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## DIVERSITY OF DESERT VEGETATION OF THE KETPEN RIDGE

The article presents the results of many years of research into the desert vegetation of the Ketpen ridge. The paper presents an analysis of the desert vegetation of the Ketpen ridge. Within the study area, desert vegetation is represented by various communities. Communities with *Artemisia* stand out here, these are *Artemisia terrae-albae*; *Salsola orientalis* + *Artemisia terrae albae*, and *Salsola orientalis* + *Artemisia terrae – albae* + *Haloxylon aphyllum* associations. The total projective cover in these communities ranges from 25 to 70%, *artemisia* cover is 25–30%. They always include short-vegetating (*Poa bulbosa*, 8–10%) and long-vegetating (*Stipa caucasica*, 15–25%). Subshrubs include *Salsola orientalis*, *Salsola arbusculiformis*, *Anabasis salsa*, and *Nanophyton erinaceum*. Annual saltwort species are also abundant: *Petrosimonia sibirica*, *Climacoptera brachiata*, *Girgensohnia oppositiflora*, *Climacoptera lanata*. These communities are more saturated with ephemerals and ephemerooids, forming ephemeral-*artemisia* groups of communities. *Artemisia sublessingiana* + *Artemisia terrae-albae* stand out; *Stipa caucasica* + *Artemisia sublessingiana* + *Artemisia sublessingiana*; *Artemisia terrae-albae* + *Stipa capillata*; *Ceratocarpus utriculosus* + *Artemisia terrae-albae* associations. The grass herbage contains: *Festuca sulcata*, *Poa stepposa*, *Poa bulbosa*, *Stipa caucasica*; from forbs – *Ceratocarpus utriculosus*, *C. arenaria*, *Climacoptera brachiata*, as well as weeds and poisonous plants: *Goebelia pachycarpa*, *Acroptilon repens*, *Xanthium strumarium*, *Urtica dioica*, *Atriplex tatarica* and others.

**Key words:** Ketpen Ridge, diversity, desert vegetation.

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### Кетпен жотасының шөл өсімдіктерінің әртүрлілігі

Мақалада Кетпен жотасының шөл өсімдіктері туралы көпжылдық зерттеулердің нәтижелері келтірілген. Жұмыста Кетпен жотасының шөл өсімдіктерін талдау ұсынылған. Зерттелетін аумақта шөл өсімдіктері әртүрлі қауымдастықтармен ұсынылған. Мұнда с *Artemisia* қауымдастықтары ерекшеленеді, олар *Artemisia terrae-albae*; *Salsola orientalis* + *Artemisia terrae albae*, және *Salsola orientalis* + *Artemisia terrae albae* + *Haloxylon aphyllum* бірлестіктері. Бұл қауымдастықтардағы жалпы проективті қамту 25–70% құрайды, жусан жабыны 25–30% құрайды. Олардың құрамына әрдайым қысқа вегетативті (*Poa bulbosa*, 8–10%) және ұзақ вегетативті (*Stipa caucasica*, 15–25%) қатысады. Бұталардың ішінен *Salsola orientalis*, *Salsola arbusculiformis*, *Anabasis salsa*, *nanophyton erinaceum* кездеседі. Жыл сайынғы тұзсыз түрлер де көп кездеседі: *Petrosimonia sibirica*, *Climacoptera brachiata*, *Girgensohnia oppositiflora*, *Climacoptera lanata*. Бұл қауымдастықтар эфемерлік және эфемероидтармен қаныққан, олар қауымдастықтардың эфемерлік-жусан топтарын құрайды. Сублессингиан-жусан, астық-сублессингиан-жусан, тарсик-жусан, эбелек-арамшөп-жусан, ақмия-астық-жусан бірлестіктері ерекшеленеді. The шөпті дәнді дақылдар: *Festuca sulcata*, *Poa stepposa*, *Poa bulbosa*, *Stipa caucasica*; шөптен – *Ceratocarpus utriculosus*, *C. arenaria*, *Climacoptera brachiata*, сондай-ақ арамшөптер мен ұлы өсімдіктер: *Goebelia pachycarpa*, *Acroptilon repens*, *Xanthium strumarium*, *Urtica dioica*, *Atriplex tatarica* және басқалары.

