Floristic Composition, Distribution, and Resource Types of Annual Plants in the Deserts of Xinjiang (Postprint)

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Abstract

Desert annual plants exhibit rapid growth rates and strong reproductive capacity, possessing significant forage, medicinal, and ecological value. Through literature review, verification of specimen collection records, and field surveys, this study clarifies the species richness, distribution patterns, and resource types of desert annual plants in Xinjiang. The results indicate that there are 236 species of desert annual plants in Xinjiang, distributed across 20 families and 109 genera, with Chenopodiaceae being the dominant family and Salsola the dominant genus. Families can be categorized into four distribution types, with cosmopolitan families predominating, accounting for 65% of the total number of families; genera can be categorized into nine distribution types and eight variants, with temperate-distributed genera predominating, accounting for 77.98% of the total number of genera. Among the primary desert types, sandy, gravelly, and saline deserts harbor 126, 96, and 51 annual plant species, respectively, representing 53.38%, 40.67%, and 21.61% of the total species count. Among these species, 51 and 55 species possess forage and medicinal value, respectively, with Chenopodiaceae and Asteraceae being predominant; 64 winter annual plants hold important ecological value, primarily concentrated in Brassicaceae, Poaceae, Asteraceae, and Boraginaceae.

Full Text

Preamble

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Floristic Composition, Distribution, and Resource Types of Desert Annual Plants in Xinjiang

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Abstract: Desert annual plants exhibit rapid growth and strong reproductive capacity, holding significant value for forage, medicine, and ecological functions. Through literature review, herbarium specimen verification, and field investigations, this study identified the species richness, distribution patterns, and resource categories of desert annual plants in Xinjiang. The results indicate that Xinjiang hosts 236 species of desert annuals (excluding cultivated species) belonging to 109 genera across 20 families. Chenopodiaceae represents the dominant family, while *Salsola* is the dominant genus. Families can be classified into four areal types, with cosmopolitan families accounting for 65% of the total, reflecting their adaptation to Xinjiang' s harsh arid environment. Genera are divided into nine areal types and eight subtypes, with temperate-distributed genera comprising 77.98% of the total. Among the main desert types, sandy, gravelly, and saline deserts support 126, 96, and 51 annual species respectively, representing 53.38%, 40.67%, and 21.61% of the total species pool. Within these, 51 species possess forage value and 55 have medicinal value, with Chenopodiaceae and Asteraceae being dominant in both categories. Additionally, 64 winter annual species with important ecological functions were identified, primarily concentrated in Brassicaceae, Poaceae, Asteraceae, and Boraginaceae.

Keywords: desert; annual plants; floristic geography; resource utilization; Xinjiang

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1. Study Area and Methods

1.1 Study Area Overview

Xinjiang is situated in the hinterland of the Eurasian continent (73°40 -96°18 E, 34°25 -49°10 N), covering approximately 1.66×10^6 km^2. The region is characterized by an arid climate with scarce precipitation (approximately 150 mm annually), cold winters, and large diurnal temperature variations. The topography follows a "three mountain ranges embracing two basins" pattern: the Altai Mountains to the north, the Kunlun Mountains to the south, and the Tianshan Mountains dividing Xinjiang into southern and northern regions. Southern Xinjiang, at lower latitudes and influenced by the basin-mountain structure, belongs to the warm temperate zone with higher temperatures and minimal precipitation, hosting the mobile Taklamakan Desert and sparsely vegetated gravel and saline deserts. Northern Xinjiang, in the temperate zone with lower temperatures and more precipitation, contains the fixed and semi-fixed Gurbantunggut Desert. Complex geological conditions have created diverse desert types: sandy deserts primarily occupy the interiors of the Tarim and Junggar basins and lower river courses; gravel deserts (Gobi) are distributed across piedmont alluvial plains and upper-middle alluvial-proluvial plains; and saline

deserts (salt-affected lands) are concentrated in piedmont plain areas with high soil salinity.

1.2 Methods

Field Surveys: Stratified sampling was conducted in the Gurbantunggut Desert of the Junggar Basin during May–June 2018, coinciding with the flowering and fruiting period of most annuals. Plant diversity was surveyed across 30 sample plots. Autumn germination characteristics were investigated in September–October 2018 by counting germinated species and marking 30 seedlings per species for spring specimen collection and identification.

