

## **Subclassis: ROSIDAE**

The subclassis Rosidae, also known as “Choripetala”, includes about 60,000 species. Members tend to have perianths with unfused parts. Characteristic chemical compounds include polyacetylenes and various phenoloids, such as tannins.

### **Ordo: Saxifragales**

#### **Familia: Grossulariaceae – Currant family**

The Grossulariaceae are shrubs or small trees, with spiral leaves and sometimes spines. The small, 5-merous, greenish flowers are arranged in racemes. The ovary is inferior, the fruit is a false berry.

*Ribes* is a genus native throughout the temperate regions of the northern hemisphere, including the edible currants blackcurrant (*R. nigrum*), redcurrant (*R. rubrum*) and gooseberries (*R. uva-crispa*). The leaves of *R. nigrum* are diuretic and, due to their flavonoid content, antihypertensive (lower blood pressure). The syrup made of the berries is rich in anthocyanins with antioxidant effect.

#### **Familia: Crassulaceae – Stonecrop family**

“Stonecrop” means “thick or succulent little plant”. The Crassulaceae consist of herbs, shrubs or rarely trees. Members of the family often grow in arid environments, but also occur in mesic or moist habitats with distributions worldwide, except Australia and Pacific islands. The leaves are characteristically succulent. The flowers are usually bisexual, actinomorphic, the perianth is heterochlamydeous. The corolla consists of typically 5, rarely 4 or 6 petals. The gynoecium is apocarpous, with a superior ovary. Nectaries are present, consisting of scale-like structures at the base of the carpels. The fruit is a follicle, rarely a capsule, with very little seeds, which are rich both in oils and proteins. The stem xylem is usually in a continuous cylinder, leaves often have Kranz anatomy, with Crassulacean Acid Metabolism (CAM) photosynthesis. The succulent plant parts are rich in mucilage. Characteristic chemical compounds include alkaloids, tannins, flavonoids and proanthocyanidins.

Stonecrops (*Sedum*) vary from annual creeping herbs to shrubs. Biting stonecrop (*S. acre*) contains high quantities of piperidine alkaloids (e.g. sedanine), which give it a sharp, peppery, acrid taste. Consumption may cause irritation of the mucous membranes, cramps and paralysis. Liveforevers (*Sempervivum*), also known as houseleeks, grow in rosettes. The plants typically grow several years before flowering. The extracts of common houseleek (*S. tectorum*) are excellent antiphlogistics in treatment of the oral cavity or the ears. Both stonecrops and liveforevers are widely cultivated, with several ornamental varieties, especially for rock gardens.

Exotic genera include *Cotyledon*, *Kalanchoe*, *Aeonium* and *Echeveria*. The *Cotyledon* and *Kalanchoe* species contain bufadienolide cardiac glycosides, which can cause cardiac poisoning, particularly in grazing animals.

#### **Familia: Saxifragaceae – Saxifrage family**

The Saxifragaceae (saxifrage meaning “rock breaking” in Latin) consist of perennial herbs or subshrubs, widely distributed especially in the northern temperate and cold regions. The stems and the spirally arranged leaves are sometimes succulent. The flowers are bisexual, actinomorphic, the perianth is heterochlamydeous, with 5 (3-10) sepals and petals. The

stamens are variable in number, the gynoecium is syncarpous and often lobed. A nectariferous ovary disk is often present. The fruit is a usually septicidal capsule.

Significant genera, mostly cultivated as ornamentals, include saxifrages or stone-breakers (*Saxifraga*), false spireas or false goat's beards (*Astilbe*) and elephant's ears (*Bergenia*). *B. crassifolia* and *B. cordifolia* contain high levels of arbutine and bergenin, and are known for their immunomodulatory effect. Alternate-leaved golden saxifrage (*Chrysosplenium alternifolium*) is native to Hungary, living in shady, wet habitats.

### **Familia: Droseraceae – Sundew family**

Droseraceae consist of carnivorous plants: sundews (*Drosera*) and the even more famous Venus fly-trap (*Dionaea muscipula*). These herbaceous plants derive some or most of their nutrients from trapping and consuming animals, typically insects and other arthropods. They grow in places where the soil is poor in nutrients, especially nitrogen, such as acidic bogs. The sundews have tentacular leaves that produce sticky substances to trap prey, and the Venus fly-trap has leaves that form traps that close when disturbed. The third genus contains the single, aquatic species *Aldrovanda vesiculosa*, which traps prey underwater. The latter species, along with common or round-leaved sundew (*D. rotundifolia*), occur in Hungary, as well.

*Drosera* species are rich in naphthoquinones and flavonoids, and show great efficacy as an anti-inflammatory, antispasmodic and antitussive. Since many sundew species are considered endangered or threatened in several countries, most of them cannot be collected for medical purposes. The Madagascan species *D. ramantacea* is commercially available as a drug source.

## **Ordo: Rosales**

### **Familia: Rosaceae - Rose family**

The Rosaceae consist of trees, shrubs or herbs, with worldwide distribution, but more concentrated in the north temperate regions. The leaves are spiral (rarely opposite), simple or compound, undivided to divided. The inflorescence is variable. The flowers are bisexual and actinomorphic, the receptacle is sometimes expanded or sunken. The perianth is heterochlamydeous, usually pentamerous, a hypanthium present. The calyx is chorisepalous with 5 (3-10) sepals, the corolla is choripetalous, with 5 (3-10) petals. The stamens are 20-∞, arranged in whorls. The gynoecium is syncarpous or apocarpous, with a superior or inferior ovary, 1-∞ carpels and 1-∞ locules. Nectaries are often present on the hypanthium. The fruit is a drupe, pome, hip, follicle, achene or capsule. The seeds are usually without endosperm.

The family is economically very important as the source of many cultivated fruits, including *Fragaria* (strawberry), *Rubus* (blackberry, raspberry), *Malus* (apple), *Pyrus* (pear) and *Prunus* (almond, apricot, cherry, peach, plum); as well as essential oils (e.g. *Rosa*); and numerous ornamentals, such as *Cotoneaster*, *Pyracantha*, *Rosa* and *Spiraea*.

The Rosaceae are traditionally classified into four subfamilies.

### **Subfamily: Spiraeoideae**

This subfamily includes shrubs, subshrubs and rarely trees. The gynoecium is apocarpous, forming an aggregate of follicles. The small, white flowers of meadowsweet (*Spiraea*) species form dense racemes. Representatives native to Hungary include *S. media*, living in dry, rocky habitats and *Aruncus sylvestris*, occurring in wet habitats.

### Subfamily: Rosoideae

Rosoideae includes perennial herbs and shrubs, with palmately or pinnately compound leaves. The perianth is pentamerous, and there are numerous stamens and carpels in the flowers. The apocarpous gynoecium develops into an aggregate of drupelets (e.g. *Rubus*) or aggregate of achenes, the receptacle varying from expanded and fleshy (e.g. *Fragaria*) to sunken (e.g. the hips of *Rosa*). Floral formula: \*  $Ca_5Co_5A_{\infty}G_{(\infty)}$ .

Several of our important fruit crops belong to this subfamily, as well as numerous medicinal plants. The medicinal value of the latter group is due to the special composition of organic acids, esters, tannins and flavonoids (e.g. *Agrimonia*, *Alchemilla*, *Filipendula*, *Potentilla*, *Sanguisorba* species).

The genus *Rosa* is the most remarkable, with numerous wild species, as well as widely cultivated ornamentals and valuable medicinal plants. The pseudofruit (*Rosae pseudofructus*) of rosehip or dog rose (*Rosa canina*) and alpine rose (*R. pendulina*) is the most popular drug with high vitamin C content, a frequent component of teas, syrups and jams. *R. canina* is native to Europe, northwest Africa and western Asia. It is a deciduous shrub, its stems are covered with sharp, hooked prickles, the leaves are pinnately compound, with 5-7 leaflets. The flowers are usually pale pink. Rosehips are the aggregates of achenes, surrounded by the fleshy, red receptacle. *R. pendulina* can be found in various mountains of Europe. Prickles are scarce on shoots, and the pinnately compound leaves consist of 7-11 leaflets. The flowers are bright pink, and the pseudofruit is pendulous (hence the name "pendulina"). Gallic rose (*R. gallica*), also known as French rose, is native to southern and central Europe, eastwards to Turkey and the Caucasus. The cultivar *R. gallica* cv. *officinalis* is also called apothecary's rose, referring to its petal extracts being used in dermatological preparations. The deep red or pink petals of *R. gallica* prov. *trigintipetala* are the source of the world-famous Bulgarian rose (essential) oil.

