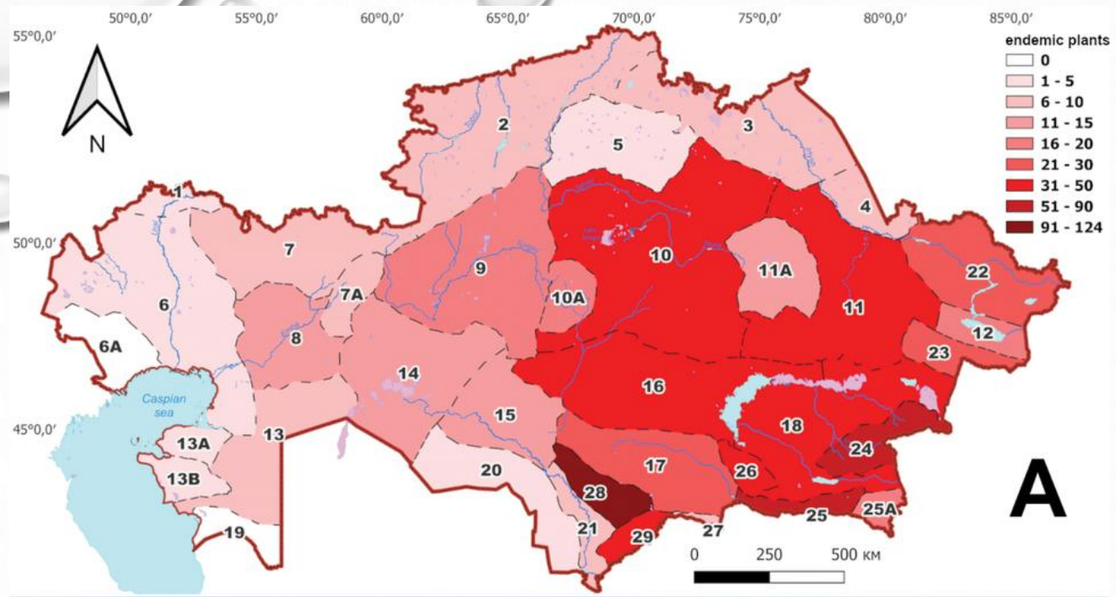
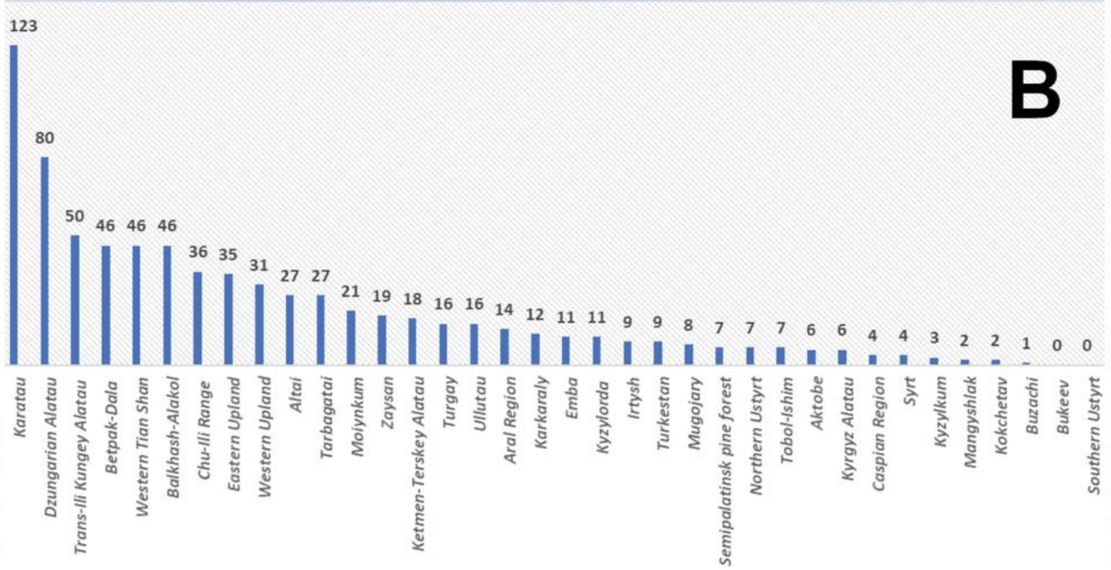




AL-FARABI KAZAKH NATIONAL UNIVERSITY
FACULTY OF BIOLOGY AND BIOTECHNOLOGY
DEPARTMENT OF BOTANY AND AGROECOLOGY

LECTURE 5

Review of endemic and relict plants of saline zones of the Republic of Kazakhstan

Lecturer: Doctor of Biological Sciences, Professor Kurmanbayeva M.S.

