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FEATURES OF THE DISTRIBUTION OF ALTITUDINAL-BELT VEGETATION OF THE UZYNKARA (KETPEN) RIDGE

The article shows the results of the Uzynkara (Ketpen) range vegetation studies during route and semi-stationary studies. The article presents the analysis of the Uzynkara ridge vegetation on specific profiles and summarizes all available data on the patterns of altitudinal zonality of vegetation. The flora of the territory we studied is comparatively rich and includes 1890 species of higher vascular plants belonging to 120 families and 596 genera. About 67.8% of the entire flora are perennial herbaceous hemicryptophytes. A very large proportion (more than 21%) are summer-green biennials (annuals and biennials) – therophytes, i.e. plants with an accelerated development cycle. This feature – the abundance of annuals and biennials and the presence of a large number of ephemerals and ephemeroids – is characteristic of the mountain flora of the entire Middle Asia. In this territory, we have identified the following altitudinal zonality zones, each with its own specific type of plant communities. The macrorelief of the Uzynkara ridge is represented by the mountainous part and the foothills. The belt zone includes the highlands – alpine and subalpine belt, middle mountains, foothill-steppe low mountains, foothill semi-desert and desert. Plant communities in the alpine and subalpine belts consist of cryophilic low-grass kobresia meadows and cryophilic cushion-shaped semi-shrubs; the middle belt consists of coniferous-forest-meadow forbs and lithophilic vegetation of rocks and screes; the lower belt is represented by deciduous-forest-shrub and steppe vegetation; the desert belt consists of xerophilic shrubs and semi-shrubs.

Key words: groups of plant communities, altitudinal zones, Uzynkara-Ketpen.

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Ұзынқара (Кетпен) жотасының биіктік өсімдіктерінің таралу ерекшеліктері

Мақалада Ұзынқара жотасының өсімдік жамылғысын трассалық және жартылай стационарлық зерттеу процесінде зерттеу нәтижелері берілген. Мақалада Ұзынқара жотасының өсімдіктер жамылғысының нақты профильдер бойынша талдауы көрсетіліп, өсімдік жамылғысының биіктік белдеуі заңдылықтары бойынша қолда бар барлық деректер жинақталған. Біз зерттеген аумақтың флорасы салыстырмалы түрде бай және 120 тұқымдас пен 596 тұқымдасқа жататын жоғары тамырлы өсімдіктердің 1890 түрін қамтиды. Жалпы флораның 67,8%-ға жуығын көпжылдық шөптесін гемикриптофиттер құрайды. Өте үлкен үлес (21%-дан астам) жазғы-жасыл жас өсімдіктерден (біржылдық-екіжылдықтар) – терофиттерден, яғни. жеделдетілген даму циклі бар өсімдіктер. Бұл белгі – біржылдық және екі жылдық өсімдіктердің көптігі және эфемерлер мен эфемероидтардың көп болуы – бүкіл Орталық Азияның тау флорасына тән. Бұл аумақта өсімдіктер қауымының өзіндік спецификалық түріне сәйкес келетін келесі биіктік белдеулерін анықтадық. Ұзынқара жотасының макрорельефі таулы бөлігімен және тау етегімен бейнеленген. Белдеу аймағына биік таулы аймақтар – альпі және субальпілік белдеулер, орта таулар, тау

етегіндегі-далалық ойпаңдар, тау етегіндегі жартылай шөл және шөлейттер жатады. Альпі және субальпі белдеуіндегі өсімдіктер қауымдастығы криофильді аз шөпті кобрезия шалғындарынан және криофильді жастық бұталарынан тұрады; ортаңғы белдеу қылқан жапырақты-орманды-шалғынды бұталардан және тау жыныстары мен жартастардың литофильді өсімдіктерінен тұрады; төменгі аймақ жапырақты-орманды-бұталы және дала өсімдіктерімен ұсынылған; Шөл белдеуі ксерофильді бұталар мен шалабұталардан тұрады.

Түйін сөздер: өсімдік бірлестігінің топтары, биіктік белдеулері, аудандастыру, Ұзынқара-Кетпен.

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Особенности распределение высотно-поясной растительности хребта Узынкара (Кетпен)

В данной статье показаны результаты многолетних исследований растительности хребта Узынкара в процессе маршрутных и полустационарных исследований. В статье показан анализ растительности хребта Узынкара на конкретных профилях и обобщены все имеющиеся данные по закономерностям высотной поясности растительности. Флора изученной нами территории сравнительно богата и насчитывает 1890 видов высших сосудистых растений, относящихся к 120 семействам и 596 родам. Около 67,8 % всей флоры – многолетние травянистые растения-гемикриптофиты. Очень большую долю (более 21%) составляют летнезеленые малолетники (одно-двулетники) – терофиты, т.е. растения с ускоренным циклом развития. Эта особенность – обилие одно-двулетников и присутствие большого количества эфемеров и эфемероидов – свойственна горной флоре всей Средней Азии. На данной территории нами выделены следующие зоны высотной поясности, которой соответствует свой определенный тип растительных сообществ. Макрорельеф хребта Узынкара представлен горной частью и предгорьем. Поясная зона включает в себя высокогорье – альпийский и субальпийский пояс, среднегорье, предгорно-степное низкогорье, предгорная полупустыня и пустыня. Растительные сообщества в альпийском и субальпийском поясе состоят из криофильных низкотравных кобрезиевых лугов и криофильных подушковидных полукустарников; средний пояс состоит из хвойно-лесолугового разнотравья и литофильной растительности скал и осыпей; нижний пояс представлен лиственно-лесокустарниковой и степной растительностью; пустынный пояс состоит из ксерофильных кустарников и полукустарничков.

Ключевые слова: Группировки растительных сообществ, высотные пояса, зональность, Узынкара.

Introduction

Today, the study of mountain vegetation is of great theoretical and practical importance. The study of mountain vegetation attracts much attention from foreign scientists for several reasons. The study of vegetation in these conditions allows us to better understand how ecosystems adapt to new conditions and can help develop effective strategies for their protection and restoration. In addition, mountain areas serve as a source of natural resources such as water, wood, and medicinal plants, making their study important not only from a scientific point of view, but also for the sustainable management of natural resources. Among foreign studies, one can highlight works devoted to phytogeography [2,3,4,5,6,7], ecology of mountain ecosystems [8,9,10,11,12], as well as studies aimed at assessing the impact of anthropogenic load on vegetation [13,14,15].

Geographical names of mountain ranges are associated with human economic activity, appearance, relief features, history of the region, and natural landscape. In the name of the Ketpen ridge, the first component “Ket (kete)” means the ethnic name of ancient peoples, the second component “pen” means barrier [16]. The Ketpen ridge has another name, Uzynkara. The first component of the toponym “uzin” in Kazakh means long, the second component “kara” means mountain. The word “kara” means a hill or elevation at the end of a complex geographical name [17]. The toponym Uzynkara is associated with the length of the ridge, which is located on the territory of two states – Kazakhstan and

China. The ridge is characterized by smooth transitions in altitude, without sharply defined peaks. The continuation of the ridge on the territory of China is called Temirlik. The toponym Temirlik consists of the component temir, which in translation from the Kazakh language means iron, and the word-formation affix -lik. The Temirlik river of the same name originates in the gorges of the Ketpen ridge. According to local residents, the name Temirlik is connected with the fact that in ancient times iron ore was mined in these places, smelted and various products were made from it [18].