**Түйін сөздер:** Кетпен жотасы, әртүрлілік, шөл өсімдіктері.

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### Разнообразие пустынной растительности хребта Кетпен

В статье приводятся результаты многолетних исследований пустынной растительности хребта Кетпен. В работе представлен анализ пустынной растительности хребта Кетпен. В пределах исследуемой территории пустынная растительность представлена различными сообществами. Здесь выделяются сообщества с *Artemisia*, это *Artemisia terrae-albae*; *Salsola orientalis* + *Artemisia terrae albae*, и *Salsola orientalis* + *Artemisia terrae albae* + *Haloxylon aphyllum* т.е. солянково-саксаулово-серополынные ассоциации. Общее проективное покрытие в этих сообществах составляет от 25 до 70 %, покрытие полыни составляет 25-30%. В их составе всегда принимают участие коротковегетирующие (*Poa bulbosa*, 8-10%) и длительновегетирующие (*Stipa caucasica*, 15-25%). Из полукустарничков здесь встречаются *Salsola orientalis*, *Salsola arbusculiformis*, *Anabasis salsa*, *Nanophyton erinaceum*. Обильно встречаются и однолетнесолянковые виды: *Petrosimonia sibirica*, *Climacoptera brachiata*, *Girgensohnia oppositiflora*, *Climacoptera lanata*. Данные сообщества в большей степени насыщены эфемерами и эфемероидами, образуя эфемерово-полынные группы сообществ. Выделяются сублессингианово-полынные, злаково-сублессингианово-полынные, тырсиково-полынные, эбелеково-сорнотравно-полынные, бунцово-злаково-полынные ассоциации. В травостое из злаков присутствуют: *Festuca sulcata*, *Poa stepposa*, *Poa bulbosa*, *Stipa caucasica*; из разнотравья – *Ceratocarpus utriculosus*, *C. arenaria*, *Climacoptera brachiata*, а также сорные и ядовитые растения: *Goebelia pachycarpa*, *Acroptilon repens*, *Xanthium strumarium*, *Urtica dioica*, *Atriplex tatarica* и другие.

**Ключевые слова:** Хребет Кетпен, разнообразие, пустынная растительность.

### Introduction

The Ketpen ridge, being the eastern extremity of the Northern Tien Shan, extends in the latitudinal direction, where the total length is about 300 km, the width is 40-50 km. We have conducted research on the vegetation and flora of the northern and southern slopes of the Ketpen ridge for 20 years. The studied desert flora of the Ketpen ridge is confined to the

northern slopes, where it rises to 1400-1500 m, which is due to the protection from the northern slopes of the Ketpen ridge from the humid winds of the Dzhungar Alatau, which condenses a large amount of precipitation on the northern and northwestern slopes. The desert and desert-steppe zone of the Ketpen ridge is located slightly higher and occupies a strip of foothills with absolute heights from 1000-1200 to 1300 m above sea level. m. (Figure 1).



Figure 1 – Ketpen ridge

The climate features of the study area are determined by the fact that the Ketpen ridge belongs to the desert zone. According to the diversity of natural and climatic conditions, according to the conditions of heat and moisture supply, and the growing season, the territory of the Almaty region of the Uyghur region, to which the study area belongs, is divided into the following agroclimatic regions: 1. A very arid foothill-plain region, occupying a strip of foothill (piedmont) plains. 2. An arid foothill region, occupying an even more southern part of the territory of the Uyghur region, covering the foothills of the mountains in a narrow strip. It represents the foothills or “counters” of the Ketpen ridge. 3. Mountainous region, starting from an altitude of 1200 – 1600 m. Changes in climatic conditions of the study area are subject to the law of vertical zonation. The climate of the Ketpen ridge is primarily influenced by its location in the southern latitudes, near the deserts of the Balkhash region; great distance from seas and oceans; features of atmospheric circulation and complexity of relief. In general terms, the climate of the Ketpen ridge is characterized by significant solar insolation, continentality, dryness, hot summers, cold winters with little snow in the foothills, frequent temperature inversions, and heavy snow cover in the mountains. The foothills are characterized by a harsh continental climate, dry air, low precipitation, cold winters, dry and warm autumns and intense springs [1].

