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BIOECOLOGY AND IMPORTANCE OF HALOXYLON AND SALSOLA SPECIES FROM THE CHENOPODIACEAE FAMILY DISTRIBUTED AROUND NUKUS CITY IN THE KYZYLKUM DESERT

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Abstract
The Kyzylkum Desert is one of the largest deserts in Uzbekistan, located between the Amu Darya and Syr Darya rivers. The areas around Nukus city, particularly in the northwestern part of the Republic of Karakalpakstan, occupy a significant portion of this desert. Here, species of Haloxylon (saxaul) and Salsola (saltwort) belonging to the Chenopodiaceae family (now part of Amaranthaceae) are widespread. These plants form the main component of the desert ecosystem and are highly adapted to desert conditions. This article details the bioecology, distribution, and importance of these species.

Keywords: Kyzylkum Desert, Nukus, Haloxylon aphyllum, Haloxylon persicum,Salsola richteri, Salsola arbuscula, Salsola orientalis, Chenopodiaceae, Amaranthaceae, bioecology

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Introduction

The Kyzylkum Desert, spanning approximately 300,000 square kilometers, is one of the largest deserts in Central Asia and Uzbekistan, situated between the Amu Darya and Syr Darya rivers. This vast arid region features diverse landscapes including sand dunes, plains, lowlands, and areas with saline or gypsum soils, with extreme climate conditions characterized by hot summers (up to 50°C) and cold winters (down to -30°C), and annual precipitation rarely exceeding 100-200 mm. The areas surrounding Nukus city, in the northwestern part of the Republic of Karakalpakstan, represent a critical portion of this desert, heavily impacted by the Aral Sea crisis, leading to increased salinization and desertification. In this harsh environment, species from the Chenopodiaceae family (now classified under Amaranthaceae), particularly Haloxylon (saxaul) and Salsola (saltwort), dominate the vegetation. These plants are essential components of the desert ecosystem, exhibiting remarkable adaptations to drought, salinity, and extreme temperatures.[1] This expanded article provides a detailed examination of their bioecology, distribution, and multifaceted importance, drawing on recent ecological studies and biogeographical analyses.

Distribution Haloxylon and Salsola species are extensively distributed across the Kyzylkum Desert, particularly in sandy, saline, and gypsum-rich terrains around Nukus. Haloxylon aphyllum (black saxaul) and Haloxylon persicum (white saxaul) thrive in sandy plains, saline brown soils, and the Ustyurt plateau, extending to the desiccated Aral Sea bed (Aralkum), which covers over 5.5 million hectares.[2] These species are broadly found in Middle Asia, including the Kyzylkum and Karakum deserts, as well as northwest China. In the vicinity of Nukus, such as the Tashkuduk Kum and Karakalpak Ustyurt, their projective cover ranges from 10-15%, often forming associations with Artemisia and Anabasis communities. Salsola species, including S.richteri, S.arbuscula, and S.orientalis, are obligate psammophytes and halophytes, predominant in semi-stabilized sand dunes, saline marshes, and low-salinity brown soils.[3,4] S.richteri, for instance, is distributed across southern Kazakhstan, Uzbekistan, and Turkmenistan, while S. arbuscula is common in low-salt content soils

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alongside Artemisia turanica. Biogeographical analyses indicate high adaptation to local conditions, with these species comprising about 45% of desert vegetation in saline rangelands.(Table-1)

Table-1 The following expanded table illustrates the distribution of key species, including additional environmental factors

Species	Distribution Area	Soil Type	Associated Communities	Altitude Range (m)	Precipitation Tolerance (mm/year)
Haloxylon aphyllum	Sandy plains, saline brown soils, Ustyurt plateau, Aralkum	Saline, sandy, gypsum	Artemisia, Anabasis	50-500	50-150
Haloxylon persicum	Sandy hills, slopes of dunes, sandy-brown soils	Sandy, low salinity	Calligonum, Ephedra	100-600	70-200
Salsola richteri	Saline marshes, semi-stabilized sand dunes	Saline, sandy-loamy	Haloxylon, Artemisia	0-400	50-100
Salsola arbuscula	Sandy-brown soils, fixed dunes	Sandy, low salinity	Artemisia turanica	100-500	80-150
Salsola orientalis	Gypsum sandy areas, saline plains	Gypsum, moderately saline	Anabasis, Salsola spp.	50-300	60-120