The diversity of natural conditions of the Uzynkara ridge under study is determined, first of all, by the altitudinal dissection of its surface. The Uzynkara ridge is an ancient Paleozoic structure, leveled to the stage of peneplain plains and again raised in the Tertiary and Quaternary to the level of modern heights. The Uzynkara n range is an ancient Paleozoic structure, leveled to the stage of peneplain plains and again raised in the Tertiary and Quaternary to the level of modern heights. The territory of the study area is characterized by a complex, highly dissected relief. 1. The mountainous part is represented by highlands, middle mountains and lowlands 1300 – 3600 m above sea level; 2. The foothill steppe part – 800 – 1600 m above sea level. 3. The foothill semi-desert and desert part – 650–800 m. [19].

The aim of this study is the ecological and geographical characteristics of the main plant communities of the Uzynkara range.

Materials and Methods

For a comprehensive study of plant communities in the mountainous areas of the Uzynkara Range, an integrated approach was used, combining botanical, floristic and ecological methods. It is important to take into account the specifics of mountain ecosystems, which can undergo rapid changes due to both natural and anthropogenic factors. Long-term expeditionary research on the Uzynkara Range was conducted from 2001 to 2024, during field periods by the route method on cars, where the entire territory of the Uzynkara Range was surveyed and reconnaissance trips were made to all the gorges of this range. An important part of the research of the mountainous areas of the Uzynkara Range was long-term monitoring of the state of vegetation in dynamics. The description of the vegetation was made on sites of approximately 100 m2; for floristic poor and sparse groups, large sites were taken. The abundance of species in phytocenoses was determined according to the Drude abundance scale. The classification of vegetation in the Uzynkara Ridge is based on ecological and phytocenological principles widely used in modern geobotany. This includes regular field studies, measurements, analysis of the state of ecosystems and monitoring of anthropogenic impacts (e.g. grazing load, climate change, mining). The works of A.K. Skvortsov [20] were used to collect and process plants. Various reference materials and methods were used to determine the herbarium and geographic ranges of plants, which made it possible to systematize, classify and analyze plant species, identify taxa based on their morphological characteristics, and also establish their distribution in a certain area [21, 22, 23, 24, 25, 26, 27, 28].

Results and Discussion

A significant number of scientific articles, reviews, and monographs are devoted to the description and characteristics of the vegetation cover of the Northern Tien Shan, which includes the Uzunkar Range under study. The altitudinal-zonal distribution of the vegetation cover of the Northern Tien Shan was reflected in the fundamental works of A.N. Krasnov, N.V. Pavlov, R.I. Abolin, M.G. Popov [29.30.31] and others. The vegetation of the Northern Tien Shan is described in the works of N.I. Rubtsov [32,33,34,35,36.37.38.39], V.P. Goloskokov [40], Z.V. Kubanskaya [41] and others.

Studies of the flora of the western (Kazakh) part of the Uzynkara ridge have revealed 1766 species of vascular plants belonging to 593 genera and 111 families.

In our review of the vegetation of the Uzynkara ridge, we relied on scientific data and supplemented them with materials obtained during our research work. In the review of the vegetation of the Uzynkara ridge, we relied on scientific data and supplemented them with materials obtained during our research work. The ecological and geographical characteristics of the main plant communities of the Uzynkara ridge are given by us according to L.E. Rodin.

L.E. Rodin [42, 43] proposed the following vertical vegetation zonation for the Uzynkara ridge: from 600 to 900 m is the belt of semi-deserts and deserts; from 900 m to 1500 m extends the steppe belt; from 1500 to 1800 m is the belt of deciduous forests and shrubs; from 1800 to 2900 m is the subalpine belt; from 2900 to 3500 m begins the belt of alpine meadows.

The territory of the Uzynkara ridge that we are studying is located in the zone of temperate deserts. The mountainous relief imparts very special features to the soil and vegetation cover. Its formation in the mountains is subject to the law of vertical zonality, but the proximity of deserts and the continental climate determine, even on one ridge, at the same altitude, depending on the exposure and steepness of the slope, the development of sharply different soils and vegetation. Interpenetration of high-altitude landscape zones, their displacements in altitude and wedging out are frequent.

1. Highlands (alpine belt). The high-mountain zone of the Uzynkara ridge under study includes the alpine and subalpine belt. The height of the alpine belt is between 2400 and 3600 m. The zonal type of this high-mountain alpine belt is cryophytic low-grass kobresia meadows, which are formed by *Kobresia capillariformis, K. humilis, K. stenocarpa* (Fig. 1).

1.

2.

3.

4.

Figure 1 – Plants of the highlands of the Uzynkara ridge.1. Paraquilegia anemonoides (Willd.) Ulbr. 2.Trollius lilacinus Bunge. 3.Pentaphylloides parvifolia (Fischer ex Lehm.) Sojak. 4. Dracocephalum imberbe Bunge, Rhodiola coccinea (Royle) Boriss.

Alpine meadows are connected with Kobresia meadows into a single whole, their introduction is caused by the sparseness of the kobresia cover. Kobresia and forb-sedge-kobresia plant groups are noted here. In all cases, Kobresia (*Kobresia capilliformis, K. humilis, K. stenocarpa*) dominates. Pure monodominant thickets of *Kobresia capilliformis* and *K. iranica* are not uncommon. Meadow forbs consist of *Gentiana algida, G. kaufmanniana, Papaver croceum, Erigeron aurantica, Aster alpina, Eritrichium villosum,* etc. Among Carex, the most widespread are sedges *Carex stenocarpa, C. atrofusca, C.aneurocarpa*. Forbs are represented by *Leontopodium fedtschenkoanum, Alchimilla sibirica, A. scalaris, Eritrichium villosum, Erigeron aurantiacus, Dichodon cerastoides, Primula algida, Aster*

alpinus, etc. Cereals are represented by *Festuca kryloviana, Trisetum spicatum, Poa alpina* and *Helictotrichon tianschanicum*.

