. Өзен аңғарлары бойындағы аралас ормандар ағаштары мен бұталарында тіршілік етеді. Дендро-тамнобионт (тал, қайың, қандыағаш, сирек көктеректе, үшқатта); мезофил; көпқоректі; жылына бір рет ұрпақ береді; ересек дарасы қыстайды [26].

Elasmucha fieberi Jakovlev, 1865. Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, Темірлік өзені аңғары, 11.06.2018. 3♂, 3♀; 28-29.06.2019, 3♀, 4♂; 11-12.07.2019, 4♂, 5♀; 08-10.08.2019, 2♀, 2♂. Өзен аңғарлары бойындағы аралас ормандар ағаштары мен бұталарында тіршілік етеді. Дендро-тамнобионт; мезофил; көпқоректі (жапырақты ағаштар); жылына бір рет ұрпақ береді; ересек дарасы қыстайды [26].

Нағыз қалқаншалылар тұқымдасы – Pentatomidae

Cellobius abdominalis Jakovlev, 1885. Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 3♀; 28-29.06.2019, 2♀, 3♂; Темірлік өзені аңғары, 11.06.2018. 2♂, 2♀; 29.06.2019, 2♂, 2♀; ерен тоғайы, 28-29.06.2019, 3♀, 2♂; 11-12.07.2019, 3♂, 3♀. Тамнобионт; мезофил (өзені аңғарларындағы тоғайларда); тар олигофитофаг (тораңғыда); жылына бір рет ұрпақ береді; ересек дарасы қыстайды [26].

Apodiphus integriceps Horvath, 1888. Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 1♀; 28-29.06.2019, 2♀, 2♂; Темірлік өзені аңғары, 12.06.2018. 1♂, 2♀; 29.06.2019, 2♂, 1♀; ерен тоғайы, 28-29.06.2019, 1♀, 2♂+ 2 личинки; 11-12.07.2019, 3♂, 3♀; 08-10.08.2019, 2♀, 2♂. Дендробионт (терек, алма, тал, қарағаш және т.б. ағаштарда); мезофил; көпқоректі; жылына бір рет ұрпақ береді; ересек дарасы қыстайды. Тұт ағашы мен жидені зақымдайды [26].

Desertomenida quadrimaculata (Horvath, 1892). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 1♀; 28-29.06.2019, 3♀, 3♂; Темірлік өзені аңғары, 12.06.2018. 2♂, 3♀; 29.06.2019, 1♂, 2♀; ерен тоғайы, 28-29.06.2019, 2♀, 2♂; 11-12.07.2019, 3♂, 2♀; 08-10.08.2019, 1♀, 2♂. Дендробионт (жыңғыл мен жүзгінде); мезофил (өзені аңғары тоғайларында); көпқоректі; жылына бір рет ұрпақ береді; ересек дарасы қыстайды [26].

Rhapigaster nebulosa (Poda, 1761). Алматы облысы,Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 2♀; 28-29.06.2019, 4♀, 3♂+ 3 дернәсілі; Темірлік өзені аңғары, 12.06.2018. 2♂, 3♀; 29.06.2019, 2♂, 1♀; ерен тоғайы, 28-29.06.2019, 3♀, 2♂; 10-12.07.2019, 4♂, 3♀; 08-10.08.2019, 3♀, 2♂. Дендробионт (талда *Salix,* теректе *Populus,* орманжаңғақта *Corylus*); жылусүйгіш, ағаш құрамының сирек болғанын қалайды; мезофил (аралас мезофильді орман); көпқоректі (түрлі жапырақты ағаштармен, бұталармен қоректенеді); жылына бір рет ұрпақ береді; ересек дарасы қыстайды [26].

