

Classification of the Kyzyl Kum Plants around Nukus City

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1. Introduction

It is well known that today the problem of desertification is one of the most actual problems in the world. Year after year, plant resources throughout the world, including in Central Asia, are declining, and in their place the area of low-yielding eroded territories is expanding. One of such natural geographical areas is the Kyzyl Kum.

Forming new natural complex structure and its dynamics, development trends and changes of the sea bottom, hydrogeological regime, forming the new composition of the soil salt regime, plant life, plants migration, succession, and landscape changings of the drying of the Aral Sea requires a thorough study. An integrated approach to the study to biodiversity of the Southern Aral Kum will make it possible to determine and use the promising plant species fixing moving sands and salt marshes [Sherimbetov et al., 2015].

Currently, specific biological processes, including the flora of the Tashkuduk Kum are taking place in the inner sands of the Kyzyl Kum. In many ways, it can be recognized that this is due to natural geographical changes that have occurred in the Central Asian region in recent years (reduction of the Aral Sea, acceleration of desertification). The flora of the northwestern part of the Kyzyl Kum Desert, which belongs to the Republic of Karakalpakstan, including Tashkuduk, and the biological processes occurring in it have not been studied in detail.



Figure 1: The landscape photo of the Tashkuduk Kum, May 2014.

2. Review of Botanical Researches

Results of the floristic and geobotany studies of the North-Western Kyzyl Kum Desert were described for the first time by Bondarenko [], Turemuratov [], Erejepov [], Korovina [] and Sherbaev [].

In the work of researchers in recent years, some remnant mountains of the Kyzyl Kum [Serekeeva, Batashev, Robiya] and certain areas of it are devoted to desert plant diversity [Shomuradov, Abdiniyazova]. Also, the study of plant diversity around the city of Nukus in the Kyzyl Kum is directly related to the study of plant diversity in the Ustyurt [Tajetdinova] and the Southern Aral Kum [Sherimbetov, 2009, 2017] regions.

3. Materials and methods

The Kyzyl Kum is the second largest desert in Central Asia after the Kara Kum Desert. The Kyzyl Kum itself consists of several deserts of different sizes: Tashkuduk Kum, Yamon Kum, Kimirak Kum, Marzali sands, each of which has its own geographical location, soil and, of course, flora.

The Tashkuduk Kum Desert is first largest on the Kuzul Kum Desert (Fig. 1).



Plant materials and data analysis

The object of research is the plant diversity of the Tashkuduk Kum: herbarium materials (more than 1000 examples) collected in the different long-term season's expeditions in 2005-2018. Taxonomic identification performed in the National Herbarium of Uzbekistan (TASH), Institute of the Botany Academy Sciences of the Republic of Uzbekistan.

Methods. We carried out flora and taxonomy analysis using classical morphological and geographical method of Popov [27; 221-290]. There were also used the following proceedings: "Flora of USSR" [20], "Flora of Uzbekistan" [21], "Flora of Kazakhstan" [19], "Determinant plants of Middle Asia" [9], "Illustrated determinant plants of Karakalpakstan and Khorezm" [24], "Flora and vegetation of Karakalpakstan" [29]. In definition of rare species of plants it was accepted principles of "The Red Data Book of the Republic of Uzbekistan" [36] following the classification of the International Union for Conservation of Nature. A detailed study of herbarium material was conducted using botanical nomenclature [1, 26] and taking into account the changes introduced by Czerepanov [8]. We also used data of International Plant Names Index (<http://www.ipni.org>).

Aim of this study is to determine the plant diversity of the Kyzyl Kum plants around Nukus city (the Tashkuduk Kum), as well as the development of the system of species based on the rules of botanical nomenclature. Also, we need to reveal the species requiring protection.

4. Results

Classification of plant taxonomical units. Based on this analysis, the system of plant species of the Kyzyl Kum plants around Nukus city was developed for the first time.

Of plant classification of the Kyzyl Kum plants around Nukus city: divisions, classes, subclasses, superorders, orders, families and genera are based in Takhtajan's system [], but species – in alphabetical order.