2. *Subalpine belt.* Botanists and geographers consider the upper limit of forest vegetation distribution to be the lower boundary of the highlands. The upper forest boundary of the Uzynkara range is more constant and coincides with the altitudes of 2900-3000 m. However, already at the altitude of 2600-2700 m, there is a noticeable suppression of spruce, the tree stand thins out and meadow vegetation is more common. Researchers define the boundary of the subalpine belt for the northern ridges of the Tien Shan by altitude marks from approximately 2400-2500 m to 2800-3000 m. At the same time, only such grassy, mesophilic and xerophilic cenoses that live near the upper limit of the distribution of the Tien Shan spruce are classified as subalpine meadows and steppes. In the conditions of the Northern Tien Shan, they are closely associated with the abundantly developed cushion-shaped *Juniperus turkestanica*, which lives just at the upper limit of the spruce distribution. The lower boundary of its distribution usually coincides with the upper boundary of the forest-steppe belt (2600 – 2700 m). It should also be noted that junipers are a characteristic element of the subalpine belt of the Uzynkara range, where mainly the creeping forms of this low-growing shrub are found. On the Uzynkara range, *Alchemilla meadows* occupy all the fine-grained slopes of northern exposures. They are the main and characteristic element of the subalpine vegetation: there are 12 *Alchemilla* species on the studied ridge. Of these, only two species in the Northern Tien Shan are ecologically more or less sharply isolated and are edificators of cenoses – *Alchemilla sibirica* and *Alchemilla krylovii*. Geranium meadows are less common than *Alchemilla.* They are formed along the banks of mountain rivers, often choosing more humid habitats. The basis of their grass stand is *Geranium albifolrum*, mixed with *Geranium saxatile.* These meadows are constantly represented by *Alchimilla krylovii, Trollius dshungaricus, Bistorta elliptica, Alopecurus songaricus, Phleum alpinum, Poa pratensis, Millium effusum* and others. Phlomoides meadows are a secondary phenomenon that arose as a result of intensive grazing. The dominant plant of these meadows is *Phlomoides oreophila* – a large plant up to 50 cm in height, completely uneatable by cattle. *Geranium saxatile, Alchimilla sibirica, Pulsatilla campanella, Carex turkestanica, Festuca kryloviana, F. sulcata, Koeleria gracilis* and others are mixed with it. The formation of these meadows is also associated with intensive grazing. Buttercup meadows are formed by a special mountain species *Ranunculus grandifolius*, which is found in small areas in well-watered habitats. The composition of the buttercup meadow is characterized by *Trollius dshungaricus, Carex melanantha, Rumex acetosa, Primula algida, Anthoxanthum odoratum, Trisetum spicatum* and others. Meadows of Carex stenocarpa on the Uzynkara range are found fragmentarily, in small areas. They are typical for steep rocky slopes, overgrown rocky screes, ancient moraine deposits. Common components are *Bistorta elliptica, Festuca tianschanica, F. kryloviana, Papaver croceum, Schultzia albiflora, Potentilla gelida, Saussurea sordida, Poa alpina* and others. A special place in the vegetation of the subalpine and forest belts of the Uzynkara range is occupied by *Juniperus* formations with the dominance of *Juniperus turkestanica, J. sibirica, J. sabina*. Due to the habitat conditions on the Uzynkara range, *Juniperus turkestanica* very rarely has the form of a tree. It is mainly represented by creeping forms and forms a characteristic belt of juniper elfin trees on the southern slopes. In the shrub-forb and juniper-grass-forb communities there are *Caragana jubata, Carex aneurocarpa, Carex stenocarpa, Potentilla nervosa*. In the subalpine belt along the southern and southeastern slopes of the Uzynkara range there are communities of Ajania. The dominant plant is *Ajania fastigiata*, a perennial plant 10-30 cm high. The herbage also includes *Ziziphora clinopodioide, Artemisia dracunculus, Festuca sulcata, Helictotrichon tianschanica.* Below (2700-2600-1700 m) there is a belt of coniferous (spruce) forest.

3. *Coniferous-forest-meadow belt*. The boundaries of the belt vary in different parts of the study area. The landscapes of this belt with absolute heights of 2600-2500-1800 m are characterized by great diversity, as they are formed on rocks of different composition and genesis in different geomorphological conditions. The relief of the coniferous-forest-meadow belt differs significantly from the relief of the two previous belts. Here, leveling surfaces completely disappear, smooth gentle slopes are rare. The relief is highly dissected, the slopes are steep and precipitous, with inclinations exceeding 30 – 40°. The river beds are located in deep (500-600 m), narrow erosional valleys. There are frequent outcrops of bedrock, bare rocks, scree and scattered rocks. The mountain forests of the Uzynkara range are park-like in nature and are lo-

cated in separate isolated massifs, in the form of islands among mountain meadows and steppes, mainly on the slopes of the northern exposure of the ridge. On the slopes of the southern exposure of the Uzynkara ridge are represented by steppe vegetation or lithophilic vegetation of rocks and scree, which occupy considerable areas here due to the highly dissected and steep relief. Forests and shrub thickets on the southern slope are represented by small fragments and spots. The lower boundary of the spruce on the Uzynkara range is determined by the height of 1800 – 1700 m. In the direction to the east, the boundary of the spruce gradually rises to 2000 m. In their structure, typical spruce forests are heterogeneous and are divided into several types. In the lower part of the belt, in a narrow strip from 1850 to 2050 m, shrub spruce forests (*Picea schrenkiana*) are widespread. The grass cover is not rich, but very diverse. The undergrowth is represented by *Euonymus semenovi, Lonicera altmanii* and *Rosa alberti*. At an altitude of 2050 – 2150 m, grass spruce forests predominate. There is almost no undergrowth in them, but the grass cover is unusually rich. The upper part of the forest belt in the interval from 2300 m to 2050 m is represented by moss spruce forests. The shrub layer is almost absent in them, the grass cover, among which mosses stand out, occupies 70 – 80%. Meadow vegetation with a predominance of cereals and forbs is widespread in the coniferous forest-meadow belt. The main communities that make up the mid-mountain meadows are *Dactylis glomerata, Brachypodium pinnata, Calamagrostis epigeios, Elytrigia repens, Bromopsis inermis*. Meadows of *Dactylis glomerata* are found starting from the foothills (1000-1200 m) and ending at the upper boundaries of spruce forests (2600-2700 m), in small areas. On the Uzynkara range they are not as widespread as, for example, in the Dzungarian or Zailiysky Alatau. *Bromopsis inermis, Calamagrostis epigeios, Lamium album, Thalictrum minus, Trifolium pratense, Elytrigia repens, Poa pratensis, P. nemoralis, Taraxacum vulgare* and others are mixed in with them. On the Uzynkara range there are meadows of *Brachypodium pinnata*. Mixed with herbs are *Dactylis glomerata, Calamagrostis epigeios, Poa pratensis, P. nemoralis, Origanum vulgare, Galium boreale, Geranium collinum, Thalictrum minus, Hypericum perforatum, Codonopsis clematidea, Lathyrus pratensis, Cerastium dahuricum, Viola acutifolia, Trifolium pratense, hillea millefolium , Potentilla asiatica*; from shrubs – *Rosa albertii, R. platyacantha, Lonicera tatarica*. Grass-forb meadows are confined to mountain slopes, mainly of northern exposure, and hollows. Of the cereals, there are both meadow and steppe species, where *Phleum pratensis, and on steppe slopes – Ajania fastigiata, Thymus marschallianus, Ziziphora clinopodioides, Tanacetum vulgare*, etc. (Fig. 2).

In the upper part of the coniferous-forest-meadow belt, forbs occupy a dominant position in the communities. Below, cereals predominate, and even lower – wormwoods. Cereals are represented by *Alopecurus pratensis, Poa pratensis, P. angustifolia, Dactylis glomerata, Phleum phleoides, Festuca kryloviana, Elytrigia repens, Agrostis alba*. In the valleys, lowlands, in the depressions of intermountain valleys, in the valleys of mountain rivers and streams, as well as at the foot of slopes, rush, sedge, reed, marsh meadows are widespread, especially in the valleys of the Kegen, Shalkudusu rivers, in places with close occurrence of groundwater. Rush meadows are found in the valley of the Kegen river in small spots. The herbage consists of Juncus gerardii, *Agrostis gigantea, Hordeum bogdanii.* Carex meadows with cereals, rush and forbs are found in depressions of intermountain valleys and valleys of mountain rivers and streams. The basis of the herbage is *Carex songarica, C. karoi, C. melanantha, C. orbicularis, C. melanostachya, C. oxyleuc*a, *Inula rhizocephala, Ligularia macrophylla, Cirsium esculentum, Catabrosa aquatica, Ranunculus acer, R.. polyanthemus, Iris brevituba, I. sogdiana.* Reed meadows are located in the depressions of the intermountain valleys of the Kegen and Shalkudysu rivers, where the grass consists of *Phragmites australis*, mixed with *Achnatherum splendens* and shrubs *Caragana aurantiaca, Hippophae rhamnoides, Euonymus semenovii*.

