Session 1

Topic: Spore-bearing and Gymnosperm Plants of Kyrgyzstan. Classes Pinopsida and Gnetopsida. Rare and endemic species: Semyonov fir, Schrenk's spruce, Junipers (Archa), Middle ephedra and Horsetail ephedra, etc.

Objective of the lesson: To form in-depth theoretical knowledge about the peculiarities of biology, systematics, geographical distribution, resource base and medicinal value of higher spore-bearing and gymnosperm plants of the flora of the Kyrgyz Republic, as well as to study the status of rare, endemic and relict taxa.

Target tasks:

1. To study modern principles of systematics and phylogeny of higher spore-bearing and gymnosperm plants, their role in the phytocenoses of the Tien Shan and Pamir-Alai.
2. To investigate morphological and anatomical features of representatives of the classes Pinopsida and Gnetopsida, their adaptation to high-mountain and arid climate conditions.
3. To conduct a detailed analysis of rare, endemic and relict woody edificators of Kyrgyzstan: Schrenk's spruce (Picea schrenkiana), Semyonov fir (Abies semenovii) and main juniper (archa) species.
4. To study the chemical composition, pharmacological properties and raw material base of medicinal plants from the class Gnetopsida (genus Ephedra).
5. To get acquainted with the issues of protection of the gene pool of rare plants of the KR listed in the Red Book, and the rules of rational use of medicinal raw materials.

Self-control questions:

1. What are the general characteristics and coenotic role of higher spore-bearing plants (bryophytes, ferns, horsetails and clubmosses) in the vegetation cover of Kyrgyzstan?
2. Characterize the class Pinopsida: features of life forms, structure of vegetative and generative organs.
3. Give a detailed botanical and ecological description of the endemic Schrenk's spruce and the relict Semyonov fir. What is the difference between them?
4. The genus Juniper (Archa Juniperus) in Kyrgyzstan: species diversity (semi-globular, Zarafshan, Turkestan archa), their soil-forming and anti-erosion significance.
5. Characterize the class Gnetopsida and the family Ephedraceae. Morphological features of middle ephedra and horsetail ephedra.
6. Pharmacognostic significance of ephedra herb (Herba Ephedrae): active substances (ephedrine, pseudoephedrine), pharmacological action and medical application.

INFORMATIONAL MATERIAL

The vegetation cover of Kyrgyzstan is distinguished by exceptional diversity of its floristic composition, caused by the complex orographic structure of the territory, sharp contrasts in altitudinal zonation, climatic and soil-ground conditions of the Tien Shan and Pamir-Alai. Both ancient autochthonous elements and migrants from neighboring floristic regions participate in the formation of the plant world.

Higher spore-bearing plants (bryophytes, ferns, horsetails, clubmosses) are widely represented in humid spruce forests, subalpine and alpine meadows, along the banks of mountain streams. They play an important role in moisture accumulation, soil formation and the formation of ground cover. However, the leading environment-forming, water-protecting and resource-forming role in the forest ecosystems of the republic belongs to gymnosperms, among which coniferous species and xerophytic shrubs dominate.

1. Higher Spore-Bearing Plants in the Flora of Kyrgyzstan

Higher spore-bearing plants are characterized by the fact that they reproduce and spread with the help of spores, and the sporophyte (asexual generation) dominates in the life cycle, while the gametophyte is reduced.

- **Division Bryophyta:** Represented by green and sphagnum mosses, as well as liverworts. They inhabit damp soils, rocks, and tree trunks in spruce forests. They contribute to regulating the water balance of soils by retaining precipitation.
- **Division Polypodiophyta:** Includes perennial herbs with large fronds. In Kyrgyzstan, they grow in shady gorges, along river banks and springs (dryopteris, athyrium, asplenium).
- **Divisions Equisetophyta and Lycopodiophyta:** Distributed in meadows, fields and forests (field horsetail, forest horsetail, clubmoss). Field horsetail is widely used in medical practice as a diuretic and hemostatic agent.

2. Class Pinopsida: Forest Formers of the Tien Shan

Coniferous plants are an ancient group of seed plants in which seeds lie openly on cone scales. In the flora of Kyrgyzstan, conifers form unique mountain forests.

- **Schrenk's spruce (Picea schrenkiana Fisch. et C.A. Mey.)** — the main forest-forming species of the Tien Shan, an endemic of Central Asia. A powerful tree up to 40-50 m high, trunk diameter up to 1-1.5 m. The crown is narrowly pyramidal. Needles are four-sided, rigid, prickly, dark green. Cones are large, cylindrical (7-10 cm long), young purple-green, mature brown, drooping. Forms extensive spruce forests on the northern slopes of ridges in the range of 1700-3000 m. Performs an exceptional water-protecting, soil-protecting and climate-regulating role.