REGNUM VEGETABLE
EMBRYOBOTA/EMBRYOPHYTA
DIVISIO PYNOPHYTA/GYMNOSPERMAE
CLASS GNETOPSIDA

Order *Ephedrales*

Family *Ephedraceae* Dumort. (1 genus, 3 species):

Ephedra distachya L., *E. lomatolepis* Schrenk, *E. strobilacea* Bunge

DIVISIO MAGNOLIOPHYTA/ANGYOSPERMAE
CLASS MAGNOLIOPSIDA/DICOTYLEDONES

Subclass *Ranunculidae*

Superorder *Ranunculanae*

Order *Ranunculales*

Family *Ranunculaceae* J.Juss. (2 genus, 4 species):

Ceratocephala falcata (L.) Pers., *C. testiculata* (Crantz) Bess., *Delphinium camptocarpum* Fisch. et C.A. Mey., *D. rugulosum* Boiss.

Order *Papaverales*

Family *Papaveraceae* Juss. (1 genus, 2 species):

Reomeria hybrida (L.) DC., *R. refracta* DC.

Family *Hypecoaceae* K.M.Nakai (1 genus, 1 species):

Hypecoum parviflorum Kar. et Kir.

Subclass *Caryophyllidae*

Superorder *Caryophyllanae*

Order *Caryophyllales*

Family *Caryophyllaceae* J.Juss. (1 genus, 1 species):

Acanthopyllum borsczowii Litv.

Family *Chenopodiaceae* Vent. (24 genera, 59 species):

Atriplex dimorphostegia Kar. et Kir., *A. moneta* Bunge, *A. pratovii* Sukhor., *A. tatarica* L., *Krascheninnikovia ewersmanniana* (Stschegl. ex Losinsk.) Grub., *Ceratocarpus arenarius* L., *C. urticulosus* Bluk., *Bassia hyssopifolia* (J.Pall.) O.Kuntze, *Kochia prostrata* (L.) Schrad., *K. scoparia* (L.) Schrad., *Corispermum aralo-caspicum* Iljin, *C. lehmannianum* Bunge, *Agriophyllum lateriflorum* (Lam.) Moq., *Kalidium caspicum* (L.) Ung.-Sternb., *Halostachys belangeriana* (Moq.) Botsch., *Halochnemum strobilaceum* (J.Pall.) M.Bieb., *Salicornia europaea* L., *Horaninovia anoloma* (C.A. Mey.) Moq., *H. excellens* Iljin, *H. ulicina* B.Fisch. et C.A. Mey., *Salsola arbuscula* J.Pall., *S. arbusculaformis* Drob., *S. australis* R. Br., *S. dendroides* J.Pall., *S. deserticola* Iljin, *S. foliosa* (L.) Schrad., *S. gemmascens* J.Pall., *S. implicata* Botsch., *S. incanescens* C.A. Mey., *S. micranthera* Botsch., *S. nitraria* J.Pall., *S. orientalis* S.G. Gmel., *S. paletziana* Litv., *S. paulsenii* Litv., *S. richteri* (Moq.) Kar. ex Litv., *Halothammus subaphylla* (C.A. Mey.) Aellen, *Haloxylon aphyllum* (Minkw.) Iljin, *H. persicum* Bunge ex Boiss., *Ofaiston monandrum* (Pall.) Moq., *Girgensohnia oppositiflora* (Pall.) Fenzl, *Anabasis salsa* (C.A. Mey.) Benth., *Nanophyton erinaceum* (Pall.) Bunge, *Halimocnemis karelinii* Moq., *H. mollissima* Bunge, *H. sclerosperma* (J.Pall.) C.A. Mey., *Gamanthus gamocarpus* (Moq.) Bunge, *Climacoptera aralensis* (Iljin) Botsch., *C. affinis* (C.A. Mey.) Botsch., *C. brachiata* (J.Pall.) Botsch., *C. crassa* (M.Bieb.) Botsch., *C. ferganica* (Drob.) Botsch., *C. lanata* (J.Pall.) Botsch., *C. olgae* (Iljin) Botsch., *C. turcomanica* (Litv.) Botsch., *Halogeton glomeratus* C.A. Mey., *Suaeda acuminata* (C.A. Mey.) Moq., *S. crassifolia* J.Pall., *S. dendroides* (C.A. Mey.) Moq., *S. linifolia* J.Pall., *S. microphylla* Pall., *S. microsperma* (C.A. Mey.) Fenzl, *S. salsa* (L.) J.Pall.

