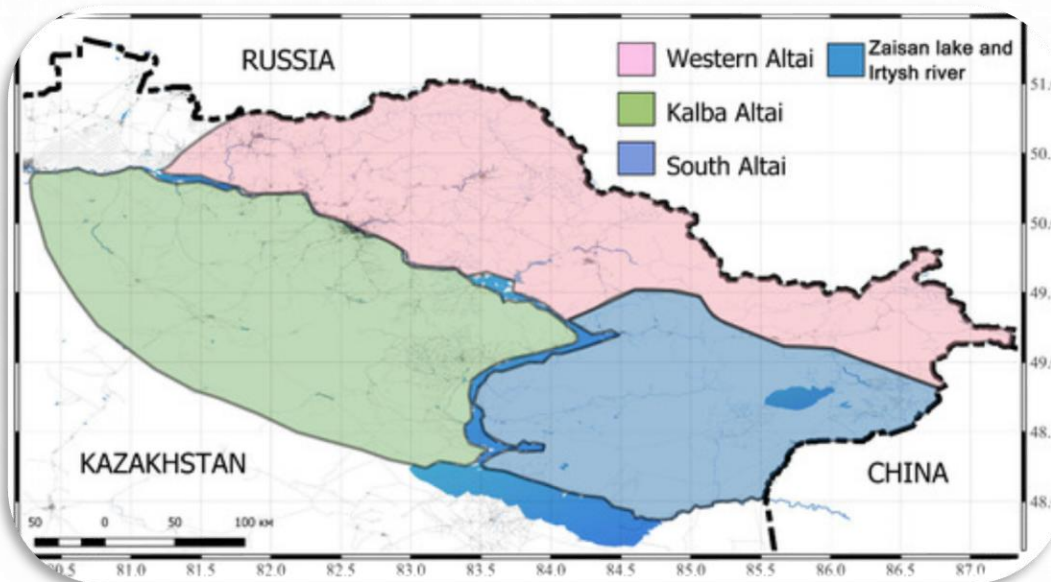




**AL-FARABI KAZAKH NATIONAL UNIVERSITY
FACULTY OF BIOLOGY AND BIOTECHNOLOGY
DEPARTMENT OF BOTANY AND AGROECOLOGY**

LECTURE 8

Analysis of endemic and relict plants of the Tarbagatai Mountain Range



**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)

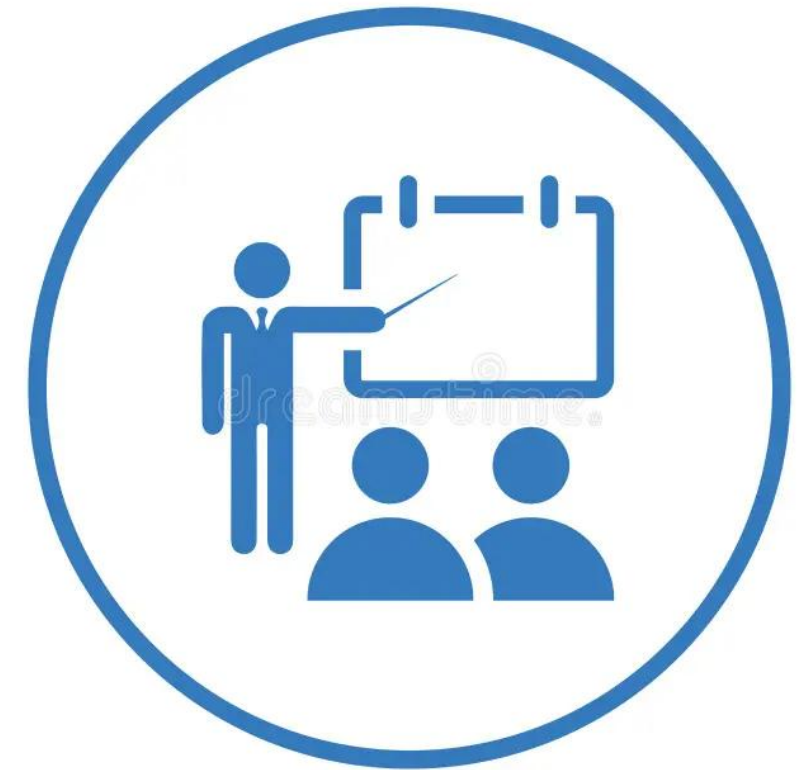
- Topic and purpose of the lesson.
- Geographic location of the tarbagatai range (east kazakhstan).
- Importance of tarbagatai as a center of plant diversity and endemism.