Course title:Conservation of Rare and Endangered Plant Species

LESSON PLAN (50 MINUTES)

1. Introduction (5 min)

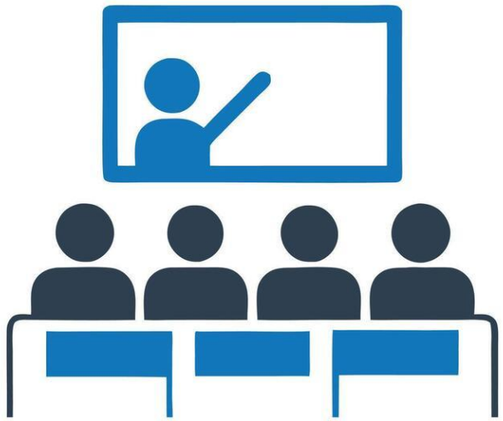
- Topic and aim.
- Where saline zones occur in kazakhstan (caspian lowland, aral region).

2. Main part (35 min)

- **Concepts (5 min):** endemics, relicts, halophytes.
- **Conditions (5 min):** dry climate, saline soils.
- **Examples (20 min):**
  - *Endemic: kochia prostrata, kalidium caspicum.*
  - *Relict: halocnemum strobilaceum, salicornia perennans.*
  - Adaptations: salt tolerance, succulent tissues.
- **Protection (5 min):** threats and conservation areas (barsakelmes, altyn-dala).

3. Conclusion (10 min)

- Summary, short discussion or quiz.
- Homework: describe one saline-zone plant.



Endemic and Relict Plants of Saline Zones in Kazakhstan

Relict plants represent one of botany's most evocative categories—survivors from past climatic epochs that have persisted through the immense temporal scales of geological history. These species are living laboratories for understanding how plant lineages respond to environmental transformation, serving as botanical time capsules that preserve genetic information from periods when climates differed substantially from present conditions. In Kazakhstan's saline zones, relict species often occupy specialised refugia—saline and semi-arid habitats where they have maintained continuous populations despite profound climatic and biogeographic changes.