Superorder *Polygonanae*

Order *Polygonales*

Family *Polygonaceae* J.Juss. (3 genera, 15 species):

Rheum tataricum L., *Atraphaxis frutescens* (L.) C. Koch., *A. replicata* Lam., *A. spinosa* L., *Calligonum acanthopterum* Borszcz., *C. aphyllum* (J.Pall.) W.R.Guerke, *C. aralense* Borszcz., *C. caput-medusae* H.Schrenk, *C. eriopodium* Bunge, *C. junceum* (B.Fisch. et C.A. Mey.) Litv., *C. leucocladum* (H.Schrenk) Bunge, *C. macrocarpum* Borszcz., *C. microcarpum* Borszcz., *C. setosum* (Litv.) Litv., *C. squarrosus* Pavl.

Superorder *Plumbaginanae*

Order *Plumbaginales*

Family *Plumbaginaceae* Juss. (1 genus, 3 species):

Limonium gmelini (Willd.) Kuntze, *L. otolepis* (H.Schrenk) Kuntze, *L. suffruticosum* (L.) Kuntze,

Subclass Dilleniidae

Superorder Violanae

Order Tamaricales

Family *Tamaricaceae* Link. (1 genus, 5 species):

Tamarix elongata Ledeb., *T. florida* Bunge, *T. hispida* Willd., *T. laxa* Willd., *T. ramosissima* Ledeb.

Family *Frankeniaceae* S.F.Gray (1 genus, 1 species):

Frankenia hirsuta L.

Order Capparales

Family *Capparaceae* Juss. (1 genus, 1 species):

Capparis spinosa L.

Family *Brassicaceae* Burnett (13 genera, 21 species):

Descurainia sophia (L.) C.J.Webb et Silipr., *Arabidopsis pumila* (Steph.) N. Busch., *Isatis boissieriana* Reichenb. *I. emarginata* Kar. et Kir., *I. minima* Bunge, *Strigosella africana* (L.) Botsch., *S. brevipes* (Bunge) Botsch., *S. circinata* (Bunge) Botsch., *S. intermedia* (C.A. Mey.) Botsch., *S. scorpioides* (Bunge) Botsch., *Leptaleum filifolium* (Willd.) DC., *Matthiola chenopodiifolia* Fisch et C.A.Mey., *Tetracme quadricornis* (Steph.) Bunge, *Chorispora tenella* (Pall.) DC., *Alyssum desertorum* (Spaft) Botsch., *Litwinowia tenuissima* (Pall.) Woronov ex Pavl., *Lepidium latifolium* L., *L. obtusum* Basiner, *L. perfoliatum* L., *Crambe edentula* B.Fisch. et Mey. ex Korsh., *Octoceras lehmannianum* Bunge

Order Euphorbiales

Family *Euphorbiaceae* Juss. (1 genus, 1 species):

Euphorbia seguieriana Neck.

Subclass Rosidae

Order Rosales

Family *Rosaceae* Juss. (2 genera, 2 species):

Hulthemia persica (Michx ex Juss.) Bornm., *Rosa majalis* Herrm.

