

## **Phylum: SPERMATOPHYTA – SEED PLANTS**

### **1. Subphylum: CONIFEROPHYTINA – CONIFERS**

This subphylum comprises woody plants that are characterized by special male and female inflorescences, called cones. The male cones release a large number of pollen grains, which fertilize the ovules that will develop into seeds on the fertile scales of the female cones. The ovules and developing seeds do not enjoy the protection of a closed pistil that we will see later on in angiosperms. In the majority of species, pollen transfer is enhanced by bladder-like structures (called saccus, Pl. sacci) attached to each pollen grain, whereas seed dispersal by the wind is aided by wings attached to the seeds. The scales of the female cones become hard and woody and these cones can be used as characteristic features in identifying coniferous species.

**Classis: GINKGOPSIDA**

#### **Ordo: Ginkgoales**

##### **Familia: Ginkgoaceae – Ginkgo family / Maidenhair tree family**

The family contains only one extant species, *Ginkgo biloba*, native to China, but planted worldwide. *G. biloba* is a highly branched, woody tree, with fan-shaped, often two-lobed (hence the name: biloba) leaves with dichotomous venation. *Ginkgo* is dioecious: male trees bear reproductive structures that are called „cones”, bearing microsporangia that release pollen grains; whereas female trees are lacking cones, and their reproductive structures bear ovules. In Asia the seeds are consumed. For medicine the leaves (*Ginkgo bilobae folium*) are valuable, and their extract is used as memory and concentration enhancer, due to its flavonoid glycosides and terpenoids (ginkgolides, bilobalides).

**Classis: CONIFEROPSIDA**

#### **Ordo: Coniferales (Pinales)**

All members of the order are trees or shrubs, mostly evergreen, with needle-like leaves and resin ducts in all plant parts.

##### **Familia: Araucariaceae – Araucaria family**

These evergreen, mostly dioecious trees are primarily found in the southern hemisphere. The *Araucaria* genus comprises coniferous trees with regularly whorled branches and scale-like or sometimes needle-like leaves, including the well-known ornamental, *A. excelsa*. Species in the *Agathis* genus are large, evergreen trees, with straight boles beneath a globular crown. The branches are horizontal or turning irregularly upward, the leaves are oval to linear, flat, broad, leathery, thick, with multiple parallel veins. The inner bark of the Malaysian *Agathis alba* exudes a translucent or white resin, soluble in alcohol, called Manila copal. *Agathis australis*, commonly known as the kauri is the largest, but not tallest tree species in New Zealand, with smooth bark and small, narrow leaves. In the past, the size and strength of kauri timber made it a popular wood for construction and ship building, and a considerable industry was based on kauri gum (semi-fossilized kauri resin / kauri copal), collected for making varnishes and linoleum.

## **Familia: Abietaceae / Pinaceae – Pine family**

The Abietaceae are trees, rarely shrubs, abundant in the northern hemisphere. Apart from their great value as timber and paper-making material, many species yield oleoresin.

### Subfamily: Abietoideae

Firs (*Abies* sp.) are evergreen conifers, found throughout the northern hemisphere. Their leaves are flat and needle-like, and the erect, cylindrical cones disintegrate at maturity to release the winged seeds. European silver fir (*A. alba*) is a fir native to the mountains of Europe. Balsam fir (*A. balsamea*) is a North American fir, whose resin is used to produce Canada balsam, which was traditionally applied as a cold remedy, and is still used for preparing permanent mounts of microscope specimens.

Spruces (*Picea* sp.) are large coniferous trees found in the northern temperate and boreal regions of the earth. Spruces can be distinguished by their whorled branches and conical form. Their needles or leaves are attached singly to the branches in a spiral fashion. The female cones are pendulous. The essential oil, resin and pitch of Norway spruce (*P. abies*) are important for pharmaceutical purposes.

Hemlock (*Tsuga*) species occur in North America and eastern Asia, with flattened to slightly angular leaves that are borne singly and arranged spirally on the branches, and small cones. A well-known representative is the North American eastern hemlock (*T. canadensis*).

