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

LECTURE 9

Review of endemic and relict plants of the Dzungarian Alatau

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

Course title:Conservation of Rare and Endangered Plant Species

LESSON PLAN (50 MIN)

1. Introduction (5 min)

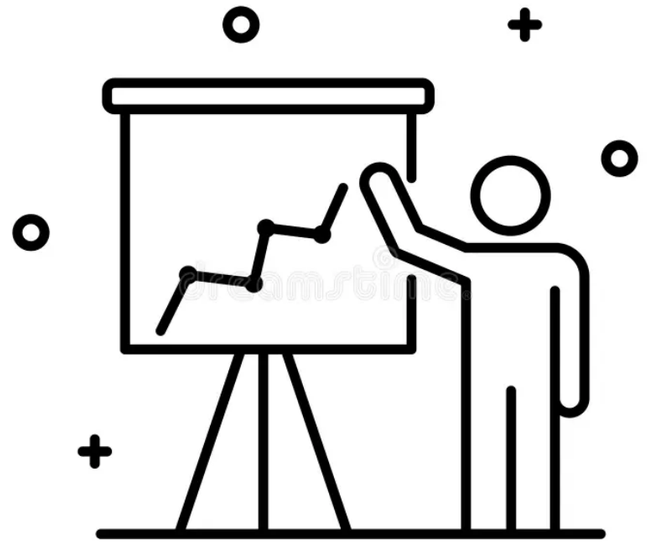
- Greeting, announcement of the topic and goals.
- Location of the dzungarian alatau (southeast kazakhstan).
- Importance of the region as a biodiversity hotspot and transition zone between steppe and mountain ecosystems.

2. Main part (35 min)

- **Key concepts (5 min):** endemic, relict, mountain flora, endemism centers.
- **Natural conditions (5 min):** sharply continental climate, high altitudinal variation, diverse habitats (steppes, forests, alpine meadows).
- **Examples of species (20 min):**
    - *Endemic plants: tulipa alberti, iris alberti, eremurus sogdianus, allium semenovii.*
    - *Relict plants: betula tianschanica, ephedra equisetina, juniperus sabina.*
    - Adaptations: cold and drought resistance, short vegetation period, compact growth forms.
- **Conservation (5 min):** main threats — overgrazing, tourism, deforestation; protected areas — dzungarian alatau national park.

3. Conclusion (10 min)

- Summary of key points.
- Discussion: “why is the dzungarian alatau important for preserving unique flora?”
- Homework: prepare a short description of one endemic or relict plant of the dzungarian alatau (with photo or sketch).