### Materials and methods

The main methods for studying plant species of the forest belt of the Ketpen ridge were generally accepted classical methods of botanical and floristic research and traditional methods of geobotanical research: in the field conditions, the traditional route-reconnaissance method was used. The collection and processing of herbarium material was carried out according to generally accepted methods. Specimens of forest plant species were collected in herbarium folders with a description of the collection sites, date and collector. At points recorded on the ground by a GPS device, a detailed geobotanical description of the plant communities present was carried out. Office processing and species identification were carried out in the laboratory: after field work, the material was subjected to additional drying and viewing using binocular loupes and distributed into systematic groups. The collection and processing of

herbarium material was carried out according to the generally accepted method of A.K. Skvortsova [2]. In the process of identifying the herbarium, multi-volume summaries were used as sources: “Flora of the USSR” [3], “Flora of Kazakhstan” [4], “Plants of Central Asia” [5], “Identifier of plants of Central Asia” [6], “Illustrated identification of plants Kazakhstan” [7] and others. To clarify species and generic names, the latest reports by S.K. Cherepanova, S.A. Abdulina [8.9]. The types of life forms are carried out according to the classifications of K.Raunkier and I.G. Serebryakov [10].

### Results and discussion

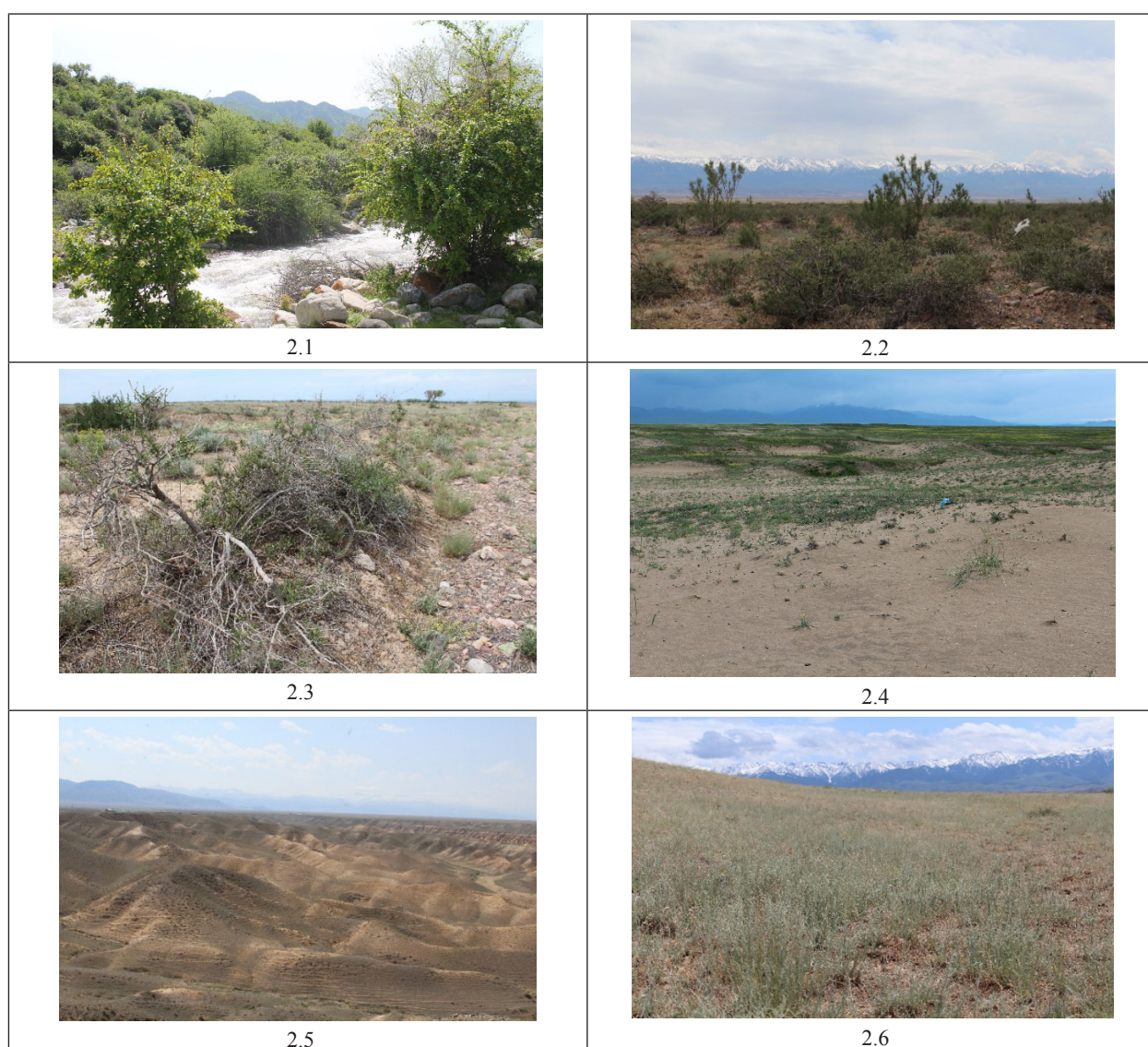
The Ketpen ridge belongs to the desert zone, where desert vegetation, classified as desert type, occupies the entire piedmont plain and the lower part of the low mountains. Rocky deserts, or “hamads,” on the Ketpen ridge occupy the lower parts of the low mountains and foothill plains, which are well represented in the western extremity of the ridge. The foothill plain itself is cut by small rivers that dry up in the summer. Several ecological types have been identified for the deserts of the Northern Tien Shan and rocky deserts of Kazakhstan [11, 12, 13, 14]. 1. Rubbly foothill deserts dominated by *Artemisia*, where this type is represented by a special group of ephemeral communities with the participation of *Artemisia terrae-albae*. 2. Rocky deserts with *Salsola* species. 3. Deserts dominated by *Salsola* and *Artemisia* species. 4. Psammophytic deserts. The desert part of the Ketpen ridge is characterized by 3 ecological types of deserts: 1. deserts with a group of ephemeral + *Artemisia terrae-albae* communities; 2. rocky deserts dominated by *Salsola*; 3. Psammophytic deserts (Figure 2).