*Rubus* species, like raspberry (*R. idaeus*) and European dewberry or blackberry (*R. caesius*) are also valued for their medicinal properties. These plants have woody stems with prickles, spines and bristles. The *Rubus* fruit, sometimes called a bramble fruit, is an aggregate of drupelets. The syrup made of the fruits of raspberry and dewberry is a popular drink and can make the taste of various medicinal preparations more agreeable. The tea prepared from the leaves of *Rubus* species has a pleasant flavour and a mild anti-diarrheal property.

Woodland strawberry (*Fragaria vesca*), also known as wild (European) strawberry, occurs naturally throughout the northern hemisphere. The plant primarily propagates via runners. The leaves are palmately compound, with 3 leaflets. The pentamerous flowers have white petals. The achene fruits are clustered on the surface of the expanded, fleshy, red receptacle. Several strawberry cultivars are popular for their tasty fruits. The leaves can be made into a tea with a pleasant flavor and mild astringent properties.

Common agrimony (*Agrimonia eupatoria*) has dark green, pinnate leaves and a spike of yellow flowers at the shoot tip. The curved hairs on the fruits help fruit dispersal by sticking to any animal or person coming in contact with the plant. Agrimony has been stated to have medical properties since the Roman times. It is a mild astringent, applied in the case of pharyngitis (sore throat) and gastroenteritis (inflammation of the gastrointestinal tract). It may also help gallstone removal.

Lady's mantle (*Alchemilla vulgaris*) is a perennial herb with cloak-like, slightly lobed leaves. The numerous flowers are small and yellowish-green. Due to its tannins, it is an effective astringent, with haemostatic properties (stops bleeding), particularly used in gynecological problems.

Meadowsweet (*Filipendula ulmaria*), also known as queen of the meadow, pride of the meadow and meadow-wort, is a perennial herb that grows in damp meadows. It is native throughout Europe and western Asia. The pinnate leaves are made up by serrate leaflets, the upper side of which is dark green, while the lower side is whitish. The creamy white flowers are clustered in irregularly branched cymes, having a strong, sweet scent. The whole herb possesses a pleasant taste and flavor, and is frequently used to flavor wine, beer and vinegars. The plant can be used in the treatment of diarrhea. The flowers, when made into a tea, are a comfort to flu sufferers, due to their analgesic (relieves pain) and antipyretic (reduces fever) properties. The active ingredients include salicin, flavone-glycosides, essential oil and tannins. In 1897 Felix Hoffmann created a synthetically altered version of salicin, derived from this species, which caused less digestive upset than pure salicylic acid. The new drug, acetylsalicylic acid, was named aspirin by Hoffmann's employer Bayer AG after the old botanical name for meadowsweet, *Spiraea ulmaria*.

Common tormentil (*Potentilla erecta*) is an herbaceous perennial, growing wild all over Asia and northern Europe. The rhizomatous root is thick, with a reddish color, due to the presence of anthocyanidins and phenolic substances, called phlobaphenes (tormentil red). The palmately compound leaves consist of three leaflets. Exceptionally, this species has only four, yellow petals. A lotion prepared from the dried root (*Tormentillae rhizoma*) has been used both as medicine to treat a number of ailments (to stop bleedings and against diarrhea), for food in times of need and to dye leather red. The plant is particularly used in herbal medicine as an astringent because of its tannin content, which is unusually high for an herbaceous plant.

Common silverweed (*Potentilla anserina*) is a perennial herbaceous plant with creeping red stolons, native throughout the northern hemisphere. The leaves are evenly pinnate, covered with silky white hairs, particularly on the underside (the plant got its name from this silvery appearance). These hairs are also present on the stem and the stolons. The solitary flowers have five yellow petals. The fruit is a cluster of dry achenes. Herbal tea from the roots is used as antispasmodic for diarrhea. The plant has also been cultivated as a food crop for its edible roots.

Finally, the flowers of *Hagenia abyssinica*, native to central Africa, are used as antihelminthic, due to the presence of acyl-floroglucin derivatives.

#### Subfamily: Maloideae

The Maloideae consists of trees and shrubs, distributed mainly in the northern temperate regions, but also occurring in the Far East and South-America. The subfamily has great economical importance, containing several pome fruits with excellent aroma substances, organic acids and esters. Floral formula:  $* C_5 C_0 A_{10+5+5} \overline{G}_{(1-5)}$ . The pentamerous flowers, with an inferior ovary, develop into a pseudo-fruit, called a pome. In *Malus*, *Pyrus* and *Cydonia* the original follicles, having a pergamen-like fruit wall, are surrounded and united by the fleshy receptacle and the sepals. Stone cells (sclereids) frequently occur in the fruit flesh (e.g. in pears and quinces). In *Crataegus* and *Mespilus* the pome contains 1-5 hard-walled pyrenes, each with a single seed, resembling the "stones" of plums. Pome fruits are rich in flavonoids and mucilage (pectin).

Members of the *Malus* genus live in temperate regions of Eurasia, being important as fruit trees and ornamentals. Thousands of apple (*M. domestica*) cultivars are known, varying in yield and fruit characteristics. European wild apple (*M. silvestris*) is a tree with thorns, often used as rootstock for apple cultivars.

Pears (*Pyrus*) live in the temperate and subtropical areas of Eurasia. The pome fruit of pears is full of stone cells, and rich in pectin and fibers. The leaves are rich in tannins, and

especially in arbutin, which makes them an excellent anti-inflammatory agent in the urinary tract. Important representatives are European pear (*P. communis*) and wild pear (*P. pyraster*).

Quince (*Cydonia oblonga*) is native to Asia. It is a small deciduous tree, the leaves are densely pubescent with fine white hairs. The flowers are large (cca. 5 cm across), with 5 white or pink petals. The pome fruit can be either apple-shaped or pear shaped, depending on the cultivar. In quince the mucilage accumulates in the seed coat, together with flavonoids, providing a valuable drug for medical and cosmetic purposes.

Rowan or mountain ash (*Sorbus*) species are trees or shrubs, distributed in temperate northern regions. European rowan (*S. aucuparia*) has pinnate leaves, with 9-19 serrate leaflets. The inflorescence is a creamy-white corymb, the fruit is a small, bright red or orange pome. Like other rowans, it is widely grown as an ornamental tree. The fresh fruits are rich in vitamin C, but also contain the carcinogenic (cancer-causing) parasorbic acid, which is, however neutralized by cooking the berries (e.g. into jams). The leaves and fruits of *Sorbus* species – similarly to many other Rosaceae representatives – accumulate large amounts of sorbitol.

Hawthorn or thornapple (*Crataegus*) is a large genus of shrubs and small trees, with small pome fruits and thorny branches, native to temperate regions of the northern hemisphere. The leaves of most species have lobed or serrate margins. The flowers have 5 white or pale pink petals and 20 stamens with pink or red anthers. The fruit, sometimes known as a “haw”, is berry-like, but is structurally a pome. Several species of hawthorn have been used in traditional medicine, the extracts are used to treat chronic cardiac insufficiency (heart failure) and to lower blood pressure. Another use of hawthorn is as a mild sedative to promote sleep. Active ingredients of hawthorns include tannins, flavonoids, proanthocyanidins and phenolic acids. The two most wide-spread species in Hungary are common hawthorn (*C. monogyna*), with deeply lobed leaves and just one style in the flowers; and midland hawthorn or woodland hawthorn (*C. oxyacantha* or *C. laevigata*), with shallowly lobed leaves and 2 or 3 styles in the flowers.

Finally, we should mention a few ornamental shrubs, like flowering or Japanese quince (*Chaenomeles japonica*), firethorn (*Pyracantha coccinea*), cotoneasters (*Cotoneaster*), and serviceberry or saskatoon (*Amelanchier*).

#### Subfamily: Prunoideae

The Prunoideae consists of trees and shrubs with European and Asian origin, including fruit trees widely cultivated in the temperate and Mediterranean areas. Blooming typically precedes foliation. The inflorescence is gradually reduced, from the long raceme (e.g. *Padus*), through the short racemose corymb (e.g. *Cerasus mahaleb*) and 1-5-flowered cherry (*C. avium*) to the solitary flowers of plum (*Prunus*), almond (*Amygdalus*), peach (*Persica*) and apricot (*Armeniaca*). The flowers are pentamerous, the petals are white or pink; the stamens are arranged in 3 whorls, with 5 or 10 stamens in each whorl; and the gynoecium comprises a single pistil bearing one ovule, partly embedded in the nectariferous, cup-like receptacle (hypanthium). Floral formula: \*  $Ca_5Co_5A_{10+10+10}$  or  $10+5+5G_{(1)}$ . The fruit is a drupe, with a leathery exocarp, fleshy mesocarp and hard endocarp (stone) with a single seed inside. Besides the compounds that are characteristic to the whole family, Prunoideae species frequently contain cyanogenic glycosides (e.g. amygdaline, prunasine) and gum resins.