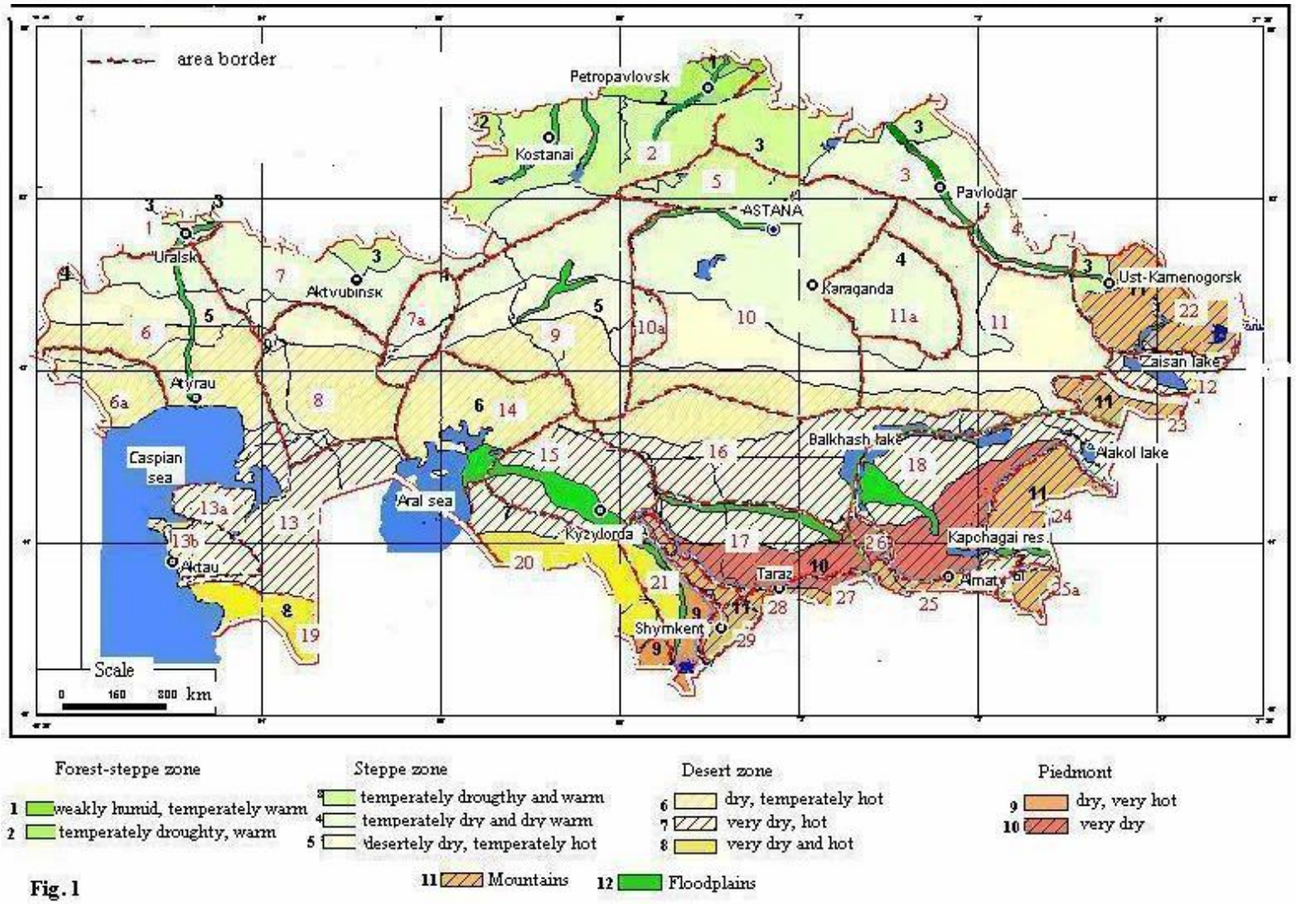


Fig. 1

Kazakhstan's Unique Saline Flora: An Overview

Kazakhstan's botanical richness is remarkable, hosting **451 endemic vascular plant taxa** that represent nearly **8% of the country's entire flora**. These figures underscore the nation's exceptional importance as a centre of plant endemism, particularly within Central Asia's complex biogeographic regions. The saline zones—encompassing vast salt flats, halophytic deserts, and salt-affected steppes—harbour a particularly specialised assemblage of endemic and relict species, each exquisitely adapted to survive in some of Earth's harshest terrestrial environments.

These plants are far more than botanical curiosities. They represent vital components of ecosystem stability and biodiversity, serving as bellwethers for understanding how flora responds to extreme environmental pressures. The saline zones of Kazakhstan offer unparalleled opportunities for scientific investigation into plant evolution, adaptation mechanisms, and the resilience strategies that enable organisms to thrive where others cannot. From a conservation perspective, these ecosystems are irreplaceable repositories of genetic diversity and evolutionary innovation.

Endemic Richness

451 vascular plant taxa endemic to Kazakhstan, nearly 8% of total flora

Saline Specialisation

Desert and salt flat habitats harbour uniquely adapted species found nowhere else

Scientific Significance

Key to understanding plant evolution and adaptation in arid environments

Allium lehmannianum: A Desert Endemic

The remarkable Allium lehmannianum exemplifies the exceptional specialisation found in Kazakhstan's saline flora. This striking species occurs exclusively in the northeastern Betpakdala desert, one of Central Asia's most formidable arid landscapes. Within this restricted range, the plant demonstrates a pronounced preference for specific substrate types—rubble-rocky and clayey soils that characterise the desert's distinctive terrain. This narrow geographic distribution and substrate specificity render Allium lehmannianum an outstanding example of extreme endemism.

Taxonomically, this species belongs to the genus Allium, a cosmopolitan assemblage comprising over 1,000 species exhibiting remarkable morphological and genetic diversity. The complex taxonomy of Allium has historically presented challenges to systematists, but recent advances in molecular phylogenetics and cytometric analysis have substantially clarified species boundaries and evolutionary relationships. These modern investigative approaches have confirmed Allium lehmannianum's distinctiveness and validated its status as a true endemic species.