Deserts with the participation of *Artemisia* on the Ketpen ridge are distributed on gravelly foothill plains on light chestnut, often washed away, glistly-gravelly, sometimes underdeveloped, loamy carbonate soils along intermountain valleys, hollows and mountain slopes. The species composition of deserts containing *Artemisia* is not rich. Among *Artemisia* communities, the dominant role is played by communities with – *Artemisia terrae-albae* from the subgenus *Seriphidium*. These are either pure *Artemisia* or herbage with an admixture of *salsola*: *Salsola orientalis*, *Kochia prostrata*, *Nanophyton erinaceum*, *Hololachne songarica*, *Ephedra distachya*, *Allium galanthum*. Species of the genus *Artemisia*



are mostly low xerophytic subshrubs 20–45 cm high, forming communities on soils of varying mechanical composition and varying degrees of salinity. Of the subgenus *Seriphidium*, in addition to communities with the participation of *Artemisia terrae-albae*, *Artemisia sublessingiana* and *Artemisia heptapotamica* play an important role in the formation of the desert, which occupy large areas in the study area of the Ketpen ridge, especially in the central part. The dominant communities with participation rise to 1200–1300 m. They form homogeneous communities, but they are often mixed with grasses: *Fes-*

*tuca sulcata*, *Stipa sareptana* and shrubs: *Spiraea hypericifolia*, *Atraphaxis spinosa*. Rocky deserts dominated by *Salsola* in the study area of the Ketpen ridge are developed along gently sloping piedmont plains and trails on gray-brown carbonate gypsum-bearing soils. These deserts are characterized by communities involving *Krascheninnikovia fruticulosa*, *Nanophyton erinaceum*, *Salsola orientalis*, *Anabasis salsa*, *Kochia prostate*, *Arthrophytum iliense*, *Halocnemum strobilaceum*, *Kalidium foliatum*, *Suaeda altissima*, which occupy large areas in the studied region. The predominant ones are



**Figure 2** – Ketpen ridge. 2.1. Lower belt of the Ketpen ridge, Ketpen village. 2.2. Foothills of the Ketpen ridge. 2.3. Community of *Haloxylon aphyllum* (Minkw.) Iljin in the foothill plain of the Ketpen ridge. 2.4. Mountain hilly-ridge sands “Kum-Tekey” in the Kegen intermountain valley, at altitude. 2000m. 2.5. Lower belt in the Kegen Valley. 2.6. *Artemisia* communities in the Kegen valley.