Previously, most Prunoideae species were classified into the genus *Prunus*, but recently they have been separated into several genera. Almond (*Amygdalus communis* or *Prunus amygdalus*) is the earliest blooming representative within the subfamily. Depending on the chemical compounds in the seeds, we can distinguish sweet almond (*A. communis* provar. *dulcis*) and bitter almond (*A. c.* provar. *amara*), the latter containing much higher

levels of cyanogenic glycosides. The seeds are used in confectionery products, and almond oil is used for medical purposes, as well. Apricot (*Armeniaca vulgaris* or *P. armeniaca*) is of Asian origin, but Hungary is also famous for its apricot cultivars. The velvety fruits of peach (*Persica vulgaris* or *Prunus persica*), as well as the smooth fruits of nectarine (provar. *mucipersica*) are also popular. The fruit stalks (pedicels) of both (sweet) cherry (*Cerasus avium* or *P. avium*) and sour cherry (*C. vulgaris* or *P. cerasus/P. vulgaris*) are used in herbal medicine as diuretics and adjuvants in treatment of heart failure. The fruits of plum (*P. domestica*) are mildly laxative, consumed either fresh or cooked (e.g. jam). Blackthorn or sloe (*P. spinosa*) is a large shrub with spiny branches and sour, astringent fruits, due to the high tannin content. The flowers are rich in flavonoids and are frequent components of herb teas.

### **Ordo: Fabales**

This order includes about 13,000 species, characterized by compound leaves, mostly zygomorphic flowers and a superior ovary, out of which a legume will develop (hence the name “legumes”). The seeds do not have an endosperm, nutrients are accumulated by the two cotyledons. Several species are important as food and fodder or medicinal plants, but some are poisonous. Families within the order have a lot in common, consequently some authors treat them as subfamilies within the family Fabaceae (including Mimosoideae, Caesalpinioideae and Faboideae). Here we discuss them as separate families.

#### **Familia: Mimosaceae**

The Mimosaceae are trees or herbs, widespread in hot, arid areas. Members of the family are dominant species in some ecosystems, such as *Acacia* species in parts of Africa and Australia. The leaves are bipinnate, basal pulvini often present, sometimes functioning in tactile (“thigmonastic”) leaflet folding responses (*Mimosa* spp.). Flowers are clustered in a flower head or a compound inflorescence. The flowers are actinomorphic, with a corolla of five, distinct or basally fused petals. A hypanthium is sometimes present. Stamens are numerous, colorful, distinct or basally fused.

*Mimosa catechu* (*Acacia catechu*) is a deciduous, thorny tree, found in Asia and the Indian Ocean area. Through derivatives of the flavanols in its extracts, the species has lent its name to the important catechins, catechols and catecholamins. The extract, called catechu, is used to treat sore throats and diarrhea. The tree’s seeds are a good source of protein.

Gum acacia or gum Arabic tree (*A. senegal*), a small deciduous tree, is native to semi-desert regions of Sub-Saharan Africa, as well as Oman, Pakistan and northwestern India. It produces gum arabic, which is used as a food additive and as a cosmetic; for soothing mucous membranes of the intestine and to treat inflamed skin. Due to its astringent properties, it is used to treat bleeding, diarrhea and upper respiratory tract infections. The gum is drained from cuts in the bark, and an individual tree will yield 200 to 300 grams.

#### **Familia: Caesalpinaceae**

Caesalpinaceae consist of trees, shrubs and lianas, with distributions in the subtropical, Mediterranean and temperate regions. The leaves are pinnate or bipinnate, the flowers are generally zygomorphic with usually 5 or 10 distinct stamens and a corolla with typically 5 distinct petals, the posterior, median petal inner to (overlapped by) the two lateral petals. The fruit is a legume.

Important representatives include *Cassia* species, widespread in Asia and Africa, being characterized by the presence of various anthraquinones. The leaves are evenly pinnate, the

yellow flowers are arranged in racemes. Golden shower tree (*C. fistula*) is native to southern Asia, widely grown as an ornamental in tropical and subtropical areas, and also being the national tree of Thailand. The yellow flowers are produced in pendulous racemes, the fruit is a large legume, with a pungent odor and containing several seeds, which are poisonous. Its fruit pulp is used as a laxative, due to abundant anthraquinones.

Tinnevely senna (*C. angustifolia*), native to southern India, is a shrub, the leaves consisting of 4-6 pairs of leaflets. Alexandrian senna (*C. senna* or *C. acutifolia*) is native to Egypt and Sudan. The legumes are flattened, reniform and contain about 6 seeds. The plants have been used since ancient times in the form of senna pods, or as a tea made from the leaves, as a laxative, attributed to various sennosides.

Tamarind (*Tamarindus indica*) is widely distributed throughout the tropical belt, from Africa to South Asia, but also introduced to Mexico and South America. The red and yellow flowers are borne in small racemes. The fruit is an indehiscent legume, sometimes called a pod, with a hard, brown shell and a fleshy, juicy pulp. It tastes sweet and sour, containing high levels of acids, sugars and vitamin B. The pulp, often consumed in the form of jams or syrups, is laxative.

The carob tree (*Ceratonia siliqua*) is an evergreen shrub, native to the Mediterranean region, as well as Iran and the Middle East. It is cultivated for its edible seed pods (legumes). The leaves are pinnately compound, with or without a terminal leaflet. The flowers are small and numerous, spirally arranged in catkin-like racemes, borne on spurs from old wood and even on the trunk (cauliflory). The pods take a full year to develop and ripen. Actually the dried (and sometimes roasted) pods are consumed, and not the seeds. Carob has also been known as a common sweetener, as an ingredient in cakes and cookies, or even as a substitute for chocolate. The seeds, also known as locust beans, are the source of locust bean gum, a thickening agent used in numerous processed foods.

Further species of interest include the cauliflorous Judas tree (*Cercis siliquastrum*), with bright pink flowers and kidney-shaped leaves; honey locust (*Gleditsia triacanthos*), a deciduous tree, native to eastern North America, with branched thorns growing out of the branches, and conspicuous, 20-30-cm long legumes; or flamboyant (*Delonix regia*), an ornamental tree with a spectacular display of orange red flowers.

### **Familia: Fabaceae / Papilionaceae – Bean / Pea family**

The Fabaceae consist of herbs, shrubs, trees or vines, with a worldwide distribution. The roots of many members have a symbiotic association with nitrogen-fixing bacteria (*Rhizobium* spp.), which induce formation of root nodules. Spines are sometimes present on stems. The leaves are usually compound (pinnate, bipinnate, trifoliolate, rarely palmate), generally spirally arranged, leaf or leaflet tendrils are common. The inflorescence is variable, typically bracteates. The “papilionaceous” flowers are zygomorphic, with connate stamens (either 10 monadelphous or 9+1 diadelphous) and a corolla with five petals, consisting of a large, median, usually posterior petal (the “banner” or “standard”), which is outer to (overlapping) the adjacent petals, two lateral “wing” petals (overlapped by the banner), and two anterior, distally fused “keel” petals. The gynoecium is unicarpellous, with a superior ovary. Floral formula:  $Ca_{(5)}Co_{5}A_{(10) \text{ or } (9)+1}G_{\underline{1}}$ . Nectaries are often present as a ring at the base of the ovary. The fruit is a legume, sometimes indehiscent (e.g. *Arachis*, peanut), winged (a samara), drupe-like, or divided into transverse partitions (a loment).

Economically, legumes are one of the most important plant groups, being the source of numerous pulses (such as *Arachis hypogaea*, peanut; *Glycine max*, soybeans; *Lens culinaris*, lentil; *Phaseolus* spp., beans; *Pisum sativum*, peas); fodder and soil rotation plants (such as

*Medicago sativa*, alfalfa; or *Trifolium* spp., clovers); oils, timber trees, gums, dyes and insecticides.

The seeds are rich in proteins and starch (beans, peas, lentils), as well as oils (peanut and soybean). Other seeds accumulate mucilaginous polysaccharides (e.g. fenugreek, *Trigonella*; milk-vetch, *Astragalus*). Seeds of Fabaceae species may contain lectins, which are glycoproteins with specific sugar binding sites. Some lectins are used in blood typing (*Canavalia*, *Dolichos*, *Vicia*). Some (e.g. robin in *Robinia pseudoacacia*, phasin in *Phaseolus* spp., abrin in *Abrus precatorius*, favin in *Vicia faba*, and concanavalin-A in *Canavalia ensiformis*) are toxic. Non-proteogenic, toxic amino acids also occur in some species, canavanin being the most significant (e.g. in *Lathyrus* and *Vicia* spp.), causing various forms of lathyrism (neurolathyrism or osteolathyrism).