2. Main part (35 min)

- **Key concepts (5 min):** endemic, relict, mountain flora.
- **Natural conditions (5 min):** moderate continental climate, rich soils, vertical vegetation zones.
- **Examples of plants (20 min):**
 - Endemic species: *tulipa tarbagataica*, *oxytropis tarbagataica*, *allium tarbagataicum*, *astragalus karakugensis*.
 - Relict species: *betula tianschanica*, *juniperus pseudosabina*, *spiraea media*.
 - Adaptations: frost resistance, drought tolerance, slow growth.
- **Conservation (5 min):** threats (pasture overuse, deforestation); protection measures — tarbagatai national park.

3. Conclusion (10 min)

- Summary of main ideas.
- Discussion: “why are mountain ecosystems important for preserving rare species?”
- Homework: prepare a brief description of one endemic plant of tarbagatai.



The Tarbagatai Mountains: A Biodiversity Hotspot in Kazakhstan

Geographic Significance

Nestled in eastern Kazakhstan as part of the broader Central Asian mountain system, the Tarbagatai Mountains occupy a distinctive ecological position that has shaped the evolution and persistence of remarkable plant communities. The range's geographical isolation and altitude gradients create a mosaic of microhabitats ranging from steppe to alpine zones, each harbouring specialised flora adapted to specific environmental conditions.

Ecological Importance

The unique convergence of climatic and geological conditions has fostered extraordinarily high plant diversity and endemism rates. Acting as a refuge for relict species that have survived since the Miocene epoch—some 23 million years ago—Tarbagatai represents a living laboratory of evolutionary resilience. The mountains' capacity to maintain stable microclimates during periods of global climate upheaval has enabled ancient lineages to persist when they vanished elsewhere.

Defining Endemic and Relict Plants

Endemic Plants

Species native to and restricted exclusively to the Tarbagatai region. These organisms have evolved in isolation within this geographic area and are found nowhere else on Earth. Endemics represent unique evolutionary experiments shaped by local selective pressures and represent irreplaceable components of regional biodiversity.

Relict Plants

Ancient species that have survived from past geological periods, often as isolated populations with narrow distributions. Relicts are evolutionary survivors—remnants of flora that dominated during different climatic regimes. Their persistence in refugia like Tarbagatai provides crucial insights into historical biogeography and ecosystem stability.

Conservation Significance

Both groups are vital for understanding evolutionary history, ecosystem resilience, and the mechanisms enabling species survival through environmental change. They serve as sentinels of ecological health and hold invaluable information about adapting to future climate challenges and maintaining functional biodiversity.

Why This Matters: Endemic and relict plants represent millions of years of evolutionary history compressed into small geographic areas. Their loss would mean erasing irreplaceable chapters of life's story on Earth.

Case Study: *Rhaponticum carthamoides*

The Medicinal Relic of Tarbagatai



Rhaponticum carthamoides — (Willd.) Iljin



Ecological Profile: A large perennial herb belonging to the Asteraceae family, *Rhaponticum carthamoides* has been valued in traditional and modern medicine for its powerful adaptogenic properties—compounds that enhance the body's resilience to stress and fatigue. Indigenous knowledge systems recognised its efficacy centuries before scientific validation.

Conservation Status: Found exclusively within Tarbagatai National Nature Park, this species has been granted protected status as of 2024, reflecting growing recognition of its ecological and economic importance. This designation restricts harvesting and mandates habitat protection.

Research Findings: Contemporary studies reveal complex relationships between above-ground and below-ground biomass allocation, soil nutrient cycling, and population dynamics. Research demonstrates that sustainable harvesting presents significant challenges; traditional collection methods often damage rhizomes, compromising regeneration and long-term population viability.

Management Implications: Continuous monitoring protocols and adaptive harvesting regimes are essential to balance medicinal resource extraction with population persistence and ecosystem function.

Case Study: *Incarvillea semiretschenskia*

A Rare Relic Endemic in Central Asia

1

Botanical Characteristics

A xerophytic dwarf semishrub exhibiting remarkable morphological adaptations to arid environments. Its growth form, leaf structure, and physiological mechanisms reflect millions of years of selection in water-limited habitats. The species represents a unique lineage within the Bignoniaceae family.

2

Geographic Distribution

Endemic to the Shu-Ile low mountains immediately adjacent to the Tarbagatai range. This extremely restricted distribution—representing perhaps only a few thousand individual plants across an area of a few hundred square kilometres—exemplifies the vulnerability of highly localised species to environmental perturbations.

3

Conservation Status

Listed in Kazakhstan's Red Data Book due to its rarity and restricted range. The species faces multiple threats including grazing pressure from domestic livestock, wildfires that destroy habitat, and mining activities that fragment populations and degrade soil structure and hydrology.