Superorder Fabanae

Order Fabales

Family *Fabaceae* Lindl. (7 genera, 13 species):

Ammodendron conollyi Bunge ex Boiss., *A. karelinii* B.Fisch. et C.A. Mey., *A. lehmanni* Bunge ex Boiss., *Eremosparton aphyllum* (J.Pall.) B.Fisch. et Mey., *Halimodendron halodendron* (J.Pall.) Voss, *Astragalus ammodendron* Bunge, *A. brachypus* H.Schrenk, *A. lehmannianus* Bunge, *A. villosissimus* Bunge, *A. kirghisorum* H.Schrenk, *Alhagi pseudalhagi* (M.Bieb.) Desv., *Glycyrrhiza glabra* L., *Medicago sativa* L.

Superorder Geraniae

Order Geraniales

Family *Geraniaceae* Juss. (1 genus, 1 species):

Geranium transversale (Kar. et Kir.) Vved.

Order Biebersteiniales

Family *Biebersteiniaceae* Endl. (1 genus, 1 species):

Biebersteinia multifida DC.

Order Zygophyllales

Family *Zygophyllaceae* R.Br. (1 genus, 2 species):

Zygophyllum eichwaldii C.A. Mey., *Z. oxianum* Boriss.

Family *Peganaceae* (Engl.) Tiegh. ex Takht. (1 genus, 1 species):

Peganum harmala L.

Family *Nitrariaceae* Bercht. et J. Presl. (1 genus, 2 species):

Nitraria schoberi L., *N. sibirica* J.Pall.

Superorder Rhamnanae

Order Elaeagnales

Family *Elaeagnaceae* J.Juss. (1 genus, 1 species):

Elaeagnus turcomanica Kozlowsk.

Subclass Cornidae

Superorder Cornanae

Order Araliales

Family *Apiaceae* Lyndl. (1 genus, 1 species):

Daucus carota L.

Subclass Asteridae

Superorder Asteranae

Order Asterales

Family *Asteraceae* Dumort. (16 genera, 25 species):

Aster tripolium L., *Karelinia caspia* (J.Pall.) Less., *Xanthium strumarium* L., *Mausolea eriocarpa* (Bunge) Poljak. ex Podlech, *Artemisia austriaca* Jacq., *A. diffusa* Krasch. ex Poljak., *A. ferganensis* Krasch. ex Poljak., *A. schrenkiana* Ledeb., *A. scoparia* Waldst. et Kit., *A. terrae-albae* Krasch., *A. turanica* Krasch., *Jurinea multiloba* Iljin, *Senecio noëanus* Rupr., *S. subdentatus* Ledeb., *Circium ochrolepidium* Juz., *Acroptilon repens* (L.) DC., *Koelpinia tenuissima* Pavlov et Lipsch., *K. turanica* Vavass., *Scorzonera sericeolanata* (Bunge) Krasch. et Lipsch., *Takhtajaniantha pusilla* (Pall.) Nazarova (= *Scorzonera pusilla* Pall.), *Chondrilla ambigua* B.Fisch. ex Kar. & Kir., *Taraxacum officinale* Wigg., *Tragopogon sabulosus* Krasch. et S. Nikit., *Lactuca tatarica* (L.) C. A. Mey., *L. undulate* Ledeb.

Subclass Lamiidae

Superorder Gentiananae

Order Apocynales

Family *Apocynaceae* Juss. (1 genus, 1 species):

Cynanchum sibiricum Willd.

Superorder Solananae

Order Solanales

Family *Solanaceae* J.Juss. (1 genus, 1 species):

Lycium ruthenicum Murr.

Order Convolvulales

Family *Convolvulaceae* Juss. (1 genus, 3 species):

Convolvulus arvensis L., *C. erinaceum* Ledeb., *C. fruticosus* Pall.