Common bean (*Phaseolus vulgaris*) is an herbaceous annual plant, domesticated in ancient Mesoamerica and the Andes, now grown worldwide for its edible bean, popular both dry and as a green bean. The leaves consist of three leaflets, the flowers are white, pink or purple. The pods contain 4 to 6 kidney-shaped beans. The toxic compound phytohemagglutinin, a lectin, is present in many varieties of common bean, but is especially concentrated in red kidney beans. Phytohaemagglutinin can be deactivated by cooking beans at 100°C for 10 minutes.

The other major type of beans is broad bean or fava bean (*Vicia faba*), native to North Africa and southwest Asia, and extensively cultivated elsewhere. The leaves are pinnate, with 2-7 leaflets. The flowers are white, with a black spot on the wing petals. Each pod contains 3-8 flattened seeds. Broad beans are important in the cuisine of several countries like Iran, Egypt, Greece or Ethiopia. Raw broad beans contain the alkaloids vicine, isouramil and convicine, which can induce hemolytic anemia in persons with the hereditary condition glucose-6-phosphate dehydrogenase deficiency. This potentially fatal condition is called “favism” after the fava bean. Areas of origin of the bean correspond to malarial areas, and epidemiological studies suggest that the hemolysis resulting from favism acts as a protection from malaria, because certain species of malarial protozoa are very sensitive to oxidative damage. Broad beans are rich in L-dopa, a substance used in the treatment of Parkinson’s disease.

Alkaloids also occur frequently in the family. The most significant ones are the quinolizidine type alkaloids in the genera *Sarothamnus*, *Laburnum* and *Lupinus*. Common laburnum (*Laburnum anagyroides*) is a small tree or large shrub, native to central and southern Europe. The leaves are made up of three leaflets, the flowers are arranged in pendulous racemes. The fruits are legumes with large number of seeds, which contain cytisine, an alkaloid poisonous to humans, as well as goats and horses, but not to hares and deer. Pharmacologically it exhibits similar effects to nicotine, therefore cytisine is used to aid smoking cessation. Common broom (*Sarothamnus scoparius*) is a deciduous shrub native to western and central Europe. It has green shoots with small trifoliate leaves. Flowers are golden yellow, and legumes mature to black. Its main alkaloid, sparteine (being dominant also in *Lupinus mutabilis*) is an antiarrhythmic agent.

Calabar bean (*Physostigma venenosum*) is native to tropical Africa. The plant is a climbing perennial, with woody stem at the base. The flowers are pink or purple. The seed pods (legumes) contain 2 to 3 chocolate-brown seeds, which are rich in physostigmine, a reversible cholinesterase inhibitor alkaloid. Calabar bean is poisonous to humans, disrupting communication between nerves and muscles. Today physostigmine is an important drug, used in the treatment of anticholinergic syndrome and glaucoma.

Soybean (*Glycine max* or *G. soja*) is native to East Asia, classed as an oilseed rather than a pulse. The pods, stems and leaves are covered with fine hairs. The leaves are trifoliate. The white, pink or purple flowers are borne in the axil of the leaf. Soybean is an

important source of protein in the diet of humans and animals, in the form of products like textured vegetable protein. Soy vegetable oil is another valuable product of soybeans. Traditional non-fermented food uses include soymilk, and from the latter tofu and tofu skin, which can be consumed by persons affected by lactose intolerance. Fermented foods include soy sauce, fermented bean paste and tempeh. For human consumption, soybeans must be cooked with “wet” heat in order to destroy the tripsin inhibitor lectin.

Alfalfa (*Medicago*) and clover or trefoil (*Trifolium*) species are cultivated as important forage crops. *M. sativa* is a perennial legume, with trifoliate leaves and clusters of small purple flowers. The genus *Trifolium* includes annual, biennial and short-lived perennial herbs. The most widely cultivated species are white clover (*T. repens*) and (*T. pratense*). Clover flowers are important nectar sources for honeybees, similarly to sweet clover (*Melilotus*) species. Yellow sweet clover (*M. officinalis*) and white sweet clover (*M. albus*) have a characteristic sweet odor, intensified by drying, derived from coumarin. Coumarin converts to dicumarol, which is a powerful anticoagulant (stops blood from clotting), and can be used as a medication for thrombotic disorders.

Black locust (*Robinia pseudoacacia*) is a tree native to North America, but naturalized also in Europe, Asia and Africa. The leaves are pinnate with 9-19 oval leaflets, each leaf having a pair of thorns at the base. The fragrant white flowers are borne in pendulous racemes, and are considered edible. The brown or black legumes contain 4-10 seeds. Black locust is a major honey plant in several countries, including the U.S., China and Hungary. The flowers and leaves are rich in flavonoids. Flowers are used as antispasmodic and to lower stomach acid. Leaves are diuretic and antihypertensive.

The pagoda tree (*Sophora japonica*) is native to eastern Asia. The leaves are pinnate, with 9-21 lanceolate leaflets, and the greenish yellow flowers are clustered in axillary racemes. Flower buds are rich in the flavonoid glycoside rutin (10-15%), providing the most important source for pharmaceutical purposes.

Spiny retharow (*Ononis spinosa*) is a semi-shrub with spines. The lower leaves are trifoliate, the upper leaves are simple, and the pink or white flowers are in the axil of the leaf. It contains triterpene saponins, which act as diuretic.

Liquorice (*Glycyrrhiza glabra*) is an herbaceous perennial, with pinnate leaves, and purple flowers produced in a loose inflorescence. The characteristic flavor of liquorice comes mainly from anethole, a compound also found in anise and fennel. Much of the sweetness comes from glycyrrhizin, a compound sweeter than sugar. The root (*Liquiritiae radix*) and its extracts act as expectorant and are used in the treatment of gastrointestinal ulcers.

The peanut or groundnut (*Arachis hypogaea*) has opposite, pinnate leaves with four leaflets. The flowers are yellow with reddish veining. After pollination, legumes develop underground.

Fenugreek (*Trigonella foenum-graecum*) is cultivated world-wide as a semi-arid crop. It is used both as an herb (the leaves) and as a spice (the seeds). Fenugreek seeds are widely used as galactagogue, to increase milk supply in lactating women. The seeds are also valued for their antidiabetic effect, reducing serum glucose levels and improving glucose tolerance. The seeds are a rich source of the polysaccharide galactomannan, as well as saponins such as diosgenin. Other bioactive constituents include mucilage, volatile oil and alkaloids.

The guar bean (*Cyamopsis tetragonoloba*) is an annual legume, the source of guar gum. Guar beans have a large endosperm that contains galactomannan (guaran), a substance which forms a gel in water. This is commonly known as guar gum, which is used in dairy products like ice cream, and as a stabilizer in cheese and cold-meat processing. Guar beans can be used in the therapy of diabetes.

*Astragalus gummifer* gum or Tragacanth gum is the dried resinous exudate obtained from goat's thorn (*Astragalus gummifer*, *A. tragacanthus*) trees, located in southwestern Europe, Greece, Turkey and Iran.

*Myroxylon balsamum* is a tree native to Central and South America. *M. balsamum* var. *pereirae* is the source of Peru balsam, while *M. balsamum* var. *balsamum* is the source of Tolu balsam. Balsam of Peru has been used as a cough suppressant, in suppositories for hemorrhoids, and topically as a treatment of wounds and ulcers. Peru balsam can also be found in hair tonics, antidandruff preparations and as a natural fragrance in soaps, lotions, creams etc.

### **Ordo: Myrtales**

#### **Familia: Myrtaceae – Myrtle family**

The family includes trees or shrubs, with distributions in the Mediterranean, subtropical and tropical regions. The stems have secretory cavities. Leaves are simple, glandular-punctate, and often coriaceous. The flowers are actinomorphic 4- or 5-merous, but stamens are numerous. Perianth segments are sometimes (e.g. in *Eucalyptus*) fused into a lidlike calyptra (operculum). The gynoecium is syncarpous, with an inferior ovary. Nectaries are present, as a disk atop the ovary or on the inner hypanthium. The fruit is a berry or loculicidal capsule. The species are characterized by the presence of essential oil.

Common or true myrtle (*Myrtus communis*) is native to southern Europe and North Africa. The plant is an evergreen shrub or small tree. The leaf is entire, with a fragrant essential oil. The star-like flower has 5 sepals and 5 white petals and numerous stamens. The fruit is a round blue-back berry containing several seeds. The essential oil is excellent at clearing the airways.