Douglas-firs (*Pseudotsuga* sp.) are medium-size to large evergreen trees, with flat, soft, linear leaves that completely encircle the branches. The female cones are pendulous, with persistent scales (unlike true firs) and have a long three-pointed bract that protrudes above each scale. The best-known representative is the North American green Douglas-fir (*P. menziesii*).

### Subfamily: Laricoideae

Larches are deciduous! trees (lose their leaves in fall), widespread in the cooler temperate northern hemisphere, being among the dominant plants in the huge boreal forests of Russia and Canada. The 2 to 5 cm long needle-like leaves are borne singly, spirally arranged on the long shoots, and in dense clusters of 20-50 needles on the short shoots. The needles turn yellow and fall in autumn. European larch (*Larix decidua*) is native to the mountains of central Europe. Its viscous resin is the source of Venice turpentine, used in painting, and as an additive to thicken other media.

Cedars (*Cedrus* sp.) are trees up to 30-40 m, with resinous scented wood, native to the mountains of Himalaya and the Mediterranean region. The leaves are evergreen and needle-like, arranged spirally on long shoots and in clusters of 15-45 on short shoots. The seed-cones are barrel-shaped and disintegrate at maturity. Deodar cedar (*C. deodara*) occurs in Western Himalaya, cedar of Lebanon (*C. libani*) in mountains of the Mediterranean region, and atlas cedar (*C. atlantica*) in the Atlas mountains in Morocco and Algeria. Cedars are popular ornamental trees in temperate climates. Cedar wood and cedar oil are known to be a natural repellent to moths. Cedar oil is also used as immersion oil in light microscopy, to increase the resolution.

### Subfamily: Pinoideae

Pines (*Pinus* sp.) are evergreen resinous trees (rarely shrubs), native to most of the northern hemisphere. The needles are bundled in clusters of 2-5. The leaves are in fascicles of two, i.e. in pairs, in European black pine (*P. nigra*), maritime pine (*P. pinaster*), Scots pine (*P. silvestris*) and stone pine or umbrella pine (*P. pinea*); and in bundles of five in Swiss pine (*P. cembra*).

Pines are mostly monoecious, having the male and female cones on the same tree. The male cones are small (1-5 cm long) and present for a short time – usually in spring –, falling as soon as they have shed their pollen. Similarly to several other conifers (e.g. firs, spruces and hemlocks, but not larches!) pine pollen are saccate, i.e. each pollen grain bears two bladders or sacs, enhancing pollen dispersal by wind. The female cones take 1.5-3 years to mature after pollination. Each cone is made up of several spirally arranged scales, with two seeds on each fertile scale. The seeds are mostly winged and anemophilous (wind-dispersed).

Resin accumulates in schizogenous resin ducts within various plant parts, such as the leaves and the twigs. The essential oil and balsam act as expectorant (helps dissolve and bring up mucus from the respiratory tract) and can be used in dermatology. The resin of various pines, called *Colophonium*, as well as the essential oil extracted from the needles of Scots pine, called *Pini silvestris aetheroleum*, and the essential oil gained from the balsam of maritime pine, called *Terebinthi aetheroleum ab pinum pinastrum*, are official in the Hungarian (Ph.Hg. VIII.) and European pharmacopoeias (Ph.Eur. 5.). The large, 2 cm long seeds of *P. pinea*, the so-called pine nuts, are edible.

### **Familia: Taxodiaceae – Bald cypress family**

The family includes large size conifers occurring mainly in the northern hemisphere, with needle-like or scale-like leaves. Some species are deciduous, while others are evergreen.

Species of *Taxodium* are extremely flood-tolerant conifers occurring in the southern part of North America, ranging from deciduous in the north to evergreen in the south. The needle-like leaves appear in two flat rows on either side of the shoot. The cones are globose and disintegrate to release the seeds. Bald cypress or swamp cypress (*T. distichum*) is deciduous, losing its leaves in winter (hence the name 'bald'). The trees growing in swamps have woody projections sent above the ground or water, the so-called cypress knees that are part of the root system. The function of these pneumatophores is to provide oxygen to the roots (hence they are also called respiratory/aerating roots), as well as structural support and stabilization to the large trees.