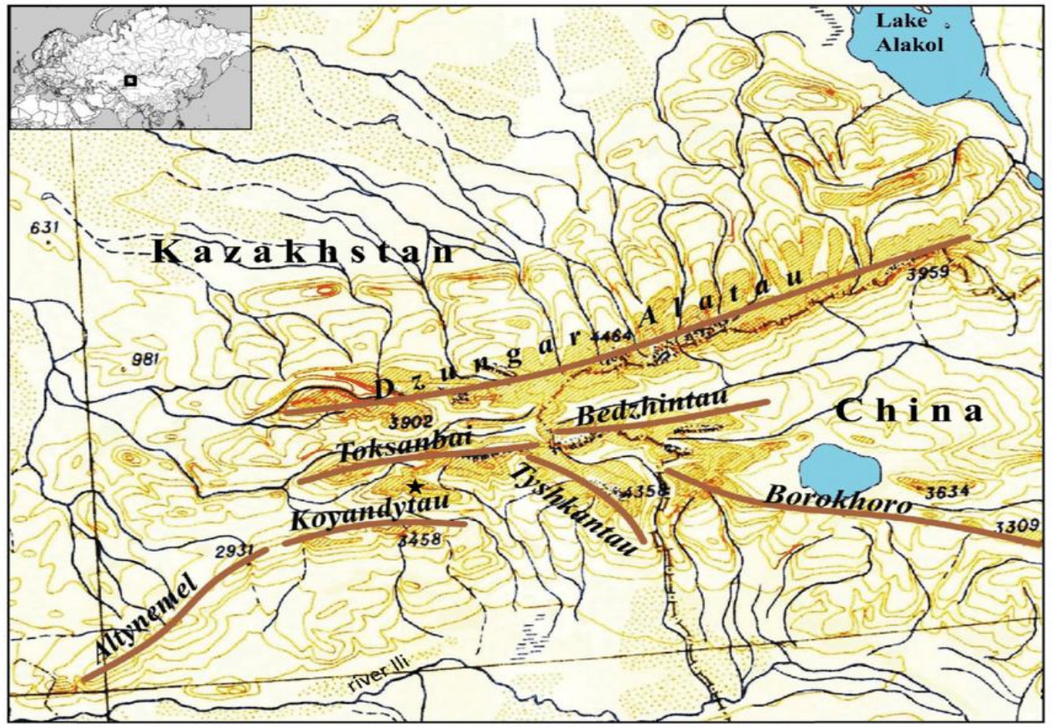


The Botanical Richness of Dzungarian Alatau

The Dzungarian Alatau mountain range represents one of Kazakhstan's most significant botanical hotspots, harbouring approximately 80 endemic vascular plant taxa found nowhere else on Earth. This extraordinary concentration of endemic species reflects the region's exceptional ecological importance within Central Asia. The mountains' unique geography and complex climate patterns have fostered the development and persistence of rare and relict species across diverse ecosystems ranging from alpine meadows to coniferous forests.

Kazakhstan's total endemic vascular flora comprises 7.97% of the nation's plant diversity, with the Dzungarian Alatau accounting for a disproportionately large share of this irreplaceable genetic heritage. The region's elevation gradients, varied soil types, and orographic precipitation patterns create distinct ecological niches that have allowed species to evolve in isolation, developing specialised adaptations found in few other locations globally. These endemic species are not merely botanical curiosities; they represent millions of years of evolutionary history and adaptation, making them invaluable for understanding how plants respond to extreme mountain environments.

THE BOTANICAL RICHNESS OF DZUNGARIAN ALATAU



Iconic Endemic Species of the Region

Pedicularis songarica

A distinctive hemiparasitic herb endemic to Dzungarian Alatau, displaying unique morphological features. This parasitic flowering plant has evolved specialised roots that tap into neighbouring plant tissues for nutrients, demonstrating remarkable coevolutionary adaptations.

Festuca goloskokovii

A rare alpine grass species superbly adapted to harsh high-altitude meadow environments. Its compact growth form and deep root system enable survival in windy, nutrient-poor alpine conditions where few other grasses can persist.

Astragalus & Delphinium

Astragalus abbreviatus and Delphinium dasyanthum showcase remarkable adaptations to mountain habitats, including pubescent leaves for moisture retention and concentrated root systems for stability on rocky slopes.

Emblematic Flowering Plants: Taraxacum alatavicum (Alatau dandelion) represents a unique endemic dandelion lineage distinct from widespread species, whilst Rosa schrenkiana (Schrenk's rosehip) produces nutrient-rich fruits supporting wildlife throughout the region. These flowering plants symbolise the botanical diversity characterising the Dzungarian Alatau.

Relict Plants: Living Links to the Past

Saussurea involucrata

The snow lotus (Saussurea involucrata) is perhaps the most iconic relict species inhabiting the Dzungarian Alatau's highest elevations. This rare, endangered plant represents an evolutionary lineage dating back millions of years, surviving in extreme high-altitude zones where temperatures plunge and oxygen becomes scarce. Revered in traditional Tibetan medicine for centuries, this sacred plant is now increasingly threatened by unsustainable harvesting and climate-induced habitat loss. Its silvery, woolly appearance serves as adaptation to intense ultraviolet radiation and desiccating winds.

Incarvillea semiretschenskia

This narrowly endemic relic species represents an extraordinary survivor, persisting since the Miocene epoch (approximately 23 million years ago) when global climates were warmer and vegetation patterns fundamentally different. Today, Incarvillea semiretschenskia survives exclusively on rocky slopes within the Shu-Ile low mountains, a testament to its remarkable specialisation to specific microsites. Its persistence provides invaluable insights into ancient flora and evolutionary history, allowing botanists to reconstruct prehistoric ecosystems and understand how species respond to prolonged environmental change.

Vegetation Communities and Ecological Roles

The Dzungarian Alatau's vegetation mosaic comprises distinct, interrelated communities that provide essential ecosystem services and support remarkable biodiversity. The region's forests represent critical carbon storage and water retention systems vital for downstream ecosystems and human populations throughout Central Asia.