Clove tree (*Syzygium aromaticum*) is an evergreen native to Indonesia, having large square leaves and bright red flowers in numerous groups of terminal clusters. Cloves are the dried aromatic flower buds, consisting of a long calyx, terminating in four spreading sepals and four unopened petals which form a small ball in the center. Cloves can be used as a spice either whole or in a ground form. Cloves are used as a carminative and topically to relieve toothache. The main constituent of the essential oil is eugenol, reaching up to 80% in cultivated varieties.

Members of the genus *Eucalyptus* dominate the tree flora of Australia, and a few species are native to Asia. Many are known as gum trees, because they exude copious sap from any break in the bark. They are fast-growing source of wood, their oil functions as a natural insecticide, and they are sometimes used to drain swamps and thereby reduce the risk of malaria. Nearly all *Eucalyptus* are evergreen, the leaves are usually lanceolate, and covered with oil glands. Flowers have numerous fluffy stamens, enclosed in a cup known as operculum, composed of the fused sepals or petals or both. The woody fruits are cone-shaped capsules that have valves at the end which open to release the seeds. The essential oil extracted from *Eucalyptus* leaves contains compounds that are powerful natural disinfectants and can be toxic in large quantities. Several marsupial herbivores, notably koalas and some possums, are relatively tolerant of it. The flowers produce a great abundance of nectar, providing food for many pollinators, including insects, birds, bats and possums; and being the source of a high-quality monofloral honey. Eucalyptus oil is readily steam distilled from the leaves and can be used for cleaning, deodorizing, and in very small quantities in sweets and cough drops. It also has antimicrobial and insect repellent properties. Tasmanian blue gum (*E. globulus*) is one of the most widely cultivated trees in Australia.

*Melaleuca* species are also endemic to Australia. They are shrubs or trees, often with flaky, exfoliating bark (hence one of the common names “paperbark”). The leaves are evergreen, alternately arranged, ovate to lanceolate, with an entire margin. The flowers are produced in dense clusters, each flower with small petals and a tight bundle of stamens. The fruit is a small capsule containing numerous minute seeds. One well-known melaleuca, *M. alternifolia*, is notable for its essential oil, which is both antifungal and antibiotic, while safely usable for topical applications. This is produced on a commercial scale, and marketed as tea tree oil. Cajeput oil is obtained from *M. leucadendron*, the principal constituent of the essential oil being cineol (45-55%). The oil is used as antiseptic, anthelmintic and diaphoretic. Broad-leaved paperbark (*M. viridiflora*) is the source of Niaouli oil. The infusion from the leaves is drunk, inhaled or used for bathing to coughs, colds, headache, fever and influenza.

Other species of interest include the tropical gua(ja)va trees (*Psidium guajava*), cultivated for their vitamin-rich fruits; and spices like allspice (*Pimenta*).

### **Familia: Punicaceae – Pomegranate family**

The Punicaceae consist of shrubs or small trees, native to the Mediterranean region and the Himalayas. Pomegranate (*Punica granatum*) is a deciduous shrub, cultivated from ancient times. The leaves are glossy, narrow oblong, entire; the flowers are bright red, with four to five petals. The edible fruit is a false berry, with a thick, reddish skin and about 600 seeds. Each seed has a surrounding water-laden pulp – the aril – ranging in color from white to deep red or purple. This aril is the edible part of the fruit. The seeds are embedded in a white, spongy, astringent pulp. Pomegranate juice is a good source of vitamin C and B<sub>5</sub>, as well as potassium, tannins and flavonoids, and can be effective in reducing cardiovascular disease risk factors. The root and bark are used as anthelmintic in veterinary medicine.

### **Familia: Lythraceae – Loosestrife family**

The members of the family have a worldwide distribution, tropical species being rather trees and shrubs, while in temperate regions, including Hungary, they are herbs. The leaves are opposite, simple with entire margin; the flowers are bisexual, 4-6-merous. The floral axis is tubular, the fruit is a capsule.

Henna (*Lawsonia inermis*) is native to tropical and subtropical regions of Africa, southern Asia and northern Australasia. The henna plant is a tall shrub or small tree, with glabrous, spine-tipped branchlets and entire, glabrous leaves. Henna flowers have four sepals and petals, the sepals forming a calyx tube with spread lobes. The stamens are inserted in pairs on the rim of the calyx tube. The fruits are small capsules. Henna has been used since ancient times to dye skin, hair, fingernails, leather, silk and wool. Henna’s coloring properties are due to lawsone, a compound that has an affinity for bonding with protein. Lawsone is primarily concentrated in the leaves, especially in the petioles.

Purple loosestrife (*Lythrum salicaria*) is native to Europe, Asia, northwest Africa and southeastern Australia. It is an herbaceous, perennial plant with green or rarely reddish-purple stems that are square in cross-section. The leaves are lanceolate, arranged opposite or in whorls of three. The flowers are reddish-purple with 6 petals and 12 stamens. There are three different flower types (heterostyly), i.e. the stamens and style are of three different lengths: short, medium or long; successful pollination can only take place between stamens and styles of the same length. The fruit is a small capsule containing numerous minute seeds. It has been used as an astringent to treat diarrhea and bleeding. Active compounds include tannins and flavonoids.

## **Familia: Onagraceae – Evening-primrose family**

The Onagraceae consist of terrestrial or aquatic herbs and shrubs, rarely trees, with worldwide distribution. The stems often have epidermal oil cells. The flowers are bisexual, actinomorphic, the hypanthium elongate in some taxa (resulting in a tubular flower). Perianth consists of 4 (rarely 2-6) sepals and petals. The stamens are 4+4 (2-6). The gynoecium is syncarpous, with an inferior ovary, and usually 4 carpels. The fruit is a capsule, achene (nut) or berry. Seeds are oily endospermous.

Common evening primrose or evening star (*Oenothera biennis*) is native to North America, and naturalized elsewhere in temperate and subtropical regions. It is a biennial species with lanceolate leaves that are produced in a rosette in the first year, and spirally on the stem in the second year. The flowers are pale yellow, with four petals, produced on a tall spike. They open in the evening, hence the name “evening primrose” and close by the following noon. The fruit is a capsule with numerous seeds. The mature seeds contain 7-10%  $\gamma$ -linolenic acid, a rare essential fatty acid. Seed oil is used to reduce the pains of premenstrual stress syndrome and is beneficial to the skin of the face. Red-sepaled evening-primrose (*Oe. erythrosepala*) is often cultivated for essential oil production.

Willowherb (*Epilobium*) species have a worldwide distribution. They are mostly herbaceous plants, either annual or perennial. The leaves are mostly opposite or whorled, and ovate to lanceolate in shape. The flowers have four petals. The fruit is a slender, cylindrical capsule containing numerous seeds embedded in fine, soft silky fluff (seed hairs) which helps seed dispersal by wind. Small-flowered willowherb (*E. parviflorum*) and pale willowherb (*E. roseum*) are credited for their anti-inflammatory properties, improve urogenital functions, and are effective in treating benign prostatic hyperplasia (BPH) and prostatitis.

## **Ordo: Rutales**

### **Familia: Rutaceae – Rue / Citrus family**

The Rutaceae consist of trees, shrubs, lianas or rarely herbs, with worldwide distribution, especially in tropical regions. The stems of some taxa have thorns. The leaves are simple, trifoliolate or pinnate, usually with pellucid glands. The flowers are usually bisexual and actinomorphic. The perianth is usually 4-5-merous, the stamens are 8-10- $\infty$ , in 2 whorls. The gynoecium is syncarpous, with a superior ovary, typically 4-5 carpels. Nectaries are usually present as an annular disk at the base of the ovary. The fruit is a shizocarp, berry, drupe or hesperidium. Lysigenous secretory cavities containing essential oils are present in many tissues, including the leaves and pericarp.

Economic importance includes many important fruits, among them *Citrus* spp. (oranges, grapefruits, lemons, limes etc.), herbs such as rue (*Ruta graveolens*), timber trees, medicinal plants, and a number of ornamental cultivars.

Citrus fruits, originating from Asia, have been cultivated since ancient times. The plants are large shrubs or small trees, with spiny shoots and alternately arranged evergreen leaves with an entire margin. The flowers are solitary or in small corymbs with five (rarely four) petals and numerous stamens, and often they are very strongly scented. The fruit is a hesperidium, which is a specialized berry with a leathery rind (exocarp) containing volatile oil glands (flavedo); a thick, white, spongy layer (mesocarp, albedo); and internal, swollen trichomes termed juice sacs (endocarp). Many species are cultivated for their fruit, which is eaten fresh, pressed for juice, or preserved in marmalades. Citrus fruits are notable for their fragrance, due to terpenes in the essential oil and flavonoids. The fruits contain 8-9% sugar, 1% citric acid and about 40mg/100g vitamin C. The most well-known taxa include bitter

orange (*Citrus aurantium* ssp. *amara*); bergamot orange (*C. aurantium* ssp. *bergamia*) – cultivated for the production of bergamot oil, a component of many brands of perfume and tea, especially Earl Grey tea –; sweet orange (*C. sinensis*); mandarin (*C. reticulata*); lemon (*C. lemon*), grapefruit (*C. paradisi*); and pomelo (*C. maxima*), the largest citrus fruit.