Order Boraginales

Family *Boraginaceae* J.Juss. (7 genera, 10 species):

Heliotropium arguzioides Kar. et Kir., *H. dasycarpum* Ledeb., *Heterocaryum rigidum* DC., *H. szovitsianum* (Fisch et C.A.Mey.) A. DC., *Lappula semiglabra* (Ledeb) Guerke, *L. spinocarpos* (Forssk.) Aschers., *Rochelia retorta* (Pall.) Lipsky, *Onosma staminea* Lebed., *Arnebia decumbens* (Vent.) Coss. et Kral., *Nonnea caspica* (Willd.) G. Don

Calamagrostis dubia Bunge, *Phragmites australis* (Cav.) Trin. ex Steud., *Aeluropus litoralis* (Gouan) Parl., *Poa bulbosa* L., *Anisantha tectorum* (L.) Nevski, *Agropyron fragile* (Roth.) P. Candargy, *Eremopyrum distans* (C. Koch) Nevski, *E. orientale* (L.) Jaub. et Spach, *E. triticeum* (Gaertn.) Nevski., *Elymus kirghizorum* Drob., *E. recamosus* Lam. *Catabrosella humilis* (Bieb.) Tzvel.

Order Scrophulariales

Family Scrophulariaceae Juss. (1 genus, 1 species):
Veronica campylopoda Boiss.

Family Orobanchaceae Vent. (2 genera, 2 species):
Cistanche salsa (C.A.Mey.) G.Beck., *Orobanche cernua* Loefl.

Family Plantaginaceae Juss. (1 genus, 1 species):
Plantago minuta Pall.

Order Lamiales

Family Lamiaceae Lindl. (3 genera, 3 species):
Thuspeinantha persia (Boiss.) Briq., *Eremostachys tuberosa* (Pall.) Bunge, *Lagochilus acutilobus* (Ledeb) B.Fisch. et C.A.Mey.

CLASS LILIOPSIDA

Subclass Liliidae

Superorder Lilianae

Order Liliales

Family Liliaceae J.Juss. (3 genera, 4 species):
Gagea afghanica Terr., *Phinopetalum karelinii* B.Fisch. ex D. Don., *Tulipa biflora* Pall., *T. buhseana* Boiss.

Order Amaryllidales

Family Alliaceae J.G. Agardh. (1 genus, 1 species):
Allium sabulosum Stev. ex Bunge

Order Asparagales

Family Asparagaceae J.Juss. (1 genus, 1 species):
Asparagus inderiensis Blum ex Pacz.

Subclass Commelinidae

Superorder Juncanae

Order Cyperales

Family Cyperaceae J.Juss. (2 genus, 3 species):
Bolboschoenus popovii E.M.Egorova, *Carex pachystylis* J. Gay, *C. physodes* M.Bieb.

Superorder Poanae

Order Poales

Family Poaceae Barnhart (11 genera, 15 species):

Stipagrostis karelinii (Trin. et Rupr.) Tzvelev, *S. pennata* (Trin.) De Winter, *Stipa szovitsiana* Trin. ex Hoher.,

Subclass (11) Alismatidae

Superorder Alismatanae

Order Najadales

Family Najadaceae J.Juss. (1 genus, 1 species):

Najas marina L.

Order Zosteriales

Family Zosteraceae Dumort. (1 genus, 1 species):

Zostera minor (Cavolo) Nolte

Subclass Aridae

Superorder Typhananae

Order Typhales

Family Typhaceae J.Juss. (1 genus, 1 species):

Typha angustifolia L.

Discussion and Conclusions

As result, 248 types of vascular plants belonging to 2 divisions, 3 classes, 9 subclasses, 27 orders, 34 families and 127 genera were classified in the Kyzyl Kum plants around Nukus city. Especially, the division of gymnospermous plants (*Pynophyta*) includes only 3 species (0.01%). Division of magnolia make up 212 species from 216 types of vascular plants of the dry seafloor of Aral Sea (98.14%) members of the division of magnolia: *Magnoliopsida* has 185 species (85.64%; 99 genera and 31 families); *Liliopsida* has 27 species (12.50%; 21 genera and 8 families).