4. Deciduous forest-shrub belt. On the Uzynkara range, deciduous forests do not form a continuous belt, as, for example, in the Dzungarian or Zailiysky Alatau. Individual fragments of them are found at the lower forest boundary on soft and more humid slopes. They are especially widespread in the central part of the ridge (in the Ardolaity, Tigermen, Maly and Bolshoy Kirgiz gorges). On the Uzynkara range, the shrub vegetation is formed by *Rubus caesius, Rosa spinosissima, R. platyacantha, Lonicera tatarica, Spiraea hypericifolia, Cerasus tianschanica, Caragana laeta, C. leucophloea, C. aurantica, C. camillischneideri, Rhamnus cathartica, Atraphaxis spi-*

nosa, A. virgata, Cotoneaster melanocarpus, C. suavis, Berberis sphaerocarpa, Ephedra equisetina, E. intermedia, Halimodendron halodendron, Tamarix ramosissima, T. laxa. In this case, the shrubs form continuous thickets or are distributed in separate small areas.

Figure 2 – Plants of the mid-mountains and lowlands of the Uzynkara ridge. 1. *Viola altaica* Ker Gawl. 2. *Sedum alberti* Regel. 3. *Primula algida* Adams. 4. *Semenovia transiliensis* Regel & Herder. 5. *Kaufmania semenovii* Regel. 6. *Aster alpinus* L.

5. Steppe belt. Steppe vegetation on the Uzynkara range is found along the entire section of the mountain profile – from the foothills to the upper belt, i.e. not only in the foothills and lowlands, but also in the middle and high mountain belts. This is one of the specific features of the Uzynkara range. The steppes of the Uzynkara range are represented by various communities, which in turn have a significant number of variants. The following main communities of the steppe type of vegetation can be distinguished:1. *Helictotrichon tianschanicum* и *H. hookeri*. 2. *Ptilagrostis mongholica*. 3. *Poa versicolor* (P. relaxa). 4. *Festuca sulcata*. 5. *Stipa capillata*. 6. *Stipa kirghisorum*. 7. *Stipa caucasica*. 8. *Achnatherum splendens*. *9. Bothriochloa ischaemum. 10. Psathyrostachys juncea. 11. Puccinella distans.12. Leymus angustus.* Communities with a predominance of *Helictotrichon tianschanicum* and *H. hookeri* (*H. asiatica*) are characteristic of the subalpine and alpine belts. They are widespread on the southern slope of the Uzynkara range in the intermountain valley of Shalkudysu and are represented by a grass-oat community. Other grasses are abundant in the herbage: *Festuca sulcata, F. kryloviana, Poa angustifolia* and *Poa stepposa, Agrostis gigantea. The following are represented by forbs: Thymus marschallianus, Leontopodium ochroleucum, L. fedtschenkoanum, Phlomoides oreophila, Erigeron auranticum, E. seravschanica. Ptilagrostis mongholica* communities are also characteristic of the subalpine and alpine belts. On the Uzynkara range, these communities have a limited distribution. The grass cover includes *Ptilagrostis mongholica, Kobresia capilliformis, Callianthemum alatavicum, Festuca coelestis, Thalictrum alpinum, Poa alpina, Potentilla nervosa, Polygonum rupestre* and others. Communities of *Poa versicolor* (P. relaxa) are located mainly in the upper and middle belts of the Uzynkara range, which are confined to rocky and gravelly habitats, mainly on southern slopes of exposures, where they occupy small areas and are encountered rarely. Communities of *Stipa capillata* on the Uzynkara range are distributed along gentle slopes at various exposures and along hollows both in the lowlands and in the midlands with significant participation in the grass stand *Poa angustifolia, Phleum phleoides, Helictotrichon pubescens, H. asiatica, Brachypodium pinnatum, Festuca sulcata, Agropyrum pectinatum*. *Stipa rubens* communities are confined to the belt of middle and high foothills (up to 1500-1700 m). *Stipa kirghisorum* communities are rare – near the villages of Tigermen, Dardymty, Bolshoy Dekhan. They are confined to the peaks and slopes of the middle and low mountains. They are found on the summits and upper parts of slopes. Quite often, other steppe grasses join the feather grass: often steppe forbs, less often − Artemisia tianschanica and A. sublessingiana. Of the grasses, *Festuca sulcata, Stipa capillata join; of the forbs − Ajania fastigiata, Alfredia acantholepis. Achnatherum splendens* communities are widespread in river valleys and depressions, intermountain valleys of the Sumbe, Kegen, Shalkudysu rivers. *Achnatherum splendens dominates in the grass stand. Other grasses include Festuca sulcata, Koeleria gracilis, Poa pratensis, P. angustifolia, Poa stepposa, Agropyron czimganicum, Elytrigia repens, A. pectinatum, Stipa caucasica, S. capillata, Leymus angustus, Psathyrostachys juncea, Calamagrostis epigeios*. *Bothriochloa ischaemum* communities on the Uzynkara range are common in the forest-steppe and steppe belts, and are found in small spots on the slopes of mountains with southern and southeastern exposure. *Bothriochloa ischaemum* is accompanied in the grass stand by *Artemisia sublessingiana, A. transiliensis, Agropyron pectinatum, Festuca sulcata*, and *Stipa capillata*. The Psathyrostachys juncea community is found only near the village of Saryzhaz, in the depressions of the intermountain valley, which is represented by one association – saltwort-fragmentary. The *Puccinella distans* community is found in small spots near the villages of Saryzhaz and Narynkol, in the valleys of the Karabulak and Shalkudusu rivers. The herbage includes saltworts *Camphorosma lessingii, Climacoptera brachiata and inedible herbs Limonium gmelinii* and *Plantago maritima*. *Leymus angustus* communities are found in small areas along the intermountain valley near the villages of Talass, Saryzhaz, Karatogan, Narynkol. The herbage often consists of *Leymus angustus*, mixed with other cereals, wormwoods and saltworts. Among the cereals there are: *Psathyrostachys juncea, Puccinella distans, Leymus dasystachys, Agropyron pectinatum, Festuca sulcata;* among the wormwoods there are *Artemisia tianschanica, A. serotina;* among the saltworts there are *Camphorosma lessingii* [44].