communities involving *Nanophyton erinaceum* and *Salsola arbusculiformis*. The solonchaks and saline soils of the intermountain valleys of the Ketpen ridge are characterized by communities dominated by desert species *Kalidium foliatum*, *Halocnemum strobilaceum*, as well as annual *Salsola* (*Climacoptera brachiata*, *Salsola foliosa*). They are especially widespread in higher intermountain valleys, such as in the Kegen valley, where they are found at an altitude of 2000 m. Communities involving *Salsola arbusculiformis*, *Salsola orientalis* on the Ketpen ridge are found on the mountain slopes of light chestnut underdeveloped loamy soils on the slopes of low mountains and piedmont plains on heavily gravelly gray-brown soils. *Salsola arbuscula* dominates, where it is mixed with *Salsola orientalis*, *Nanophyton erinaceum*, *Arthrophytum ilensis*. Communities involving *Nanophyton erinaceum* are found in the western part of the Ketpen ridge. Communities of *Salsola orientalis* are widespread throughout the foothill plain, mainly on the northern slope of the studied ridge. *Salsola orientalis* is confined to serozems, light loamy, sometimes cartilaginous-gravelly, solonchakous, gray-brown solonchakous soils. Along with *Salsola orientalis*, annual *Salsola* predominates in the herbage: *Ceratocarpus utriculosus*, *Girgensohnia oppositiflora*, *Petrosimonia sibirica*. Communities of *Krascheninnikovia ceratoides* are found along the foothill plain, mainly along hollows and streams on gray loamy gray soils and on gray-brown loamy soils in small areas almost throughout the entire foothill plain of the Ketpen ridge. In addition to *Krascheninnikovia ceratoides*, the grass stand is formed by *Artemisia terrae-albae*, *Artemisia heptapotamica*, *Nanophyton erinaceum*, *Salsola orientalis*. Communities with *Nanophyton erinaceum* in the study area of the Ketpen ridge are found in patches among *Salsola orientalis*. *Artemisia heptapotamica* communities, being the most widespread in the foothill plain. These communities usually grow on rocky, gravelly soils. Communities with the participation of *Arthrophytum iliense* are found along watercourses, flattened and low areas of the foothill plain of the Ketpen ridge. The soils are gray-brown, gristly, gravelly, solonchakous, loamy. The herbage of these communities is absolutely dominated by *Arthrophytum iliense*. There are few

communities with *Suaeda altissima* in the studied area of the Ketpen ridge; they are found mainly in the Kara-Dala and Sunkar sections, in the villages of Dardymty and Ketpen. Here, various species of *Salsola*, *Artemisia*, and *Alhagi* are mixed into the *Suaeda altissima* communities. Communities with *Haloxylon aphyllum* occupy large areas in the study area. Particularly large areas of *Haloxylon aphyllum* are located in the Kara-Dala village area Sunkar.

In communities dominated by *Haloxylon aphyllum*, there are a large variety of herbs and ephemerals, including saltworts *Kochia prostrata*, *Ceratocarpus utriculosus*, *Suaeda acuminata*, *Krascheninnikovia ceratoides*, *Kalidium foliatum*, *Hololachne songarica*; of forbs found – *Cynanchum sibiricum*, *Acroptilon repens*, *Alhagi kirghisorum*; эфемеры представлены *Erodium oxyrrhynchum*, *Astragalus oxyglottis*, *Astragalus commixtus*, *Chorispora sibirica*, *Halogeton glomeratus*. In addition to the above-mentioned deserts with the participation of *Artemisia* and *Salsola*, there are gravelly deserts on thin and gypsum-bearing soils. The vegetation cover is represented by the communities of *Salsola arbuscula*, *Artemisia terrae-albae*, and *Salsola orientalis*. Psammophytic deserts within the Ketpen ridge have a very limited distribution. This small area of lumpy-ridge sands is noted in the valley of the Kegen river, these are the so-called mountain sands “Kum-Tekey” located in the Kegen intermountain valley, at an altitude of 2000m, surrounded by meadows and steppes. This small area of psammophytic desert was described by N.I. Rubtsov [15], where he notes that this small island of hilly-ridge sands, lost high in the mountains, cannot be classified as a desert, since its vegetation cover is dominated by: *Elymus giganteus* and *Medicago sulcata*. Xerophilous shrubs and shrubs characteristic of desert type vegetation are practically absent in the described sands. Plants of the meadow and steppe type are represented and occupied mainly here. N.I. Rubtsov believes that the Kum-Tekey sands are apparently a residual relict formation, which are probably the remains of ancient deltaic or ancient lacustrine-alluvial deposits of the Pleistocene. Here he discovered a relict endemic species of astragalus – *Astragalus rubtsovii* (Figure 3).