Giant sequoias (*Sequoiadendron giganteum*) are the world's largest trees in terms of volume, growing to an average height of 50-85 m and 6-8 m in diameter. The oldest known giant sequoia is 3500 years old (based on ring count). The leaves are evergreen, awl-like, 3-6 mm long, and arranged spirally on the shoots. The seed-cones are 4-7 cm long and typically remain green and closed for up to 20 years. The natural distribution of giant sequoia is restricted to California, but the trees are cultivated in other parts of North America and Europe, as well.

Dawn redwood (*Metasequoia glyptostroboides*) is a deciduous tree, native to China. Although shortest of the so-called redwoods – which also include coast redwood (*Sequoia sempervirens*) and the previously mentioned giant sequoia – it grows to at least 60 m in height.

## **Familia: Cupressaceae – Cypress family**

The cypress family comprises coniferous shrubs and trees with worldwide distribution, occurring in both the northern and southern hemisphere. The leaves are scale-like (*Biota*, *Thuja*) or needle-like (*Juniperus*). The seed-cones are either woody, leathery (e.g. *Thuja*) or berry-like and fleshy (*Juniperus*). Some species are valuable pharmaceutically (e.g. *Juniperus communis*), but poisonous plants dominate the family (e.g. *Biota*, *Juniperus sabina*, *Thuja*).

### Subfamily: Thujoideae

The members of this subfamily are native to North America and East Asia, with monoecious shrubs or trees. The leaves are small and scale-like, the cones are woody or leathery, with a smooth or horn-like tip – depending on the species. Eastern arborvitae (*Thuja occidentalis*) is native to North America, while oriental arborvitae (*Thuja/Biota orientalis*) to East Asia, both being popular ornamentals in Europe, as well. The cones of *T. occidentalis* are narrow, with pergament-like scales, whereas those of *T. orientalis* are fleshy, with small horns at the tip of each scale. The essential oil of *Thuja* contains the monoterpene thujone and other thujane-derivatives that are responsible for the toxicity of these plants. The sap or oil of the trees may cause pain, redness, swelling and blisters localized to the affected area (contact dermatitis).

### Subfamily: Cupressoideae

Monoecious shrubs or trees with scale-like leaves and woody cones. The cone-scales are shield-shaped. Cupresses are native to warm temperate regions in the northern hemisphere. The Mediterranean cypress (*Cupressus sempervirens*) is native to the eastern Mediterranean region. It is an evergreen tree to 35 m tall, with a conic crown, scale-like leaves and ovoid seed-cones that are green at first, and brown when mature. Mediterranean cypress is widely cultivated as an ornamental, and it is also known for its durable, scented wood.

### Subfamily: Juniperoideae

Mono- or dioecious shrubs, rarely trees, most often with rigid, needle-like leaves, arranged opposite or in whorls. The fleshy, berry-like cones are usually non-dehiscent.

Common juniper (*Juniperus communis*), the only juniper native to Hungary, is a low evergreen shrub with needle-like leaves in whorls of 3. The cone is berry-like, fleshy and globe-shaped, fused from 3 scales, at first green, than after 18 months of maturation bluish-black with a whitish film that rubs off. “Juniper berries” are dried and used to flavor meats and sauces, as well as alcoholic drinks like gin; and they have long been used as medicine in many cultures. Juniper berries act as strong diuretic and urinary tract disinfectant.

Savin juniper (*J. sabina*) is a dioecious species, native to the mountains of central and southern Europe, and western to central Asia, widely cultivated as an ornamental. It is a shrub, reaching 1-4 m tall. The leaves are of two forms, the juvenile, needle-like leaves are 5-10 mm long, while adult scale-leaves are 1-2 mm long. Similarly to common juniper, the cones are berry-like and blue-black. All parts of the plant are poisonous, causing inflammation and eczema on the skin externally, as well as damage to the mucous membranes and bleeding internally, due to toxic monoterpene compounds like sabinene, thujone, terpinen-ol etc. in the essential oil.