6. Desert belt. The desert belt on the Uzynkara ridge is located within absolute altitudes from 850–900 m to 1100–1300 m. For the Uzynkara range, wormwood deserts, in addition to the two communities mentioned above, are also represented by other types of xerophilous subshrub wormwoods from other sections of the genus *Ar-*

temisia. Artemisia terrae-albae communities are dominant and are found on the lower slopes of the lowlands and the piedmont plain of the study area. These are mainly "pure" wormwoods or wormwoods with the participation of: *Salsola orientalis, Reamuria songarica, Nanophyton erinaceum, Climacoptera brachiata, Haloxylon aphyllum.. Ephemeral synusia* reaches its peak in the second half of May. The species composition of ephemerals and ephemeroids is relatively rich. Of the ephemeroids there are *Carex stenophylloides, C. pachystylis, Poa bulbosa, Tulipa kolpakovskiana, T. ostrovskiana, Ixiolirion tataricum, Leontice incerta, Crocus alatavicus*; из эфемеров − *Trigonella orthoceras, T. arcuata, Alyssum dasycarpum, A. turkestanicum, Meniocus linifolius, Chorispora tenella, Ch. sibirica, Strigosella scorpioides, S. africana, Tauscheria lasiocarpa, Tetracme quadricornis, Astragalus filicaulis, A. commixtus, A. vicarius, Bromus japonicus, B. oxydon, Eremopyrum orientale, E. triticeum, Papaver pavonium, Roemeria refracta*, *Ceratocephalus orthoceras, Heteracia szovitsiana, Torularia korolkovii, Lappula microcarpa* and others. In the intermountain valleys, basins and on the slopes of the Uzynkara range, *Artemisia sublessingiana* communities are widespread. Steppe variants are widespread, in the formation of which an important role is played by typical steppe sod grasses: *Festuca sulcata, Stipa capillata, S. sareptana, S. lessingiana*. The upper boundary of cenoses with a predominance of *Artemisia sublessingiana* rises very high – up to 1400 m. The grass stand of cereals includes: *Festuca sulcata, Poa stepposa, Poa bulbosa, Stipa caucasica; from the herbs – Ceratocarpus utriculosus, C. arenaria, Climacoptera brachiata*, as well as weeds and poisonous plants: *Goebelia pachycarpa, Acroptilon repens, Xanthium strumarium, Urtica dioica, Atriplex tatarica.* They are found in the middle belt, lowlands and along mountain trails near the villages of Talas, Kainar, Saryzhaz, on slopes of various, but more often southern exposures. *Artemisia tianschanica* dominates the grass stand, it is joined by *Artemisia dracunculus, A. serotina, A. vulgaris*, often mixed with turf grasses: *Stipa caucasica, S. kirghisorum, Festuca sulcata, Agropyron pectinatum, Poa bulbosa, P. pratensis*; of the herbs there are *Taraxacum officinalis, Ajania fastigiata, Lappula occultata, Scutellaria przewalskii, Thymus marschalianus, Potentilla asiatica.* The *Artemisia rutifolia* community is found near the settlement of Sumbe on steep slopes of western exposure. The grass stand includes the following cereals: *Stipa caucasica, S. kirghisorum, Festuca sulcata; from shrubs – Atraphaxis hypericifolia, A. frutescens, Ephedra equsetina. Artemisia heptopotamica* communities are found near the settlements of Karatogan, Narynkol. The grass stand is dominated by *Artemisia heptopotamica*, mixed with cereals: *Festuca sulcata, Stipa caucasica, Puccinella distans, Ceratocarpus utriculosus. Artemisia schrenkiana* communities are found in small spots near the settlements of Saryzhaz, Narynkol along the depressions of intermountain valleys. *Artemisia absinthium* communities are found near the settlement of Tegistik on gentle slopes. The basis of the grass stand is *Artemisia absinthium*, mixed with *Festuca sulcata. Salsola deserts* occupy a smaller area than wormwood deserts, but are still quite widespread in the foothill plains, where they are represented mainly by two plant communities: *Anabasis salsa* and *Nanophyton erinaceum*. The *Anabasis salsa* community is widespread in the study area near the village of Uzynkara *Anabasis salsa* dominates in the grass stand. *Krascheninnikovia ceratoides, Kochia prostrata, Salsola orientalis* and *Artemisia terrae-albae*. *Nanophytum erinaceum* communities are widespread in the western part of the foothill plain of the Uzynkara n range. *Artemisia heptopotamica, A. longibracteatum, Zygophyllum rozovii, Stipa caucasica* are often mixed with the grass; ephemerals include *Eremopyrum orientalis, Chorispora sibirica, Astragalus commixtus, A. oxyglotis Lactuca undulata, Nonnea caspica, Tetracme quadricornis. Salsola arbuscula* communities are found in areas near the villages of Maly Dekhan and Sunkar. The grass stand is composed of *Salsola arbuscula*, mixed with saltworts: *Nanophyton erinaceum, Salsola orientalis, Ceratocarpus utriculosus, Climacoptera brachiata, Arthrophytum iliensis, A. longibracteatum, Artemisia heptopotamica, A. terrae-albae, A. sublessingiana*. Communities of *Kochia prostrata* are found near the villages of Kalzhat, Maly Dekhan, Bolshoy Aksu and are widespread throughout the foothill plain of the Uzynkara range. The grass stand is dominated by *Kochia prostrata,* mixed with wormwoods: *Artemisia terrae-albae, A. heptopotamica, Ceratocarpus utriculosus, Girgensohnia oppositiflora. Communities of Krascheninnikovia ceratoides* are found in the foothill plain, mainly in hollows and watercourses, in

small areas almost throughout the foothill belt and foothill plain of the Uzynkara range. The grass stand, in addition to *Kraschenninnikovia ceratoides, consists of Artemisia terrae-albae, A. heptopotamica, Salsola orientalis, Nanophyton erinaceum*. Salsola orientalis communities are widespread in the foothill plain, near the villages of Sunkar and Kalzhat. *Salsola orientalis* dominates the herbage, and *Artemisia terrae-albae, Petrosimonia sibirica, Salsola paulsenii, Anabasis elaitior, Nanophyton erinaceum, Tamarix ramosissima*, and *Haloxylon aphyllum* are also found. *Arthrophytum iliensis* communities are found in low places in the foothill plain, near the village of Sumbe. *Arthrophytum iliensis* dominates the herbage, and saltworts are mixed in with it: *Salsola orientalis, Ceratocarpus utriculosus, Nanophyton erinaceum*, and *Haloxylon aphyllum. Haloxylon aphyllum* communities occupy large areas in the study area. Particularly large communities of *Haloxylon aphyllum* are found in the Kara-Dala area of the village of Sunkar, where *Haloxylon aphyllum* dominates; among the saltworts there are *Kochia prostrata, Ceratocarpus utriculosus, Suaeda acuminata, Kraschenninnikovia ceratoides, Kalidium foliatum, Hololachne songarica*; among the forbs there are *Cynanchum sibiricum, Acroptilon repens, Alhagi kirghisorum;* ephemerals are represented by *Erodium oxyrrhynchum, Astragalus oxyglottis, Astragalus commixtus, Chorispora sibirica, Halogeton glomeratus*. Suaeda acuminata communities are rare, mainly in areas near the village of Sunkar. The herbage, in addition to *Suaeda acuminata*, is formed by *Salsola arbuscula, Nanophyton erinaceum, Kalidium foliatum, Artemisia terrae-albae, A. heptopotamica*; the shrubs include *Tamarix laxa, T. arceuthoides, Haloxylon aphyllum.* The *Kalidium foliatum* community is widespread in low-lying areas near the villages of Chundzha and Dubun. The herbage is dominated by *Kalidium foliatum*, *Halocnemum strobilaceum, Anabasis elatior*; the shrubs include *Tamarix laxa, Haloxylon aphyllum;* Weeds include *Peganum harmala, Goebelia alopecuroides, Ceratocarpus utriculosus, Alhagi kirghisorum, Acroptilon repens, Glycyrrhiza glabra. Halocnemum strobilaceum* communities are found in depressions of intermountain valleys near the village of Saryzhaz, in low-lying areas near the villages of Chundzha and Dubun. *Halocnemum strobilaceum* dominates the herbage, with other saltworts mixed in: *Halostachys belangeriana, Camphorosma lessingiana, Kalidium foliatum, Anabasis salsa,* and also weeds: *Karelina caspia, Atriplex tatarica, Alhagi kirghisorum*. The *Camphorosma lessingiana* community is found in depressions of intermountain valleys near the villages of Saryzhaz and Talas. The herbage consists entirely of *Camphorosma lessingiana, Climacoptera brachiata, Kochia prostrata, Suaeda acuminata, Salicornia europaea. The Halostachys belangeriana* community occurs in small patches near the villages of Sumbe and Sunkar. *Halostachys belangeriana* dominates the herbage; other saltworts include *Suaeda physophora, S. acuminata, Kalidium foliatum, Halocnemum strobilaceum, Salsola arbuscula, Climacoptera crassa.* The *Salsola paulseni* community is found in small patches near the Aktam settlement. *Salsola paulsenii* dominates the herbage; other common species include *Reamuria soongarica, Kalidium foliatum, Halocnemum strobilaceum, Petrosimonia triandra, Halostachys belangeriana*, and *Nitraria schoberi. Sympegma regeli* communities are landscape-type. They are located on the northwestern spurs of the Uzynkara range, usually occupying lower relief areas: wide ravines cutting through the plateau, and gentle slopes of the plateau between the Temerlik river and the Chundzha settlement. The herbage includes *Artemisia heptopotanica, Arthrophytum balchaschensis, Salsola laricina, Reaumeria soongarica, Kraschenninnikovia ceratoides,* and *Kalidium schrenkianum*. The *Suaeda dendroides* community is located mainly in the elevated central part of the Temerlik Plateau and the village of Chundzha. Psammophytic groups developing on desert sands within the study area have a limited distribution in the Kegen and Saryzhaz valleys and represent a local type of vegetation. The sands in the Kegen Valley were described by N.I. Rubtsov [34], and in the Saryzhaz Valley of the Shalkudusu River at the foot of the Elchik-Uyryuk Mountains, the rivers were described by S.A. Arystangaliev and E.F. Stepanova [45].