Coniferous Forests

Dominated by Tien Shan spruce (Picea schrenkiana) and Siberian fir (Abies sibirica), these forests intermix with deciduous species including silver birch, aspen, and the ancient Sievers apple tree (Malus sieversii)—the wild progenitor of all cultivated apple varieties worldwide. This genetic heritage remains critical for developing disease-resistant and climate-adapted apple cultivars.

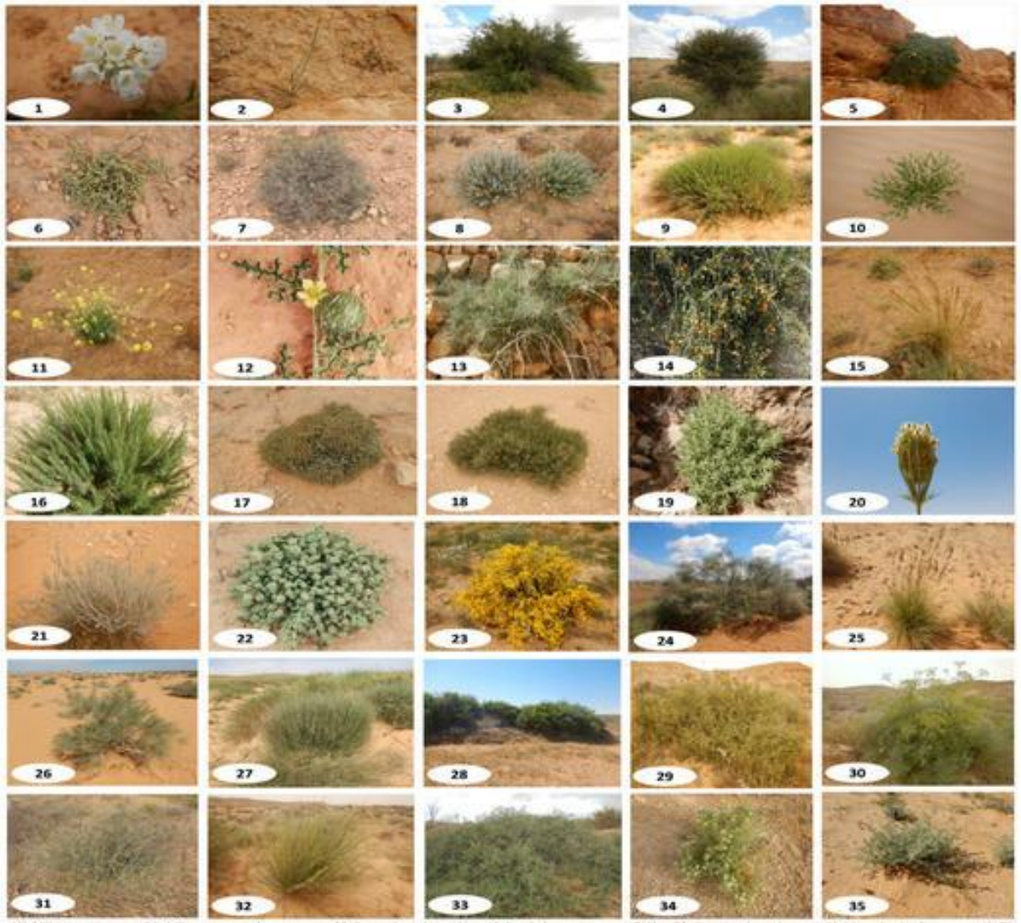
Alpine Meadows

High-altitude meadows flourish with medicinal and fodder plants including golden root (Rhodiola), valerian (Valeriana), maral root (Rhaponticum carthamoides), Alatau saffron (Colchicum speciosum), alpine meadow-grass (Poa alpina), and Tien Shan cherry (Cerasus tianschanica). These communities support local wildlife whilst sustaining traditional pastoral livelihoods.