From an evolutionary perspective, Allium lehmannianum represents a relict species—a botanical survivor from past climatic epochs that has persisted in isolated saline refugia through the vicissitudes of millennial timescale environmental change. Its continued existence in the Betpakdala demonstrates remarkable evolutionary resilience and adaptive capacity, illustrating how plant lineages can endure through periods of climatic upheaval and environmental transformation.

Geographic Range

Restricted to northeastern Betpakdala desert

Substrate Preference

Rubble-rocky and clayey substrates exclusively

Taxonomic Status

Confirmed through molecular and cytometric studies

Evolutionary Significance

Relict survivor from past climatic epochs

***Allium lehmannianum* displaying its characteristic delicate purple umbels, thriving in the harsh rocky terrain of Betpakdala desert**

Kazakhstan's saline zones harbour remarkable diversity within the grass family, with **57 endemic grass species** currently documented. This substantial assemblage reflects the extraordinary capacity of grasses to diversify under selective pressures characteristic of salt-affected environments. Two genera—Stipa and Elymus—are particularly prominent, each contributing 17 endemic species to Kazakhstan's botanical inventory. These genera are among the most ecologically significant components of Central Asian grassland ecosystems, where they function as primary producers and ecosystem engineers.

Grass Endemics of Kazakhstan's Saline Zones

These endemic grasses dominate saline steppe and semi-desert ecosystems throughout the region, establishing extensive monospecific or mixed grassland communities that characterise vast tracts of Kazakhstan's landscape. Ecologically, these species perform critical functions that extend far beyond simple vegetation cover. They stabilise friable saline soils through dense root systems, preventing wind erosion and soil degradation. They provide nutritious forage for pastoral communities and wildlife, supporting extensive grazing ecosystems that have shaped Central Asian societies for millennia. Additionally, grasses sequester carbon and contribute substantially to regional climate regulation.

The narrow distribution patterns exhibited by many endemic grass species underscore the critical importance of habitat protection. Some taxa occupy extremely restricted geographic ranges, rendering them vulnerable to localised disturbances. Habitat fragmentation, overgrazing, and climate change pose escalating threats to these irreplaceable genetic resources, necessitating comprehensive conservation strategies.

Stipa Species

17 endemic species, dominating semi-desert grasslands and crucial for soil stabilisation

- Fine leaf architecture
- Exceptional drought adaptation
- Deep root systems

Elymus Species

17 endemic species, adapted to saline and alkaline soils

- Salt tolerance mechanisms
- Rapid rhizome proliferation
- Halophytic specialisation

Relict Species and Their Ecological Roles

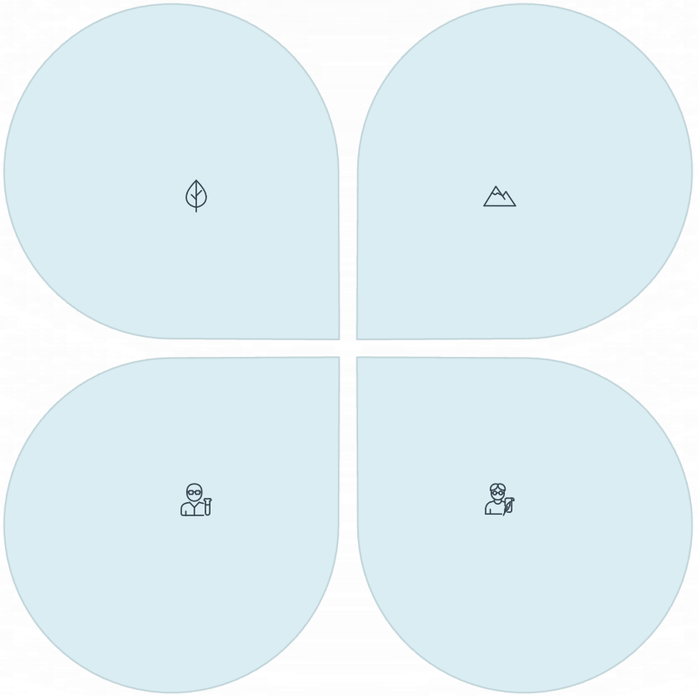
Prominent examples include species within the genera Arthrophytum and Haloxylon, both characterised by extraordinary physiological adaptations to hypersaline environments. Arthrophytum species exhibit distinctive jointed, segmented stems that reduce water loss through transpiration and facilitate ion compartmentalisation in root tissues. Haloxylon species, conversely, employ alternative pathways including C4 photosynthesis and specialised vacuolar compartmentalisation to concentrate salts away from photosynthetically active tissues. These adaptations represent evolutionary innovations refined through countless generations under extreme environmental selection. Relict species maintain irreplaceable genetic diversity and provide profound insights into Central Asia's climatic and biogeographic history. By studying their physiological adaptations, genetic structures, and distribution patterns, scientists reconstruct historical climate systems, past vegetation distributions, and ecological succession pathways. This knowledge proves invaluable for predicting how ecosystems might respond to future climatic change.