Conclusion

The study confirmed that the flora of the Uzynkara Ridge is heterogeneous as a result of the impact of various floristic centers, the different ages of the formation of its individual taxa, and the influence of the deserts of Central and Middle Asia. The flora of the Uzynkara Ridge includes 1,766 species, which

is 63.0% of the flora of the entire Northern Tien Shan. The geographical position of the Uzynkara Ridge, located in the desert zone of temperate latitudes, determines the sharply continental nature of its climate as a whole. The macrorelief of the studied mountainous territory of Uzynkara imparts specific features to its soils and vegetation. In the mountains, its formation is subject to the principle of vertical zonality. However, the proximity of deserts and the continental climate lead to the fact that even at the same altitude and within the same ridge, significant differences in soils and vegetation are observed depending on the exposure and steepness of the slopes. Due to the location of the Uzynkara Ridge in the desert zone, the vegetation cover of the studied region reflects the complex natural and climatic conditions of the mountainous relief associated with sharp differences in altitude zones and a variety of relief forms. The vegetation cover of the Uzynkara Ridge is dominated by the forest-meadow-steppe belt, where forests of Tien Shan spruce are widely represented. Spruce forests stretch in an even strip along the entire northern slope at altitudes from 1750 to 2800 m, representing sparse park complexes consisting exclusively of Tien Shan spruce. The Uzynkara Ridge, located in the extreme north of the chain of the front ridges of the Northern Tien Shan, is the most remote from the humid Atlantic air masses. This leads to excessive dryness of the air and, as a consequence, to the widespread distribution of desert and steppe landscapes. Such ecological specificity of the ridge conditions is reflected in the increased participation of representatives of the families Amaranthaceae, Fabaceae, Asteraceae. Ephemeral-wormwood deserts occupy the entire foothill plain, rising to a level of 1200 m, and the steppes cover not only the foothills, but also the mountain step up to 1700 m, cutting a wide front into the subalpine belt.

The obtained results of the study on the current state of the vegetation cover of the Uzynkara ridge are of great practical importance for reducing anthropogenic load and preserving the biodiversity of ecosystems of the mountainous territories of the Northern Tien Shan.

References

1. Balemlay Sewale, Siraj Mammo. Analysis of floristic composition and plant community types in Kenech Natural Forest, Kaffa Zone, Ethiopia //Trees, Forests and People. – 2022. – Vol. 7. – P. 100170.

2. Givnish TJ. On the causes of gradients in tropical tree diversity. //J. Ecology. – 1999. – Vol. 87. – P. 193–210.

3. Gu Z, Duan X, Shi Y, Li Y, Pan X. Spatiotemporal variation in vegetation coverage and its response to climatic factors in the Red River Basin China //Ecol. Indic. – 2018. – Vol. 93, – P. 54–64.

4. Davis E, et al. Plant–environment interactions in the low Arctic torngat mountains of labrador //Ecosystems. – 2021. – Vol. 24. – P. 1038–1058.

5. Cañadas EM, et al. Hotspots within hotspots: Endemic plant richness, environmental drivers, and implications for conservation //Biol. Conserv. – 2014. – Vol. 170. P. 282–291.

6. Lamchin M, et al. Long-term trend and correlation between vegetation greenness and climate variables in Asia based on satellite data. Sci. //Total Environ. – 2018. – Vol. 618. – P. 1089–1095.

7. Peng W, Kuang T, Tao S. Quantifying influences of natural factors on vegetation NDVI changes based on geographical detector in Sichuan, Western China //J. Clean. Prod. – 2019. – Vol. 233. – P. 353–367.

8. Li Q, Yang L, Zhou J. (2002). Comparative analysis on species diversity of hillclosed afforested plant community in Beijing Jiulong Mountain //Ecol. – Vol. 13. – P. 1065–1068.

9. Barros MJF, et al. Environmental drivers of diversity in Subtropical Highland Grasslands. Perspect //Plant Ecol. Evol. Syst. – 2015. – Vol. 17. – P. 360–368.

10. Willig MR, Kaufman DM, Stevens RD. Latitudinal gradients of biodiversity: Pattern, process, scale, and synthesis. //Annu. Rev. Ecol. Evol. Syst. – 2003. – Vol. 34. – P. 273–309.

11. Franklin O, et al. Organizing principles for vegetation dynamics //Nat. Plants. – 2020. – Vol. 6. – P. 444–453.

12. Zobel M. The relative of species pools in determining plant species richness: An alternative explanation of species coexistence? //Trends Ecol. Evol. – 1997. – Vol. 12, – P. 266–269.

13. Wang Z-J, Jiao J-Y, Su Y, Chen Y. The efficiency of large-scale afforestation with fish-scale pits for revegetation and soil erosion control in the steppe zone on the hill-gully Loess Plateau //CATENA. – 2014. – Vol. 115. – P. 159–167.

14. Karami R, Mehrabi HR, Ariapoor A. The effect of altitude and slope in the species diversity of herbaceous plants (case study: Watershed Miandar Qarootag-Gilangharb) J. Appl. Environ //Biol. Sci. – 2015. – Vol. 5. – P. 197–204.