Common rue (*Ruta graveolens*) is native to the Balkan Peninsula, southeastern Europe. It is grown as an ornamental (especially because of its bluish leaves), as a medicinal herb, as a condiment, and to a lesser extent as insect repellent. The aerial parts of the plant contain rutin (4-5%), which can serve pharmaceutical purposes. Chemical compounds include yellow, acridone alkaloids which have a favorable effect on bile function.

Burning-bush (*Dictamnus albus*) is a perennial plant native to southern Europe, North Africa and southern and central Asia. It is a popular garden plant, both for its flowers and fragrance. The name burning-bush derives from the volatile oils produced by the plant, which can catch fire readily in hot weather. Other active compounds include flavonoids and coumarin-derivatives.

Round leaf buchu *Agathosma (Barosma) betulina* is an evergreen shrub, native to South Africa. The leaves are opposite and rounded, the flowers or white or pale pink, the fruit is a five-parted capsule. The essential oil and extracts of the leaf (*Bucco folium*) are used as flavoring for teas, candy and a liquor known as buchu brandy in South Africa. It has been used as a medicine for urinary tract disorders, acting as desinfectant.

Jaborandi species (*Pilocarpus* spp., especially *P. jaborandi*) are native to South America, accumulating imidazole alkaloids (pilocarpine), particularly in their leaves (*Jaborandi folium*). Pilocarpine is a parasympathomimetic alkaloid, which is applied topically e.g. in glaucoma.

### **Familia: Anacardiaceae – Cashew family**

The Anacardiaceae consist of trees, shrubs, lianas or rarely perennial herbs, with a broad distribution in tropical to temperate regions. The tissues of various plant organs contain resin ducts or laticifers, the resin being allergenic in some taxa. The leaves are pinnate, trifoliolate or simple, usually spirally arranged. The inflorescence is a terminal or axillary thyrse. The flowers are actinomorphic, the receptacle is swollen and fleshy in some taxa (e.g. *Anacardium*). The perianth is heterochlamydeous: the calyx is usually basally synsepalous with usually 5 sepals or lobes; the corolla is choripetalous with usually 5 petals. The stamens are 5-10; the gynoeceum is syncarpous, with a superior ovary, 1-3 or 5 carpels. Nectaries are present as a nectariferous disk. The fruit is a drupe, with the mesocarp usually resinous.

Economic importance includes ornamentals (e.g. *Cotinus*), fruit and seed trees, such as pistachio (*Pistacia vera*), sumacs (*Rhus* spp.), cashew (*Anacardium occidentale*) and mango (*Mangifera indica*), plus several dye, timber and lacquer trees. *Toxicodendron* spp. (poison oak, poison ivy) and related taxa cause contact dermatitis, and fruits/seeds can be allergenic in sensitive individuals. Active compounds include various components of the essential oil, balsam, resin or latex; as well as tannins and flavonoids.

The cashew tree (*Anacardium occidentale*), native to Brazil, is widely grown in tropical climates for its edible cashew nuts and cashew apples. The tree is small and evergreen; the leaves are leathery textured; the flowers are small, pale green at first, then turning red. The true fruit of the cashew tree is a kidney-shaped drupe, with a single seed, called the cashew nut. The seed is surrounded by a double shell containing an allergenic phenolic resin, anacardic acid, a potent skin irritant, chemically related to the allergenic catechin-derivative urushiol, which is a toxin found in the related species poison ivy (*Rhus toxicodendron* / *Toxicodendron quercifolia*). Some people are allergic to cashew nuts, but less

frequently than to nuts or peanuts. Cashew apple is a false or accessory fruit, an oval or pear-shaped structure, developing from the pedicel and the receptacle of the flower.

Smoke tree (*Cotinus coggygria*) is native to southern Europe and central Asia. It is a multiple-branching shrub, with rounded oval leaves with varied autumn colors. The flowers are numerous, produced in large inflorescences. Most of the flowers abort, elongating into feathery plumes (lending a smoke-like appearance to the shrub, hence the common name), which surround the small, drupaceous fruits. Due to their tannins and flavonoids, the extracts of the leaves (*Cotini folium*) are commonly used in mouthwashes and to reduce the symptoms of gingivitis (inflammation of the gum tissue).

The genus *Pistacia* includes dioecious shrubs and small trees, either evergreen or deciduous, depending on the species. *P. vera*, a small tree best known as pistachio, is grown for its edible seeds. *P. terebinthus*, a native of Iran and the western Mediterranean countries, is tapped for turpentine. *P. lentiscus*, an evergreen shrub or small tree of the Mediterranean region, supplies a resin called mastic, which is desinfectant, and used to heal wounds.

### **Familia: Burseraceae – Myrrh family / Incense tree family**

The Burseraceae include trees and shrubs native to tropical and subtropical regions. Members are characterized by the non-allergenic resin and balsam they produce in virtually all plant tissues, in lysigenous or schizogenous cavities; and the smooth, yet flaking aromatic bark. The fruit is a drupe or a capsule.

Frankincense species (*Boswellia* spp., especially *B. sacra*) are known for their fragrant resin which has many pharmacological uses, particularly in treatment of asthma and various inflammatory conditions.

The genus *Commiphora* includes trees and shrubs, native to Africa, Arabia and India, often with thorns. Several species produce fragrant resins used for incense, perfume and medication, including myrrh (*Commiphora* spp., especially *C. myrrha*) and balsam of Mecca (*C. opobalsamum*).

### **Ordo: Sapindales**

#### **Familia: Hippocastanaceae – Horse-chestnut family**

The family includes trees and shrubs with palmately compound leaves. They are distributed in the Balkan Peninsula, East Asia, as well as North and South America, but are often cultivated as ornamentals. The inflorescence is a panicle, the fruit is a fleshy, spiky capsule with a single nut-like seed, called conker or horse-chestnut.

Horse-chestnut (*Aesculus hippocastanum*) is a large deciduous tree, cultivated throughout the temperate region. The fresh nuts are slightly poisonous if eaten, due to the presence of saponins. The bark, leaves and seeds are used for medical purposes, such as treating varicose veins, edema and sprains. Active compounds include triterpene saponins (aescin), coumarin-derivatives (aesculin) and flavonoids.

#### **Familia: Aceraceae – Maple family**

Aceraceae consist of trees and shrubs, widespread in the temperate regions. The leaves are opposite (decussate), usually palmately divided, rarely pinnate (e.g. *Acer negundo*). The flowers are small, greenish-yellow, with or without perianth. The fruits are the so-called maple keys, a schizocarp (double samara), whose size and shape is characteristic to the

species. Calcium oxalate crystals occur frequently in all parenchymatous tissues. Some species are characterized by high levels of sucrose (e.g. *A. saccharinum*).

Maples (*Acer* spp.) are mostly deciduous, but a few in southern Asia and the Mediterranean region are evergreen. Norway maple (*Acer platanoides*), sycamore maple (*A. pseudoplatanus*) and field maple (*A. campestre*) are native to central Europe and southwest Asia. Boxelder maple (*A. negundo*), silver maple (*A. saccharinum*) and sugar maple (*A. saccharum*) are native to North America, the latter species being the major source of sap for making maple syrup.

## **Ordo: Geraniales**

### **Familia: Geraniaceae – Geranium family**

The Geraniaceae consist of herbs or shrubs, distributed mainly in temperate regions, some in tropical regions. The flowers are bisexual, mostly actinomorphic, but zygomorphic in *Pelargonium*, often bracteates. The calyx consists of 5 (4) sepals, the adaxial sepal a nectariferous spur in *Pelargonium*. The corolla is choripetalous with typically 5 petals. The stamens are usually 10, in two whorls. The gynoecium is syncarpous, with a superior ovary, 5 carpels, and as many locules as carpels. Nectaries are present, usually between petals and stamens. The fruit is a loculicidal capsule or a schizocarp of mericarps or follicles, usually separating from a persistent “beak” arising from an accrescent style. Multicellular, capitate glandular trichomes are often present, producing essential oil, its main components being geraniol and citronellol. Other active compounds include polyphenols (tannins) and allantoin.