Analysis of division of genera and species according to the family shows that the large 7 families (*Chenopodiaceae* (59:27.31%), *Asteraceae* (25:11.57%), *Brassicaceae* (21:9.72%), *Polygonaceae* (15:6.94%), *Poaceae* (15:6.94%), *Fabaceae* (13:6.01%), *Boraginaceae* (10:4.62%)) unite make up 158 species (73.14%). The largest family is *Chenopodiaceae* includes 24 genera and 59 species (45.83%); 20 families (*Equisetaceae*, *Hypocoaceae*, *Caryophyllaceae*, *Frankeniaceae*, *Capparaceae*, *Euphorbiaceae*, *Geraniaceae*, *Biebersteiniaceae*, *Peganaceae*, *Elaeagnaceae*, *Apiaceae*, *Apocynaceae*, *Solanaceae*, *Scrophulariaceae*, *Plantaginaceae*, *Alliaceae*, *Asparagaceae*, *Najadaceae*, *Zosteraceae*, *Typhaceae*) have only one genus and one species (9.25%) (Fig.2.).

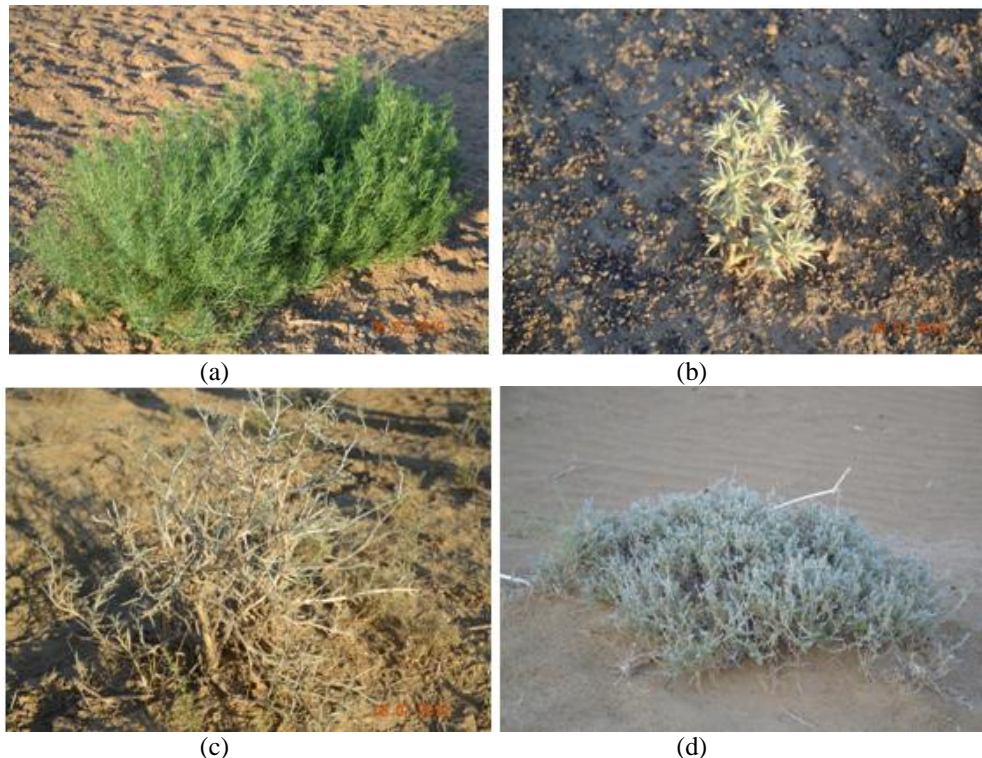


Figure 2: Some plants of Tashkuduk Kum:

a) *Pegalum harmala*; b) *Halimocnemis karelinii*; c) *Astragalus ammodendron*; d) *Salsola orientalis*.

Research results can be used to write scientific papers about the flora of the Republic of Karakalpakstan as well as to develop a modern system of higher plants of Uzbekistan. Certain types can be used to consolidate the moving sands and salt marshes with phytomeliorative works, as well as species with forage value can be used as livestock grazing land. Herbarium materials collected during the expedition makes particular importance for replenishment of desert plants of the National Herbarium of Uzbekistan (TASH), Institute of the Botany Academy Sciences of the Republic of Uzbekistan.

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