Genetic Heritage

Preserve ancient plant lineages with irreplaceable genetic information

Climatic Survivors

Persisted through millennia of environmental change in isolated refugia



Evolutionary Innovation

Demonstrate adaptive strategies to extreme physiological stresses

Historical Records

Reveal past climate systems and vegetation patterns across Central Asia

Conservation Status and Challenges

Kazakhstan recognises the conservation value of its endemic flora through comprehensive legal protections. Currently, **107 endemic species** benefit from formal legal safeguards, reflecting national commitment to biodiversity preservation. However, this legislative framework, whilst representing significant progress, proves insufficient in isolation. The saline zone habitats harbouring these irreplaceable species face escalating and multifaceted threats that demand urgent, coordinated conservation responses.

Land use change represents a primary threat, as saline zone habitats are converted to agricultural land, industrial installations, and urban developments. The changing character of salinisation itself poses paradoxical challenges—as climate change and irrigation patterns alter water table dynamics and soil chemistry, previously suitable habitats become chemically or hydrologically unsuitable for incumbent plant communities. Climate change amplifies these pressures, altering precipitation patterns, increasing evaporation rates, and shifting temperature regimes beyond the physiological tolerance limits of many specialised endemic species.

A critical impediment to effective conservation planning stems from fundamental data deficiencies. Comprehensive population data for many endemic species remain fragmentary or entirely absent. Population size estimates, demographic parameters, genetic diversity metrics, and long-term population trends remain poorly quantified for most taxa. This information deficit hampers evidence-based conservation prioritisation, undermining the capacity to allocate limited conservation resources efficiently. Addressing these gaps requires sustained investment in field surveys, population monitoring programmes, and advanced genetic analyses. The urgency of these conservation requirements cannot be overstated—without immediate action, irreplaceable botanical heritage risks permanent loss.

1 **Legal Protections**

107 endemic species formally protected, representing significant legislative commitment to biodiversity conservation

2 **Habitat Threats**

Land use conversion, changing salinisation patterns, and climate change collectively undermine ecosystem integrity

3 **Data Deficiencies**

Comprehensive population information lacking for most endemic species, hindering evidence-based conservation prioritisation

4 **Conservation Imperative**

Urgent need for targeted research, habitat preservation, and population monitoring to prevent irreplaceable loss

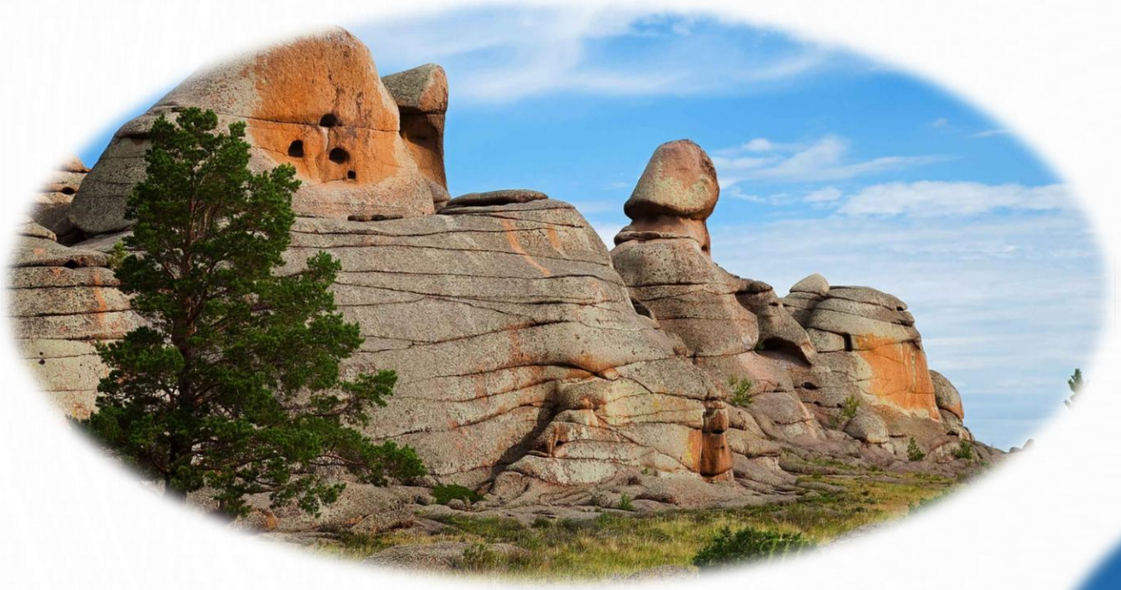
Bayanaul National Park: Case Study in Endemic Diversity