Crane’s bills (*Geranium* spp.) are annual, biennial or perennial plants found throughout the temperate regions and the mountains of the tropics. The name crane’s bill derives from the appearance of the capsule, which consists of five carpels each containing one seed, joined to a column produced from the center of the flower. The shape of the unsprung column looks like the bill of a crane. The fruit column springs open when ripe and casts the seeds some distance. Bigroot geranium (*G. macrorrhizum*) is a fragrant plant, used in the perfume industry, similarly to *Pelargonium* species. The freshly picked, crushed leaves of herb Robert or Robert geranium (*G. robertianum*) have an odor resembling burning tires, and if they are rubbed on the body the smell is said to repel mosquitoes. The infusion made from the aerial parts has been used for its diuretic and tonic effect.

Confusingly, geranium is also the common name of another genus in the family, *Pelargonium*, commonly known also as stork’s bills or scented geraniums. The genus includes about 200 species of perennials, succulents and shrubs, which are indigenous to southern Africa, and are drought and heat tolerant. They are extremely popular garden plants, grown as annuals in temperate climates. Geranium (essential) oil (*Geranii aetheroleum*), used in perfumes, is produced by lemon geranium (*P. odoratissimum*) and related species (e.g. *P. capitatum* and *P. graveolens*).

Common stork’s bill (*Erodium cicutarium*) is a hairy, sticky annual, native to the Mediterranean Basin. It is considered a weed in many places, but the whole plant is edible, with a taste similar to parsley. The fruit, shaped like the bill of a stork, bursts open in a spiral when ripe, sending the seeds, which have little feathery “parachutes” attached, into the air.

### **Familia: Linaceae – Flax family**

The Linaceae consist of annual or perennial herbaceous species, distributed in temperate and subtropical regions. The actinomorphic flowers are colorful and pentamerous,

frequently with only 5 stamens. The fruit is a capsule, rarely a drupe. The seed coat contains mucilage, whereas the cotyledons of the seed are rich in oil.

Common flax (*Linum usitatissimum*) is grown both for its fibers and seeds. The fibers are the source of linen cloth. The seeds are the source of linseed oil, which has uses as an edible oil, as nutritional supplement and as an ingredient in many wood finishing products. Linseed oil is rich in unsaturated fatty acids like linoleic acid and linolenic acid. The seeds are also used as laxative, accompanied with the consumption of abundant water.

### **Familia: Erythroxylaceae – Coca family**

The coca family comprises shrubs that are native to the Andes in South America. The leaves are spirally arranged, the flowers are pentamerous. The one-seeded fruit is a drupe or berry, surrounded by the persistent calyx.

The most significant representatives are the coca shrubs (*Erythroxylum coca* and *E. novogranatense*), which are widely cultivated not only in their native region of Peru and Columbia, but also in other tropical areas. *E. coca* shrubs grow to a height of 2-3 m. The leaves are thin, opaque, oval, and taper at the extremities. A marked characteristic of the leaf is an areolated portion bounded by two longitudinal curved lines, one line on each side of the midrib, and more conspicuous on the abaxial side of the leaf. The flowers are small, the corolla is composed of five yellowish-white petals, the anthers are heart-shaped, and the pistil consists of three carpels. The flowers mature into red berries.

The leaves (*Cocae folium*) contain 1% cocaine, which is a powerful stimulant. Chewing of coca leaves and drinking coca tea look back on a long tradition among the native Indian population, having played an important role in religious ceremonies, as well. Coca was traditionally used as a stimulant to overcome fatigue, hunger and thirst. It is considered particularly effective against altitude sickness, and it has also been used previously as an anesthetic to alleviate pain of headache, rheumatism, wounds etc. Currently it has been replaced by safer and not narcotic anesthetics; and both growing and trading of coca is illegal, and prohibited worldwide. Today Coca-cola does not contain any cocaine, but the original version, similarly to the popular “health drink” cocawine, used to contain coca extracts. These products became illegal in most countries in the early 20th century, after the addictive nature of cocaine was widely recognized.

### **Familia: Zygophyllaceae – Caltrop family**

The caltrop family comprises halophytes and xerophytes living in hot, arid areas like deserts or semi-deserts. Representatives include herbaceous, annual plants as well as woody shrubs and little trees. The leaves are typically opposite, pinnately compound, the flowers are 4- or 5-merous. The fruit is a capsule or a berry, rarely a drupe or schizocarp. Effective substances generally include lignanes, while specific compounds are resins, alkaloids and pigments.

Caltrop (*Tribulus terrestris*) grows as an annual plant in Hungary (perennial in warmer climates). The prostrate stems radiate from the centre, the leaves are pinnately compound, the flowers are yellow. The fruit falls apart into 4 or 5 single-seeded nutlets, each bearing 2-3 sharp spines. *Tribulus* extract is claimed to increase testosterone levels and improve male sexual performance and help build muscle; however, it has consistently failed to increase testosterone levels in controlled studies, and also failed to demonstrate strength-enhancing properties.

Harmal or wild rue (*Peganum harmala*) is a perennial plant native to the Mediterranean region. The seeds are used to dye wool: when extracted with water, a yellow

dye is obtained, while extraction with alcohol results in a red dye. The seeds also contain an alkaloid, harmine, which has psychoactive effects.

*Guajacum* (*Quajacum*) species are native to the dry, coastal woods of tropical America. Their precious wood is the hardest of any commercially harvested tree, with a resin content of 30%. The balsam (resin) has medical properties. Holywood lignum-vitae or tree-of-life (*G. sanctum*) is a large shrub or small tree, with shiny, evergreen, pinnately compound leaves and blue flowers. The active ingredients in the resin of *G. officinale* are effective anti-inflammatory agents.

## **Ordo: Polygalales**

### **Familia: Polygalaceae – Milkwort family**

The milkwort family includes herbs, shrubs and trees, with a near-cosmopolitan range. Over half of the species belong to the genus of milkworts (*Polygala* sp.). Seneca snake-root (*Polygala senega*) is native to eastern North America. The roots (*Senegae radix*) are used as expectorant due to their saponin content.

### **Familia: Krameriaceae –**

Krameriaceae is a monotypic family, containing a single genus (*Krameria* sp.). The family shares some characteristics with both the Polygalaceae and the Fabaceae family (e.g. compound leaves, zygomorphic flowers). Peruvian rhatany (*Krameria triandra*) is a species living in the Andes, valued for its root (*Ratanhiae radix*), which is rich in tannins.

## **Ordo: Celastrales**

### **Familia: Celastraceae – Bittersweet family**

The family comprises more than 1000 species of vines, shrubs and small trees. The great majority of the genera are tropical, but some, such as *Celastrus* (the staff vines), *Euonymus* (the spindles) are widespread in temperate climates. The leaves are generally opposite and entire. The 3-5-merous flowers form a loose pseudo-umbel. A well developed nectariferous disc can be found within the whorl of stamens. The fruit is a capsule, berry, drupe or samara. The seeds are often surrounded by a brightly coloured aril.

The dermal tissues of the young shoots often show features characteristic to the given species, as e.g. in spindles. Two European representatives of this genus are *E. europaeus* (European spindle) with cork-like ridges and *E. verrucosus*, distinguished by cork-like warts. The fruits of *E. europaeus* are poisonous, containing various alkaloids and a bitter terpen.

Bushman's tea or khat (*Catha edulis*) is a slow-growing shrub or tree with evergreen leaves, native to the Horn of Africa and the Arabian Peninsula, where khat chewing has a long tradition. The fresh leaves are chewed, whereas dried leaves are used in pipes or consumed as tea. The main effective substance of khat is the protoalkaloid chatinon, an amphetamine-like stimulant, causing excitement, loss of appetite and euphoria. The WHO has classified khat as a drug of abuse that can produce mild to moderate psychological dependence, although it is not considered to be seriously addictive.

## **Ordo: Rhamnales**

### **Familia: Rhamnaceae – Buckthorn family**

The buckthorn family includes shrubs and trees that might be used as medicinal and/or ornamental plants and the fruits of some species are edible. The shoots are often covered with thorns, the leaves are simple. The small flowers are yellowish green. The ovary is more or less sunken into the receptacle (hypanthium), the fruit is a drupe-like berry or samara.

The most important chemical substances are anthraquinones (anthraglycosides), but in some species toxic proteins or alkaloids might also occur.