15. Rahman A, Khan N, Brauning A, Ullah R, Rahman I. Effects of environmental and spatial gradients on Quercus-dominated Mountain Forest communities in the Hindu-Kush ranges of Pakistan //Saudi J. Biol. Sci. – 2022. Vol. 29(4). – P. 2867-2877.

16. Койчубаев Е. Краткий толковый словарь топонимов Казахстана. – Алма-Ата, 1974. – С. 134.

17. Конкашпаев Г. К. Словарь казахских географических названий. – Алма-Ата, 1963. – С. 137

18. Жанұзақ Т. Қазақстанның географиялық атаулары. Алматы облысы. – Алматы, 2005. – С. 176.

19. Атлас Казахской ССР: Природные условия и ресурсы. // Главное управление геодезии и картографии при Совете Министров СССР. 1982. – Т.1. − 81 с.

20. Скворцов А.К. Гербарий. − М., – 1977. − 199 с.

21. Флора Казахстана. − Алма-Ата, – 1956 − 1966. – Т.Т. 1 – 9.

22. Мушегян А. М. Деревья и кустарники Казахстана. Дикорастущие и интродуцированные. – Алма-Ата, – 1962-1966. – Т.Т. 1-2.

23. Растения Центральной Азии /Под ред. В.И. Грубова. – М.−Л., 1963 − 1989. – Т.Т. 1 − 9.

24. Определитель растений Средней Азии. – Ташкент: ФАН, – 1968−1993. – Т. 1− 10.

25. Иллюстрированный определитель растений Казахстана. − Алма-Ата, – 1962-1975. – Т. 1-2.

26. Тахтаджян А.Л. Система магнолиофитов. – М.−Л., – 1987. − 439 с.

27. Черепанов С.К. Сосудистые растения России и сопредельных государств (в пределах бывшего СССР). – С.-Пб., – 1995. – 990 с.

28. Абдулина С.А. Сосудистые растения Казахстана. − Алматы, – 1998. − 188 с.

29. Краснов А.Н. Опыт истории развития флоры южной части Восточного Тянь-Шаня. //Записки русского географического общества. – М., – 1888. – Т. 19. − 413 с.

30. Павлов Н.В. Ботаническая география СССР. – Алма-Ата, – 1948. − 704 с.

31. Аболин Р.И. От пустынных степей Прибалхашья до системы Хан-Тенгри //Труды института почвоведения и геоботаники САГУ. – 1930. – № 5. − 179 с.

32. Попов М.Г. Высотные пояса Заилийского Алатау. Растительность Казахстана. – М., – 1941. − С. 40.

33. Рубцов Н.И. О геоботаническом районировании Тянь-Шаня // Бюллетень московского общества испытателей природы. – 1950. – Т. 55. № 4. − С. 86 − 94.

34. Рубцов Н.И. О родовом эндемизме флоры Средней Азии. Бот. матер. герб. института ботаники. − Алма-Ата, – 1964. – № 2. − С. 3 − 12.

35. Рубцов Н.И. О ботанико-географических связях Джунгарского Алатау с Алтаем и Тянь-Шанем. Бюллетень московского общества испытателей природы. – 1950. – № 4.

36. Рубцов Н.И. Пустыни Северного Тянь-Шаня // Известия АН КазССР. Серия ботаническая. – 1950. – № 5. − С. 31 − 47.

37. Рубцов Н.И. Степи Северного Тянь-Шаня // Известия АН КазССР. Серия биологическая. – 1954. – № 7. − С. 3 − 27.

38. Рубцов Н.И. К истории растительного покрова Тянь-Шаня. Материалы по истории фауны и флоры Казахстана. − Алма-Ата, – 1955 б. – Т. 1. − С. 169 − 181.

39. Рубцов Н.И. Луга Северного Тянь-Шаня // Труды института ботаники АН КазССР. -1965. – Т. 1. − С. 5 − 35.

40. Голоскоков В.П. Формация симпегмы в Тянь-Шане // Труды института ботаники. – 1964. – Т. 18. − С. 3 – 30.

41. Кубанская З.В. Солянковые пустыни Казахстана. – 1980. – 207 с.

42. Родиным Л.Е. Кетменский хребет // Ботанический журнал. – М, – 1933. − С. 23 − 29.

43. Родиным Л.Е. Ельники Кетменского хребта. Материалы к познанию лесов Тянь-Шаня. Известие Всесоюзного общества. 1934 а, Т. 66, № 1. − С. 124 − 140.

44. Садырова Г.А. Биоразнообразие флоры хребта Кетпен (в пределах Казахстана и Китая). – Алматы, – 2019. – 271 с,

45. Арыстангалиев С.А., Степанова Е.Ф. Флора и растительность реликтовых песков межгорной Кегенской долины // Известия АН КазССР. Серия биол. – 1977. – №3. − С. 15 − 21.

References

1. Atlas Kazakhskoy SSR. (1982) Prirodnyye usloviya i resursy [Atlas of the Kazakh SSR. Natural conditions and resources] Glavnoye upravleniye geodezii i kartografii pri Sovete Ministrov SSSR, vol.1, 81 p.

2. Abdulina S.A. (1998) Sosudistye rastenia Kazakhstana [Vascular plants of Kazakhstan]. – Almaty, 188 p.

3. Abolin R.I. (1930) Ot pustynnykh stepey Pribalkhash'ya do sistemy Khan-Tengri [From the desert steppes of the Balkhash region to the Khan-Tengri system]. Trudy instituta pochvovedeniya i geobotaniki SAGU, vol. 5, 179 p.

4. Arystangaliyev S.A., Stepanova EF. (1977) Flora i rastitel'nost' reliktovykh peskov mezhgornoy Kegenskoy doliny [Flora and vegetation of relict sands of the intermountain Kegen valley]. Izvestiya AN KazSSR. Seriya biologicheskaya, no 3, pp.15 − 21.

5. Balemlay Sewale, Siraj Mammo. (2022). Analysis of floristic composition and plant community types in Kenech Natural Forest, Kaffa Zone, Ethiopia. Trees, Forests and People. vol. 7, 100170.

6. Barros MJF, et al. (2015). Environmental drivers of diversity in Subtropical Highland Grasslands. Perspect. Plant Ecol. Evol. Syst.17, 360–368. Lamchin M, et al. (2018). Long-term trend and correlation between vegetation greenness and climate variables in Asia based on satellite data. Sci. Total Environ, 618, pp. 1089–1095.

7.Cañadas EM, et al. (2014). Hotspots within hotspots: Endemic plant richness, environmental drivers, and implications for conservation. Biol. Conserv, 170, 282–291.

8. Davis E, et al. (2021). Plant–environment interactions in the low Arctic torngat mountains of labrador. Ecosystems, 24, 1038–1058.

9. Cherepanov S.K. (1995) Sosudistye rastenia Rossii i sopredelnykh gosudarstv, v predelakh byvshego SSSR [Vascular plants of Russia and neighboring states, within the former USSR], -SPb., 990 p.

10. Flora Kazakhstana (1956-1966) [Flora of Kazakhstan], Alma-Ata, vol.1-9.

11. Franklin O, et al. (2020). Organizing principles for vegetation dynamics. Nat. Plants, 6, 444–453.

12. Givnish TJ. (1999). On the causes of gradients in tropical tree diversity. J. Ecology, 87, 193–210.

13. Goloskokov V.P. Formatsiya simpegmy v Tyan'-Shane [Sympegma formation in Tien Shan]. Trudy instituta botaniki, 1964. vol. 18, pp. 3 – 30.