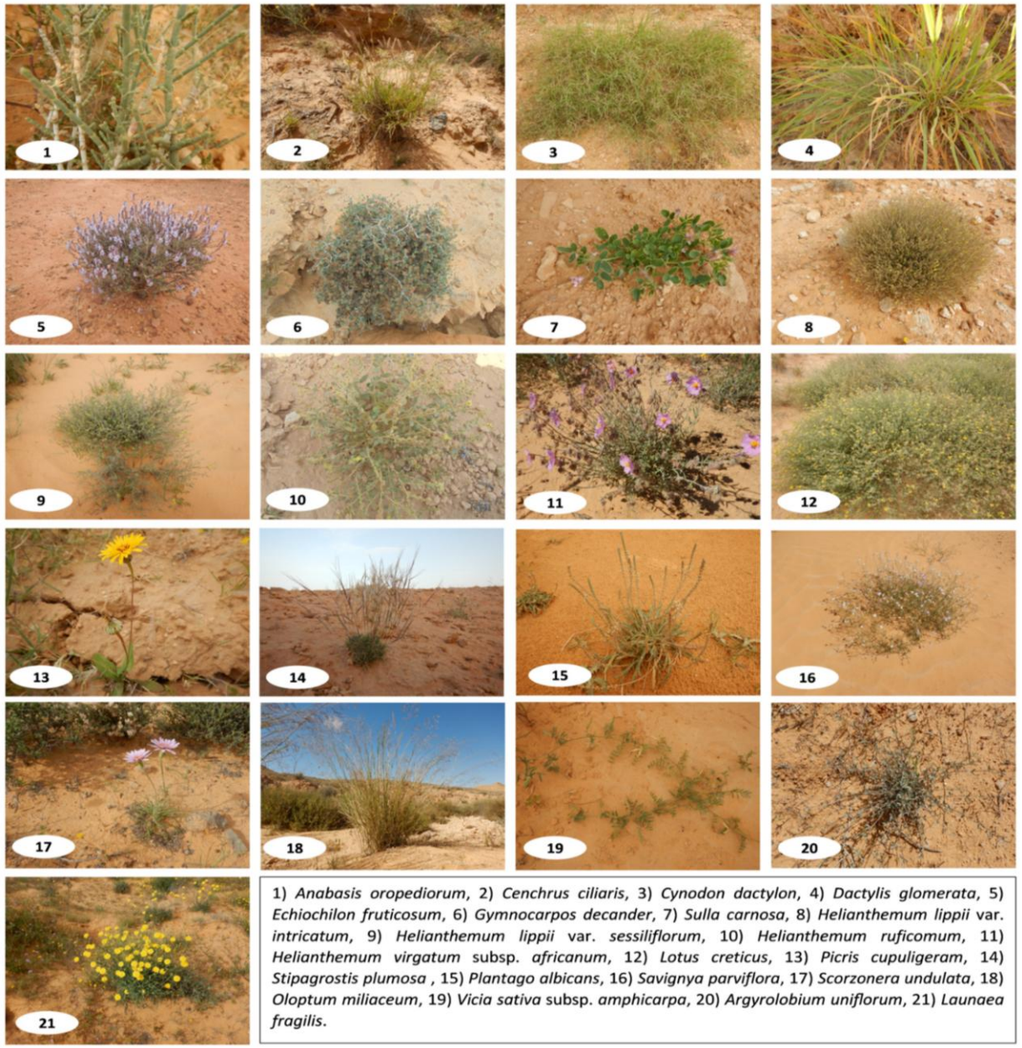
Ecosystem Services

These diverse communities provide watershed protection, wildlife habitat, medicinal plant resources, and cultural ecosystem services. They represent centuries of coevolution between flora, fauna, and human societies dependent upon these landscapes.

Vegetation Communities and Ecological Roles



1) *Allium roseum*, 2) *Allium ampeloprasum*, 3) *Searsia tripartita*, 4) *Periploca angustifolia*, 5) *Capparis spinosa*, 6) *Herniaria fontanesii*, 7) *Hammada scoparia*, 8) *Artemisia herba-alba*, 9) *Artemisia campestris*, 10) *Henophyton deserti*, 11) *Diplotaxis harra*, 12) *Citrullus colocynthis*, 13) *Ephedra alata*, 14) *Ephedra altissima*, 15) *Hyparrhenia hirta*, 16) *Rosmarinus officinalis*, 17) *Thymus algeriensis*, 18) *Thymbra capitata*, 19) *Ajuga iva*, 20) *Daucus carota*, 21) *Marrubium deserti*, 22) *Teucrium polium*, 23) *Calicotome villosa*, 24) *Retama raetam*, 25) *Cymbopogon schoenanthus*, 26) *Calligonum polygonoides*, 27) *Polygonum equisetiforme*, 28) *Ziziphus lotus*, 29) *Thymelaea hirsuta*, 30) *Thapsia garganica*, 31) *Deverra tortuosa*, 32) *Deverra denudata*, 33) *Nitraria retusa*, 34) *Peganum harmala*, 35) *Zygophyllum album*.