Alder buckthorn (*Rhamnus frangula*, syn. *Frangula alnus*) and common buckthorn (*Rh. catharticus* or *Rh. cathartica*) are deciduous shrubs, native to Europe, northernmost Africa and some parts of Asia. *Rh. frangula* grows in wet soils in woods and bogs, whereas *Rh. catharticus* easily adapts to various environments, and is regarded as an invasive species. The bark of *Rh. frangula* (*Frangulae cortex*), with dark brown outer and bright orange inner surface, is used as a laxative, due to its 3-7% anthraquinone content. As a distinguishing feature, *Rh. catharticus* has spiny branches and grey-brown bark, which, together with the fruits, was used as a purgative in the past, but due to their potential side effects (causing severe gastrointestinal cramps) they are now rarely used. Cascara buckthorn (*Rh. purshianus* or *Rh. purshiana*) is native to North America. Cascara bark (*Rhamni purshianae cortex*) is widely used as a laxative, attributed to its various anthraglycosides such as cascarosides and aloines.

### **Familia: Vitaceae – Grape family**

The family comprises tropical, subtropical and temperate zone lianas. The shoots are equipped with tendrils (*Vitis*) or sticky disks (*Parthenocissus*) that facilitate climbing. The flowers are small and not conspicuous; the fruits are berries (grapes). The family is rich in tannins and flavonoids. Anthocyanins are important particularly in the berries.

The *Vitis* genus involves some of the most ancient cultivated plants. One of the ancestor species is wild grape (*V. sylvestris*), giving rise to about 5000 cultivars of common grape vine (*V. vinifera*). Some of the wines produced in Hungary (*Vinum tokajense*, *Vinum samorodni*) were included in earlier pharmacopoeias, ordered for convalescent patients.

Virginia creeper (*Parthenocissus quinquefolia*), with compound leaves consisting of 5 leaflets, as well as Japanese creeper (*P. tricuspidata*), characterised with palmately lobed leaves, are frequently grown ornamentals.

## **Ordo: Santalales**

### **Familia: Santalaceae – Sandalwood family**

Members of the Santalaceae family are hemiparasitic tropical trees and shrubs, while in the temperate zone they are herbaceous plants. Typically they attach their haustoria to the roots of the host plant, and obtain water through this parasitic root.

In the European flora they are represented by the genera *Osiris* and *Thesium*. The genus *Santalum* occurs in India, New Zealand and Australia. Indian sandalwood (*Santalum album*) is valued for its wood and the 5% essential oil content. Another representative, true sandalwood (*S. lanceolatum*) is native to Australia. Their essential oil is the source of an excellent bactericide and anti-inflammatory agent in the urinary tract.

### **Familia: Loranthaceae – Mistletoe family**

The family contains deciduous or evergreen hemiparasites (semiparasites) that grow on the branches of woody trees. The haustorium invades the xylem of the host plant, receiving water and minerals from it. The branching is dichotomous, the leaves are opposite, the flowers are protected by 2-4 tepals. In *Loranthus* sp. there is a ring-shaped protuberance below the flower, which is missing in the genus *Viscum*. The gynoecium is inferior, the fruit is a pseudoberry with a mucilage-rich wall, the seed is embedded in the very sticky fruit pulp.

In Hungary the family is represented by the deciduous European yellow mistletoe (*Loranthus europaeus*) and the evergreen European or common mistletoe (*Viscum album*). The latter species parasitizes various deciduous trees such as poplar, black locust and apple, and the pseudofruits are usually white. The main active compounds include lectins (i.e. glycoproteins with specific sugar-binding capacity) and the polypeptide viscotoxin. The shoots (*Visci stipes*) are applied as antihypertensive, often in combination with garlic and/or hawthorn. Purified mistletoe lectins have demonstrated cytotoxic and immune system stimulating activities, and are gaining importance in cancer therapy.

### **Ordo: Araliales**

#### **Familia: Araliaceae – Ginseng/ Ivy family**

The family consists mainly of tropical and subtropical trees and lianas, but there are also some herbaceous representatives. The name-giving *Aralia* genus comprises shrubs and small trees that are frequently planted as ornamentals. The leaves are alternate, mostly palmately or pinnately compound; the inflorescence is a terminal umbel or head; the fruit can be a drupe or a berry.

The only Central European representative of the family is common ivy (*Hedera helix*), a climbing plant with aerial roots (climbing roots or suckers) that support the plant's growth on trees and walls. The leaves are of two types (the phenomenon being called heterophylly), with palmately five-lobed leaves on creeping and climbing stems, and unlobed cordate leaves on flowering stems exposed to full sun, usually high in the crowns of trees. The greenish-yellow flowers are produced in 3-5 cm diameter umbels, blooming from late summer to late autumn; providing a rich source of nectar for bees. The berries ripen in late winter or next spring and are poisonous to humans. The plant is rich in triterpene saponins. The leaves (*Hederae helix folium*) serve as the raw material of herbal products for the treatment of bronchitis.

The *Panax* genus is distributed in Asia (*P. ginseng*) and North America (*P. quinquefolius*), with well developed rhizomes and roots, which are rich in tetracyclic triterpene saponins (ginsenosides). The roots are most often available in dried form, either whole or sliced. The above-ground shoot is 50-70 cm, bearing palmately compound leaves and flowers forming an umbel. The fruit is a drupe-like berry. Both Asian ginseng (*P. ginseng*) and American ginseng (*P. quinquefolius*) roots are taken orally as adaptogens, improving stress tolerance and physical and/or mental achievement. Combined with vitamins they are excellent roborants and geriatrics.

Siberian ginseng (*Eleutherococcus senticosus*, formerly *Acanthopanax senticosus*) is native to eastern Asia. The active compounds include triterpene saponins, phenyl-propanes and coumarins. Similarly to *Panax* species, various plant parts and root extracts *Eleutherococcus* are used as adaptogens and tonic.

## **Familia: Apiaceae / Umbelliferae – Carrot family**

The Apiaceae have a worldwide distribution, containing herbs, less often shrubs or trees. The taproot has a storage function (e.g. carrot) in biennial and perennial species. The stem is often ribbed and hollow. Leaves are spirally arranged, often accompanied with a well-developed sheath, varying from simple divided to doubly pinnately compound. The inflorescence is a compound umbel, often with subtending involucral bracts (involucre). The flowers are small, bisexual, actinomorphic, with a floral formula:  $*Ca_5Co_5A_5G_2$ . The ovary is inferior, consisting of two carpels. Below the stigma a disc-shaped nectary can be found. The fruit is a double achene, the two mericarps are connected with a carpophor. Schizogenous cavities are present in each vegetative and reproductive organ, secreting and storing mainly essential oil, which is the basis of usage as herbs and spices. Other effective substances include coumarins, fur(an)ocoumarins.

Well-known garden plants, often used as food plants and/or spices, include dill (*Anethum graveolens*), chervil (*Anthriscus cerefolium*), caraway (*Carum carvi*), coriander (*Coriandrum sativum*), fennel (*Foeniculum vulgare*), lovage (*Levisticum officinale*), parsnip (*Pastinaca sativa*), parsley (*Petroselinum crispum*) and anise (*Pimpinella anisum*). The essential oil is composed of various terpenes and phenylpropane-derivatives, the composition and the main compound being specific for each species, e.g. linalool in *Coriandrum sativum*, carvone in *Carum carvi*, anethole in *Foeniculum vulgare* and *Pimpinella anisum*, and apiole in *Petroselinum crispum*. They can increase appetite and aid digestion, they are used as carminative and spasmolytic. Various plant parts and the essential oil of parsley have a diuretic effect. The modified taproot (storage root) of wild carrot (*Daucus carota*) and its cultivated varieties is rich in carotenoids, which have an ulcus protective and antioxidant effect.

Coumarins and coumarin-derivatives are frequently present in some Apiaceae members, often accompanied by essential oil. Among hydroxycoumarins, umbelliferone is the most widely distributed within the family. Fur(an)ocoumarins such as psoralen, imperatorin and bergapten are characteristic in the genera *Angelica* and *Peucedanum*. Coumarin-containing plants can be used as diuretic and spasmolytic agents, as well as in the treatment of psoriasis. However, due to their damaging effect on DNA synthesis, they belong to drugs with risk factors. At the same time these plants are photosensitizing, i.e. they can cause photodermatitis, if consumed, touched or applied externally, followed by exposure to sun. A well-known photosensitizing plant is garden angelica (*Angelica archangelica*), whose essential oil can be used against rheuma, but its furocoumarins can cause contact dermatitis.

The family is also known for its poisonous representatives. Cowbane or northern water hemlock (*Cicuta virosa*) contains polyacetylenes like cicutoxin, which affects the central nervous system. Poison hemlock (*Conium maculatum*) accumulates coniine, a fluid alkaloid, causing an ascending muscular paralysis with eventual paralysis of the respiratory muscles, which results in death. In ancient Greece, hemlock was used to poison condemned prisoners. The most famous victim of hemlock poisoning is the philosopher Socrates.