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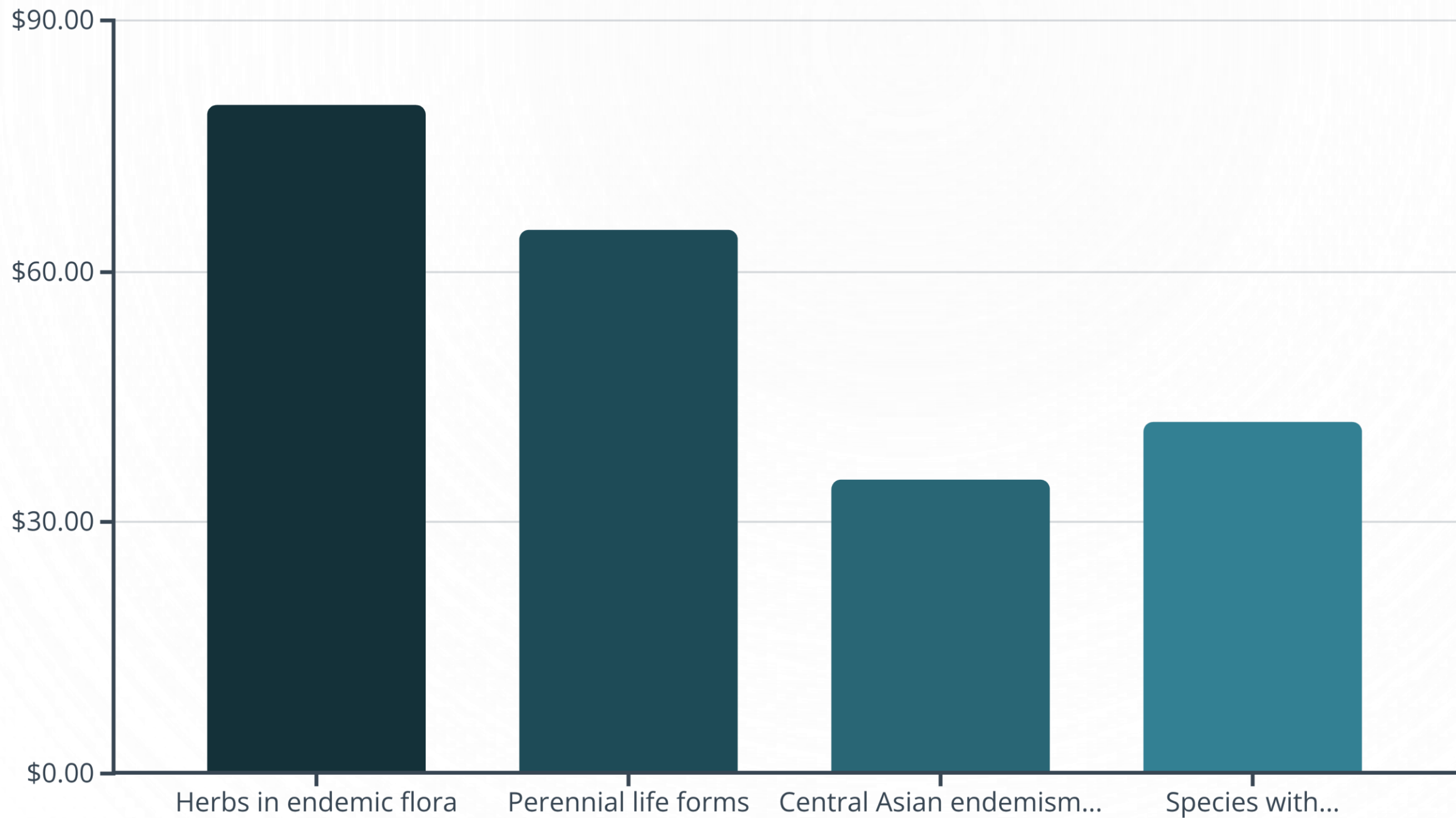
Molecular Insights

Phylogenetic analysis reveals that *Incarvillea semiretschenskia* harbours unexpected genetic variability within its small population, suggesting either recent admixture or maintenance of ancestral polymorphism. This genetic structure guides conservation design, indicating that micro-reserves must encompass sufficient population size to maintain genetic diversity across generations.

Key Finding: This Miocene survivor—potentially 15-20 million years old as a lineage—demonstrates that relic species can harbour genetic complexity that proves crucial for adaptive potential in changing environments.

Biodiversity and Endemism in Tarbagatai and Surrounding Regions

Central Asia's Botanical Significance: Kazakhstan hosts 451 endemic vascular plant taxa distributed unevenly across the country, with mountain ranges like Tarbagatai, Tian Shan, and the Altai serving as primary endemism hotspots. These ranges collectively account for disproportionately high concentrations of endemic species, reflecting their roles as topographic refugia.