1) *Anabasis oropediorum*, 2) *Cenchrus ciliaris*, 3) *Cynodon dactylon*, 4) *Dactylis glomerata*, 5) *Echiochilon fruticosum*, 6) *Gymnocarpos decander*, 7) *Sulla carnosa*, 8) *Helianthemum lippii* var. *intricatum*, 9) *Helianthemum lippii* var. *sessiliflorum*, 10) *Helianthemum ruficomum*, 11) *Helianthemum virgatum* subsp. *africanum*, 12) *Lotus creticus*, 13) *Picris cupuligeram*, 14) *Stipagrostis plumosa* , 15) *Plantago albicans*, 16) *Savignya parviflora*, 17) *Scorzonera undulata*, 18) *Oloptum miliaceum*, 19) *Vicia sativa* subsp. *amphicarpa*, 20) *Argyrolobium uniflorum*, 21) *Launaea fragilis*.

Conservation Status and Threats

Legal Protection

Many endemic and relict species possess formal legal protection status under Kazakhstan's environmental legislation and international conservation agreements. However, legal designation alone proves insufficient without effective implementation, habitat restoration, and enforcement against illegal collection. Several species appear in international conservation lists recognising their global significance and vulnerability.

Multifaceted Threats

Endemic and relict plants face converging threats including progressive habitat degradation through infrastructure development, intensified overgrazing by livestock, increasing pastoral pressure, and accelerating climate change altering precipitation patterns and temperature regimes. Additional stressors include illegal collection for traditional medicine markets and recreational picking.

Ecosystem Indicators: The presence of specialist fauna such as the Central Asian salamander (Ranodon sibiricus) and the rare ibisbill bird (Ibidorhyncha struthersii) highlights the fragile interconnected nature of these mountain ecosystems. These species serve as biological indicators of ecosystem health and depend upon intact habitats supporting diverse endemic plants.

Recent Scientific Advances

Contemporary botanical and molecular research has revolutionised our understanding of endemic and relict plant diversity within the Dzungarian Alatau, providing unprecedented insights into genetic structure, evolutionary history, and conservation priorities.

Genomic Analysis

Chloroplast genome sequencing of species including Astragalus rubtzovii and Rheum wittrockii has revealed significant genetic distinctiveness and documented unique adaptations to alpine conditions. These molecular markers enable precise species identification and population genetic assessment.

Phylogenetic Studies

Molecular phylogenetic analyses clarify evolutionary relationships amongst endemic lineages, illuminating speciation processes and historical biogeographic patterns. These phylogenies reveal ancient divergence events and guide understanding of species' roles within broader Central Asian plant communities.

Population Monitoring

Comprehensive field surveys document population sizes, distribution ranges, and demographic trends for rare species. Data reveal that whilst certain populations remain stable, others show concerning declines requiring urgent conservation intervention and targeted habitat protection.

RECENT SCIENTIFIC ADVANCES

Conservation Efforts and Future Directions

Protecting the Dzungarian Alatau's endemic and relict flora requires integrated, science-based conservation strategies combining habitat protection, restoration, sustainable management, and continuous monitoring. Successful implementation demands collaboration amongst government agencies, research institutions, local communities, and international conservation organisations.

1

Micro-Reserve Establishment

Creating strategically located micro-reserves and expanding existing protected areas to safeguard endemic and relic species' critical habitats, particularly rare alpine meadows and rocky slope communities where populations remain small and geographically restricted.

2

Vegetation Restoration

Implementing native vegetation restoration programmes and adopting sustainable grazing practices that reduce anthropogenic pressures whilst supporting traditional pastoral livelihoods. These initiatives aim to recover degraded habitats and expand population sizes of threatened species.