**Figure 3** – Desert views of the Ketpen ridge. 3.1. *Krascheninnikovia ceratoides* (L.) Gueldenst.  
3.2. *Ceratocarpus utriculosus* Bluket ex Krylov. 3.3. *Caragana camilli-schneideri* Kom. 3.4. *Astragalus rubtzovii* Boriss.  
3.5. *Alyssum campestre* L. 3.6. *Rhamnus songorica* Gontsch. 3.7. *Anabasis salsa* Benth. ex Volkens.  
3.8. *Atraphaxis virgata* (Regel) Krasn.



## Conclusion

Thus, on the Ketpen ridge, the desert type of vegetation (xerophytic subshrubs, shrubs and shrubs) is mainly vegetation of *Artemisia terrae-albae*, with an admixture of ephemerals. The desert belt on the Ketpen ridge occupies the lower part of the low mountains within the absolute altitudes from 850 – 900 m to 1100 – 1300 m. The desert type of vegetation on the Ketpen ridge includes phytocenoses, the dominants of which are xerophilous shrubs and subshrubs. Deserts predominate, represented by two main communities: *Artemisia terrae-albae* and *Artemisia sublessingiana*. These communities have a well-developed ephemeral-ephemeral synusia, which is associated with an increased amount of spring

precipitation in the submountain zone. The species composition of ephemerals and ephemeroids is relatively rich. Of the ephemeroids present – *Carex stenophylloides*, *C. pachystylis*, *Poa bulbosa*, *Tulipa kolpakovskiana*, *T. ostrovskiana*, *Ixiolirion tataricum*, *Leontice incerta*, *Crocus alatavicus*; of the ephemera are present – *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.

## References

1. Atlas Kazakhskoy SSR. Prirodnyye usloviya i resursy [Atlas of the Kazakh SSR. Natural conditions and resources] – M.: Main Directorate of Geodesy and Cartography under the Council of Ministers of the USSR. -1982. – 81 p.
2. Skvortsov A.K. Gerbariy [Herbarium]. – Moscow, -1977. – 199 p.
3. Flora SSSR (1934 – 1964) [Flora SSSR]. M.: L., vol.1–30 [in Russian].
4. Flora Kazakhstana (1956-1966) [Flora of Kazakhstan], Alma-Ata, vol.1-9.
5. Rastenia Tsentralnoi Azii (1963 -1989) [Plants of Central Asia], M.: L., vol.1-9.
6. Opredeletel rastenii Srednei Azii (1968 – 1993) [The determinant of plants in Central Asia], Tashkent, vol.1-10.
7. Illyustrirovannyi opredelitel' rastenii Kazakhstana (1962 – 1975) [Illustrated determinant of plants of Kazakhstan], Alma-Ata, vol. 1-2.
8. 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. [in Russian].
9. Abdulina S.A. (1998) Sosudistye rastenia Kazakhstana [Vascular plants of Kazakhstan], Almaty, 188 p. [in Russian].
10. Serebryakov I. G. (1962). Ekologicheskaya morfologiya rasteniy [Ecological morphology of plants]. M., 378 p. [in Russian].
11. Takhtadzhyan A.L. (1987) Sistema magnoliofitov [Magnoliophyte system], M.: L., 439 p. [in Russian].
12. Bykov B.A. (1979) Ocherki istorii rastitel'nogo mira Kazakhstana i Sredney Azii [Essays on the history of the flora of Kazakhstan and Central Asia] Alma-Ata, 107 p. [in Russian].
13. Korovin E. P., Korotkova E.E. (1946) Tipy rastitel'nosti Sredney Azii //Trudy Sredneaziatskogo Gosudarstvennogo Universiteta, Biologicheskiye nauki [Types of vegetation of Central Asia //Proceedings of the Central Asian State University, Biological Sciences], –Tashkent, 8, 24 p.
14. Rubtsov N.I. (1950) O geobotanicheskom rayonirovanii Tyan'-Shanya// Byulleten' moskovskogo obshchestva ispytateley prirody [On the geobotanical zoning of the Tien Shan // Bulletin of the Moscow Society of Naturalists], 55 (4). – P. 86 – 94.
15. Rubtsov N.I. (1964) O rodovom endemizme flory Sredney Azii// Botanicheskiye Materialy gerbariya instituta botaniki [On the generic endemism of the flora of Central Asia // Botanical Materials of the Herbarium of the Institute of Botany], – Alma-Ata, 107 p. [in Russian].

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