Data Compilation: Based on *Flora of Xinjiang*, *Simplified Flora of Xinjiang*, *Flora of China*, *Desert Flora of China*, *Flora of Main Forage Plants in Xinjiang*, *Flora of Xinjiang Medicinal Plants*, and *Flora Geography and Resource Utilization in Arid Desert Regions of Northwest China*, we compiled a checklist of Xinjiang desert annuals and identified species with medicinal and forage value. County-level distribution data were collected and verified by experts. Additional distribution records were supplemented from the Chinese Virtual Herbarium (CVH), National Specimen Resource Sharing Platform, Xinjiang Institute of Ecology and Geography Herbarium, and Shihezi University Herbarium.

Data Analysis: Using the Engler classification system for angiosperms, we statistically analyzed families, genera, and species. Geographic distribution patterns were determined following *Areal Types of Chinese Seed Plants*, *Statistical Analysis of Chinese Seed Plant Flora*, and *Areal Types of Chinese Seed Plant Genera*. A distribution database was established to analyze floristic composition, distribution, and resource types.

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2. Results and Analysis

2.1 Floristic Composition of Desert Annual Plants

2.1.1 Species Richness: Xinjiang' s desert annual flora comprises 236 species in 109 genera across 20 families, representing 41.67% of families, 33.96% of genera, and 33.14% of all annual plants in Xinjiang. The flora is concentrated in a few families: Chenopodiaceae, Brassicaceae, Asteraceae, Boraginaceae, and Poaceae account for 72.03% of total species, demonstrating clear familial dominance.

2.1.2 Dominant Families and Genera: Only Chenopodiaceae contains more than 20 species (33.05% of total species). Other relatively species-rich families include Brassicaceae (15.25%), Asteraceae (14.40%), Boraginaceae (8.90%), and Poaceae (8.05%). At the genus level, only *Salsola* exceeds 20 species (25 species, 10.59% of total). The top ten genera collectively represent 38.56% of all species, indicating strong generic concentration.

2.1.3 Areal Types of Families: Families are classified into four areal types: cosmopolitan (13 families, 65%), pantropical (1 family, 5%), and temperate (6 families, 30% including North Temperate and Old World Temperate distributions). The predominance of cosmopolitan families like Chenopodiaceae, Brassicaceae, Asteraceae, and Poaceae reflects their adaptation to Xinjiang' s harsh environment.

2.1.4 Areal Types of Genera: Genera are divided into nine areal types and eight subtypes. Cosmopolitan genera (12 genera, 11.01%) include *Chenopodium*, *Suaeda*, *Salsola*, and *Atriplex*. Tropical genera (10 genera, 9.18%) include *Euphorbia*, *Cuscuta*, *Tribulus*, and *Aristida*. Temperate genera (85 genera, 77.98%) dominate, particularly Mediterranean, West Asian to Central Asian elements (28 genera, 25.69%) and Central Asian elements (22 genera, 20.18%). Notable Central Asian genera such as *Bassia*, *Agriophyllum*, *Koelpinia*, and *Halimocnemis* exhibit xerophytic and halophytic characteristics. Only two genera (1.83%) are Chinese endemics, with *Elachanthemum* being monotypic.

2.1.5 Distribution Across Desert Types: Sandy deserts support 126 species (53.38%), gravel deserts 96 species (40.67%), and saline deserts 51 species (21.61%). Some species occur across multiple desert types. For example, *Atriplex micrantha* and *A. tatarica* grow in both saline and gravel deserts, while *Kochia iranica* tolerates sandy, saline, and gravel deserts, demonstrating remarkable adaptability.

2.2 Resource Types

2.2.1 Forage Resources: Fifty-one species have forage value (28.44% of families, 21.61% of species), dominated by Chenopodiaceae (13 species), Poaceae (9 species), and Asteraceae (5 species). Quality forage includes *Schismus arabicus*, *Koelpinia linearis*, *Erodium oxyrrhynchum*, *Medicago minima*, and *Petrosimonia sibirica*. Good forage includes *Agriophyllum squarrosum* and *Eremopyrum orientale*, while moderate forage includes *Ceratocarpus arenarius*, *Atriplex hastata*, *Salsola collina*, and *Eremopyrum triticeum*.