3

Adaptive Management

Establishing continuous monitoring programmes that integrate molecular genetic data with field observations, enabling evidence-based adaptive management decisions that respond to changing environmental conditions and emerging threats including climate change impacts.

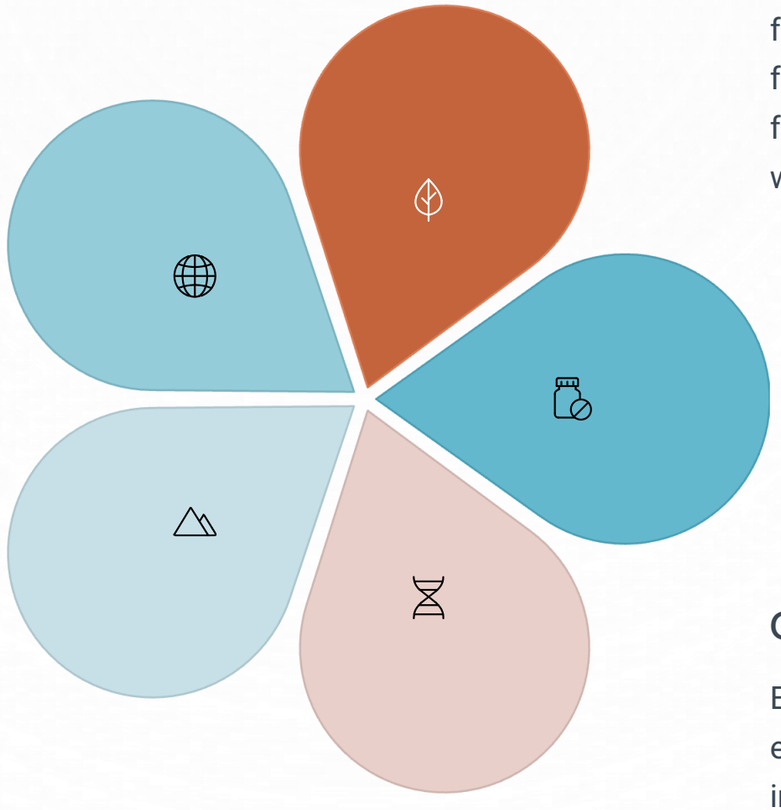
Why Protect Dzungarian Alatau's Endemic Flora?

Irreplaceable Biodiversity

Endemic species exist nowhere else on Earth. Their extinction represents permanent loss of unique genetic heritage and millions of years of evolutionary history, diminishing global biodiversity irreversibly.

Cultural Heritage

These plants feature prominently in local traditions, indigenous knowledge systems, and regional cultural identity. They connect communities to ancestral lands and represent irreplaceable elements of Central Asian heritage.



Ecological Value

These plants stabilise mountain slopes, retain soil, filter water, and provide critical habitat for dependent fauna. They maintain ecosystem resilience essential for downstream communities relying upon mountain water and resources.

Medicinal Potential

Many endemic species possess bioactive compounds with pharmaceutical applications. Saussurea involucrata, maral root, and other species offer promising therapeutic possibilities for modern medicine and disease treatment.

Genetic Resources

Endemic plants harbour unique genetic adaptations to extreme mountain conditions. These genes possess immense value for developing climate-resilient crop varieties and understanding biological responses to environmental stress.

Conclusion: Preserving a Botanical Treasure

The Dzungarian Alatau's endemic and relict plants narrate an extraordinary story of biological survival, remarkable adaptation, and ancient evolutionary lineage stretching back millions of years. These species survived dramatic climate fluctuations, geological upheavals, and environmental transformations that reshaped Earth's landscapes. Yet today, they face unprecedented threats from rapid anthropogenic change, habitat destruction, and accelerating climate change occurring at scales and speeds exceeding natural adaptation capacities.

The urgency of science-driven conservation cannot be overstated. Without immediate, decisive action—including habitat protection, restoration initiatives, sustainable management practices, and international cooperation—irreversible biodiversity loss looms imminent. The window for effective intervention narrows as populations decline and habitats degrade.

A Call to Action: Protecting these botanical treasures requires commitment from governments, research communities, conservation organisations, and engaged citizens. Through coordinated scientific effort, policy implementation, and community involvement, we can ensure these living remnants of Earth's distant past endure for future generations, maintaining the ecological integrity and biological richness of Central Asia's mountain ecosystems.