Haloxylon Species

Haloxylon species are ultra-xerophytic, leafless shrubs or small trees exquisitely adapted to arid conditions through specialized morphological and physiological traits. Haloxylon aphyllum, commonly known as black saxaul, can reach heights of 4-12 m, with a deep root system penetrating up to 10-15 m to access groundwater, and lateral roots spreading 10-20 m for stability in shifting sands. It exhibits higher biomass compared to H. persicum, influenced by environmental factors and human activities.[5] Flowering occurs from March to April, with wind-dispersed seeds ripening in October; reproduction includes both seeds and vegetative root suckers. This species demands high light and heat, tolerating severe drought and salinity levels up to 1-2% chloride in soils. Haloxylon persicum (white saxaul) grows 2-5 m tall, preferring slopes and escarpments of

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sand dunes with less saline conditions. Its allometric variability reflects adaptations to water scarcity, with photosynthesis optimized for C4 pathways in harsh deserts. Genetic studies reveal significant diversity in Uzbekistan populations, aiding resilience to salinity. (Fig.1)

Salsola Species

Salsola species are halophytic shrubs tolerant to extreme stresses, representing key elements in saline desert ecosystems. Salsola richteri grows 1.5-4 m tall, with roots extending laterally 4 m and deeply up to 11 m, enabling survival in bare sands and significant salinity. Its vegetation period lasts 7 months, starting flowering in May, and it reproduces via seeds and cuttings. This species is rich in secondary metabolites, providing tolerance to water, heat, and salt stresses. Salsola arbuscula, often found in low-salt soils, shows phenological variations affecting soluble carbohydrates, crucial for forage quality in saline rangelands. S. orientalis and similar species exist in annual or perennial forms, participating in

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mixed communities and accumulating proteins (up to 22.3%) and fats. These plants are sources of valuable compounds for medicinal and industrial uses, with adaptive fruit structures aiding dispersal in arid zones.(Fig.2)

Fig.2

Importance Haloxylon and Salsola species hold profound ecological, economic, and social significance in the Kyzylkum. Ecologically, Haloxylon species stabilize sands, prevent erosion, and mitigate desertification, particularly in Aral Sea restoration efforts, reducing annual dust and salt emissions by up to 72 million tons.[6] They enhance biodiversity by providing habitats and contribute to soil protection and pasture maintenance. Economically, they serve as vital fodder for livestock like sheep, goats, and camels, especially in autumn-winter, with Salsola offering 86.4 feed units per 100 kg due to high protein and fat content. Salsola species are utilized in phytomelioration for reclaiming saline lands, and their metabolites have medicinal (e.g., anti-inflammatory) and industrial applications. In pastures like those on the Karakalpak Ustyurt, Haloxylon communities support year-round grazing, though overgrazing poses threats. Overall, conserving these species is crucial for ecosystem stability amid climate change.

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Conclusion

Haloxylon and Salsola species stand as cornerstone elements of the Kyzylkum Desert's ecosystem, particularly in the regions surrounding Nukus, where their remarkable adaptations to drought, salinity, and extreme temperatures enable them to thrive in one of Central Asia's most challenging environments. These plants not only anchor the fragile desert soils but also contribute to the broader ecological balance by mitigating erosion, enhancing water retention, and supporting a diverse array of wildlife. However, the escalating threats posed by climate change, including rising temperatures, altered precipitation patterns, and increased salinization due to the Aral Sea's desiccation, underscore the urgency for proactive conservation strategies. Studies indicate that modern climate shifts are delaying the onset of vegetation regeneration in Uzbekistan's deserts, leading to reduced plant biomass in pastures and potential declines in species like Haloxylon aphyllum. Genetic diversity assessments of Salsola species in the Kyzylkum reveal adaptations that could be leveraged for resilience, but ongoing habitat degradation necessitates further investigation into their responses to environmental stressors.

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