14. Gu Z, Duan X, Shi Y, Li Y, Pan X. (2018). Spatiotemporal variation in vegetation coverage and its response to climatic factors in the Red River Basin. China. Ecol. Indic. 93, pp. 54–64.

15. Illyustrirovannyi opredelitel' rastenii Kazakhstana (1962 – 1975) [Illustrated determinant of plants of Kazakhstan]. – Alma-Ata, vol, 1-2.

16. Karami R, Mehrabi HR, Ariapoor A. (2015). The effect of altitude and slope in the species diversity of herbaceous plants (case study: Watershed Miandar Qarootag-Gilangharb) J. Appl. Environ. Biol. Sci.5, pp. 197–204.

17. Koychubaev E. (1974) Kratkij tolkovyj slovar' toponimov Kazahstana [Dictionary of Kazakh geographical names]. – Alma-Ata, p. 134.

18. Konkashpaev G. K. (1963) Slovar' kazahskih geograficheskih nazvanij [Brief explanatory dictionary of toponyms of Kazakhstan]. – Alma-Ata, p. 137.

19. Krasnov A.N. (1888) Opyt istorii razvitiya flory yuzhnoy chasti Vostochnogo Tyan'-Shanya. Zapiski russkogo geograficheskogo obshchestva [Experience of the history of the development of the flora of the southern part of the Eastern Tien Shan]. Zapiski russkogo geograficheskogo obshchestva, vol. 19, 413 p.

20. Kubanskaya Z.V. (1980) Solyankovyye pustyni Kazakhstana [Saltwort deserts of Kazakhstan]. – Alma-Ata, 207 p.

21. Lamchin M, et al. (2018). Long-term trend and correlation between vegetation greenness and climate variables in Asia based on satellite data. Sci. Total Environ, 618, pp. 1089–1095.

22. Li Q, Yang L, Zhou J. (2002). Comparative analysis on species diversity of hillclosed afforested plant community in Beijing Jiulong Mountain. Ying yong sheng tai xue bao= J. Appl. Ecol., 13, pp. 1065–1068.

23. Mushegyan A. M. (1962-1966) Derev'ya i kustarniki Kazakhstana. Dikorastushchiye i introdutsirovannyye [Trees and shrubs of Kazakhstan. Wild and introduced]. – Alma-Ata, vol.1-2.

24. Opredelitel rastenii Srednei Azii (1968 – 1993) [The determinant of plants in Central Asia]. – Tashkent, vol.1-10.

25. Pavlov N.V. (1948.) Botaničeskaâ geografiâ SSSR [Botanical geography of the USSR]. – Alma-Ata, 704 p.

26. Peng W, Kuang T, Tao S. (2019). Quantifying influences of natural factors on vegetation NDVI changes based on geographical detector in Sichuan, Western China. J. Clean. Prod., 233, pp. 353–367.

27. Popov M.G. (1941) Vysotnyye poyasa Zailiyskogo Alatau. Rastitel'nost' Kazakhstana [Altitudinal belts of the Trans-Ili Alatau. Vegetation of Kazakhstan]. – M., 40 p.

28. Rahman A, Khan N, Brauning A, Ullah R, Rahman I. (2022). Effects of environmental and spatial gradients on Quercus-dominated Mountain forest communities in the Hindu-Kush ranges of Pakistan. Saudi J. Biol. Sci. 29(4), pp. 2867-2877.

29. Rastenia Tsentralnoi Azii [Plants of Central Asia]. (1963 -1989). – M.: L., vol.1-9.

30. Rodin L. E. (1933) Ketmenskiy khrebet [Ketmen range]. Botanicheskiy zhurnal, pp. 23 − 29.

31. Rodin L. E. (1934, a) Yel'niki Ketmenskogo khrebta. Materialy k poznaniyu lesov Tyan'-Shanya [Spruce forests of the Ketmen range. Materials for the knowledge of the Tien Shan forests]. Izvestiye Vsesoyuznogo obshchestva, vol. 66 (1), pp. 124 − 140.

32. Rubtsov N.I. (1950) O geobotanicheskom rayonirovanii Tyan'-Shanyav [On the geobotanical zoning of the Tien Shan]. Byulleten' moskovskogo obshchestva ispytateley prirody, 55 (4), pp. 86 − 94.

33. Rubtsov N.I. (1964) O rodovom endemizme flory Sredney Azii. [On the generic endemism of the flora of Central Asia]. Bot. mater. gerb. instituta botaniki, 107 p.

34. Rubtsov N.I. (1950) O botaniko-geograficheskikh svyazyakh Dzhungarskogo Alatau s Altayem i Tyan'-Shanem [On the botanical and geographical connections of the Dzungarian Alatau with Altai and Tien Shan]. Byulleten' moskovskogo obshchestva ispytateley prirody, vol 4.

35. Rubtsov N.I. (1950) Pustyni Severnogo Tyan'-Shanya [Deserts of the Northern Tien Shan] Izvestiya AN KazSSR. Seriya botanicheskaya, vol. 5, pp. 31 − 47.

36. Rubtsov N.I. (1954) Stepi Severnogo Tyan'-Shanya [Steppes of the Northern Tien Shan]. Izvestiya AN KazSSR. Seriya biologicheskaya. – Alma-Ata, vol. 7, pp. 3 − 27.

37. Rubtsov N.I. (1955, b) K istorii rastitel'nogo pokrova Tyan'-Shanya [On the history of the vegetation cover of Tien Shan]. Materialy po istorii fauny i flory Kazakhstana. − Alma-Ata, vol. 1, pp. 169 − 181.

38. Rubtsov N.I. (1965) Luga Severnogo Tyan'-Shanya [Meadows of the Northern Tien Shan]. Trudy instituta botaniki AN KazSSR. – Alma-Ata, vol. 1, pp. 5 − 35.

39. Sadyrova G.A. (2019) Bioraznoobraziye flory khrebta Ketpen (v predelakh Kazakhstana i Kitaya) [Biodiversity of the Ketpen range flora (within Kazakhstan and China)]. – Almaty, 271 p,

40.Skvortsov A.K. (1977) Gerbariy [Herbarium]. – Moscow, 199 p.

41. Takhtadzhyan A.L. (1987) Sistema magnoliofitov [Magnoliophyte system], M.: L., 439 p.

42. Wang Z-J, Jiao J-Y, Su Y, Chen Y. (2014). The efficiency of large-scale afforestation with fish-scale pits for revegetation and soil erosion control in the steppe zone on the hill-gully Loess Plateau. CATENA, 115, pp. 159–167.

43. Willig MR, Kaufman DM, Stevens RD. (2003). Latitudinal gradients of biodiversity: Pattern, process, scale, and synthesis. Annu. Rev. Ecol. Evol. Syst.34, pp. 273–309.

44. Zhanuzak T. (2005) Қазақстанның географиялық аталарыKazakhstan geography and ataulary [Kazakhstan geography and ataulary]. Almaty, p.176.

45. Zobel M. (1997). The relative of species pools in determining plant species richness: An alternative explanation of species coexistence? Trends Ecol. Evol.12, pp. 266–269.

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