**Classis: TAXOPSIDA**

**Ordo: Taxales**

**Familia: Taxaceae – Yew family**

The yew family includes evergreen trees and shrubs, with spirally arranged leaves that appear two-ranked. The plants are dioecious, the male cones are 2-5 mm long and shed pollen in early spring; the female cones are highly reduced, with just one ovuliferous scale and one seed. As the seed matures, the ovuliferous scale develops into a fleshy aril partly enclosing the seed. The mature aril is brightly coloured, soft and juicy, and is eaten by birds which then disperse the seed. However, the seeds, just like all other plant parts, except the aril, are deadly poisonous to humans.

European yew (*Taxus baccata*) is native to most of Europe (including Hungary), northwest Africa and southwest Asia. Most parts of the tree are toxic – except the bright red aril surrounding the seed –, the main toxic component being the alkaloid taxane.

Pacific yew or western yew (*T. brevifolia*) is native to North America. The chemotherapy drug paclitaxel (taxol) used in breast, ovarian and lung cancer treatment, is derived from *T. brevifolia*. As this species was becoming scarce, the widespread use of paclitaxel was enabled when a semi-synthetic pathway was developed from extracts of other, cultivated yew species.

## **2. Subphylum: CYCADOPHYTINA – CYCADS**

**Classis: CYCADOPSIDA**

The class comprises palm-like gymnosperms, including the surviving order Cycadales and several extinct orders.

**Ordo: Cycadales**

**Familia: Cycadaceae – Cycad family**

*Cycas* is the type genus of the cycad family, native to the Old World, with the species concentrated around the equatorial regions. The plants are dioecious, and the family Cycadaceae is unique among the cycads in not forming seed cones on the female plants, but rather a group of leaf-like structures, each with seeds on the lower margins; and pollen cones on the male individuals. The best-known species is the sago palm or sago cycad (*C. revoluta*), native to Japan. The plants have a thick trunk up to 3 m tall, with glossy, feather-like, pinnate leaves that form a rosette, and the basal leaflets are gradually reduced to spines. All parts of the plant are toxic, and the seeds contain the highest level of the toxin cycasin, which causes gastrointestinal irritation, and in high enough doses leads to liver failure. On the other hand, sago palm is widely cultivated and the seed starch is used to produce sago flour. Unwashed cycad flour contains the neurotoxin BMAA ( $\beta$ -methylamino-L-alanine) that produces neurodegeneration. However, washing the cycad flour substantially reduces the BMAA-content.

Bread palms (*Encephalartos* sp.) are native to Africa, their name referring to the bread-like starchy food that can be prepared from the centre of the stem. The cone-like structures of *Encephalartos* can reach 45 kg.

### **Ordo: Welwitschiales**

#### **Familia: Welwitschiaceae**

*Welwitschia* is the only genus of the family Welwitschiaceae. The plant is considered a living fossil, named after the Austrian botanist, Friedrich Welwitsch, who discovered it in 1859. The plant's geographic distribution is limited to the Namib desert in Africa. *Welwitschia* grows from a short, thick, woody trunk, with only two leaves that continuously grow from their base, eventually reaching a length of 2-4 m, and usually become split into several strap-shaped sections. The species is dioecious, with separate male and female plants. The plant absorbs moisture through structures on its leaves, harvesting moisture originating from dew that forms during the night.

### **Ordo: Ephedrales**

#### **Familia: Ephedraceae**

The only family in the order Ephedrales comprises dioecious gymnosperm shrubs that occur in dry climates mainly in the northern hemisphere. The plants are called joint-pine, jointfir, Mormon-tea, and the Chinese name is mahuang. The scale-like leaves are opposite or in whorls of 3 or 4, resembling horsetails in their habit. Plants of the *Ephedra* genus have traditionally been used for a variety of medicinal purposes, including treatment of asthma, hay fever and the common cold. The alkaloids ephedrine and pseudoephedrine are active constituents of the Chinese Ma-huang (*E. sinica*) and other members of the genus. Ephedrine is a frequent component of nasal drops and suppositories against haemorrhoids. *E. distachya* is a 25-50 cm tall shrub that grows in some parts of Europe (including Hungary) and Asia. On the female plants the bracts surrounding the developing seed become fleshy and red and thus show a berry-like appearance.