Piezodorus lituratus (Fabricius, 1794). Алматы облысы, Ұйғыр ауданы, Шарын МҰТП, Шарын өзені аңғары, 11.06.2018. 2♂, 3♀; 28-29.06.2019, 4♀, 3♂+ 3 дернәсілі; Темірлік өзені аңғары, 12.06.2018. 2♂, 2♀; 29.06.2019, 2♂, 1♀. Хорто-тамно-дендробионт; мезофил (өзені аңғары тоғайларында); кең олигофитофаг (бұршақ тұқымдастарда Leguminosae: *Vicia, Caragana* және т.б., жаңа шыққан ересек даралары жиі көптеген ағаштар мен бұталарда кездеседі [26]; жылына бір рет ұрпақ береді; ересек дарасы қыстайды.

1-кесте – Шарын мемлекеттік ұлттық табиғи паркі ағаш жартылай қаттықанаттыларының таксондық құрамы, олардың биологиялық және экологиялық ерекшеліктері

Түр атауы	Қыстау кезеңі	Коректік байланысы	Ұрпақ саны
Жай көзшесіздер тұқымдасы – Miridae			
Lygidea illota (Stal, 1858)	ересек дарасы	көпқоректі	жылына бір рет ұрпақ береді
Lygocoris contaminatus (Fallen, 1807)	жұмыртқасы	көпқоректі	жылына екі рет ұрпақ береді
Auchenocrepis reuteri Jakovlev, 1876	жұмыртқасы	тар олигофитофаг	жылына бір рет ұрпақ береді
Agnocoris rubicundus (Fallen, 1807)	ересек дарасы	көпқоректі	жылына бір рет ұрпақ береді
Salicarus concinnus V.G.Putshkov, 1977	жұмыртқасы	кең олигофитофаг	жылына бір рет ұрпақ береді
Salicarus roseri (Herrich-Schaeffer, 1838)	жұмыртқасы	кең олигофитофаг	жылына бір рет ұрпақ береді
Tuponia distincta Drapolyuk, 1980	жұмыртқасы	тар олигофитофаг	жылына бір рет ұрпақ береді
Tuponia prasina (Fieber, 1864)	жұмыртқасы	тар олигофитофаг	жылына екі рет ұрпақ береді
Tuponia spinifera Drapolyuk, 1982	жұмыртқасы	тар олигофитофаг	жылына екі рет ұрпақ береді
Tuponia elegans (Jakovlev, 1867)	жұмыртқасы	тар олигофитофаг	жылына екі рет ұрпақ береді
Tuponia roseipennis Reuter, 1878	жұмыртқасы	тар олигофитофаг	жылына екі рет ұрпақ береді
Қабық асты қандалалар тұқымдасы – Aradidae			
Aradus betulae (Linnaeus, 1758)	ересек дарасы, дернәсілі	мицетофаг	ациклді
Aradus setiger Kiritshenko, 1913	ересек дарасы, дернәсілі	мицетофаг	ациклді
Жер қандалалары тұқымдасы – Lygaeidae			
Arocatus melanocephalus (Fabr., 1798)	ересек дарасы	көпқоректі	жылына бір рет ұрпақ береді
Gonocerus patellatus Kiritshenko, 1916	ересек дарасы	көпқоректі	жылына бір рет ұрпақ береді
Gonocerus acuteangulatus Goeze, 1778	ересек дарасы	көпқоректі	жылына бір рет ұрпақ береді
Шілтерлілер тұқымдасы – Tingidae			
Stephanitis pyri (Fabricius, 1775)	ересек дарасы	көпқоректі	жылына 3-4 рет ұрпақ береді
*Monosteira discoidalis (*Jakovlev, 1883)	ересек дарасы	кең олигофитофаг	жылына екі рет ұрпақ береді
Monosteira unicostata (Mulsant & Rey, 1852)	ересек дарасы	кең олигофитофаг	жылына екі рет ұрпақ береді
Ағаш қалқаншалылар тұқымдасы – Acanthosomatidae			
Acanthosoma haemorrhoidale (Linnaeus, 1758)	ересек дарасы	көпқоректі	жылына бір рет ұрпақ береді
Elasmotethus brevis Lindberg, 1934	ересек дарасы	көпқоректі	жылына бір рет ұрпақ береді
Elasmotethus interstinctus (L., 1758)	ересек дарасы	көпқоректі	жылына бір рет ұрпақ береді
Elasmucha fieberi Jakovlev, 1865	ересек дарасы	көпқоректі	жылына бір рет ұрпақ береді
Нағыз қалқаншалылар тұқымдасы – Pentatomidae			
Cellobius abdominalis Jakovlev, 1885	ересек дарасы	тар олигофитофаг	жылына бір рет ұрпақ береді
Apodiphus integriceps Horvath, 1888	ересек дарасы	көпқоректі	жылына бір рет ұрпақ береді
Rhapigaster nebulosa (Poda, 1761)	ересек дарасы	көпқоректі	жылына бір рет ұрпақ береді