Bayanaul National Park exemplifies the exceptional conservation value achievable through dedicated habitat protection and scientific investigation. Recent comprehensive surveys have substantially expanded the documented flora of this remarkable protected area to **762 species**, representing one of Central Asia's most floristically rich landscapes relative to protected area size. Particularly significant, these surveys have identified **16 endemic taxa** previously undocumented or inadequately catalogued within the park's boundaries.

The park's distinctive topography and geological heterogeneity create an extraordinary diversity of habitat types. Saline and rocky habitats support a remarkable assemblage of endemic plants alongside boreal relict species—botanical survivors from cooler climatic epochs that have retreated to higher elevations and cooler microclimates as global temperatures increased. This coexistence of endemics and relicts within a single protected area illustrates Bayanaul's exceptional biogeographic complexity and demonstrates its disproportionate importance for Central Asian biodiversity.

The Bayanaul case study carries profound implications for conservation science and policy. The discovery of previously undocumented endemic species within a supposedly well-known protected area suggests that comprehensive botanical survey remains incomplete across much of Kazakhstan's saline zone landscape. The park demonstrates the conservation potential of protected areas when combined with rigorous scientific investigation. Furthermore, the diversity preserved within Bayanaul's boundaries indicates that strategic protection of biogeographically important regions can effectively safeguard multiple endemic and relict species simultaneously, rendering protected area expansion a highly efficient conservation strategy.

Survey Metric	Total Flora	Endemic Taxa
Bayanaul Park	762 species	16 species
Endemism Rate	High diversity	2.1% endemic



The spectacular saline steppe landscape of Bayanaul National Park, where endemic and relict plants thrive among distinctive rocky formations, demonstrating the conservation value of protected areas

Protecting Kazakhstan's Saline Plant Heritage: A Conclusion

Endemic and relict plants of Kazakhstan's saline zones represent irreplaceable components of the nation's natural heritage and constitute invaluable resources for global botanical science. These extraordinary organisms have survived through millennia of environmental change, preserving within their genomes and phenotypes evolutionary innovations refined through countless generations under extreme selection pressures. Their disappearance would extinguish unique genetic information, eliminate evolutionary insights unavailable elsewhere, and diminish global biodiversity irreversibly.

Effective conservation of these botanical treasures demands integrated, multidisciplinary approaches that combine scientific research, policy implementation, and community engagement. Molecular biological research must clarify taxonomic relationships, define evolutionary lineages, and identify conservation genetics priorities. Comprehensive field surveys must systematically document species distributions, population structures, and ecosystem associations across Kazakhstan's saline zones. Advanced monitoring techniques must establish baseline data and track population dynamics across temporal scales, enabling assessment of conservation intervention effectiveness.

Conservation policies must translate scientific knowledge into practical habitat protection mechanisms, including expanded protected area networks strategically positioned to encompass regions of high endemic concentration. Climate change adaptation strategies must anticipate and mitigate anticipated shifts in species distributions and habitat suitability. Public awareness campaigns must cultivate understanding of endemic plants' significance and inspire support for conservation initiatives.

Call to Action: Support biodiversity monitoring programmes, habitat protection initiatives, and public awareness campaigns to ensure Kazakhstan's unique endemic and relict plants endure for future generations, preserving irreplaceable evolutionary heritage for scientific discovery and ecological stability.