- **Semyonov fir (Abies semenovii B. Fedtsch.)** — the rarest endemic relict species of the tertiary flora, listed in the Red Book of the KR. It grows locally in the Inner Tien Shan and on the Fergana Ridge (in particular, in the Sary-Chelek Biosphere Reserve). A tree up to 30 m high with smooth light gray bark. Needles are flat, soft, blunt, with two white stripes below. Cones are cylindrical, vertically standing ("candles"), upon ripening they crumble into scales right on the tree, leaving bare axes.
- **Genus Juniper (Archa, Juniperus L.)** — the most important mountain-xerophytic woody-shrub formation of Kyrgyzstan. Archa forests occupy huge areas in the middle and high mountain belts (1500-3200 m). Main species:
  - Semi-globular archa (Juniperus semiglobosa) — a tree or creeping shrub (stlanik) with scaly needles.
  - Zarafshan archa (Juniperus seravschanica) — a tree with a spherical crown and a long-liver (the age of some specimens reaches 1000 years or more).
  - Turkestan archa (Juniperus turkestanica) — a tree up to 10-15 m high, rising high into the subalpine belt.

    Archa possesses powerful phytoncide properties, improves the air basin, strengthens steep rocky slopes, preventing mudflows and erosion. Cone-berries and wood of archa are used in traditional medicine and pharmacognosy.

3. Class Gnetopsida and Family Ephedraceae

Gnetopsida are an isolated group of gymnosperms combining features of conifers and angiosperms (presence of vessels in the xylem, flower primordia). In the arid and high-mountain ecosystems of Kyrgyzstan, representatives of the Ephedraceae family are widely represented.

- **Middle ephedra (Ephedra intermedia Schrenk ex C.A. Mey.) and Horsetail ephedra (Ephedra equisetina Bunge)** — strongly branched xerophytic shrubs up to 50-150 cm high with jointed twig-like shoots of gray-green color. Leaves are reduced to small scales fused at the base. Plants are dioecious, wind-pollinated.
- **Pharmacognostic significance:** Green unlignified shoots (herb) of ephedra (Herba Ephedrae) contain alkaloids (l-ephedrine, d-pseudoephedrine, norephedrine). Ephedrine is a powerful adrenomimetic: it stimulates the sympathetic nervous system, narrows peripheral blood vessels, increases blood pressure, dilates bronchi (relieving spasm in bronchial asthma), and excites the respiratory center. Due to the fact that ephedra alkaloids are used for the illegal synthesis of psychotropic substances, procurement, storage and processing of raw materials are under strict state control.

Environmental aspects: Anthropogenic load (excessive livestock grazing, illegal logging of valuable species, forest fires, uncontrolled collection of medicinal raw materials) poses a threat to the preservation of unique gene pools of Schrenk's spruce, Semyonov fir and

juniper forests. The creation of reserves (Sary-Chelek, Besh-Aral, Karatal-Jarykchay) and national parks is the basis for preserving the biodiversity of the KR.

Comparative characteristics of main coniferous and gnetophyte forest formers and medicinal plants of the KR

Taxon (Species)	Systematic Position	Life Form	Morphological Features	Range in Kyrgyzstan	Economic and Medicinal Value
Schrenk's spruce Picea schrenkiana	Division Pinophyta Class Pinopsida	Tree (up to 40-50 m)	Needles rigid, prickly, four-sided; drooping cones	Tien Shan, forest belt (1700-3000 m)	Main forest former, timber, water protection
Semyonov fir Abies semenovii	Division Pinophyta Class Pinopsida	Tree (up to 30 m)	Needles flat, soft, with white stripes; vertical cones	Inner Tien Shan, Fergana Ridge	Endemic, tertiary relict, Red Book of KR
Junipers (Archa) Juniperus spp.	Division Pinophyta Class Pinopsida	Tree / shrub / creeping	Needles scaly/ needle-like; juicy cone-berries	Everywhere in mountains of KR (1500-3200 m)	Phytoncides, anti-erosion role, essential oils
Ephedra spp.	Division Pinophyta Class Gnetopsida	Xerophytic shrub	Jointed, twig-like, green shoots; scale-like leaves	Rocky slopes, arid zones of KR	Source of ephedrine alkaloid (medicinal raw material)

TEST QUESTIONS FOR SELF-CHECK

1. The main forest-forming species of the coniferous forests of the Tien Shan is:
   A) Semyonov fir
   B) Schrenk's spruce
   C) Scots pine
   D) Siberian larch
2. A relict endemic species of coniferous plants of Kyrgyzstan, listed in the Red Book, whose cones grow vertically upwards and crumble on the tree:
   A) Semyonov fir
   B) Turkestan juniper
   C) Schrenk's spruce
   D) Middle ephedra

3. What is the significance of junipers (archa) in the mountain ecosystems of Kyrgyzstan?
   A) Only raw material for timber
   B) Soil-protective, anti-erosion and phytoncidal (air purification)
   C) Source of starch
   D) Forage base for fish
4. The main biologically active substance (alkaloid) in ephedra herb is:
   A) Morphine
   B) Atropine
   C) Ephedrine
   D) Digoxin
5. To which class do plants of the genus Ephedra belong?
   A) Pinopsida
   B) Gnetopsida
   C) Cycadopsida
   D) Liliopsida

LITERATURE

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