Threats to Endemic and Relict Plants in Tarbagatai

→ Overharvesting

Medicinal plants like *Rhaponticum carthamoides* face intense collection pressure, particularly from commercial harvesters seeking high-value compounds. Traditional harvesting methods frequently damage subterranean organs, preventing regeneration and causing population crashes. The gap between market demand and sustainable yield continues widening.

→ Climate Change Impacts

Shifting precipitation patterns and temperature regimes alter the microclimates upon which relict species depend. Alpine species occupying narrow ecological niches face compression of suitable habitat as conditions move upslope. Relicts with Miocene distributions may lack the evolutionary flexibility to track rapid modern climate changes.

→ Habitat Degradation

Grazing by domestic livestock, particularly sheep and goats, alters vegetation structure and species composition, favouring opportunistic generalists whilst eliminating specialists. Mining operations fragment habitats, contaminate soil and water, and eliminate entire microhabitats. Uncontrolled fire destroys years of growth in alpine systems with slow recovery rates.

→ Data Deficiencies

Insufficient population monitoring data hampers evidence-based conservation planning. Without robust baseline information on population sizes, growth rates, genetic structure, and demographic dynamics, managers cannot assess threat severity or design interventions with confidence. Knowledge gaps leave endemic species vulnerable to unrecognised decline.

Conservation Strategies and Research Advances



Protected Area Network

Tarbagatai State National Nature Park and associated reserves safeguard key habitats, restricting extractive activities and providing baseline conditions for population monitoring. Protected status offers legal frameworks for enforcement, though enforcement capacity remains challenged by vast territories and limited resources.



Micro-Reserve Proposals

Conservation proposals advocate establishing plant micro-reserves—intensively managed small areas optimised for maintaining populations of rare species like *Incarvillea semiretschenskia*. Ex situ collections in botanical gardens and seed banks provide insurance against extinction whilst maintaining germplasm for potential reintroduction.



Molecular Techniques

DNA barcoding enables rapid, accurate species identification, crucial for distinguishing closely related endemics. Phylogenetic analysis clarifies evolutionary relationships and identifies evolutionary lineages worthy of enhanced protection. Molecular population genetics guides reserve design by quantifying genetic structure and diversity patterns.



Integrated Management

Sustainable harvesting regimes developed through collaboration with local communities balance resource extraction with population persistence. Community engagement and benefit-sharing arrangements create economic incentives for conservation whilst respecting traditional resource use practices and ecological knowledge systems.

THE TARBAGATAI MOUNTAINS: A BIODIVERSITY HOTSPOT IN KAZAKHSTAN



Visualising the Future: Sustainable Use and Biodiversity Preservation

Integrated Strategies for Tarbagatai's Botanical Heritage

Scientific Foundations

Advanced species distribution mapping employs remote sensing, GPS surveys, and habitat modelling to delineate hotspots of endemic concentration and identify sustainable harvesting zones where populations can withstand collection pressure. This spatial framework prioritises protection of genetically distinct populations and evolutionarily unique lineages.

Integration of traditional ecological knowledge with scientific research creates hybrid management systems respecting both indigenous wisdom and contemporary conservation biology. Local herders, gatherers, and communities possess generations of accumulated knowledge about species ecology, seasonal dynamics, and sustainable use practices often overlooked by external experts.

Socioeconomic Opportunities

Ecotourism development capitalises on Tarbagatai's botanical uniqueness, generating revenue streams that incentivise habitat protection. Educational tourism raises public awareness about endemic species and evolutionary significance, building social support for conservation investments.

Collaborative regional efforts across Central Asian countries—Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan—establish coordinated conservation networks transcending political boundaries. Shared research databases, coordinated monitoring protocols, and collective capacity building amplify conservation effectiveness whilst distributing costs and responsibilities equitably.

Conclusion: Protecting Tarbagatai's Botanical Heritage for Tomorrow

The Imperative for Action: Endemic and relict plants represent irreplaceable links to deep evolutionary time and irreplaceable pillars of ecosystem health. *Incarvillea semiretschenskia* surviving 15–20 million years and *Rhaponticum carthamoides* serving human communities across centuries embody nature's resilience and value. Their loss would be permanent—extinction extinguishes evolutionary history and forecloses options for future discovery.

Research	Monitoring	Sustainable Action
Continued investigations into population genetics, ecology, and climate vulnerability	Long-term demographic tracking and ecosystem assessment	Evidence-based conservation interventions balancing use and preservation

The Tarbagatai Mountains exemplify the delicate balance between resource use and preservation essential for sustainable development in Central Asia. Through science, stewardship, and community collaboration, we can ensure these unique plants—survivors of epochs, teachers of adaptation, and treasures of biodiversity—endure for countless future generations. The choice to act decisively now determines whether Tarbagatai's botanical heritage flourishes or fades into extinction.