1-кесте нәтижесі бойынша Шарын МҰТП территориясынан өсімдікқоректі ағаш жартылай қаттықанаттыларының 7 тұқымдасқа жататын 26 түрі анықталды. *Жүргізілген зерттеулер нәтижесінде* жартылай қаттықанаттыларының ішінде мицетофагтар – 2 түр; өсімдікқоректілер – 24 түр екендігі белгілі болды. Олардың ішінде 16 түр жылына бір рет ұрпақ береді, 7 түр – екі рет, 1 түр – 3-4 рет ұрпақ береді, ал 2 түр – ациклді. Зерттеуде кездескен түрлердің бәрі мезофилдер болды. Анықталған түрлердің ішінде ересек дарасы күйінде 15 түр, ересек дарасы мен дернәсілдері күйінде – 2 түр, жұмыртқалары күйінде – 9 түр қыстайды.

Қорытынды

Шарын МҰТП территориясында зерттеу жүргізілген аймақтың бәрінде өсімдікқоректі ағаш жартылай қаттықанаттылары кездесті. Зерттеу нәтижесінде өсімдікқоректі ағаш жартылай қаттықанаттыларының 7 тұқымдасына жататын 26 түрі анықталды: Жай көзшесіздер (Miridae) – 11 түр, қабық асты қандалалары (Aradidae) – 2 түр, жер қандалалары (Lygaeidae) – 1 түр, кенереуліктер (Coreidae) – 2 түр, шілтерлілер (Tingidae) – 3 түр, ағаш қалқаншалылары (Acanthosomatidae) – 4 түр, нағыз қалқаншалылар (Pentatomidae) – 3 түр. Бұлардың арасында түр құрамы жағынан басым тұқымдастар: Miridae – 11 түр, Acanthosomatidae – 4 түр, Pentatomidae – 3 түр, қалған 5 тұқымдастан 1-3 түрден ғана белгілі болды.

Шарын МҰТП өсімдікқоректі ағаш жартылай қаттықанаттылары коректік байланысы жағынан өсімдікқоректілер, олардың ішінде 13 түр – көпқоректі, 4 түр – кең олигофитофаг, 7 түр – тар олигофитофаг, 2 түр – мицетофаг болып табылады.

Шарын МҰТП өсімдікқоректі ағаш жартылай қаттықанаттылары жылына ұрпақ беруі жағынан 4 топқа бөлінеді: 16 түр – жылына бір рет ұрпақ береді, 7 түр – екі рет, 1 түр – 3-4 рет ұрпақ береді, ал 2 түр ациклді.

Зерттеу аймағындағы өсімдікқоректі ағаш жартылай қаттықанаттылардың барлығы мезофилдер. Бұлардың арасында ересек дарасы күйінде – 15 түр (58%), ересек дарасы мен дернәсілдері күйінде – 2 түр (7%), жұмыртқалары күйінде – 9 түр (35%) қыстайды.

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