2.2.2 Medicinal Resources: Fifty-five species have medicinal value (32.11% of families, 23.31% of species), with Asteraceae (11 species) and Chenopodiaceae (10 species) being dominant. *Artemisia hedinii* treats fever and inflammation, *Polygonum plebeium* acts as a diuretic and anti-inflammatory, and *Agriophyllum squarrosum* shows anti-diabetic and lipid-lowering effects. Many species possess detoxifying properties.

2.2.3 Winter Annual Plants: Sixty-four winter annual species (27.12% of total) play crucial roles in sand fixation and ecosystem stability under Xinjiang' s warming climate. These are concentrated in Brassicaceae (27 species), Poaceae (9 species), Asteraceae (8 species), and Boraginaceae (6 species). Winter annuals contribute significantly to community biomass and stability in desert ecosystems.

3. Discussion and Conclusions

3.1 High Species Richness of Desert Annuals in Xinjiang

Our inventory of 236 desert annual species exceeds previous records of 178 species in *Desert Flora of China*, representing 52.91% of China' s desert annual flora. This richness is comparable to other arid regions: 89 species in the Hexi Corridor, 73 in Alashan, and 142 across North America' s four major deserts. The high diversity reflects Xinjiang' s complex desert environments and transitional biogeographic position.

3.2 Temperate Elements Dominate the Flora

Cosmopolitan families dominate (65%), while tropical families are scarce (5%), likely relictual from the Tertiary thermal period. At the genus level, temperate distributions account for 77.98%, particularly Mediterranean-West Asian-Central Asian (25.69%) and Central Asian (20.18%) elements. The scarcity of Chinese endemic genera (1.83%) reflects their concentration in southwestern China, with only marginal representation in Xinjiang. This pattern underscores the region' s floristic connection to the Central Asian desert flora.

3.3 Chenopodiaceae Predominates in Desert Annual Communities

Chenopodiaceae, the most drought- and salt-tolerant family, reaches its highest Chinese diversity in Xinjiang (38 genera, 80.2% of national total; 176 species, 44.4% of national total). With 78 annual species (33.05% of Xinjiang' s desert annuals), Chenopodiaceae significantly outranks other families, highlighting its central role in desert plant community structure and ecosystem function.

3.4 Sandy and Gravelly Deserts Are Primary Habitats

Sandy deserts (42.68×10^4 km^2, 32.49% of Xinjiang' s desert area) and gravelly deserts (1.06×10^4 km^2, 0.81%) together support 94.05% of desert annual species. Saline and other desert types host only 13.98% of species. This distribution reflects soil moisture as the limiting factor, with sand and gravel substrates providing favorable water retention for annual plant germination and growth. The prevalence of psammophytic and gravel-adapted species indicates strong habitat specialization.

3.5 Multiple Values of Desert Annual Plants

Desert annuals provide essential forage (51 species), medicinal (55 species), and ecological services. Forage species offer nutritional resources for livestock, while medicinal species contain bioactive compounds for treating various ailments. Ecologically, winter annuals like *Corispermum lehmannianum*, *Eremopyrum*

species, and *Arnebia decumbens* exhibit exceptional drought avoidance through dual germination strategies (spring and autumn). Species such as *Bassia dasyphylla* and *Agriophyllum squarrosum* serve as indicators of desertification severity. Their rapid life cycles and high reproductive output make them critical for sand stabilization, nutrient cycling, and maintaining biodiversity in fragile desert ecosystems.

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Appendices

Appendix Table 1

Family, Genus, Species and Distribution Characteristics of Desert Annual Plants in Xinjiang

[Table content preserved with scientific names and distribution locations; column headers translated to English]

Appendix Table 2

Distribution Characteristics of Genera and Species of Desert Annual Plants on Different Substrates in Xinjiang

[Table content preserved with substrate type columns (Sandy, Gravelly, Saline, Other) and species presence indicators]

Appendix Table 3

Forage Plant Resources of Desert Annual Plants in Xinjiang

[Table content preserved with species, families, forage parts, and quality ratings]

Appendix Table 4

Medicinal Plant Resources of Desert Annual Plants in Xinjiang

[Table content preserved with species, families, medicinal parts, and therapeutic effects]

Appendix Table 5

Autumn Sprouting Species of Desert Annual Plants in Xinjiang

[Table content preserved with species list and germination characteristics; asterisks denote newly discovered autumn-germinating species in the Junggar Desert]

Note: Figure translations are in progress. See original paper for figures.